AGRA

Growing Africa's Agriculture

Africa Agriculture Status Report 2016

PROGRESS TOWARDS AGRICULTURAL TRANSFORMATION

AFRICA AGRICULTURE STATUS REPORT 2016

Progress towards Agricultural Transformation in Africa

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Managing Editor:	David Sarfo Ameyaw, (AGRA)
Project Coordinator:	Jane Njuguna (AGRA)
Editor:	Anne Marie Nyamu, Editorial, Publishing and Training Consultant
Data Table Coordinators:	Jane Njuguna, Aboubacar Diaby, Josephine Njau (AGRA)
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FOREWORD

Over the last decade, millions of small family farms in Africa have experienced big changes. These farms are the continent's main source of food, employment, and income. Many African governments have put agriculture back to the top of the development agenda, and from a growing revenue base, they have increased the proportion of their national budgets going to this vital sector. Private companies have invested heavily in Africa's agriculture value chains in recent years, paving the way for a renaissance in Africa's agri-food systems that multiplies the options for farmers in terms of the seeds they plant, the fertilizers they use, the markets they can now tap into, and the information services now available to help them manage their farming activities. Agricultural growth in Africa has also expanded livelihood opportunities for millions of people now engaged in the growing off-farm stages of the agri-food system. Offering a glimpse of future success, these advances have helped inspire a new vision for Africa, one in which farming realizes its potential to help make the continent sustainable and hunger free.

Much more must be done, however, to sustain and deepen the agricultural transformation process that has started in Africa, as laid out in the Malabo Declaration and the Sustainable Development Goals (SDGs). The continent is still faced with many challenges such as food insecurity, emerging effects of climate change and rampant land degradation make these challenges especially daunting particularly as rapid population growth and rising urbanization increase the pressure on agriculture to deliver more and better food. But each of these challenges also represents an opportunity to strengthen agriculture, turning it into a multiplier of inclusive economic growth. My hope is that this incisive new report on recent progress—from the Alliance for a Green Revolution in Africa (AGRA) and its partners—will stimulate a more profound and impassioned debate about the kinds of future investments and other measures that are needed to make the transformation of this sector a reality. While acknowledging the progress that many countries have made toward this end, especially the ones that were quick to embrace the African Union's Comprehensive African Agriculture Development Program, the report minces no words about how much farther these countries and others have to go.

This message is especially important for the many countries of sub-Saharan Africa where agriculture remains the predominant sector of the economy, accounting for 25 percent or more of gross domestic product (GDP). A key issue for these countries, one that is hotly contested in recent years, is what strategies are most appropriate for their agricultural development. Some have questioned whether it is possible to achieve a Green Revolution in sub-Saharan Africa based largely on dramatic increases in grain yields. What we have learned together over the last 10 years is that production is one piece of the puzzle. Farmers across Africa need better access to finance, markets, and an enabling policy environment that affords them the social protections many of us across the world take for granted.

As the first President of AGRA, and the current chairman of the Board of Trustees of the African Fertilizer and Agribusiness Partnership (AFAP), I have personal experience and greatly value AGRA´s determination to keep smallholders at the center of Africa´s agricultural transformation and to create the conditions that are essential for these farmers to thrive. I urge AGRA to maintain its commitment and work with African governments and institutions, and the private sector to forge the partnerships that are necessary to achieve food security in Africa.

Dr. Namanga Ngongi,
Chairman of the Board of Trustees
Africa Fertilizer and Agribusiness Partnership

PREFACE

Africa is making steady progress towards agricultural transformation. In the past decade there has been dramatic transformation in different countries and various localities. There is a noticeable upward shift in expenditure on agriculture by national governments in African countries. African governments have reaffirmed their commitment to prioritizing agriculture in their development agendas and are investing an increased proportion of their budgets in the sector from a growing national revenue base. There is evidence of faster growth in agricultural productivity, improved nutrition, and greater job expansion even in the non-farm segments of their economies. The private sector is increasingly investing in agriculture, and the foundations have been laid for a renaissance in Africa's agriculture, one powered by the enormous progress increasingly evident in farmers who are gaining more options in the seeds they plant, in the fertilizers they use, and in the markets available to purchase their produce. These glimpses of success offer an inspiring new vision of a future Africa in which farming as a struggle to survive gives way to farming as a business that thrives. The process by which an agri-food system transforms over time from being subsistence-oriented and farm-centered into one that is more commercialized, productive, and off-farm centered is taking place in Africa. Much more remains to be done to sustain these gains and truly drive the agricultural transformation needed for Africa's development, and to ensure a better life for all of its people as laid out in the Malabo Declaration and in the Sustainable Development Goals (SDGs).

This is the fourth volume of the Africa Agriculture Status Report series focusing on, "*Progress towards African Agricultural Transformation*". The 2016 Report has tracked the progress made in the last decade with the MDGs and the Maputo Declaration as critical benchmarks, through to the current status, considering the Malabo Declaration and the projection and trajectory towards 2030 in line with the SDGs. The Report has maintained the original objective of producing an annual series that provides an in-depth and comprehensive analysis of emerging issues and challenges being faced by Africa's smallholder farmers. The series allows African scholars and development professionals, and their colleagues in non-African countries, to contribute practical and evidence-based recommendations and share knowledge that contributes to Africa's food security. The publication has also maintained its two section format: a detailed narrative that addresses various facets of the publication's theme, and a data section that presents country-level agriculture and economic growth data which reveal important trends in African agricultural development.

The 2016 Agriculture Status Report has as its main objective to: (i) highlight major trends in African agriculture, the drivers of those trends, and the emerging challenges that Africa's food systems are facing in the 21st century; (ii) identify policies and programs that can support the movement of Africa's farming systems from subsistence-oriented towards more commercialized farming systems that can raise productivity, increase incomes, generate employment and contribute to economic growth; (iii) identify areas that enable better targeting of investment resources to increase agriculture productivity; (iv) identify the necessary conditions, appropriate technologies, and institutions that can propel and catalyze African agricultural transformation; (v) examine the past and the present role of public and private sector investment in agriculture, and the success factors that can be scaled up to accelerate transformation; and (vi) explore how agricultural transformation can contribute to solving the reality of rural poverty, low productivity, food insecurity, malnutrition, unemployment, and lower income among the population in countries in sub-Saharan Africa. These objectives have been addressed in the 11 chapters of the Report.

The role of Africa agricultural transformation is to change today's rural poverty in sub-Saharan Africa into tomorrow's prosperity, through sustainably and significantly increasing the productivity of smallholder farmers, and the power and transformative effect of agriculture to sustain broad-based, inclusive and equitable sustainable economic growth. This is the aspiration of this 2016 Report.

Dr. David S. Ameyaw
Head of Monitoring and Evaluation
AGRA

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Thomas Jayne (MSU) and David Sarfo Ameyaw (AGRA)

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Strengthening the Continental Agricultural Agenda and Accountability Framework – The Road from Maputo to Malabo
Ousmane Badiane (IFPRI), Samuel Benin (IFPRI) and Tsitsi Makombe (IFPRI)

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John M. Ulimwengu (IFPRI), Julie Collins (IFPRI), Felix Yeboah (MSU) and Lulama Ndibongo Traub (Stellenbosch University)

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Contributions from: Osman Aymen A. Ali, Enock Yonazi and Amadou Bamba Diop (AfDB)

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Milan Innovincy, Hortense Mudenge (Consultant) and Washington Otieno (CABI)
Contribution (Case Studies): Liliane Uwintwali (M-Ahwi Ltd) and Didier Muyiramye (AgriProFocus, Rwanda)

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I am very proud of the accomplishment and grateful to all those who made the Africa Agriculture Status Report 2016 possible.

Dr. Agnes Matilda Kalibata
President,
AGRA

ACRONYMS

Africa Lead	Africa Leadership Training and Capacity Building Program
AAS	Agricultural Advisory Services
AASR	Africa Agriculture Status Report
AATIF	Africa Agriculture and Trade Investment Fund
ABI-ICRISAT	Agri-Business Incubation-International Crops Research Institute for the Semi-Arid Tropics
ACBF	African Capacity Building Foundation
ACCF	Africa Climate Change Fund
ACGSF	Agricultural Credit Guarantee Fund Scheme
ACI	Africa Capacity Index
ACIR	Africa Capacity Indicators Report
ACLED	Armed Conflict Location and Event Data Project
ACRE	Agriculture and Climate Risk Enterprises
AFAAS	African Forum for Agricultural Advisory Services
AFAP	African Fertilizer and Agribusiness Partnership
AFAWA	Affirmative Finance Action for Women in Africa
AfDB	African Development Bank
AgDevCo	Agricultural Development Company
AGRA	Alliance for a Green Revolution in Africa
AICAD	African Institute for Capacity Development
AIFL	Africa Improved Foods Limited
AIS	Agricultural Innovations Systems
AKIS	Agricultural Knowledge and Information Systems
ANAFE	African Network for Agriculture, Agroforestry and Natural Resources Education
APC	Agribusiness Partnership Contracts
APHLIS	African Post-harvest Losses Information System
APL	Adaptable Program Loan (World Bank)
APPSA	Agricultural Productivity Program for Southern Africa
AR4D	Agricultural research for development
ARC	African Risk Capacity
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASTI	Agricultural Science and Technology Indicators
ATONU	Agriculture to Nutrition
ATOR	Africawide Annual Trends and Outlook Report
AU	African Union
AUC	African Union Commission
AWARD	African Women in Agricultural Research and Development
AWSEM	African Women in Science Empowerment Model
BCR	Benefit-Cost Ratio
BMGF	Bill and Melinda Gates Foundation
BMZ	German Federal Ministry for Economic Cooperation and Development
BNDE	Banque Nationale de Développement Economique
CAADP	Comprehensive Africa Agriculture Development Programme
CBN	Central Bank of Nigeria
CCAFS	CGIAR Research Program on Climate Change, Agriculture, and Food Security
CCARDESA	Centre for Coordination of Agricultural Research and Development for Southern Africa
CDF	CGIAR Capacity Development Framework

CEN-SAD	Community of Sahel-Saharan States
CF on CDAIS	Common Framework on Capacity Development for Agricultural Innovation Systems
CGF	Competitive Grant Funding
CIAT	International Center for Tropical Agriculture
CIAT	International Center for Tropical Agriculture
CIF	Climate Investment Fund
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CNC	CAADP Non-State Actor Coalition
CNCAS	Caisse Nationale du Crédit Agricole du Sénégal
COMESA	Common Market for Eastern and Southern Africa
CoPs	Communities of Practice
CORAF/WECARD	West and Central African Council for Agricultural Research and Development
CPR	Common Property Regimes
CRG	Credit Risk Guarantee
CRT	Cluster Randomization Trial
CSA	Climate Smart Agriculture
CSIR	Council for Scientific and Industrial Research
CSO	Civil Society Organization
CTA	Technical Centre for Agricultural and Rural Cooperation
DAI	Development Alternatives Inc.
DFS	Digital Financial Services
DIA	Diaspora Investment in Agriculture
DRC	Democratic Republic of Congo
EAAPP	East Africa Agricultural Productivity Program
EAC	East African Community
EADD	East Africa Dairy Development
EAGC	Eastern Africa Grain Council
EAS	Extension and Advisory Services
ECCAS	Economic Community of Central African States
ECI	Economic Complexity Index
ECOWAP	ECOWAS Agricultural Policy
ECOWAS	Economic Community of West African States
EIARD	European Initiative for Agricultural Research for Development
Embrapa	Brazilian Agricultural Research Corporation
ENCS	Effective Number of Crop Species
EU	European Union
F2FE	Farmer-to-Farmer Extension
FAAP	Framework for Africa's Agricultural Productivity
FAD	Fish-Aggregating Devices
FANR	SADC Food Agriculture Natural Resources
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agriculture Research in Africa
FBO	Farmer-Based Organization
FDI	Foreign Direct Investment
FFR	Financing Facility for Remittances

FMARD	Federal Ministry of Agriculture & Rural Development
FSN	Food Security and Nutrition
FTF	Feed the Future
GACSA	Global Alliance for CSA
GAFSP	Global Agriculture and Food Security Program
GAIN	Global Alliance for Improved Nutrition
GART	Golden Valley Agricultural Research Trust
GCF	Green Climate Fund
GDP	Gross Domestic Product
GDPRD	Global Donor Platform for Rural Development
GEF	Global Environment Facility
GFAR	Global Forum on Agricultural Research
GFRAS	Global Forum for Rural Advisory Services
GIIN	Global Impact Investors Network
GVC	Global Value Chain
IAR4D	Integrated agricultural research for development
ICRAF	World Agroforestry Centre
ICT	Information and Communication Technology
IDA	International Development Association (World Bank)
IDP	Interest Drawback Program
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
IITA	International Institute of Tropical Agriculture
ILO	International Labour Organization
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IP	Innovation Platform (IP)
IRRI	International Rice Research Institute
IS&R	CAADP Implementation Strategy and Roadmap
IS&R	Implementation Strategy and Roadmap
ISAR	Institut des Sciences Agronomiques du Rwanda
ISFM	Integrated Soil Fertility Management
ISNAR	International Service for National Agricultural Research
ITC	International Trade Centre
JSR	Joint Sector Review
KALRO	Kenya Agricultural and Livestock Research Institute (formerly KARI)
KARI	Kenya Agricultural Research Institute (now KALRO)
LAFCo	Lending for African Farming Company
LDCF	Least Developed Countries Fund
Len CD	Learning Network on Capacity Development
M&E	Monitoring and Evaluation
MA	Mutual Accountability
MAFAP	Monitoring African Food and Agricultural Policies
MAFF	Management Advice for Family Farms
MCA	Millennium Challenge Account

MDG	Millennium Development Goal
MDTF	Multi-donor Trust Fund
MEA	Millennium Ecosystem Assessment
MENA	Middle East and North Africa
MFI	Microfinance Institution
NAFSIP	National Agricultural and Food Security Investment Plan
NAIP	National Agricultural Investment Plan
NAIS	National Agricultural Innovation Systems
NARES	National Agricultural and Extension System
NARI	National Agricultural Research Institute
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NASFAM	National Association of Smallholder Farmers (Malawi)
NASRO	North African Sub-Regional Organization
NEPAD	New Partnership for Africa's Development
New Alliance	New Alliance for Food Security and Nutrition
NGO	Non-Governmental Organization
NISRAL	Nigeria Incentive-based Risk Sharing System for Agricultural Lending
NPCA	NEPAD Planning and Coordinating Agency
NPPO	National Plant Protection Organization
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PAE	Public Agriculture Expenditure
PAFO	Pan African Farmers Organization
PanAAC	Pan African Agribusiness and Agro-Industry Consortium
PANGOC	Pan African NGOs Consortium on Agricultural Research
PCI	Products Complexity Index
PICS	Purdue Improved Crop Storage Bag
PMDG	Pest Management Decision Guide
PP	Partnership Platform
PPP	Purchasing Power Parity
PSNP	Productive Safety Net Program
R&D	Research and Development
RAB	Rwanda Agricultural Board
RAIP	Regional Agricultural Investment Plan
REC	Regional Economic Community
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
RESCAR-AOC	Réseau des Services de Conseil Agricole et Rural des Pays d'Afrique de l'Ouest et du Centre
RIMA	Resilience Index Measurement and Analysis
ROR	Rate of Return
RUFORUM	Regional Universities Forum for Capacity Building in Africa
RVC	Regional Value Chain
S3A	Science Agenda for Agriculture in Africa
S4AC	Science for Agriculture Consortium
SAAs	Strategic Action Areas
SACCO	Savings and Credit Cooperative Organization
SADC	Southern African Development Community

SAKSS	Strategic Analysis and Knowledge Support Systems
SBCC	Social Behaviour Communication Change Communication
SCARDA	Strengthening Capacity for Agricultural Research and Development in Africa
SCM	Sustaining the CAADP Momentum
SDG	Sustainable Development Goal
SDI	Shannon Diversity Index
SI	Sustainable Intensification
SME	Small and Medium Enterprise
SMS	Short Message Service
SOFI	State of Food Insecurity
SPS	Sanitary and Phytosanitary
SRO	Sub-Regional Organization
SSA CP	Sub-Saharan Africa Challenge Program
SSA	Sub-Saharan Africa
SSU	Shamba Shape-Up
STI	Science, Technology and Innovation
STISA-2024	Science, Technology & Innovation Strategy for Africa
SUN	Scaling Up Nutrition
SWF	Sovereign Wealth Funds
TAAT	Technologies for African Agricultural Transformation
TAP	Tropical Agriculture Initiative
TFP	Total Factor Productivity
TPA	Theatre for Policy Advocacy
UMA	Arab Maghreb Union
UniBRAIN	Universities, Business and Research for Agricultural Innovation
UNICEF	United Nations Children's Emergency Fund
VCD	Value Chain Development
WAAPP	West African Agricultural Productivity Program
WDI	World Development Indicator
WEMA	Water Efficient Maize for Africa
WFP	World Food Programme
WHO	World Health Organization
WRS	Warehouse Receipt Systems

CHAPTER 1

Africa's Emerging Agricultural Transformation – Evidence, Opportunities and Challenges

AUTHORS

Thomas S. Jayne
Michigan State University

David Ameyaw
Alliance for a Green Revolution in Africa

Introduction

For decades, observers of Africa have referred to the region's economic transformation in the future tense. Analysis focused on the preconditions that needed to be in place before transformation could begin. Today, most development scholars agree that something dramatic has been happening in Africa for at least the past decade, and that until recently it has gone relatively unnoticed (Badiane & Makombe, 2015). At the same time, the pace of transformation has been uneven across the region, and the underlying causes are still not fully understood. This introductory chapter to the 2016 Africa Agriculture Status Report (AASR) documents the major transformations in the region's agricultural sectors and broader economies, and explores the underlying drivers of these trends. Our premise is that a clear understanding of these trends and the challenges that they raise can assist African governments, private firms and civil society groups to anticipate and respond proactively to them.

Agricultural transformation in most areas of the world has generally been an important component of broader economic transformation processes (Mellor, 1976; Timmer, 1988). Agricultural transformation is the process by which an agri-food system[1] transforms over time from being subsistence-oriented and farm-centered into one that is more commercialized, productive, and off-farm centered (Timmer, 1988). Stylized facts about the role of agriculture within the broader economic transformation process are:

- The process generally starts with growth in agricultural productivity at least where farming is the primary source of employment for most of the population.
- Productive farmers with enough resources to produce a surplus lead this process.
- The money they spend from their rising surplus production stimulates demand for goods, services and jobs in the various off-farm sectors of the economy. This induces a gradual shift in the labor force from farm to non-farm activities, rural–urban migration, and a slowing of population growth in rural areas. As a result, agriculture declines in its relative share of total gross domestic product (GDP) over time. Consolidation of farmland happens gradually (unless associated with expropriation) as the more efficient producers rent or buy land from their less efficient neighbors, who leave farming or reduce the share of their time in it. Labor productivity rises as labor migrates from less productive agriculture to more productive manufacturing and service sectors (inter-sectoral gains) and through productivity growth within agriculture (intra-sectoral gains). This is generally driven by technical innovation, scale economies, shifts to higher-return crops and animal products associated with urbanization and improving market access conditions, and the exit of less productive laborers from farming. Robust economic transformation requires diversification, sophistication, and specialization of a country's agri-food system.

A fundamental point is that increased employment growth in the non-farm economy does not arise spontaneously. When most of a country's population starts out primarily in farming, agricultural productivity growth is generally necessary to generate transformative income growth and money circulating in rural areas to stimulate the growth of non-farm goods and services[2]. In much of Asia, Green Revolution technologies and supportive government policies kick-started rural economic growth processes, primarily in irrigated lowland areas. As millions of rural farmers had more cash to spend, this stimulated the demand for non-farm goods and services, created new jobs in the non-farm economy and pulled millions of people off the farm into more productive jobs. Over time, the gradual shift of the workforce from farming to non-farm sectors has transformed the economic and demographic structure of much of Asia. Agricultural productivity growth in these areas of Asia is widely regarded as a major catalyst to this structural transformation process. As will be shown throughout this report, these growth processes are now clearly visible in much of sub-Saharan Africa (SSA) as well.

Economic transformation has also been accelerated in areas with favorable conditions for export-oriented manufacturing (e.g., textiles in Bangladesh), highlighting that there are many different pathways of transformation and that we

[1] Agri-food systems are the set of activities, processes, people, and institutions involved in supplying a population with food and agricultural products. The agri-food system 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 (Allen et al., 2016)..

[2] Lipton (2005) notes that, except in the cases of a handful of city-states, there are virtually no examples of mass poverty reduction since 1700 that did not start with sharp rises in employment and self-employment income due to higher productivity in small family farms.

should not expect all of Africa to follow the same patterns. Moreover, evidence suggests that urban-based growth in countries such as Angola, Nigeria and Equatorial Guinea has at times been driven by primary product exports (e.g., oil and mining) which are not based on solid economic synergies with surrounding rural areas, leading to urbanization without industrialization or poverty reduction (Gollin, Jedwab, & Vollrath, 2016; McMillan, Rodrick, & Verduzco, 2014).

The agricultural transformation process in a country is generally associated with the following seven trends: (i) some farmers move out of farming to take advantage of better economic opportunities, while farmers remaining in production become more commercialized; (ii) farms transition from producing a diversity of goods motivated by self-sufficiency to becoming more specialized to take advantage of regional comparative advantage, and in the process they become more dependent on markets (market performance thus exerts a greater influence over the pace of agricultural transformation); (iii) the ratio of agribusiness value added to farm value added rises over time as more economic activity takes place in upstream input manufacture and supply and downstream trading, processing, and retailing; (iv) more medium to large farms begin to supply the agricultural sector to capture economies of scale in production and marketing, and mean farm size rises with the exit of rural people out of farming and consequent farm consolidation; (v) the technologies of farm production evolve to respond to changes in factor prices (land, labor, and capital) as a country develops (in most cases as non-farm wage rates rise with broader economy-wide development, farms become more capital-intensive as the cost of labor and land rise and the cost of sourcing capital declines); (vi) there is a transition from shifting cultivation to a focus on more intensive, sustainable and management-intensive cultivation of specific fields; and (vii) the agri-food system becomes more integrated into the wider economy. Many of these transformation processes have accelerated since 2005 in countries such as Ghana, Kenya, Zambia, Ethiopia and Rwanda.

Recent cross-country data from Africa suggest that at least some aspects of this agricultural transformation process are well underway. After decades of stagnation, much of Africa has enjoyed sustained agricultural productivity growth since 2005 (Table 1.1). Signs are emerging that poverty rates are declining in many countries such as Ghana, Rwanda, Ethiopia, and Burkina Faso, but not in others. Africa's workforce is shifting, in some cases quite rapidly, from farming to off-farm sectors, similar to Green Revolution in Asia. The number of medium- and large-scale farms is increasing rapidly and account for a sizeable and rising portion of total farmland in many African countries. Agribusiness and downstream food systems are responding dynamically to population growth, urbanization

Table 1.1: Annual growth in agricultural value added and total factor productivity, 2005–2012, selected African countries

	Agricultural value added, annual % growth (2005–2012)	Agricultural total factor productivity, annual % growth (2005–2012)
Burkina Faso	6.0	-0.08
Côte d'Ivoire	-1.75	3.06
DR Congo	3.13	-1.17
Ethiopia	8.35	2.68
Ghana	3.56	1.44
Kenya	2.72	0.56
Malawi	3.30	2.93
Mali	6.34	2.17
Mozambique	6.31	2.18
Nigeria	6.15	-0.47
Rwanda	5.26	6.19
South Africa	1.95	3.15
Tanzania	3.97	1.46
Uganda	1.40	-2.68
Zambia	0.33	3.14

Source: *World Bank, (2015); USDA, Economic Research Service Total Factor Productivity Database compiled by Keith Fuglie (column 3)*

and changing food diets associated with income growth. This chapter highlights the evidence behind these major trends, which generally indicate that agricultural transformation and broader economic transformation are now underway in much of the region. At the same time, major challenges are looming on the horizon. Subsequent chapters of the 2016 AASR examine these trends and challenges in detail. This chapter ends with a discussion of potential implications for African governments, the private sector, civil society and international development partners seeking to achieve their sustainable development goals through encouraging the region's nascent agricultural transformation processes.

Salient Trends

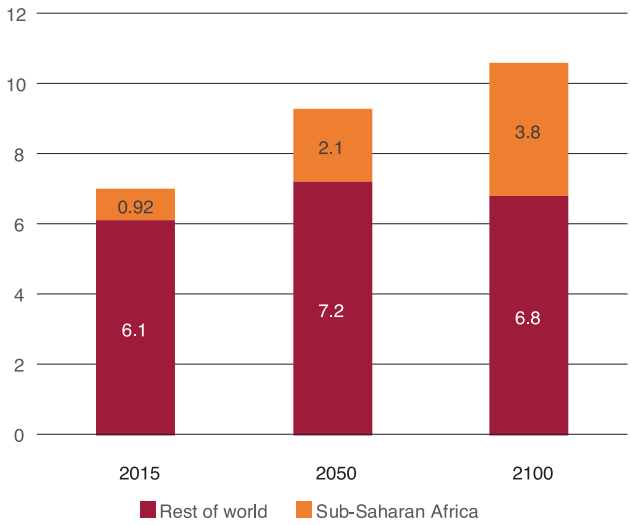
This section highlights 10 major trends: (i) Africa's mushrooming population growth; (ii) urbanization and urban population growth; (iii) shifts in the labor force toward non-farm employment; (iv) generally positive agricultural productivity growth rates and associated poverty reduction; (v) land degradation; (vi) rising land prices; (vii) increasing climate variability; (viii) the region's increasing dependence on imported staple foods; (ix) improved market access conditions for smallholder farmers; and (x) changing farmland ownership and farm size distributions. These trends present both challenges and opportunities, as summarized in this chapter and addressed in more depth in the various chapters.

Africa's population explosion

Today, SSA accounts for 950 million people, roughly 12 percent of the world's population. This share will rise to 31 percent by 2050 and to 34 percent by the end of this century as the region's population is projected to quadruple to roughly 4 billion people (Figure 1.1). As Africa comprises an increasing share of the world's population, African affairs will increasingly affect other areas of the world—economically, politically, demographically, and culturally.

The region's rapid population growth is due to rising life expectancy, declines in death rates, particularly of children, and more recently to lower fertility rates, especially among educated urban women. But compared to other regions of the world, Africa is experiencing a slow decline in fertility. While child mortality rates have declined, fertility rates have remained high, leading to the "youth bulge" that the region is now experiencing (Filmer & Fox, 2014). Today, 62 percent of Africa's population is below the age of 25 years. Africa is the only region of the world where the population of under 15s is continuing to grow (Figure 1.2).

Figure 1.1: Population projections for sub-Saharan Africa and the rest of world



Notes: The estimated population for SSA was 12.3 percent of the world's population in 2015, and is projected to comprise 21.7 percent in 2050 and 34.0 percent in 2100.

Source: *United Nations (2016)*

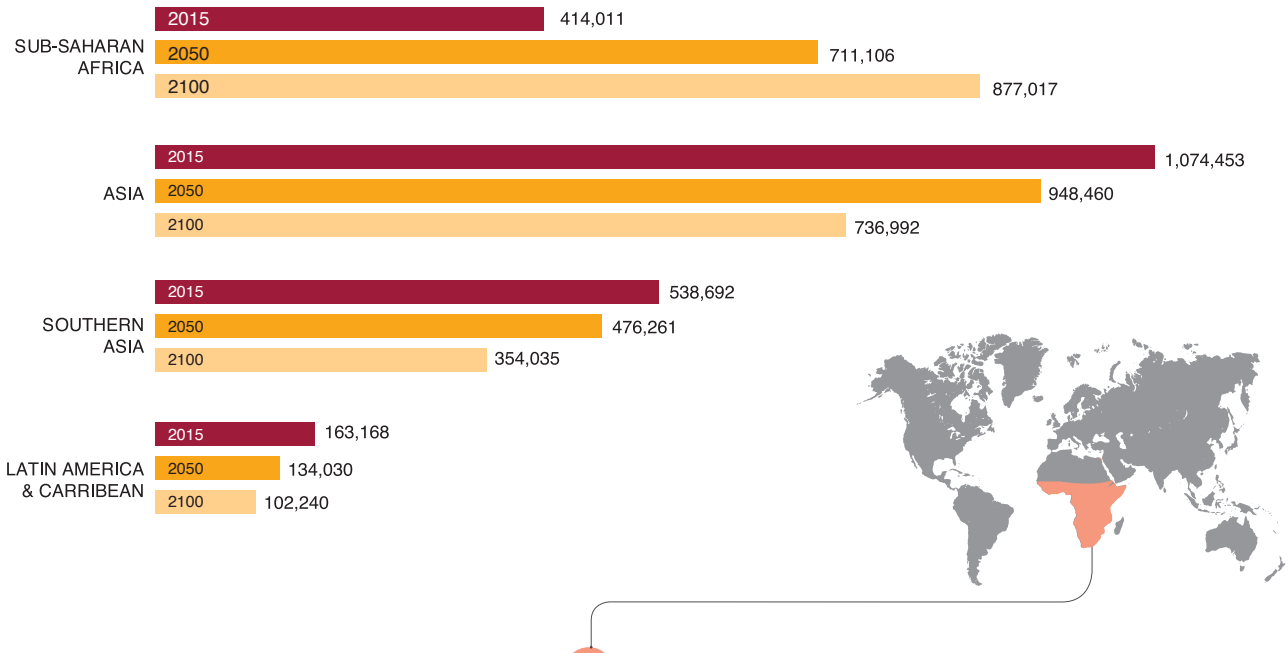
Another salient demographic trend, unlike any other continent or region, is that SSA is expected to experience expanding rural population between 2015 and 2050 (Figure 1.3). Rural Africa is expected to have nearly 60 percent more people in 2050 than it has today.

Rapid population growth, including in rural areas, may be projected to affect the region's agricultural sectors in several important ways. First, rapid population growth will put rising pressure on African food systems to feed its fast growing cities. Second, we might expect to see rising land values and the growth of land markets, especially in areas of favorable market access, as more people seek land not only for farming but for housing and other non-farm purposes. Third, as finite land becomes more populated, it will be increasingly unlikely that young people can expect to inherit land, causing migration and demographic and labor market shifts that are already well underway in relatively densely populated areas, but not yet in others.

Urbanization and urban population growth

Population is growing especially rapidly in Africa's urban areas as shown in Table 1.2. By 2050, the majority of the population in most African countries is likely to be in urban areas. But urbanization is proceeding at a highly variable pace (Bocquier, 2005; Potts, 2012). Over the past

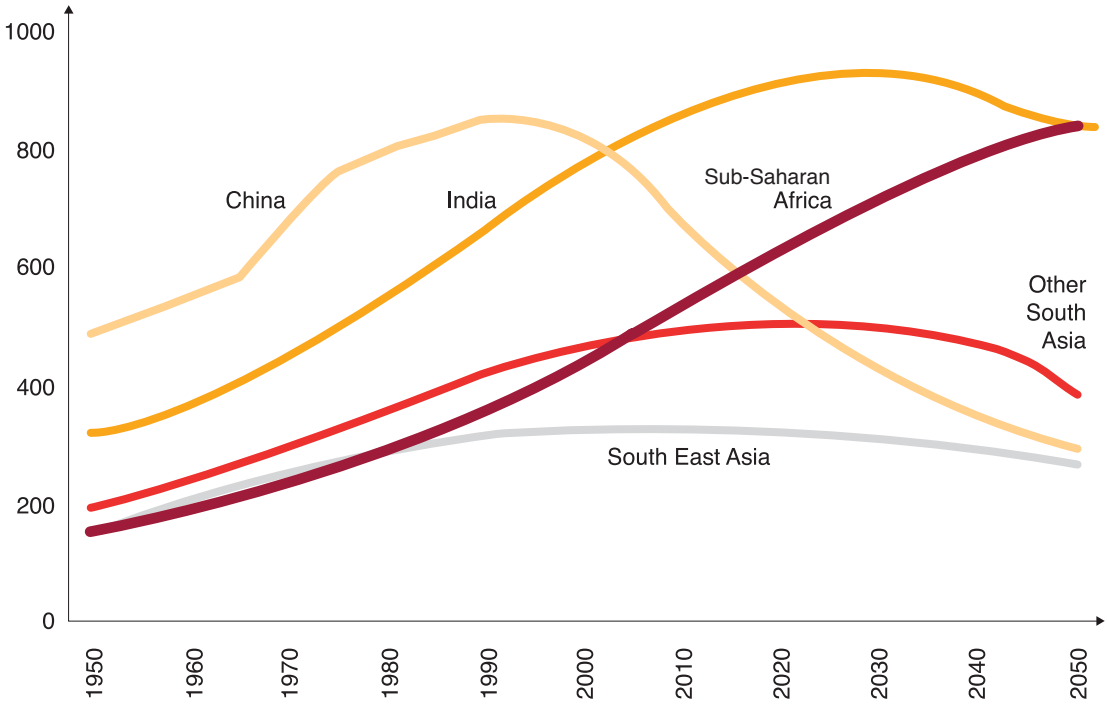
Figure 1.2. Projected population aged less than 15 years



Notes: Sub-Saharan Africa is estimated to comprise **18.3** percent of the world's developing region population below the age of 15 in 2015. This fraction is projected to rise to 31.3 percent in 2050, and 42.6 percent in 2100.

Source: *United Nations (2016)*

Figure 1.3: Trends in rural population in major developing areas of the world (Millions)



Source: *United Nations (2016)*

Table 1.2: Population growth of selected African cities

City	Country	Population (Thousands)					% Change 2010-2015
		2005	2010	2015	2020	2025	
Dar-es-Salaam	Tanzania	2,680	5,549	4,155	5,103	6,203	85.2
Nairobi	Kenya	2,914	3,523	4,303	5,192	6,246	77.3
Kinshasa	DRC	7,106	8,754	10,668	12,788	15,041	71.8
Luanda	Angola	3,533	4,772	6,013	7,080	8,077	69.3
Addis Ababa	Ethiopia	2,633	2,930	3,365	3,981	4,757	62.4
Abidjan	Cote d'Ivoire	3,564	4,125	4,288	5,500	6,321	55.2
Dakar	Senegal	2,434	2,853	3,308	3,796	4,338	51.5
Lagos	Nigeria	8,767	10,578	12,427	14,167	15,810	49.5
Ibadan	Nigeria	2,509	2,837	3,276	3,760	4,237	49.3
Accra	Ghana	1,985	2,342	2,722	3,110	4,237	49.3
Kano	Nigeria	2,993	3,395	3,922	4,495	5,060	49
Douala	Cameroon	1,767	2,125	2,478	2,815	3,131	47.3

decade or two, about a third of African countries have been experiencing either no urbanization or even de-urbanization, for example, Nigeria (Yeboah & Jayne, 2016). But there is no doubt that urban populations are rising rapidly, some of it in mega-cities, but mainly in secondary cities and tertiary towns in areas formerly considered rural.

Increasing urban population growth has several important implications for Africa's agriculture and agri-food systems. First, whereas there were three African farmers for every urban dweller in 1990, in 2020 one full-time African farmer will be expected to feed two urban dwellers. Urban-based demand for food is rising exponentially, putting major pressure on African food systems to invest massively in supply chains (Richards et al., 2016). Income growth in Africa's cities is also influencing dietary patterns and expanding the demand for food processing and value addition in agri-food systems (Tschirley et al., 2015). The region is also becoming more dependent on global markets for the major cereals, oilseeds, and animal products, resulting in a situation in which most foods in African cities are priced at import parity. As new towns spring up in former hinterland areas and as agricultural value chains develop, smallholder farmers are enjoying more favorable market access conditions than they used to (Chamberlin & Jayne, 2013; Richards et al., 2016). Improved market access conditions combined with relatively high food prices are providing unprecedented opportunities for Africa's farmers and value chain actors. It is now government policy toward markets and land and the level and composition of public investments to agricultural sector that are likely to be increasingly decisive in influencing the sector's performance.

Shifts in labor force to non-farm employment

While substantial differences across countries warrant caution against overgeneralization, the last decade witnessed a sharp increase in the rate at which Africans are exiting farming in favor of off-farm activities (Table 1.3). Because this rapid shift in the workforce occurred during an era of strong agricultural productivity growth influenced by high world food prices, it is unclear whether this shift in the labor force toward off-farm employment will continue at the same pace over the next decade. However, it is likely to continue over the long run. Trends are similar when examining employment in terms of counts of jobs versus full-time equivalents, but the share of the workforce in non-farm employment is considerably higher using the full-time equivalents measure (Table 1.3). Within the off-farm sector, the greatest number of new jobs for youth is in the off-farm informal sector, particularly construction, commerce, and manufacturing. Off-farm jobs in the agri-food system are also growing rapidly in percentage terms, but from a low initial base. Farming will continue to be a major source of employment of the workforce in most countries at least for the next decade or more (Filmer & Fox, 2014; Losch, 2012; Yeboah & Jayne, 2016).

Shifts in employment trends among Africans in the 15–24 and 25–34 age range are remarkably similar to those in the 35–64 age range. Unemployment and economic inactivity among the working-age population is rising more rapidly in rural areas than in urban areas particularly among the youth (Yeboah & Jayne, 2016). Strategies that effectively raise the returns to labor in farming will be among the most important steps that African governments can take

Table 1.3: Changes in the share of total jobs among the working age population (15 - 64 years) in farming, in off-farm jobs within agri-food systems (AFS) and in non-farm jobs (non-AFS)

Country	Survey Years	Total # of jobs in millions	Farming		Off-farm within AFS				Off-farm outside AFS	
					Agro-processing		Downstream commerce and distribution			
			% of jobs	% of FTE jobs	% of jobs	% of FTE jobs	% of jobs	% of FTE jobs	% of jobs	% of FTE jobs
Ghana	2005/06	10.1	52.1	43.5	7.5	6.3	7.1	8.6	33.3	41.0
	2012/13	13.9	43.6	34.3	3.7	3.7	13.8	15.5	38.9	46.5
Nigeria	2010/11	62.3	37.0	30.6	2.6	2.3	16.1	18.7	44.4	48.2
	2012/13	69.7	42.1	33.7	4.8	4.6	16.2	18.6	36.9	43.1
Rwanda	2005/06	6.1	75.2	65.7	0.4	0.4	6.5	7.4	18.0	26.6
	2010/11	9.1	67.4	54.0	1.1	1.2	5.7	7.7	25.9	37.0
Tanzania	2010/11	18.4	59.0	47.3	1.7	2.5	12.5	15.0	26.8	35.2
	2012/13	20.4	58.7	48.3	1.5	1.6	12.5	15.6	27.3	34.5
Uganda	2005/06	10.8	72.6	57.0	2.1	2.8	5.7	10.2	19.6	30.0
	2011/12	15.9	67.1	48.6	2.8	1.7	6.6	12.0	23.5	37.7
Zambia	2005	4.7	73.6	61.2	1.2	1.6	1.9	3.1	23.1	34.1
	2012	5.3	60.4	46.7	1.6	2.1	4.9	2.1	33.2	44.1
Kenya	1999	11.1	54.4	-	-	-	-	45.6	-	-
	2009	14.2	45.6	-	-	-	-	54.4	-	-
Malawi	1998	1.9	73.3	-	-	-	-	26.7	-	-
	2008	2.0	53.9	-	-	-	-	46.1	-	-
Mali	1998	2.0	79.6	-	-	-	-	20.4	-	-
	2008	2.6	64.2	-	-	-	-	35.8	-	-

Source: Yeboah and Jayne (2016), computed from Ghana Living Standard Survey 5 and 6; Zambia labor force surveys 2005 and 2012; Rwanda Integrated Household Living Survey; Tanzania National Panel Survey; Uganda National Panel Survey; Nigeria General Household surveys. ~Kenya, Malawi and Mali results are from population and housing census data in Integrated Public Use Microdata Series (IPUMS: https://www.ipums.org/).

to improve youth livelihoods, especially for women. Agricultural productivity growth, especially if broadly based, will generate strong multiplier effects that expand job opportunities in the downstream stages of the agri-food system and in the broader non-farm economy (Yeboah & Jayne, 2016).

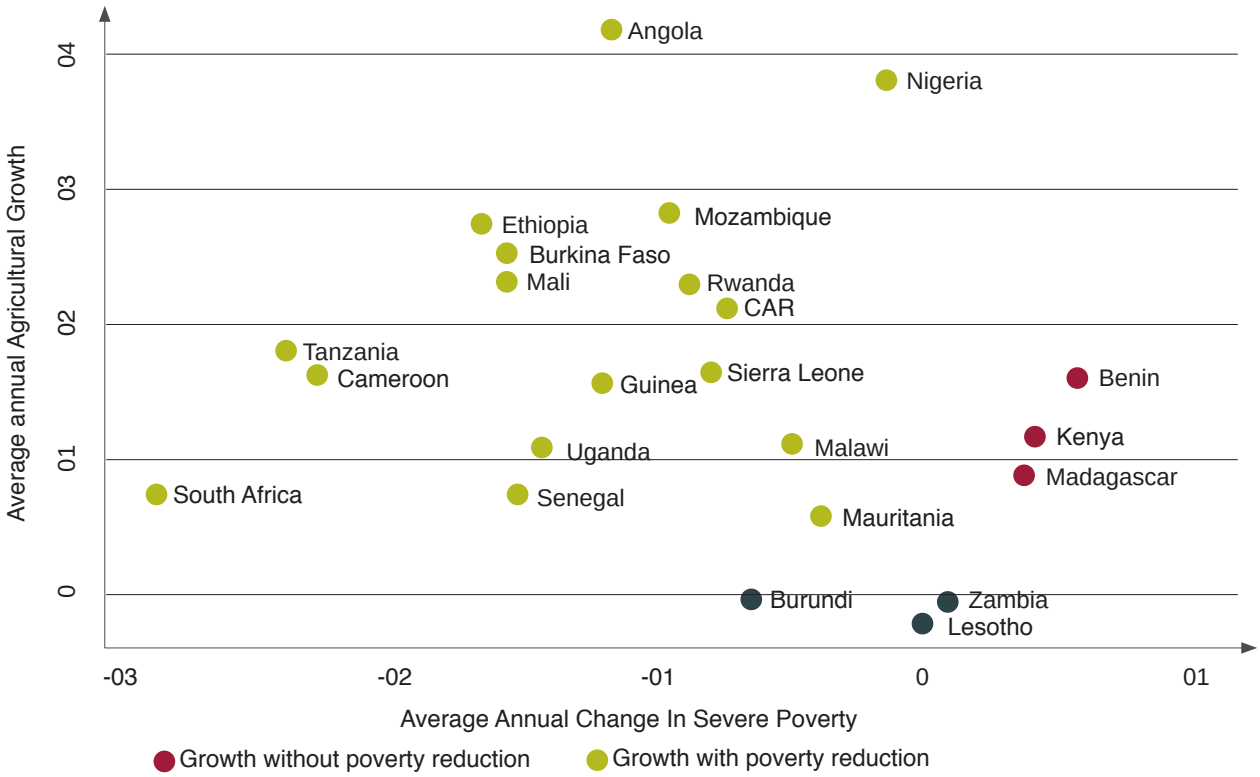
However, "labor migration" does not necessarily refer to a physical movement of people, or a binary switch out of farming to non-farm activities. Individuals may remain in rural areas, but progressively shift their labor from farm to off-farm activities over time (Reardon, 2015; Richards et al., 2016).

As highlighted, over 60 percent of Africa's population is under the age of 25. Roughly 220 million young people will be entering the labor force between now and 2035 (Filmer & Fox, 2014). Even under the most optimistic projections, wage jobs in SSA will absorb only 25 percent of these 220 million new workers. Farming and self-employment will be called upon to provide gainful employment for at least 70 percent of young Africans entering the labor force (more than half of whom live in rural areas) till at least 2030. However, agriculture will not be attractive to young people unless it earns good money.

Generally positive rates of agricultural productivity growth and poverty reduction

As shown in Table 1.1, many countries have registered impressive growth in agricultural value added and total farm factor productivity growth since 2012. And the countries registering the greatest growth in agricultural productivity per worker in farming have also tended to

Figure 1.4: Changes in annual agricultural productivity per agricultural person and annual changes in poverty rates, 2000–2013, various African countries



Note: Agricultural productivity growth is defined as the gross value of agricultural output per agricultural worker.
Sources: *World Bank 2015for agricultural output and headcount poverty rates; FAOSTAT database for persons in agriculture (see http://faostat.fao.org/site/291/default.aspx)*

experience the most rapid shifts in the labor force out of farming as well as faster labor productivity growth in non-farm sectors (see Chapter 3). However, taking a slightly longer time frame over the 2000–2012 period, there has been variability in the relationship between agricultural productivity growth and poverty reduction (Figure 1.4). Many countries do indeed show the anticipated positive relationship (as shown by the green dots in Figure 1.4), but some countries do not (the red dots). While it is generally well established that agricultural productivity growth does contribute to the reduction of poverty in areas where most of the workforce is still engaged in agriculture, this relationship is conditioned by numerous factors, including the initial distribution of productive assets that determines the degree to which agricultural productivity growth is inclusive and that, in turn, governs the strength of subsequent income and employment multipliers (Johnston & Kilby, 1975; Lipton, 2005; Mellor, 1976; Vollrath, 2007). This variability might partially reflect data discrepancies[3], but it may also reflect a weakening of the relationship between agricultural productivity growth and poverty reduction in some parts of Africa where agricultural growth is not broadly based, in the sense that a large proportion of farmers are generating increased incomes and spending. The strength of the agricultural growth–poverty reduction relationship also depends on the agricultural sub-sector from which productivity growth originates. For instance, export crop-led growth may engage a smaller number of farms and households and hence have different effects on poverty reduction than staple crop-led growth involving many more rural households.

While off-farm wage employment is growing rapidly in percentage terms, it is starting from a very small baseline level. Consequently, it will take at least a decade before more than 25 percent of the workforce is engaged in wage employment even with continued rapid growth in percentage terms. Consequently, agri-food systems will continue to employ a large share of the region's population until at least 2030 even with continued economic transformation (Filmer & Fox, 2014; Tschirley

[3] For example, divergent statistics are reported about the rate of poverty reduction in some countries.

et al., 2015; Yeboah & Jayne, 2016). Filmer and Fox predict that about 40 percent of all Africans entering the labor force over the next decade will be primarily engaged in agriculture. For this reason, continued focus on promoting agricultural productivity on smallholder farms will be important, both for reducing rural poverty and for generating the income and employment multipliers needed for rapid economic transformation. It will be difficult to achieve rapid transformation and poverty reduction if at least 40 percent of the workforce remains stuck in low-productivity farming.

Similarly, the link between agricultural productivity, food price levels, and poverty reduction has long-run and short-run dynamics. In the short run, high food prices hurt many smallholder households that are net buyers of staples. At the same time, a small proportion of farmers with sufficient land and other productive assets and who are situated in fertile areas with good market access conditions can produce large grain surpluses, and they tend to benefit from higher food prices. In the longer run, high food prices create production responses for those who can respond, which generates income and employment multiplier effects, some of which may benefit the poor. Some households that are adversely affected in the short run may find employment opportunities made possible by the greater expenditures in the rural community from net grain sellers (e.g., they spend money on bricks, roofing sheets, clothes, school fees, and veterinary services), that generate incomes and livelihoods for others and create demand for off-farm goods and services that poor rural households may benefit from (Headey, 2011; Hella et al., 2011). These effects are hard to measure with precision, but they cannot be ignored. These multiplier effects may explain why poverty rates in many parts of Africa seem to have declined in recent years even with unprecedentedly high food prices in 2007–2012. The economy-wide effects of food price changes over the long run are complex, however, and there are still robust arguments that agricultural productivity drives lower food prices, lowering imports, and reducing urban and rural poverty. The bottom line is that our review of the evidence confirms our continued focus on the productivity of smallholder farmers in countries that are in the early or intermediate stages of their economic transformation processes.

The structural transformation process is unfolding at difference paces across African countries. We see signs of rapid economic transformation in parts of Ghana, Ethiopia and Rwanda featuring a rise in the workforce engaged in non-farm sectors (Table 1.1), major self-investments by households in youth education and skill training,[4] and a rapid reduction in poverty rates (McMillan & Harttgen, 2014). In contrast, other countries have made little progress in even the initial stages of structural transformation (raising their agricultural productivity).

But the pace at which people can move into relatively high-productivity sectors is constrained by the rate of employment growth of such sectors. Inclusive forms of agricultural productivity growth can generate stronger demand for non-farm goods and services and hence greater employment growth in productive non-farm sectors that "pull" people off the farm into productive jobs. When people are pushed out of farming due to land scarcity and limited profitability of subsistence agriculture, they move into low-wage work, often in the informal sector. Alternatively, households are pulled out of agriculture when the demand for non-farm goods and services creates new business or wage-earning opportunities. This path of structural transformation leads to widespread reductions in poverty and economic growth, and the evidence indicates that this process is happening already in some countries, but only very slowly in others.

About 40–60 percent of smallholder farmers across the region remain either absolute buyers of staple foods or they buy more than they sell over the course of the year (Jayne, Mather, & Mghenyi, 2010). Smallholder farmers increasingly rely on markets for many resources and services that influence agricultural productivity[5]. Farmers' ability to reliably acquire food from the market at low cost and risk enables them to shift their land into crops with higher returns per unit land and to reinvest their labor and capital into other activities (often off the farm) that provide higher returns to their time and scarce capital. Rapidly rising urban populations provide great opportunity for farmers with the requisite skills to increase their incomes from high-value horticulture, oilseeds, dairy, and meat products. Shifts in production toward higher-value farming enterprises are

[4] Yeboah and Jayne (2016) show that the percentage of young people aged 15–25 who are "economically inactive" (mainly because they are in school) is as high as 38 percent in countries such as Ghana and Kenya, and much lower in countries such as Malawi and Uganda (15–20 percent).

[5] Some of the most important markets on which farmers rely are for food, improved seed, fertilizers, mechanization services, veterinary services, crop husbandry know-how, market information, other inputs such as plows, ox carts, bicycles, spare parts and repair services for farm and transport equipment, and of course markets for farmers to sell their surplus production.

already occurring (Headey & Jayne, 2014) and will be further encouraged to the extent that farmers can rely on staple food markets to acquire food in local rural markets at reasonable prices. In this way, well-functioning local food markets encourage both agricultural and non-farm productivity growth and therefore broader economic transformation processes.

Land degradation

Declining soil fertility is a major constaint to agricultural transformation in Africa (Montpellier Panel, 2014). Roughly 28 percent of rural Africa's farmers cultivate land that is considered to be degrading over time[6] (Barbier & Hochard, 2016), and SSA is witnessing the fastest increase in the proportion of rural households working on degraded land of any region of the world. As population pressures cause farm sizes to shrink over time for most small-scale farm households, they respond by continuously cropping their fields every year. Fallows have largely disappeared in densely populated areas[7]. More continuous cultivation of existing plots would not necessarily pose problems to sustainable intensification if soil quality were maintained or improved over time, for example, through adequate soil amendment practices, crop rotations, use of fertilizers and other inputs. However, a major body of evidence in Africa points to soil degradation arising from unsustainable cultivation practices in high density areas of the continent (e.g., Drechsel, Gyiele, Kunze, & Cofie 2001; Stoorvogel & Smaling, 1990; Tittonell & Giller, 2013). Nitrogen is one of the major nutrients mined from African soils; sufficient quantities of inorganic fertilizer can address this constraint. However, many problems leading to land degradation cannot be addressed by conventional inorganic fertilizers alone, such as losses of organic carbon and rising soil acidification. These "non-nitrogen" constraints on soil quality tend to depress the efficiency of inorganic fertilizer in contributing to crop output (Kihara et al., 2016) and thereby depress the effective demand for inorganic fertilizer. Some of these constraints are related to current forms of continuous cultivation and insufficient crop rotation. Tittonell and Giller (2013) conclude that smallholder farmers are largely unable to benefit from current yield gains offered by plant genetic improvement because they farm on depleted soils that are non-responsive to fertilizer application. A holistic and integrated land management strategy is needed, which focuses on raising organic matter, moisture retention, and other forms of soil rehabilitation in addition to greater inorganic fertilizer use are preconditions for sustainable agricultural productivity growth in densely populated rainfed farming systems of Africa (Kihara et al., 2016).

Rising land prices

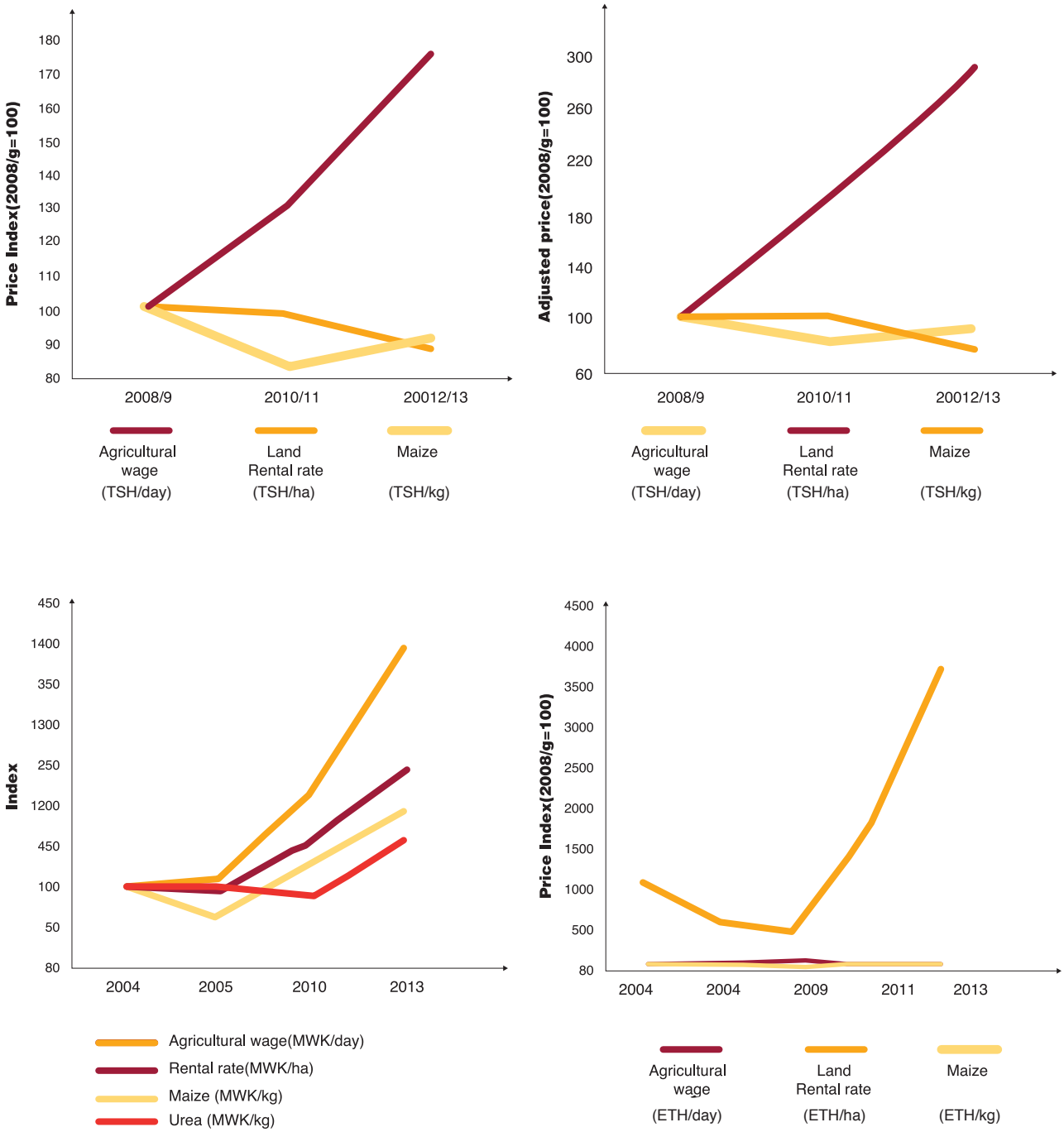
There is also growing evidence of rising land rental values in areas of agricultural commercialization with favorable access to markets. Figure 1.5 provides illustrative examples of a broader trend over the past decade in parts of Africa: that land prices appear to have risen dramatically in areas of high agro-ecological potential within reasonable proximity of urban areas (Jayne et al., in press). These trends have created new stresses on the ability of customary tenure systems to protect small-scale farmers' land from encroachment or appropriation. The region has experienced rising demand for agricultural land by both international and national companies (Deininger & Byerlee, 2011), as well as urban investor farmers (Jayne et al., 2016; Sitko & Jayne, 2014). Increased interest in African farmland may also be explained by the perception that there are large areas of unclaimed "available" arable land in Africa for investment, however, recent studies indicate that the amount of fertile land for cropland expansion may be considerably less than earlier estimates indicate (Chamberlin et al., 2014; Young, 1999).

Governments have also become increasingly aware of the potential for revenue generation from the lease or sale of agricultural land, and many are reportedly putting pressure on customary land administration institutions to gain leverage over "unutilized" rural land. This trend is particularly problematic given that land rights under most customary systems are, almost by definition, undocumented. This suggests that even if customary rights holders or their leaders do have the authority to (re-)allocate rights, in particular to non-community members, these decisions may be based on less than complete information on the actual amount and location of truly unclaimed land. Moreover, Deininger and Byerlee (2011) report widespread allegations that local chiefs sometimes perceive themselves to be "essentially private owners of the land" instead of trustees on behalf of their communities, and inefficient land administration systems have led to the sale or

[6] As proxied by a reduction in Net Primary Productivity (NPP) which is measured as the change in grams of carbon sequestered per square meter over the 1981–2000 time period after subtracting respiration losses.

[7] Fuglie and Rada (2013) report that fallowed land as a proportion of total farmland in SSA declined from 40 percent in 1960 to roughly 15 percent in 2011.

Figure 1.5: Land rental rates relative to other agricultural input and output prices (upper-left=northern Tanzania; upper right=western Tanzania; lower left=rural Malawi; lower right=southern Ethiopia.



Notes: Upper-left = northern Tanzania; upper right = western Tanzania; lower left = rural Malawi; lower right = southern Ethiopia.
Source: *World Bank LSMS data sets*

lease of customary land without the participation or even knowledge, in many cases, of communities and individuals who have customarily used the land.

As land values rise, land rental markets are growing in importance (Holden, Otsuka, & Place, 2009). The research evidence generally finds that land markets are positive developments—they shift land from less productive to more productive users and support overall agricultural productivity growth (Chamberlin & Ricker-Gilbert, 2016; Jin & Jayne, 2013). However, because of risks associated with renting out land (especially when land tenure is insecure), there is mounting evidence that the demand for rented land greatly exceeds the willingness of individuals to rent it out, resulting in an unmet demand for rented land (Chamberlin & Ricker-Gilbert, 2016) and a consequent rise in land rental rates in many parts of the region. If land tenure policies do not adequately protect current users or actively restrict land rentals, as is the case in some countries, the rate of growth of land rental and sales markets will be constrained, potentially retarding the transfer of land to productive users and impeding the pace of agricultural transformation.

Climate variability

There is growing global recognition of the urgent need to identify and implement strategies that make food systems more resilient in the face of increasing climate variability. Nowhere is this more evident than in SSA. Because most Africans' livelihoods and agri-food systems rely on rainfed farming, Africa is one of the world's most vulnerable regions to climate change (FAO, 2010). The Intergovernmental Panel on Climate Change concluded that "climate change is expected to have widespread impacts on African society and Africans' interaction with the natural environment" (IPCC, 2014, p. 812).

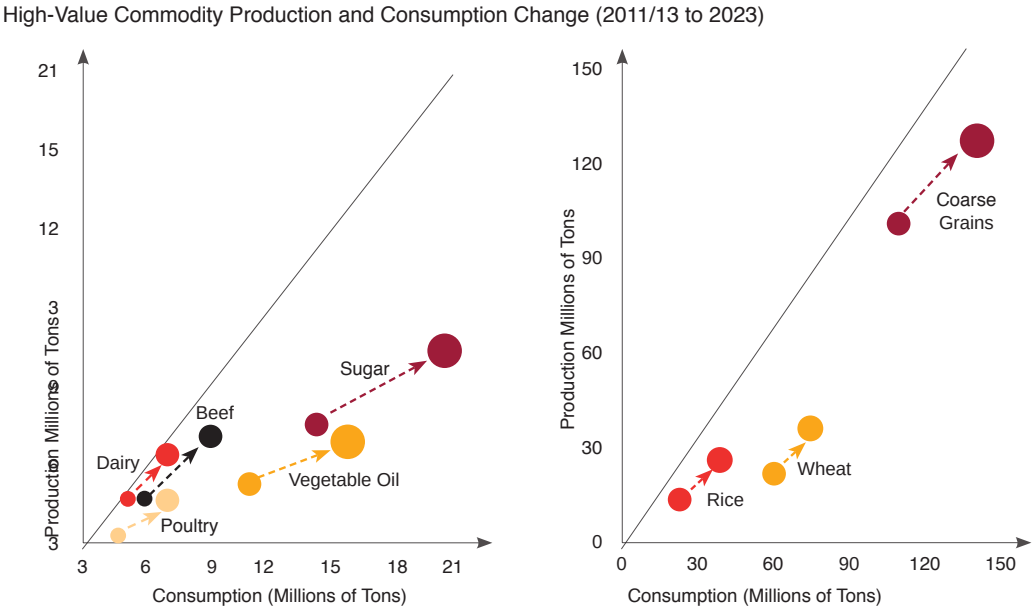
Climate smart agriculture (CSA) has emerged as an approach that enhances the resilience of farm systems to the effects of climate change. CSA is defined by three principle objectives: 1) sustainably increasing agricultural productivity and incomes; 2) adapting and building resilience to climate change; and 3) reducing and/or removing greenhouse gases emissions, where possible (FAO, 2013). The achievement of the goals of CSA in Africa will require widespread farmer adoption of practices and technologies that promote resilience and system-wide collective action to promote ex ante climate risk management activities and ex post coping strategies. Given the scope and scale of these requirements, leveraging public sector resources is critical.

As African governments and development partners understandably push hard to make progress in helping African farmers become less vulnerable and more resilient to increasing climate variability, there are major risks of overgeneralization about what kinds of farming practices really contribute to ex ante risk management and ex post coping strategies. SSA is heterogeneous with respect to its climate conditions, soil types, market access conditions, and factor price ratios. Some parts of the continent are still land abundant; labor and capital may be binding constraints in such areas. Other agricultural areas of Africa are densely populated, facing land pressures and rising land prices. In some of these areas, labor is relatively abundant and hence labor-intensive CSA practices may hold some potential to be scaled-up and incentivized through public programs. However, in areas with good market access conditions and close to urban areas, economic transformation processes are bidding up labor wages and making it difficult for farmers to adopt labor-intensive CSA practices unless they also provide high returns to labor. The heterogeneous conditions of farming systems in Africa warrant great caution against overgeneralization in promoting technologies on their own based on blanket recommendations across wide domains. Chapter 4 explores in detail the topic of sustainable agricultural intensification in an environment of rising climate variability.

Increasing reliance on imported staple foods

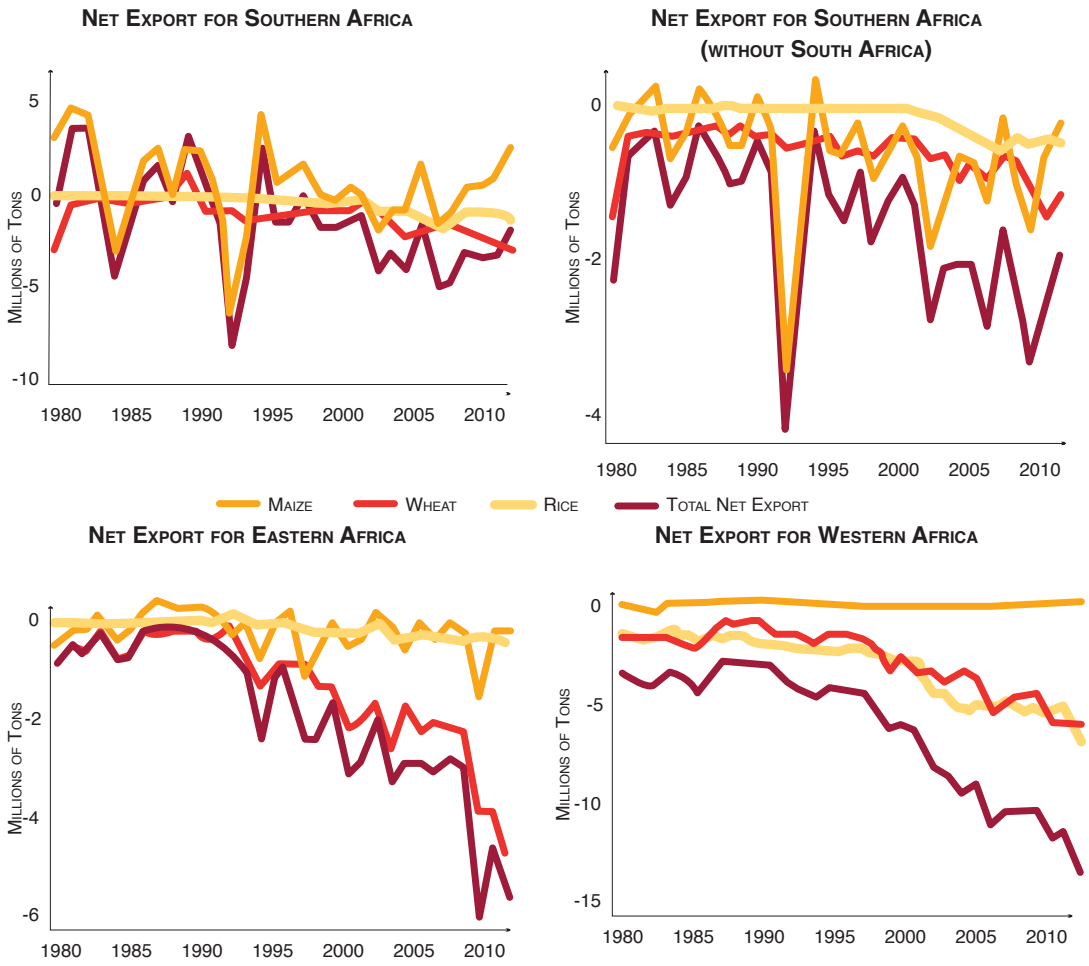
There is increasing recognition of the pace and breadth of dietary change in Africa, featuring more diversified and processed diets both in urban and rural areas, and across the entirety of the income spectrum (Tschirley et al., 2015). As population and incomes grow, the demand for food is rising rapidly in the region, and local production, especially for the main staple grains, is not keeping up. Consequently, many types of foods being consumed in African cities are increasingly being supplied by world markets. Projections by the Organisation for Economic Co-operation and Development-Food and Agriculture Organization of the United Nations (OECD-FAO) of Africa's consumption and production of high-valued commodities over the period 2011 to 2023 also indicate that an increasing share of the region's growing demand for high-value food products associated with rising consumer incomes will be met by imports (Figure 1.6). Estimates of net exports/imports of grains (rice, maize, and wheat) across the various regions of Africa show a rapidly growing dependence on imported staple grains (Figure 1.7).

Figure 1.6. Projected trends in sub-Saharan African commodity production and consumption



Source: *FAO: acknowledgements to Holger Matthey/FAO, August 2014*

Figure 1.7. Trends in grain export from Africa by region



Source: *Source: Yeboah and Jayne (2016)*

Hence, the pattern of trade illustrated in Figures 6 and 7 suggests that employment prospects arising from agricultural trading and processing have not been fully realized, as potential gains in job creation in downstream stages of the agri-food system are being lost to overseas suppliers. A recent FAO report also points to some bottlenecks underlying the slow transformation in the agro-processing sector in Africa (Hollinger & Staatz, 2015). The report highlights the dualistic nature of the agro-processing sector, which largely relies on large industrial processors and small-scale informal processors. It noted that growth among the more dynamic large-scale industrial processors is usually impeded by a general lack of a reliable supply of local raw materials of consistent quality. A large part of processing of domestically produced food products (especially those based on domestic staples) is still in the hands of small-scale and largely informal-sector operators, characterized by low capacity utilization rates and low productivity levels. Their activities are also seasonal, and often generate outputs of variable quality limiting their entry into emerging urban food distribution systems (Hollinger & Staatz, 2015). Addressing the capacity and productivity constraints to growth in the agro-processing sector is critical to expanding job opportunities in the agri-food system. Nonetheless, greater expansion of local farm production is critical to ensure an adequate supply of raw material for local agri-businesses and processors and the job growth in agri-food systems that would come with it. Domestic production growth can also promote job growth in upstream sectors of the food system including inputs supply, mechanization, and other types of farm service delivery. Farm production growth will thus remain a crucial source of broader economy-wide multiplier effects (Johnston & Kilby, 1975; Lipton, 2005; Mellor, 1976).

Improved market access conditions for African farmers

The economic landscapes in which small farmers have traditionally operated are therefore shifting rapidly. Urbanization and development of food systems to feed growing cities is reshaping African farmers' market access conditions, starting with those closest to towns and moving outward more slowly into hinterland areas. The rise of secondary cities is improving market access for many rural farmers by extending the reach of value chains into areas formerly considered remote (Chamberlin & Jayne, 2013). An increasing proportion of African farmers are enjoying better access to inputs and markets, and the share of the population living in truly remote locations is declining rapidly (Masters et al., 2013). The scale of demand in these cities, and the sheer volume of food needed to support the growing urban populations are creating new opportunities for not only farmers, but for small-, medium- and large-scale enterprises within food value chains (Reardon, 2015).

This economic shift is clearly leading to new opportunities in rural areas, in farming, off-farm small-scale employment, and in wage labor. But the shifting economic landscape is also bringing new and intense competition, and changing how farmers farm.

Over the next decade, farming in low income countries will need to evolve rapidly to remain competitive and gain access to the growing urban markets. Farmers will need to produce farm goods which will be increasingly standardized in variety, size, taste, quality, and safety. They will need to increase flexibility in their decision-making process, which implies having better access to input and output streams. The idea of the single farmer selling his goods in the market has already become an anachronism for at least some commodities, as supply chains, suppliers, and purchasers assume a greater role in the food chain, and as farmers adapt to producing for a market oriented system. Aggregators, whether in the form of cooperatives, international commodities companies, or small and medium enterprises (SMEs), will play a key role in the emerging farming landscape as input providers and as purchasers collecting food and moving it downstream, as in other parts of the world (Reardon, Timmer, & Minten 2012). Over the coming decades, the trucker, the produce sorter, the wholesaler, and the retail outlet will become as important to the farmer as the hoe and plow.

This future will impose greater discipline and cost streamlining on farmers in creating conditions that require them to remain competitive under new market conditions. Poorly educated small-scale farmers producing lower value crops (e.g., coarse grains and other staples) will face the greatest difficulties, and will struggle to compete against a variety of alternative suppliers. The greatest opportunities for small-scale farmers will lie in high value, labor-intensive activities that are not overly knowledge-intensive. To successfully engage in these activities, however, farmers will need to dramatically improve their technical knowledge related to high-value production, including an understanding of the quality, size, and safety standards of processors and wholesalers. Financial hurdles will also present an imposing challenge to poor farmers seeking to produce for higher value markets. This may imply several areas for public programs, including: (a) workforce training, and the development of specialized skills which can be leveraged for rural wage labor, both in and out of agriculture; (b) investments in value chains, with a focus on input suppliers and aggregators; (c) demand driven, targeted extension efforts coupled with farming contracts, where purchase agreements are linked to education on expected quality and regulatory standards; and (d) a shift from an emphasis on the production of coarse grains toward higher value perishable farm produce and the value

chains to make such a shift possible, including investments in electricity, storage facilities, transport sectors, and road and rail infrastructure.

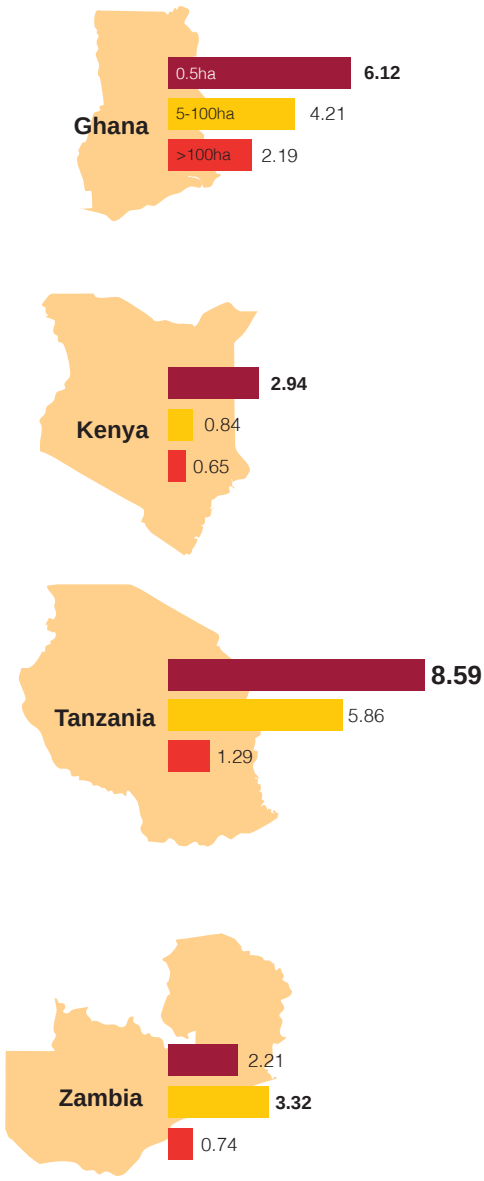
Changing farm land dynamics

Parts of SSA are experiencing major changes in farm size distribution as part of broader economic transformations the region is now experiencing. Land rental markets are increasing in importance (Deininger, Xia, & Savastano, 2015). Perhaps the most salient change in farmland ownership patterns is the rise of medium-scale farms. A recent study by Jayne et al. (2016) assesses changes over the past decade in farm size distribution in Ghana, Kenya, Tanzania and Zambia and finds that among all farms below 100 hectares, the share of land on small-scale holdings smaller than 5 hectares has declined except in Kenya (Table 1.4). Medium-scale farms (defined as farm holdings between 5 and 100 hectares) account for a rising share of total farmland, especially in the 10 to 100 hectare range where the growth in the number of these farms is especially rapid. Medium-scale farms control roughly 20 percent of total farmland (including large farms) in Kenya, 32 percent in Ghana, 39 percent in Tanzania, and over 50 percent in Zambia (Figure 1.8). This trend in most cases reflects increased interest in land by urban-based professionals or influential rural people. About half of these farmers obtained their land later in life, financed by non-farm income.

The rise of medium-scale farms is affecting the region in diverse ways that are difficult to generalize. Many such farms are a source of dynamism, technical change and commercialization of African agriculture. In densely populated areas, however, the growth of investor farms may be exacerbating problems of land scarcity within rural communities. Investor farmers tend to dominate farm lobby groups and influence agricultural policies and public expenditures to agriculture in their favor. Nationally representative Demographic and Health Survey (DHS) data from six countries (Ghana, Kenya, Malawi, Rwanda, Tanzania, and Zambia) show that urban households own 10 to 35 percent of total agricultural land and that this share is rising in all countries where DHS surveys were repeated (Jayne et al., 2016). This suggests a new and hitherto unrecognized channel by which medium-scale farmers may be shifting the strength and location of agricultural growth and employment multipliers between rural and urban areas. Under de facto land policies, medium-scale farms are likely to soon account for most farmland under production in many African countries.

Figure 1.8. Area owned/controlled by small-scale (0 - 5 ha), medium-scale (5 - 100 ha) and large-scale (>100 ha) farm holdings in 2015

All figures are in millions



Sources: *Jayne et al. (2016); large-scale areas owned/controlled are the sum of area under large-scale holdings according to data sources reported in Section 3, plus estimates of large-scale acquisitions between 2005 and 2015 from the Land Matrix (http://landmatrix.org/en/); data on area owned/controlled by small-scale and medium-scale farms come from the sources reported in Section 3*

Table 1.4: Changes in farm structure in Ghana (1992–2005), Tanzania (2008–2012), Zambia (2001–2012) and Kenya (1994V2006) based on official national survey data

Farm size category (hectares)	Number of farms (% of total)	% growth in number of farms between initial and latest year		% of total operated land on farms between 0–100 ha	
Ghana	**1992**	**2012**		**1992**	**2005**
0–5	2,037,430 (92.1)	2,792,201 (84.5)	37.1	60.7	48.9
5–10	116,800 (5.3)	304,182 (9.2)	160.4	17.2	19.5
10–-20	38,690 (1.7)	130,746 (4.0)	238.0	11.0	16.0
20–100	18,980 (0.9)	78,520 (2.4)	313.7	11.1	15.6
Total	2,211,900	3,305,649	49.5	100.0	100.0
Tanzania	**2008**	**2012**		**2008**	**2012**
0–5	5,454,961 (92.8)	6,151,035 (91.4)	12.8	62.4	56.3
5–10	300,511 (5.1)	406,947 (6.0)	35.4	15.9	18.0
10–20	77,668 (1.3)	109,960 (1.6)	41.6	7.9	9.7
20–100	45,700 (0.7)	64,588 (0.9)	41.3	13.8	16.0
Total	5,878,840	6,732,530	14.5	100.0	100.0
Zambia	**2008**	**2014**		**2008**	**2014**
0–5	984,976 (88.8)	1,142,041 (78.7)	15.9	54.1	38.8
5–10	87,719 (7.9)	211,862 (14.5)	141.5	19.6	25.6
10–20	29,197 (2.6)	74,959 (5.2)	156.7	13.3	18.1
20–100	7,471 (0.7)	22,584 (1.6)	202.3	13.0	17.5
Total	1,109,362	1,451,446	227.2	100	100
Kenya	**1994**	**2006**		**1994**	**2006**
0–5	2,217,706 (92.2)	2,972,031 (98.8)	34.0	61.5	72.0
5–10	93,871 (3.9)	17,451 (0.6)	-81.4	21.4	2.3
>10	92,498 (3.8)	19,493 (0.6)	-78.9***	17.1	22.7
Total	2,404,075	3,008,975	25.2	100.0	100.0

Sources: *Ghana Living Standards Surveys 1992/3 and 2005/2006. Tanzania National Panel Surveys, 2008 and 2012; Zambia Ministry of Agriculture Crop Forecast Surveys, 2008, 2014; Kenya Central Bureau of Statistics, Welfare Monitoring Survey II, 1994: Basic Report (Kenya: Central Bureau of Statistics, Office of the Vice-President and Ministry of Planning and National Development, 1996); Kenya National Bureau of Statistics, Kenya Integrated Household Budget Survey 2005–2006 (Nairobi, Kenya: Kenya National Bureau of Statistics, Ministry of Planning and National Development, 2006)*

In short, there appears to be great dynamism in farmland ownership and farm size distribution patterns. We do not yet know how generalizable these trends are across the region. However, it is probably safe to say that existing population-based data collection platforms are systematically under-reporting a very dynamic segment of African agriculture: the medium-scale farms. While this omission is understandable, it has profound implications. Under the status quo, African governments cannot monitor, much less understand, how farm structure is changing over time. Similarly, policy makers cannot adequately address such routine questions as the magnitude and location of farm production and marketed agricultural surplus. These questions are certainly important for guiding strategic policy decisions aimed at stimulating agricultural growth, reducing rural poverty, and managing strategic food reserves and trade policies.

Objectives and Overview of the Report: Progress towards Agricultural Transformation in Africa

Africa is now on the move. Since 2000, the share of the labor force primarily engaged in small-scale farming has been declining surprisingly rapidly. Today, farming accounts for 40 to 65 percent of primary employment in Africa's working-age population, down from 70 to 80 percent just 10 years ago. The share of the workforce engaged in farming has declined most rapidly among countries enjoying the highest rates of agricultural productivity growth. This pattern is consistent with historical economic transformation processes in Asia and elsewhere, where agricultural productivity growth was the primary driver of economic transformation and associated employment shifts to non-farm sectors among countries in their early stages of development where a large share of the workforce was still engaged in farming.

Over the last decade, African governments have brought agriculture back to the top of their development agenda and are investing an increased proportion of their budgets from a growing national revenue base. The private sector is increasingly investing in agriculture, and the foundations have been laid for long-run dynamism in Africa's agri-food systems, powered by the enormous progress increasingly evident in farmers who have more options in the seeds they plant, the fertilizers they use, and in the markets seeking to purchase their produce. So far, this is just a glimpse of success, and it is still largely a fragile success dependent on decisive government support. But it offers an inspiring vision of a future Africa in which farming as a struggle to survive gives way to farming as a business that thrives.

However, despite the unprecedented decade of impressive growth across the continent, much more remains to be done to sustain these gains and truly drive the agricultural transformation needed for Africa's development and to ensure a better life for all its people as laid out in the Malabo Declaration and the Sustainable Development Goals (SDGs). Africa is still facing tremendous challenges. The continent is the world's most food insecure continent, with relatively low levels of agricultural productivity, low rural incomes, high rates of malnutrition and a worsening food trade balance. It is a region challenged by climate change, the daunting prevalence of poverty, and an urgent need for jobs. In many countries, agriculture remains the predominant sector of the economy, accounting on average for 25 percent of the GDP in SSA and well above this level for many countries. The sector makes up close to half the GDP, on average, considering the broader agribusiness sector—including input supply, processing, and market access. Therefore stronger agricultural growth can act as a powerful multiplier for economic growth.

The good news is that a vibrant agricultural sector, while not the solution to all of these problems, will clearly promote food security and economic opportunities for all Africans. In an effort to encourage countries to increase food security, reduce poverty, promote economic growth, generate employment, and create wealth through agricultural growth, AASR 2016 is therefore devoted to the theme "Towards an Agriculture Transformation in SSA".

Overview of the Report

The chapters in this report track the trends and the progress towards African agricultural transformation. They provide evidence of the progress that has been made in recent years with the Millennium Development Goals (MDGs) and the Maputo Declaration as critical benchmarks, through to the current status taking into consideration the Malabo Declaration and the projection and trajectory towards 2030 in line with the SDGs.

The documentation of Africa's agricultural transformation starts from Chapter 2 of this report. The chapter tracks the success of the Comprehensive Africa Agriculture Development Programme (CAADP) that has become the flagship of the New Partnership for Africa's Development (NEPAD). CAADP is considered the most successful continent-wide development effort in history. Its efforts to raise the profile of agriculture in Africa and the real impact made are outlined in this chapter. The chapter reviews the CAADP framework, processes, and implementation progress, analyses its achievements on the ground, and identifies challenges that need to be addressed to sustain progress and meet the more ambitious targets set by African Heads of State and Government in the 2014 Malabo Declaration for the next decade of implementation.

Chapter 3 of the report takes a comprehensive view of the major economic trends that characterize the African economic recovery and identifies policy options to consolidate, build upon and scale up the positive recent trends in economic growth, labor productivity and employment dynamics. It explores factors that have driven the economic transformation of Africa in recent years and assesses the role the agricultural sector plays to foster Africa economic transformation. The chapter views agricultural transformation as a key precursor of this broad transformation process and proposes the diversification and sophistication across agricultural value chains as a means to spur the transformation process.

Chapter 4 takes a critical look at family farms in SSA and discusses how sustainable intensification can be achieved in ways that promote resilience of the agricultural systems. Sustainable intensification is presented as one

of the pathway to food and nutrition security in SSA that can preserve the environment while enhancing social and economic welfare.

Chapter 5 takes agricultural intensification further and examines trends in agricultural productivity and intensification in SSA compared with other regions, and among countries in SSA. The chapter then uses country level data to undertake partial correlation analysis, complemented by household level data analysis for selected countries, to examine the degree of progress being made toward agricultural intensification and productivity growth. It finally discusses issues and draws conclusions to inform policies and interventions to support services and institutional arrangements aimed at increasing agricultural productivity, promoting inclusive growth and poverty reduction.

Chapter 6 presents a critical factor in agriculture transformation that leads to sustainable productivity: the ability of SSA to develop efficient and transparent marketing systems at local, regional and international levels. The chapter examines how governments may promote greater private investment in markets to reduce the costs and risks that farmers face in producing for the market and raise their incomes from farming. Some countries have made measurable progress in developing their agricultural markets. Through innovative technologies and infrastructure improvement SSA farmers are actively reducing post-harvest losses and accessing markets. But there are still major market constraints and challenges. The chapter outlines some of the underlying causes of inefficiencies and uncertainty in food markets drawing from experiences in East and Southern Africa, and then identifies strategies that African governments may consider to address these challenges.

Recent innovations in financing African agriculture are examined in Chapter 7. It begins by exploring the financial needs of the agricultural sector in Africa and the sources and instruments that have been used to address these needs. The chapter then examines several promising new ways and approaches for improving access to sustainable financial services for agriculture and agro-enterprises in Africa. The focus of the chapter is on novel approaches and products to address existing access challenges and to attract new types of investors or sources of capital to the agricultural sector.

Chapter 8 takes a critical look at the trends and developments underpinning digital technology in agriculture in countries in SSA to date. Digital technology is seen as a launch pad of the fourth industrial revolution. It has been supporting farmers in SSA along the value chain development of key cash and food crops. The chapter pays particular attention to the models that have been successful in effectively addressing the challenges faced by smallholder farmers, the policies that are helping accelerate the generation of digitalization and its use by smallholder farmers. The chapter also identifies the new interventions with potential to empower smallholder farmers, strengthen food systems, and advance rural development in SSA for the long haul.

Chapter 9 defines agricultural advisory services (AAS) and their connection with agricultural research systems to help African farmers continue to drive agricultural transformation. The chapter tracks the current status of agricultural research systems in SSA at national and regional levels and identifies key policy changes affecting the pace of the region's agricultural transformation. It argues for locally driven approaches to achieve sustainable funding of agricultural research systems in the region. The chapter also discusses key trends and several innovative approaches that are helping bridge the supply and demand mismatch in AAS. It also discusses the pace of progress toward addressing the gender gap in agricultural research and extension.

Progress towards agriculture transformation in Africa and it impact on food and nutritional security is covered in Chapter 10. The chapter explores progress that has be made to reduce malnutrition and hunger in the past and examines the current nutritional status in light of the CAADP Nutrition Initiative. Linking agriculture and food security is part of the CAADP National Agriculture and Food Security Investment Plans (NAFSIPs). Driving agricultural transformation in SSA requires a sustained effort to end hunger, achieve food security and improve nutrition. Recommendations on how to achieve this three-pronged impact are outlined in this chapter.

The final chapter of the report synthesizes the main conclusions about progress towards Africa's agricultural transformation. It provides a summary of the achievements, current status and action-oriented recommendations needed to sustain and spur the progress being made across different countries in SSA. This chapter summarizes how the 2016 AASR contributes to Africa's agricultural transformation, what drives and enables yields and adoption of technologies for transformation, how agricultural transformation raises livelihoods, nutrition, and resilience, and why evidence-based analysis is important for continued transformation.

The key findings and recommendations in this and the other chapters will hopefully contribute to new ways of doing business and a new sense of urgency to drive the achievement of the agricultural transformation agenda.

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CHAPTER 2

Strengthening the Continental Agricultural Agenda and Accountability Framework *The Road from Maputo to Malabo*

AUTHORS

Ousmane Badiane
Samuel Benin
Tsitsi Makombe
International Food Policy Research Institute

KEY MESSAGES

ONE

CAADP is an unparalleled framework for agricultural transformation that has raised the political profile of agriculture and investments in the sector. About 80 percent of African countries have embraced the CAADP agenda by adopting its principles, targets, and processes, and 30 countries have elaborated evidence-based agricultural investment plans that are guiding program implementation and investments.

TWO

The main achievements of CAADP have been through its innovations of promoting evidence-based policy planning and implementation; strengthening inclusive review, dialogue, and mutual accountability platforms, notably through joint sector reviews; promoting alignment and coordination of development partnerships in agriculture; and raising the level of agricultural expenditures by African countries albeit only a handful of countries have met the CAADP 10 percent budget target.

THREE

Preliminary analysis indicates that CAADP has had a larger and positive impact on key outcomes of agricultural expenditures and productivity, incomes, and nutrition in countries that have signed CAADP compacts, especially in those that signed in 2007–2009 compared to those that signed later or have not signed at all.

FOUR

Sustaining this progress and realizing the more ambitious Malabo agenda will require countries to redouble their efforts to effectively address remaining key challenges in terms of meeting funding targets, creating the required technical and institutional capacities, and further improving inter-ministerial coordination. Also, although participation of non-state actors has become more institutionalized, there is need to further empower and enhance the leadership role of non-state actors. Further, the absence of African centers of knowledge in the implementation of CAADP in later years has been one of the most striking shortcomings that needs to be resolved to re-establish local leadership of the CAADP technical agenda.

FIVE

Urgent effort is needed to address these limitations through strengthening required capacities at the country, regional, and continental levels so as to accelerate progress. Strengthening capacities of non-state actors will be key to ensuring their effective participation in various CAADP processes, including review and mutual accountability. Given the upcoming CAADP biennial reviews, mutual accountability processes need to be expanded to more countries while existing ones are strengthened to ensure that they are comprehensive, regular, and technically robust. Although they have increased recently, agricultural expenditures and investments need to be increased further to help meet the ambitious goals under the 2014 Malabo Declaration.

Introduction

The Comprehensive Africa Agriculture Development Programme (CAADP) is Africa's framework for agricultural sector transformation. It was ratified by African Union (AU) Heads of State and Government in 2003 in Maputo as part of the AU New Partnership for Africa's Development (NEPAD). The Maputo Declaration already signaled strong political resolve of African leaders to revitalize agriculture as a driver of economic growth, poverty reduction, and food and nutrition security. Together, NEPAD and CAADP represent a departure from externally driven development strategies and programs characterized by shifting priorities and the absence of the necessary consistency and continuity to produce solid results (Badiane & Makombe, 2015). CAADP is not a "one-size-fits-all" plan, but rather a strategic framework that provides a set of shared principles, targets, and operational milestones to guide program planning and implementation by country governments, regional economic communities (RECs), and other stakeholder groups. With very few exceptions, African countries and RECs have embraced the agenda and are applying its modalities and processes. Major innovations of CAADP include the practice of evidence-based policy and program planning and implementation linked to mutual accountability through peer review, benchmarking, and mutual learning.

The 2014 Malabo Declaration significantly expanded the CAADP agenda in terms of thematic coverage and mutual accountability requirements. In the Declaration, AU Heads of State incorporated issues dealing with reducing child under-nutrition, post-harvest losses, and vulnerabilities of livelihoods and reaffirmed their commitment to mutual accountability by calling for a continental agricultural biennial review to assess progress on commitments. The first biennial review is scheduled for the AU Summit in January 2018. With the CAADP implementation agenda now in its second decade, work is underway to incorporate commitments of the Malabo Declaration into CAADP planning, implementation and review, dialogue, and mutual accountability processes. Countries and regions are taking steps to: (i) refine existing or develop second generation national agriculture and food security investment plans (NAIPs); and (ii) establish or strengthen review processes in preparation for the first continental biennial review.

After 10 years of implementation, CAADP has made noticeable progress, but also exposed important limitations that need to be tackled to sustain and deepen its impact. This chapter assesses the achievements and limitations of the CAADP agenda and how it can be strengthened to help accelerate agricultural transformation in Africa. Specifically, the chapter assesses the importance and contribution of CAADP by examining what has been achieved so far against what the agenda set out to accomplish in the following areas: i) CAADP Round Table process; ii) evidence-based and inclusive planning; iii) review, dialogue, and mutual accountability; and iv) alignment of development efforts. The chapter also examines progress made in achieving CAADP targets, including attainment of key growth and development outcomes. It reviews what has worked well, where and why, and provides recommendations on how the agenda can be strengthened to achieve increased results effectiveness.

The chapter is organized as follows: Section 2 discusses what the CAADP agenda set out to accomplish, CAADP progress, achievements, and limitations. Section 3 examines how the agenda can be strengthened while Section 4 summarizes the key findings and way forward.

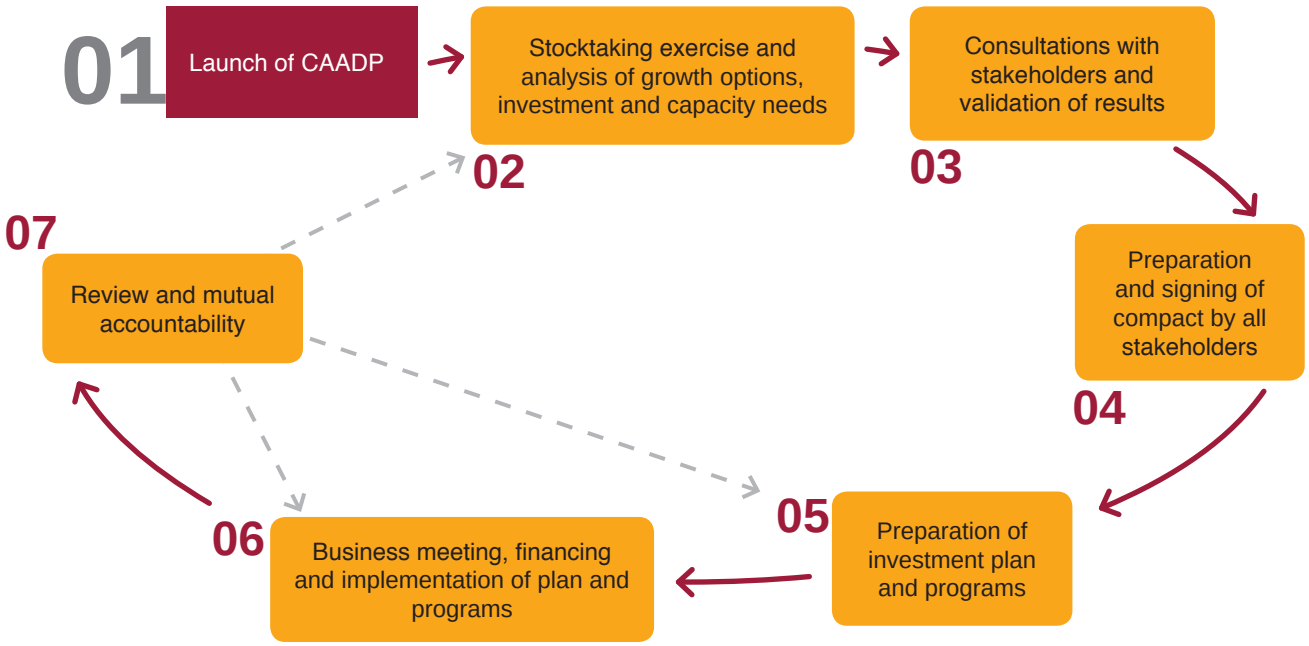
The CAADP Agenda: Implementation Progress and Achievements

CAADP represents the choice of African governments for an agriculture-led growth and poverty reduction strategy. It seeks to raise funding for the sector and improve policy practices to accelerate growth. Its core principles include African ownership and leadership, inclusivity, evidence-based planning and mutual accountability. It requires countries to follow systematic planning and implementation steps to ensure that key targets can be met (see Figure 2.1). Key CAADP targets during the first decade included, pursuing a 6 percent agricultural growth rate at the national level and allocating 10 percent of national budgets to help achieve CAADP goals and objectives. Through its Mutual Accountability (MA) Framework, CAADP promotes peer review, dialogue, and learning within countries and across regions to raise implementation effectiveness. Important MA instruments include the CAADP Partnership Platform (PP) at the continental level as well as the regular Joint Sector Reviews (JSRs) at the country and regional levels.

The Regional Strategic Analysis and Knowledge Support System (ReSAKSS), with its three regional nodes, was established in 2006 to inform CAADP MA processes. ReSAKSS provides data and knowledge products to facilitate peer review, benchmarking, and mutual learning. It helps track progress on core CAADP indicators and publishes an Africa-wide Annual Trends and Outlook Report (ATOR), the main CAADP monitoring and evaluation (M&E) report. ReSAKSS also creates MA capacities by helping to establish Strategic Analysis and Knowledge Support Systems (SAKSS) at the country level. The SAKSS platforms work with ReSAKSS to provide data and analysis in support of CAADP processes at the country level. They mobilize local centers of knowledge

Figure 2.1.Overview of the CAADP Implementation Cycle

The solid arrows represent the progression from one stage to the other; the broken arrows represent major feedback links among different stages for a dynamic process.



Source: *Benin (2016)*

to carry out the required data and analytical work to help meet the technical needs of planning, review, and dialogue activities of the CAADP agenda at the country level.

Recognizing the need to go beyond the initially narrow focus on the dual expenditure and growth targets, the CAADP agenda was significantly expanded through the 2014 Malabo Declaration. While reaffirming the principles, values and targets set at Maputo, the Declaration added ambitious commitments on ending hunger, reducing child malnutrition, and halving poverty by 2025, tripling intra-African trade, enhancing resilience in livelihoods and production systems to climate variability and other shocks, and mutual accountability to actions and results (African Union, 2014). To help translate Malabo commitments into implementable programs, the African Union Commission (AUC) and the NEPAD Planning and Coordinating Agency (NPCA) have developed a CAADP Implementation Strategy and Roadmap (IS&R), Program of Work, Results Framework, and guidelines for appraising existing and formulating second generation NAIPs.

CAADP Implementation Process: Progress and Lessons for Malabo

Progress in Moving CAADP from Strategy Framework to Implementation

In terms of approach, CAADP has sought to build on ongoing efforts in countries rather than setting up a parallel process. A good indicator of progress is where countries and RECs stand on various stages of the implementation process and in achieving key milestones. As of March 2016, about 80 percent of AU member states (42 out of 54) had held CAADP Round Table meetings and signed compacts. Of these, 30 had gone on to elaborate NAIPs and have them technically reviewed and validated. And 26 of the 30 countries had held a CAADP business meeting to discuss implementation and financing modalities for the NAIPs (Bahiigwa et al, 2015).

At the regional level, the Economic Community of West African States (ECOWAS) has made the most progress in advancing implementation; it is the only REC where all member states (15 in total) have gone all the way to approving investment plans and holding business meetings.

ECOWAS is the first REC to sign a regional compact and hold a technical review and business meeting. It took necessary steps to align the ECOWAS Agricultural Policy (ECOWAP) to CAADP, as it saw an opportunity to complement national CAADP efforts and advance the regional agricultural agenda in terms of increasing agricultural productivity and trade competitiveness. More importantly, within a year ECOWAS allocated US$9 million of its own budget to finance the regional compact and CAADP planning processes in all its 15 member states. Recently, ECOWAS initiated the establishment of the first-ever regional JSR. Although the Economic Community of Central African States (ECCAS) became actively engaged in the process late (2012), all 10 of its member states have signed compacts and all but 2 have held business meetings. In 2013, ECCAS signed its regional compact and elaborated its regional agricultural investment plan (RAIP) which underwent a technical review. A total of 15 out of 20 Common Market for Eastern and Southern Africa (COMESA) member states, 12 out of 15 Southern African Development Community (SADC) member states, and 1 out of 5 Arab Maghreb Union (UMA) member states have signed compacts. The other RECs signed their regional compacts as follows: the Intergovernmental Authority on Development (IGAD) in 2013 and COMESA in 2014. The development of RAIPs is at varying stages in COMESA, SADC, the East African Community (EAC), and IGAD. UMA has not fully engaged in the CAADP process.

The mixed progress across regions reflects, in part, the operational challenges faced by RECs and the different political and financial environments in which they operate. The mandate of RECs to coordinate the implementation process has not always been recognized in all regions (AU/NEPAD, 2010). The CAADP implementation process at the regional level has also been challenged by failures to harmonize CAADP with both existing and new regional initiatives and programs in the agricultural sector (Kimenyi, Routman, Westbury, Omiti, & Akande, 2012). Delays in the implementation process are also symptomatic of limited technical and institutional capacities at the continental, regional, and country levels. For example, the AUC has had limited technical support to facilitate the process; COMESA relied on one main regional CAADP coordinator to service 20 member states; and countries often relied on one CAADP focal point person for overall coordination.

ECOWAS and ECCAS have had well-coordinated processes to advance CAADP implementation at both the country and regional levels. ECOWAS established a special task force under the leadership of its Commissioner for Agriculture, provided financial resources (as indicated earlier) to each member state to advance implementation, and commissioned the International Food Policy Research Institute (IFPRI) and a team of regional experts to provide the necessary technical assistance. In ECCAS, implementation was coordinated through the Office of the Director of Agriculture with financial support from the CAADP Multi-donor Trust Fund (MDTF) established at the World Bank and technical assistance from IFPRI and FAO. COMESA has also made good albeit slow progress in coordinating the implementation process among its member states. It put in place a CAADP reference group to guide and oversee implementation and helped countries mobilize financial resources and technical expertise through the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN).

Some may link the acceleration of the implementation process from 2009 to the establishment of MDTF and the Global Agriculture and Food Security Program (GAFSP) at the World Bank. However, MDTF has not provided funding to support countries and by the time it became operational and GAFSP came to life, nearly all countries in West Africa had already signed their compacts. Second, the small group of countries that rushed to apply to GAFSP without following the CAADP roadmap failed to secure funding. The real boost to CAADP implementation came from the decision by ECOWAS to allocate its own resources to fund the planning process in all its member states.

CAADP has been particularly successful in raising the profile of agriculture and reclaiming African ownership and leadership of the strategic agenda in the agricultural sector. It has done so by promoting the transition to evidence-based planning and implementation and thereby increased the technical credibility of the agenda itself at the global level and of national agricultural strategies and programs at country level (Badiane, Odjo & Ulimwengu, 2011).

MA and the creation of platforms for review, benchmarking, and learning, notably ReSAKSS, are key areas of innovation and success under CAADP. MA is operationalized through the annual meetings of the CAADP PP at the continental level and the agriculture JSR at the country and regional levels. The CAADP PP was launched in 2006 and meets once a year. The Malabo Declaration directs AUC to carry out biennial reviews to report on progress, using the JSR process. For that purpose, the post-Malabo IS&R calls for the establishment and strengthening of JSR platforms in at least 70 percent of countries by 2020 and in all countries by 2025 (African Union, 2015a). Since 2014, ReSAKSS and Africa Lead have assisted 30 countries to establish comprehensive, inclusive, and technically robust JSR processes, and recently ReSAKSS helped ECOWAS launch the establishment of the first-ever regional JSR. ReSAKSS has also helped establish 10 SAKSS platforms to support CAADP review and benchmarking at the country

level. The success of ReSAKSS is best illustrated by the fact that it is being emulated in other developing regions. ReSAKSS-Asia and ReSAKSS-Latin America are adapted versions that are being supported by IFPRI in South Asia and Central America.

CAADP has improved alignment by global development agencies with country priorities and increased funding for agriculture. In 2009, G8 leaders issued the L'Aquila Joint Statement on Global Food Security, committing: "…to provide resources in support of the CAADP and other similar regional and national plans" and pledging to mobilize US$2O billion to support agricultural and food security (G8, 2009). Following the statement, the Global Donor Platform for Rural Development (GDPRD) issued the "Guidelines for Donor Support to CAADP Processes at the Country-Level". The MDTF was established at the World Bank to support CAADP implementation activities by countries, RECs, and lead pillar institutions—charged with elaborating guidance frameworks for the four mutually reinforcing pillars of CAADP. GAFSP was subsequently established following the 2009 Pittsburgh G20 meeting to provide funding for NAIPs. To date, GAFSP has approved funding for 17 African countries to the tune of US$611 million.

All these global initiatives have been strongly influenced by CAADP. For example, to qualify for GAFSP funding, African countries need to have completed the CAADP process illustrated by a technically reviewed investment plan. Countries in other developing regions are required to have CAADP-like processes to qualify for funding. This a testament to the far reaching effect of CAADP on the global agricultural and food security agenda, the first-ever development model conceived in Africa to have been espoused by countries outside of the continent.

More recent initiatives in support of CAADP include the New Alliance for Food Security and Nutrition (New Alliance) and Grow Africa. Grow Africa was launched in 2011 by the AU, NEPAD and the World Economic Forum to raise private sector investments in agriculture and accelerate the implementation of investment plans. Under the New Alliance Cooperation Frameworks, governments have committed to pursue policies that create a competitive environment for private sector investment and contribute to inclusive growth and development. Meanwhile development partners and the private sector have committed to, respectively, provide nearly US$6 billion to support CAADP investment plans and pursue investments in agriculture and food security that maximize benefits to smallholder farmers.

Governments have made progress in implementing policy reforms dealing with inputs, sector institutions, and resilience and risk management (African Union, 2015b). Meanwhile, US$3.2 billion has been disbursed by development partners to the 10 New Alliance countries and the private sector has invested $2.3 billion since 2013 out of the more than $10 billion pledged (Grow Africa, 2016).

Implementation Challenges and Lessons

Notwithstanding the progress highlighted, JSR assessments facilitated by ReSAKSS reveal that the quality and pace of CAADP implementation have fallen short of the measures required for substantial and sustained progress in several countries. Key obstacles to faster progress are observed in the following areas:

Meeting required funding levels: Although nearly all countries have significantly increased funding to agriculture, only 5 have met the CAADP 10 percent budget share target during 2008–2014. It is therefore not surprising that most NAIPs have not been fully funded. This is compounded by slow and weak implementation and hence slow disbursement of funds, as revealed in country JSR assessment reports.

Capacities for technical analysis and M&E: Program implementation has also been hindered by limited staff and technical capacities. In most countries, capacity limitations are more profound at local levels (regional and district). For example, in Ghana the ratio of agricultural extension agents to farmers is 1:1,500 compared to a more ideal ratio of 1:400 (MoFA, Ghana, 2014). And in Senegal, the capacity issues are compounded by the fact that a large proportion of technical staff are approaching retirement age (MARE, Senegal, 2014). The two examples are symptomatic of impediments that are not unique to these two countries, pointing to an urgent need to build capacity and raise the number of technical experts to provide the required technical guidance to boost agricultural sector growth and transformation. Many countries still lack the capacity for collecting timely and reliable data, and the analytical skills needed to inform and guide program planning and implementation. In nearly all cases, not enough effort is made to effectively mobilize existing local expertise. The SAKSS platforms discussed earlier are seeking to help address some of these data and capacity challenges.

Aligning sector priorities and budget allocations: Countries have not always allocated budget according to NAIP priorities or areas that generate the most returns in terms of growth and other development outcomes (Benin, Nin-Pratt, & Wood, 2016). Moreover, uneven policy and program priorities create challenges for overall implementation. For instance, the growing popularity of often poorly targeted input subsidies claim large shares of

agricultural budgets, taking resources away from critical areas such as research and development, capacity building, private sector development, agricultural diversification, and value chain development.

Adequate inter-ministerial coordination: Agricultural sector programs span different ministries and their implementation requires effective coordination. JSR assessments revealed weak coordination between ministries of agriculture and other key line ministries such as health. Poor inter-ministerial coordination can lead to ineffective institutional partnering and implementation of cross-cutting sector policies. Nonetheless, countries are enacting plans to enhance coordination and while agricultural sector working groups are attempting to bridge the gap, participation of non-state actors and other technical ministries still needs to be strengthened in many countries.

Strong MA processes: For MA processes to be effective at steering implementation toward desired goals, they need to be grounded in strong evidence, anchored by adequate technical and institutional capacity. Recent assessments carried out in several countries identified several areas requiring urgent improvement, such as systematic implementation and tracking of JSR action plans, creation of minimum data and M&E capacities in ministries of agriculture, especially at the sub-national level, and the quality of review documents. At continental level, there is significant need to increase the quality of planning, content, and guidance of deliberations of the CAADP PP to allow it to realize its full potential as an effective MA forum.

Effective participation and inclusivity: Although the participation of non-state actors has become more institutionalized in CAADP processes, representation and active participation of non-state actors is generally weak across many countries. For example, JSR participation is usually by those in the capital city while non-state actors do not actively participate due to poor capacity and inadequate planning of the JSR (MAFC, Tanzania, 2014; MoFA, Ghana, 2014). Also, some review processes such as in Ethiopia are dominated by government and development partners with virtually no participation by the private sector, civil society organizations, and non-governmental organizations (MoA, Ethiopia, 2014).

Nonetheless, as the role of non-state actors has become more institutionalized, the CAADP Non-State Actor Coalition (CNC) was launched in March 2015, formalizing a platform that brings together non-state actors to support CAADP planning, implementation and mutual accountability processes. The CNC is already active in key CAADP activities, including the CAADP PP, the JSRs, and New Alliance reviews. The Coalition currently comprises more than 100 organizations from 45 countries and is expected to grow (FTF, 2015). Its role and responsibility need to be further expanded so as to allow CNC to operate as a co-owner of the review and dialogue processes, not just a mere participant.

Moving forward with implementation of Malabo commitments requires drawing lessons from the above challenges and limitations and devising ways to overcome them. In particular, accelerating progress toward the still relevant Maputo budget target will be critical to realizing the significantly more ambitious Malabo agenda. The returns to higher expenditure in the sector will depend not only on the quantity but also on the quality of investments, hence the need to tackle the capacity constraints that have affected progress under Maputo. Enhancing planning and execution capacities will also help overcome impediments linked to weak program alignment, consistency, and coherence. The mandated biennial review is an important move that will allow countries to build on the advances realized in the area of MA and inclusivity to raise the quality of program and policy coordination.

Progress in Achieving Key CAADP Targets and Outcomes [1]

This section analyzes trends in several key indicators to show progress in achieving the two main CAADP targets (10 percent agriculture expenditure and 6 percent agricultural growth) and related outcomes including productivity, income, poverty, and food and nutrition security. The analysis here does not make any attribution to CAADP, except to provide a sense of Africa's status with regard to these indicators before and after the launch of CAADP in 2003. An indication of the effect of CAADP on the indicators is presented in the subsequent section. The results in this section are presented at an aggregate level for the entire continent and for four categories of countries constructed based on three factors:

[1] The analysis in this section draws heavily from Bahiigwa et al, 2015.

[2] Analysis of the trends by other country categories can be found in Bahiigwa et al. (2015). These include: Africa south of the Sahara; the five AU geographic regions (Central, Eastern, Northern, Southern, and Western); and the eight RECs (Community of Sahel-Saharan States (CEN-SAD), COMESA, EAC, ECCAS, ECOWAS, IGAD, SADC, and UMA).

agricultural potential, alternative (or non-agricultural) sources of growth, and income level (Benin et al., Kennedy, Lambert, & McBride, 2010). The categories reflect the notion that different countries, depending on their resource endowments and stage of development, are on different trajectories toward achieving their development objectives (Diao, Hazell, Resnick, & Thurlow, 2007)[2]. They include: low-income countries with less favorable agricultural conditions, low-income countries with more favorable agricultural conditions, low-income countries with mineral-rich economies, and middle-income countries. Three sub-periods are considered: 1995–2003, representing the baseline period; 2003–2008, representing the periods up to the initial CAADP end date of 2008; and 2008–2014, representing the period up to the year when the Malabo Declaration was made.

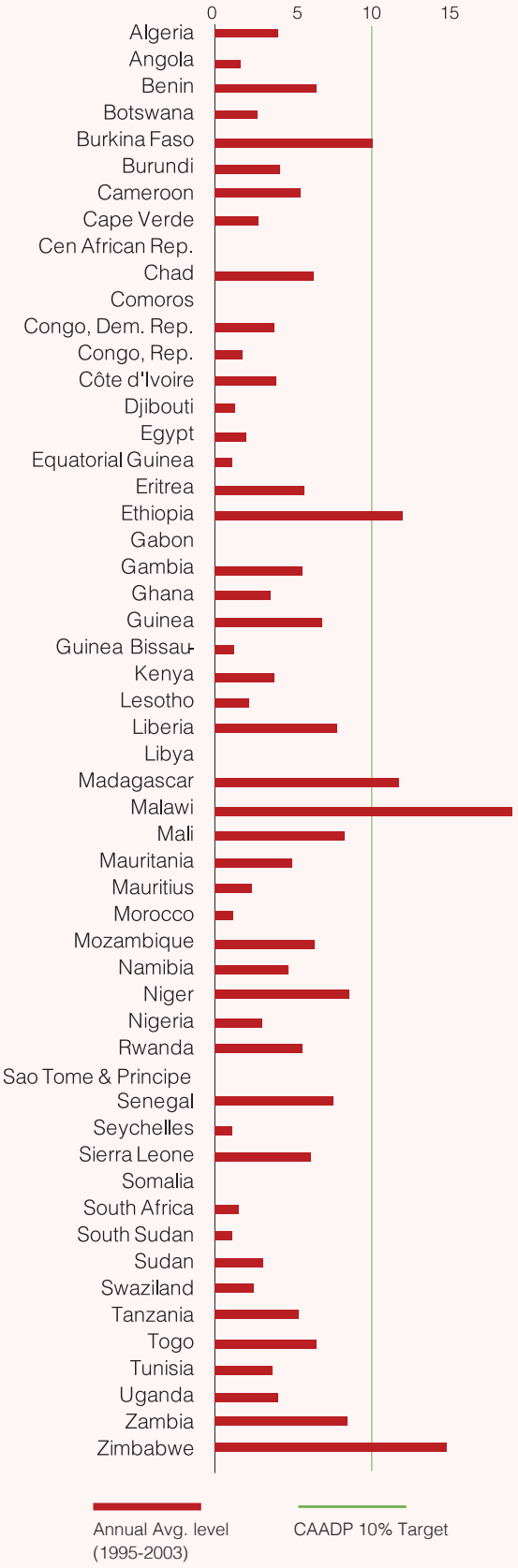
Public Agriculture Expenditure

The volume of public agriculture expenditure by African countries has increased tremendously over the last 20 years. The country average in Africa increased from $128.55 million in 1995–2003 to $186.4 million in 2003–2008, and to $219.62 million in 2008–2014 (Table 2.1). The slower growth in public agriculture expenditure in 2008–2014, 2.3 percent vs. 6.6 in 2003–2008, reflects the considerable impact of the global food and financial crises on both fiscal revenues and Official Development Assistance (ODA). Although the volume of public agriculture expenditure has increased over time, the amount spent as a share of total public expenditure has been less than 4 percent per year for Africa as a whole, far short of the CAADP target of 10 percent. The shares were higher for the low-income groups (e.g. 5.1–7.5 percent in 2008–2014) than for the middle-income group (2.5 percent). This is because middle-income countries with non-agricultural sources of growth and development may be shifting emphasis to sectors with larger returns (Benin, 2013). Since 2003, only 13 countries in Africa have managed to surpass the 10 percent target in any year (Benin & Yu, 2013) and only 5 did so more recently in 2008–2014 (see Figure 2.2). In contrast, spending intensity, i.e. the amount spent as a share of total agricultural GDP, rose faster during the post-CAADP period, from 5.1 percent in 1995–2003 to 6.1 in 2003–2008, before declining slightly to 5.8 percent during 2008–2014, but still higher than the pre-CAADP period. Comparing the different groups, spending intensity was lower for the low-income group (e.g. 3.7–6.1 percent in 2008–2014) than for the middle-income countries (6.2 percent).

Data on expenditure in different areas (e.g., research, irrigation, extension, marketing, infrastructure, farm-support subsidies, etc.) are not as comprehensive as they are for total public agriculture expenditure. For example, aside from the Agricultural Science and Technology Indicators (ASTI) database (IFPRI, 2015a), which has data on agricultural research expenditure for 37 African countries, there are no similar time-series, cross-country databases on the other major types of agricultural public spending. The Monitoring African Food and Agricultural Policies

Figure 2.2: Progress in meeting CAADP 10 percent target

Agriculture expenditure as share of total expenditure (%)



Source: *ReSAKSS (2015)*

Table 2.1.:Trends in selected CAADP indicators, annual average						
Indicator	**1995–2003**		**2003–2008**		**2008–2014**	
Region/economic group	**Level**	**Change (%)**	**Level**	**Change (%)**	**Level**	**Change (%)**
Agriculture expenditure (million 2005 US$)						
Africa	128.55	6.07	186.47	6.60	219.62	2.32
Low-income less-favorable agriculture	40.62	2.63	57.05	3.37	61.40	6.11
Low-income more-favorable agriculture	72.10	1.96	109.91	8.68	154.56	3.00
Low-income mineral-rich	27.52	1.86	40.95	19.82	89.55	12.55
Middle income	213.95	7.57	309.10	5.87	340.93	1.21
Agriculture expenditure (% of total expenditure)						
Africa	3.31	2.99	3.54	-2.04	2.97	-1.38
Low-income less-favorable agriculture	8.49	-2.40	8.90	-1.22	7.05	-1.14
Low-income more-favorable agriculture	6.77	-3.47	7.23	3.08	7.23	-4.45
Low-income mineral-rich	4.66	6.93	4.60	10.82	5.71	0.04
Middle income	2.89	4.42	3.11	-3.05	2.46	-1.79
Agriculture expenditure (% of agricultural GDP)						
Africa	5.14	3.95	6.11	2.56	5.79	-0.66
Low-income less-favorable agriculture	5.01	-0.51	4.93	-7.64	3.71	0.97
Low-income more-favorable agriculture	4.19	1.56	5.29	2.09	5.00	-4.36
Low-income mineral-rich	2.23	7.07	3.61	15.37	6.07	6.47
Middle income	5.66	4.14	6.58	3.01	6.23	-0.02
Agricultural GDP (billion 2005 US$)						
Africa	2.36	2.83	2.91	3.77	3.59	2.61
Low-income less-favorable agriculture	0.73	3.17	1.07	11.72	1.47	5.01
Low-income more-favorable agriculture	1.72	0.42	2.07	6.45	3.10	6.98
Low-income mineral-rich	1.21	-3.64	1.11	3.86	1.39	3.17
Middle income	3.50	3.99	4.39	2.57	5.10	1.10
Agricultural GDP per worker (2005 US$)						
Africa	699.35	0.76	755.33	1.61	832.45	0.61
Low-income less-favorable agriculture	379.89	-0.35	449.20	8.47	530.75	2.22
Low-income more-favorable agriculture	260.61	-2.18	261.62	3.65	341.27	4.88
Low-income mineral-rich	366.82	-5.12	299.57	1.91	336.35	1.19
Middle income	1,572.73	3.02	1,861.39	1.60	2,045.62	0.08
Agricultural GDP per ha (2005 US$)						
Africa	595.49	2.20	684.08	2.26	783.04	0.88
Low-income less-favorable agriculture	230.12	1.86	306.54	9.76	378.94	2.51
Low-income more-favorable agriculture	426.81	-1.16	438.90	3.29	560.43	3.96
Low-income mineral-rich	489.68	-4.16	417.45	2.95	472.24	0.35
Middle income	771.23	3.95	938.54	1.87	1,067.98	0.51
GDP per capita (2005 US$)						
Africa	987	1.24	1,154	3.54	1,289	1.27
Low-income less-favorable agriculture	311	1.04	370	3.16	412	1.99
Low-income more-favorable agriculture	306	0.68	371	3.22	401	3.66
Low-income mineral-rich	392	1.54	509	3.47	555	3.50
Middle income	1,500	1.57	1,909	3.85	2,013	1.15

Table 2.1: Trends in selected CAADP indicators, annual average						
Indicator	**1995–2003**		**2003–2008**		**2008–2014**	
Region/economic group	Level		Change (%)		Level	
Africa	45.5	-1.34	42.0	-1.36	38.2	-1.42
Low-income less-favorable agriculture	71.7	-3.60	57.4	-3.33	48.3	-3.25
Low-income more-favorable agriculture	60.1	-1.78	49.8	-1.61	47.3	-1.98
Low-income mineral-rich	63.8	-0.92	59.0	-1.46	55.9	-1.59
Middle income	32.7	-0.68	30.5	-0.54	29.8	-0.74
Poverty gap at national poverty lines (%)						
Africa	15.5	-1.79	14.0	-1.46	12.5	-2.64
Low-income less-favorable agriculture	26.3	-3.13	20.4	-4.42	15.3	-6.10
Low-income more-favorable agriculture	17.3	-2.46	13.4	-2.46	12.5	-3.85
Low-income mineral-rich	25.8	-3.70	19.8	-1.70	18.6	-5.85
Middle income	13.1	-1.08	12.1	-0.45	11.5	-1.63
Prevalence of undernourishment (% of population)						
Africa	24.3	-2.15	20.3	-3.56	17.6	-1.96
Low-income less-favorable agriculture	32.4	-4.59	24.6	-2.71	20.5	-3.82
Low-income more-favorable agriculture	41.2	-2.18	32.5	-3.47	30.3	-2.18
Low-income mineral-rich	36.1	1.97	36.1	-1.12	34.5	-1.98
Middle income	12.3	-3.02	8.5	-5.55	7.6	-1.55
Prevalence of underweight, weight for age (% of children under 5)						
Africa	24.6	-1.24	22.2	-1.66	20.6	-0.70
Low-income less-favorable agriculture	32.3	-1.09	31.0	-0.51	31.0	0.45
Low-income more-favorable agriculture	27.4	-2.04	22.4	-1.99	21.3	-1.36
Low-income mineral-rich	28.6	-1.08	23.8	-1.69	22.6	-1.59
Middle income	20.5	-0.86	18.2	-1.80	17.6	-0.30
Prevalence of stunting, height for age (% of children under 5)						
Africa	42.0	-1.10	39.1	-0.96	36.6	-1.02
Low-income less-favorable agriculture	45.4	-0.24	45.1	-0.11	45.4	0.50
Low-income more-favorable agriculture	48.5	-1.60	42.1	-1.60	40.6	-1.00
Low-income mineral-rich	47.4	-1.12	43.8	-0.85	42.9	-0.55
Middle income	35.8	-0.99	31.7	-0.71	30.4	-1.69
Prevalence of wasting, weight for height (% of children under 5)						
Africa	10.9	-1.26	10.0	-0.31	9.4	-0.15
Low-income less-favorable agriculture	15.7	-3.84	13.1	-2.23	12.4	-0.59
Low-income more-favorable agriculture	9.2	-1.71	8.0	-1.50	7.7	-0.27
Low-income mineral-rich	13.1	0.09	9.8	-1.73	8.8	-2.97
Middle income	10.6	-0.79	10.3	1.25	10.3	0.62

Source: *Bahiigwa et al. (2015)*

(MAFAP) database on nine countries in SSA from 2006 to 2013 covers different categories of agriculture-specific and agriculture-supportive expenditure (FAO, 2015).

NEPAD also has set a national agricultural R&D investment target of at least one percent of agricultural value-added. Close to 40 percent of the 37 countries covered in SSA in the ASTI database met that target, with Botswana, followed by Mauritius, Namibia, and South Africa having the highest shares of at least 2 percent per year (Benin, Nin-Pratt,&Wood, 2016), all of which have relatively well-established and well-funded agricultural research systems and relatively small contributions of agriculture to GDP (Beintema &Stads, 2011).

MAFAP data from 2006 to 2013 show that 30–40 percent of the total annual agricultural expenditure by countries in their database went to subsidies, except in Kenya where it was very low and Malawi where it was very high (Benin, McBride, & Mogues, 2016). Spending on irrigation, extension, and marketing were next in line, with irrigation dominating in Burkina Faso and Mali, extension in Ethiopia, Kenya, Tanzania and Uganda, and marketing in Ghana and Mozambique.

Agricultural Production and Productivity

In this section, the analysis focuses on agricultural growth rate, and labor and land productivity. Agricultural sector growth in Africa increased remarkably between 1995–2003 and 2003–2008, expanding at an annual rate of 3.8 percent, although this was still lower than the CAADP target of 6 percent (Table 2.1). However, several countries surpassed the 6 percent target during different periods and 15 did so during 2008–2014 (see Figure 2.3). The rate of growth decreased to 2.6 percent during 2008–2014, largely because of poor performance in the middle-income group, where the annual average rate was 1.1 percent during that period compared to the range of 3.2–7.0 percent for the low-income groups. Labor productivity (measured as agriculture value-added per agricultural worker) and land productivity (measured as agriculture value-added per hectare of arable land) have risen over the last 20 years across Africa as a whole, with variations in different parts of the continent. Labor productivity grew faster during 2003–2008, at 1.6 percent per year, than during 2008–2014, when it grew by 0.6 percent per year. Among the four economic groups, the highest labor productivity was recorded in the middle-income group and lowest in the more-favorable and mineral-rich low-income groups, largely because of higher rates of mechanization in the middle-income group. Land productivity exhibits trends similar to those of labor productivity. The much lower labor and land productivities in the low-income groups indicate that most parts of Africa still have great potential to double or even triple existing productivity levels.

Income

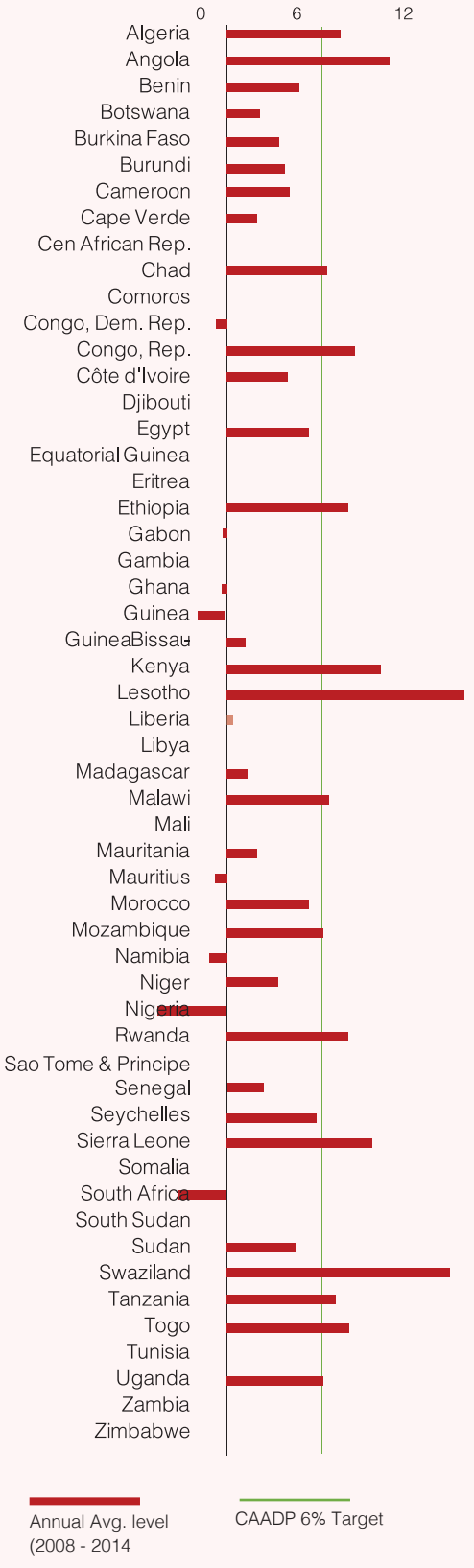
Income, measured by GDP per capita, increased in Africa as a whole from an annual average of US$987 in 1995–2003, to $1,154 in 2003–2008, and even higher in 2008–2014, when it reached an annual average of $1,289 (Table 2.1). Although income increased consistently in all four economic groups, the average levels reached were three to five times higher in the middle-income group than in the low-income groups. During 2008–2014, the rates of growth in income slowed, especially in less-favorable and middle-income groups, which grew by 2 and 1 percent per year respectively due to the ripple effects of the fuel and financial crises of 2007 and 2008.

Poverty

In Africa as a whole, the incidence of poverty has been declining, along with its depth, as measured by the poverty gap index, which declined from 15.5 percent in 1995–2003 to 12.5 percent in 2008–2014 (Table 2.1). Despite the slowdown in income growth during 2008–2014,

Figure 2.3: Progress in meeting CAADP 6 percent target

Annual agriculture value added growth (%)



Source: *ReSAKSS (2015)*

poverty fell faster during this period, at an annual rate of 2.6 percent, than during 2003–2008, at 1.5 percent per year, with the low-income less-favorable group experiencing the greatest improvement. The poverty gap index indicates the resources that would be needed to bring the poor out of extreme poverty and up to the poverty line, with the low-income mineral-rich group needing the most and the middle-income group needing the least. In Africa as a whole, the headcount poverty rate at the international poverty line of $1.25/day has dropped moderately but consistently from 45.5 percent in 1995–2003 to 42.0 percent in 2003–2008, and to 38.2 percent in 2008–2014. Incidence of poverty in 2008–2014 was lowest in the middle-income group at 29.8 percent and highest in the mineral-rich group at 55.9 percent. In general, poverty reduction appears to be accelerating, as the average annual percentage reduction in poverty during 2008–2014 was greater than the annual average reduction during 2003–2008 and 1995–2003, with varied performances among the economic groups.

Hunger and Food and Nutrition Security

Measures of hunger and food and nutrition security (undernourishment, underweight, stunting, and wasting) are also improving across Africa, albeit very slowly (Table 2.1). The prevalence of undernourished population showed continuous decline over the last 20 years, although the rates of decline were lower during 2008–2014 than during 2003–2008. More-favorable and mineral-rich groups had higher levels of undernourishment. Regarding the three measures of malnutrition in children under five years of age (underweight, stunting, and wasting), stunting is most severe with 36.6 percent of all children being affected in 2008–2014, compared to 20.6 percent for underweight, and 9.4 percent for wasting. For all three measures, the less-favorable group not only had the highest levels, but also experienced a rise in incidence in 2008–2014.

Relationship between public agriculture expenditure and outcomes

Public spending is in general justified primarily to address economic inefficiencies due to market failures, and inequality in the distribution of goods and services due to differences in initial allocation of resources across different groups and members of society. Because of competing needs, however, the CAADP 10 percent expenditure target is continuously debated. Although available evidence clearly shows the importance of doubling efforts to meet the Maputo target and improve the consistency of public investment in the agricultural sector (see e.g, Diao, Thurlow, Benin, & Fan, 2012), the demand for knowledge on the impacts of public agriculture expenditure in Africa is high. Mogues, Fan and Benin (2015), for instance, provides a summary of findings on the impacts of different types of public spending in and for agriculture globally.

They show that: (1) different types of public agriculture expenditure have different effects on different outcomes, and that some types of expenditures may not be productive at all; (2) different effects take different times to materialize; and (3) effects are different in different locations, reflecting the influence of conditioning factors.

Specifically for Africa, evidence from different studies on the relationship between different types of agriculture

Table 2.2: Estimated elasticities, rate of return (ROR), and benefit-cost ratio (BCR) of different types of agricultural expenditure in Africa

Source	Years of expenditure data	Outcome variable and measure	Type or measure of expenditure	Elasticity	ROR or BCR	Region or country	Number of countries/ units
Evenson (2001)			Research		Mean ROR = 43%	Africa	441
Thirtle, Piesse and Lin (2003)	1980–1995	agGDP/ha	Research	0.36	ROR = 22%	SSA	22
Fan, Yu and Saurkar (2008)	1980–2002	Agricultural output index	Research	0.04	n.e.	Africa	17
Fan and Zhang (2008)	1982–1999	Household agricultural output per capita	Research and extension	0.19	BCR = 12.4	Uganda	1
Alene and Coulibaly (2009)	1980–2003	agGDP/ha	National and CGIAR research	0.38	ROR = 55%	SSA	27
			National research	0.17	n.e.		
			CGIAR research	0.21	n.e.		

Continued on page 38

Alene et al. (2009)	1971–2005	agGDP	National and CGIAR maize research	n.e.	ROR = 43%	West and Central	8 to 12
Meenakshi et al. (2010)	n.a.	DALY $ saved	Biofortification research, breeding, maintenance, etc.	n.e.	BCR = 2 to 66	SSA	5
Fan, Nyange and Rao(2012)	1986–1999	Total household income	Research	n.e.	BCR = 12.5	Tanzania	1
Fuglie and Rada (2013)	1961–2006	TFP	National research	0.04	ROR = 24% to 29%	SSA	28
			CGIAR research	0.04	ROR = 55%		
Evenson (2001)	n.a.	n.a.	Extension	n.a.	Mean ROR = 30%	Africa	101
Benin et al. (2011)	2001–2007	Household revenue per capita	Extension	n.e.	ROR = 8% to 49%	Uganda	1
Wellard, Rafanomezana, Nyirenda, Okotel and Subbey(2013)	2004–2008	Staple crops	Extension	n.e.	BCR = 7.7	Ghana	1
	2002–2011				BCR = 6.8 to 11.6	Malawi	1
	2004–2008				BCR = 14.2	Uganda	1
Fan and Zhang (2008)	1982–1999	Household agricultural output per capita	Feeder roads	n.e.	BCR = 7.2	Uganda	1
Tyler and Dixie	1948–1997	Equity value	Agroprocessing	n.a.	ROR > 12%		112
(2013)					ROR = 0 to 12%		112
					ROR = -25% to 0%		92
					ROR < -25%		532
Inocencio et al. (2007)	1967–2003		Irrigation, new		ROR = 11%	SSA	452
	1967–2003		Irrigation, rehab		ROR = 14%		
	1970s		Irrigation, rehab		ROR = 4%		
	1980s		Irrigation, rehab		ROR = 13%		
	1990s		Irrigation, rehab		ROR = 22%		
	1967–2003		Irrigation, new		ROR = 14%	North Africa	392
	1967–2003		Irrigation, rehab		ROR = 17%		
Fan, Yu and Saurkar (2008)	1980–2002	Agricultural output index	Non-research	-0.07	n.e.	Africa	17
Fan, Yu and Saurkar (2008)	1980–2002	Agricultural output index	Total agriculture	0.08	n.e.	Africa	17
Mogues (2011)	1993–2001	Household consumption expenditure per capita	Total agriculture	0.04 to 0.06ns	n.e.	Ethiopia	1
Benin,Mogues, Cudjoe and Randriamamonjy (2012)	2002–2006	Household agricultural output per capita	Total agriculture per capita	0.22 to 0.26	BCR = 3.5 to 4.2	Ghana	1

Source: *Benin (2015b)*

expenditure (research, extension, irrigation, marketing, infrastructure, farm support subsidies) and growth and other development outcomes is summarized in Table 2.2 (for detailed discussion,see Benin 2015a, 2015b). It shows that different types of agriculture expenditure are positively and significantly related to agricultural growth and many other development outcomes.

However, it is difficult to identify and prioritize high-impact components of agricultural expenditures in a comprehensive and consistent manner. This is because the underlying studies vary in many aspects (including methodology, country and time-series coverage, and level and measure of expenditure and impact indicators), which limits their comparability for ranking different types of expenditures, and for understanding how the impacts have evolved over time.

A study by Fan, Gulati and Thorat (2008) in India provides an example of the nature of evidence that is extremely useful for prioritizing investments. In that study, they estimate the returns in terms of agricultural GDP and poverty reduction to public expenditure in agricultural R&D, irrigation, and fertilizer and credit subsidies as well as expenditure on rural roads, education, and power. The returns are estimated for different periods of time, 1960s-1970s, 1980s, and 1990s. The results thus offer a rich comparative analysis of temporal returns to expenditure within and across agricultural and non-agricultural sectors, with the inter-temporal differences suggesting a shift in priorities over time. For example, expenditure on roads, education, and R&D have the largest returns, whereas expenditure on fertilizer and power subsidies have the lowest returns; subsidies on credit outperform subsidies on irrigation, fertilizer and power. Subsidies on credit are among the top two or three highest ranked within the agriculture expenditure portfolio, suggesting that some forms of subsidies are indeed favorable.

Effect of CAADP on Agricultural Spending, Growth, and Other Outcomes

How has CAADP contributed to the above trends and performance in the different indicators? Answering this question fully is beyond the scope of this paper. Preliminary results of ongoing analysis to address this question show that CAADP has made significant contributions to the achievements described above (Benin, 2016). In this section, we use analysis of means and variances in several of the above indicators across different groups of countries categorized according to two definitions of CAADP implementation: (1) three groups of countries depending on when they signed their CAADP compact, whether in 2007–2009, 2010–2012, or 2013–2014, as opposed to those that had not signed a compact by the end of 2014; and (2) five groups of countries depending on the level of implementation reached by 2014, those yet to start or at the pre-compact stage—level 0, those that have a compact only—level 1, those that have a NAIP but have not secured any external funding—level 2, those that have a NAIP and have secured external funding from one source only—level 3, and those that have secured external funding from more than one source—level 4 (see Table 2.3)[3]. This method is a simplified difference-in-difference approach in which the basic result is interpreted as the percentage change in the outcome in countries that are implementing CAADP compared to the general change in the outcome in countries that are not implementing CAADP. For countries that are implementing CAADP, the result is differentiated and interpreted as the relative effect of signing a compact in the different periods or reaching different levels of implementation[4]. Because the implementation of CAADP involves several processes that take time to be institutionalized, whose effect in turn take time to materialize, we expect the effect of CAADP to be larger for those that signed their compact earlier than later and, similarly, for those that have reached higher than lower levels of implementation.

Tables 2.4 and 2.5 show the average annual percentage change in the value of different indicators over the 2003–2014 period and the two nested sub-periods of 2003–2008 and 2008–2014. We observe several patterns, but highlight two major ones. First, the changes are generally larger for countries that are implementing CAADP than for those that are not, which is consistent across the two definitions of CAADP implementation and measurement periods. More importantly, the differences are statistically significant, especially when comparing changes for countries that signed their compact in 2007–2009 versus changes for countries that have not signed (Table 2.4), and for those that

[3] The analysis is based on Benin (2016), which uses data on 46 countries that have adequate time-series data on all the indicators analyzed. The excluded countries are the Comoros, Equatorial Guinea, Gabon, Libya, São Tomé and Principe, Seychelles, Somalia, and South Sudan. There are three external funding sources used here—New Alliance Cooperation, Grow Africa, and GAFSP.

[4] Because the effect of CAADP on the various outcomes is manifested via multiple pathways—see CAADP Monitoring and Evaluation and Results Framework (AU-NEPAD, 2015; Benin, Johnson, & Omilola, 2010)—it is important not to control for any intermediate transformations, outcomes, or processes that are influenced by CAADP to get a reliable estimate of the total effect, i.e., direct and indirect effect. Factors that affect a country's decision to implement CAADP as well as the outcomes must be controlled for, which is not done here (see Benin, 2016).

Table 2.3: Distribution of the 46 countries by year of signing CAADP compact and level of CAADP implementation reached by end of 2014

Signed CAADP compact in:				Level of CAADP implementation reached by end of 2014				
2007–2009 (t=1)	2010–2012 (t=2)	2013–2014 (t=3)	Never (t=∞)	None or pre-compact (level 0)	Compact (level 1)	NAIP (level 2)	1 external funding (level 3)	More than 1 external funding (level 4)
Benin	Burkina Faso	Angola	Algeria	Algeria	Angola	Cameroon	Burundi	Benin
Burundi	Central Afr. Rep.	Cameroon	Botswana	Botswana	Chad	Cape Verde	Gambia	Burkina Faso
Cape Verde	Congo, Dem. Rep.	Chad	Egypt	Egypt	Congo, Rep.	Central Afr. Rep.	Liberia	Côte d'Ivoire
Ethiopia	Côte d'Ivoire	Congo	Eritrea	Eritrea	Lesotho	Congo, Dem. Rep.	Mali	Ethiopia
Gambia	Djibouti	Lesotho	Mauritius	Mauritius	Madagas-car	Djibouti	Niger	Ghana
Ghana	Guinea	Madagas-car	Morocco	Morocco	Sudan	Guinea	Sierra Le-one	Kenya
Liberia	Guinea Bissau	Sudan	Namibia	Namibia	Swaziland	Guinea Bissau	Togo	Malawi
Mali	Kenya	Zimbabwe	South Africa	South Africa	Zimbabwe	Mauritania	Uganda	Mozambique
Niger	Malawi		Tunisia	Tunisia			Zambia	Nigeria
Nigeria	Mauritania							Rwanda
Rwanda	Mozambique							Senegal
Sierra Leone	Senegal							Tanzania
Togo	Swaziland							
	Tanzania							
	Uganda							
	Zambia							

Source: *Authors' illustration based on (IFPRI, 2015b)*

are well-advanced in the process and secured at least two sources of external funding (Table 2.5). Second, among the three groups that have signed a compact, changes are significantly lower for the middle group that signed in 2010–2012 (Table 2.4), suggesting that this group has been less successful in deriving benefits from the CAADP process. For countries that have secured some external funding, which occurred mostly after 2009, there seems to be a substitution effect between government and external sources of financing the NAIP, as the change in the share of government expenditure in total expenditure or agriculture expenditure was significantly smaller or negative for the level 3 and level 4 groups compared to those with a NAIP but with no external funding (Table 2.5).

Focusing on the results of the change over the entire 2003–2014 periods for implementation of CAADP according to the year countries signed their compact, Table 2.4 shows that the share of agriculture expenditure in total expenditure increased by 1.8 percent on average per year for the 2007–2009 group of countries, compared to 2.4 percent for the middle group, and -2.6 percent for the group that signed last. In contrast, the group without a compact experienced a 6.6 percent decline per year on average. Agricultural production and land productivity increased by 5.9–6.7 percent on average per year for the 2007–2009 group, compared to 3.0–4.9 percent for the 2010–2012 group, 3.0–5.7 percent for the 2013–2014 group. Again, countries without a compact performed the lowest, with productivity and overall growth rates ranging between 2.1 and 2.9 percent. With respect to change in GDP per capita, it increased by 4.3 percent on average per year for the first, compared to 2.4 percent for the second, and 3.5 percent for last group of countries to have signed a compact, versus only 2.2 percent for those that have not signed. The trend is similar for the malnutrition indicator, with a decline in prevalence by 3.1, 2.4, and 5.7 percent annually on average for the first, second, and third group respectively, and only 1.2 percent for those that have not signed. Similar trends are observed for countries have advanced in implementing CAADP (level 4) versus those at lower levels (Table 2.5).

Table 2.4. Average annual change in outcomes, by year of signing CAADP compact (%, 2003–2014)

	Signed CAADP compact in:				Significant differences
	2007–2009 (t=1)	2010–2012 (t=2)	2013–2014 (t=3)	Never (t=∞)	
Average annual percent change, 2003-2008					
Agriculture expenditure (% of total expenditure)	9.65	-1.40	4.76	-8.30	1∞, 3∞, 12, 123
Agriculture expenditure (% of agricultural GDP)	13.21	2.47	11.00	-1.20	1∞, 3∞, 12, 123
Land productivity	5.39	2.11	4.25	0.18	1∞, 12, 123
Labor productivity	5.35	1.05	2.91	0.54	1∞, 12, 123
Agricultural growth	6.01	2.81	4.51	0.37	1∞, 12
GDP per capita	6.07	2.70	5.33	3.46	1∞, 12, 123
Undernourished	-7.57	-3.25	-5.73	-1.35	1∞, 2∞, 3∞, 12, 123
Average annual percent change, 2008-2014					
Agriculture expenditure (% of total expenditure)	-1.38	2.44	-6.51	-2.21	13, 23, 123
Agriculture expenditure (% of agricultural GDP)	-5.29	5.39	-12.53	-2.43	2∞, 2∞, 12, 23, 123
Land productivity	5.23	4.68	7.13	2.14	3∞
Labor productivity	4.72	3.17	3.02	3.27	13
Agricultural growth	5.48	5.18	4.52	2.48	
GDP per capita	3.42	2.43	2.67	1.26	1∞, 2∞, 3∞,
Undernourished	-0.15	-2.11	-5.19	-0.91	3∞, 13, 23
Average annual percent change, 2003-2014					
Agriculture expenditure (% of total expenditure)	1.82	2.37	-2.64	-6.58	1∞, 2∞
Agriculture expenditure (% of agricultural GDP)	1.14	5.00	-4.09	-3.08	2∞, 23
Land productivity	6.60	4.20	5.67	2.08	1∞, 2∞, 3∞, 12, 123
Labor productivity	5.95	2.98	2.99	2.89	1∞, 12, 13, 123
Agricultural growth	6.67	4.88	4.55	2.39	1∞, 2∞, 12, 13, 123
GDP per capita	4.29	2.39	3.51	2.24	1∞, 12, 123
Undernourished	-3.31	-2.38	-5.73	-1.19	3∞, 23

Source: *Based on Benin (2016)*

Because the CAADP processes take time to safeguard the expected benefits, and because accessing external funding can broaden or deepen the investments portfolio and related programs for achieving the agricultural development objectives, the generally positive and larger changes associated with countries that signed their compacts early, as well as for those that have advanced in the process and secured multiple sources of external funding, are not surprising. A rigorous assessment of the impact of CAADP has to control for the factors that affect not only countries' decisions to implement CAADP, but also the factors that affect realization of the outcomes. The implementation of CAADP involves several processes, besides signing a compact (see Figure 2.1), that take time to be effective; these also have to be considered. Basically, the quality of the processes in developing and implementing CAADP in the different countries needs to be factored in, which should help explain, for example, the generally lower performance associated with the group of countries that signed their compact in later compared to those that signed in 2007–2009. Furthermore, isolating the different pathways of impact, for example, showing the links among the different CAADP inputs, outputs and outcomes, will require a complex simultaneous-equations model that

Table 2.5. Average annual change in outcomes, by level of CAADP implementation reached by end of 2014 (%, 2003–2014)

	Level of CAADP implementation reached by 2014					Significant differences
	None/pre-compact (level 0)	Compact (level 1)	NAIP (level 2)	1 external funding (level 3)	More than 1 external funding (level 4)	
Average annual percent change, 2003–2008						
Agriculture expenditure (% of total expenditure)	-8.30	4.23	3.03	8.85	5.84	10, 20, 30, 40
Agriculture expenditure (% of agricultural GDP)	-1.20	12.63	6.12	8.65	9.73	10, 40
Land productivity	0.18	4.00	3.66	4.90	4.29	20, 30, 40
Labor productivity	0.54	2.37	2.73	3.06	4.18	40
Agricultural growth	0.37	4.29	3.83	5.69	4.96	20, 30, 40
GDP per capita	3.46	6.38	1.77	2.49	5.40	20, 40, 12, 13, 24, 34, 1234
Undernourished	-1.35	-3.76	-6.59	-3.89	-6.58	20, 40
Average annual percent change, 2008–2014						
Agriculture expenditure (% of total expenditure)	-2.21	-9.28	6.81	-3.02	-0.23	10, 20, 12, 13, 14, 23, 24, 1234
Agriculture expenditure (% of agricultural GDP)	-2.43	-16.07	11.98	-0.49	-3.19	10, 20, 12, 13, 14, 23, 24, 1234
Land productivity	2.14	8.13	1.89	3.67	5.50	10, 40, 12, 13, 24, 34, 1234
Labor productivity	3.27	2.94	1.38	2.02	4.79	14, 24, 34, 1234
Agricultural growth	2.48	4.74	2.45	4.46	5.78	40, 12, 14, 24, 1234
GDP per capita	1.26	2.86	1.43	2.40	3.31	10, 40,
Undernourished	-0.91	-3.35	-5.79	-3.23	-0.45	20, 30, 24
Average annual percent change, 2003–2014						
Agriculture expenditure (% of total expenditure)	-6.58	-4.69	7.07	2.50	1.53	20, 30, 40, 12, 24,
Agriculture expenditure (% of agricultural GDP)	-3.08	-5.65	10.59	3.87	1.30	20, 12, 13, 14, 1234
Land productivity	2.08	6.06	3.13	4.41	6.19	10, 30, 40, 12, 24, 1234
Labor productivity	2.89	2.66	2.47	2.74	5.50	40, 14, 24, 34, 1234
Agricultural growth	2.39	4.53	3.55	5.28	6.40	30, 40, 24, 1234
GDP per capita	2.24	4.06	1.37	2.48	3.94	10, 40, 12, 24, 34, 1234
Undernourished	-1.19	-3.65	-6.83	-3.81	-2.92	20, 24

Source: *Based on Benin (2016)*

captures the individual pathways of interest, in addition to a large panel data set. The evidence presented in Table 2.2 on the effects of different types of agriculture expenditure on different outcomes is indicative of the plausible links in the case CAADP. Overall, the results presented here make a strong case for sustaining and deepening the CAADP agenda and confirm the timeliness and strategic importance of the emphasis and ambitions embedded in the Malabo commitments.

Raising Future CAADP Implementation Effectiveness

With the progress achieved during the Maputo phase of CAADP, African countries have started to turn the page. The fact that African countries have effectively taken ownership and leadership of the CAADP agenda in the agricultural sector has been a significant development compared to earlier decades, as has the ability to maintain continued and consistent focus on the sector as a priority. Countries embracing peer review and inclusive dialogue are equally important developments. The above changes have created an environment for increased funding and improved policies which will continue to impact positively on future growth.

The progress over the last decade, albeit encouraging, is nowhere close to making up for the lost decades of economic stagnation and decline experienced until the turn of the century. Many of the social indicators are just starting to improve, but achieving the ambitious goals of the Malabo Declaration will require that the positive changes achieved under Maputo be sustained and deepened in the decades to come. In terms of CAADP implementation, improvements are needed in four critical areas, as discussed in the following sections

Strengthening Technical and Institutional Capacities

During the first five years of CAADP implementation, AUC and NPCA (then the NEPAD Secretariat) were at the forefront of the technical debate around CAADP. The quality of the technical leadership provided by continental organizations made it possible to clarify the agenda and its implementation modalities to the large community of stakeholders across the continent. It also established its credibility in the eyes of a doubtful international community that, similar to the African side, had hitherto not experienced anything like the level of political leadership and ownership embodied in the NEPAD initiative, particularly in its early days.

AUC and NPCA worked closely with regional and national knowledge centers to mobilize international and local expertise to technically guide the refinement and implementation of CAADP, paving the way for a successful transition from a framework document to operational programs on the ground. Key contributions in this area came from the institutions designated to lead and coordinate technical support under the CAADP pillars. The institutions produced pillar specific frameworks and action plans to guide implementation by countries and RECs[5]. They helped develop guidelines, mobilized qualified experts and coordinated the technical review of the first generation of investments plans. They set up an inter-pillar working group and designated regional liaison to work with their respective RECs to support countries.

With the dismantling of the pillar institutions, CAADP suffered a double blow. First, if they had been allowed to further develop, the lead pillar institutions would by now have expanded their expertise and consolidated their technical convening power to help create greater implementation capacity at country level. Second, strong pillar institutions would have enabled continued, high quality African leadership of the technical debate around CAADP. In contrast, the period following the dismantling of pillar institutions has been characterized by a softening of the technical content of the agenda and by the striking absence of leading African knowledge institutions from the CAADP implementation process. The result has been a palpable loss of technical leadership of the CAADP agenda at the continental level and the absence of a strong knowledge infrastructure that could mobilize and, where necessary, enhance local expertise to create the required capacities for maximum effectiveness of the implementation process on the ground.

The technical networks being planned present a great opportunity to again empower African centers of expertise, if they are given the room to self-organize and operate on purely technical grounds. The establishment of effective technical networks commensurate with the ambitions of Malabo would need to respond to critical questions such as:

- What is the current status of the technical leadership of the CAADP agenda?
- What is the technical robustness of technical documents being produced to guide implementation by countries and RECs and dialogue at critical fora such as the CAADP PP?
- Does the quality of these documents and reports enhance the credibility of African institutions at large, as thought leaders around CAADP?

[5] The Framework for African Agricultural Productivity (FARA, 2006); Framework for the Improvement of Rural Infrastructure and Trade-related Capacities for Market Access (AUC/NEPAD, 2008a); and Framework for African Food Security (AUC/NEPAD, 2008b)

- How many African centers of knowledge have recognizably and substantively contributed to any major CAADP technical documents and reports?
- Have any African centers of knowledge been given the space and opportunity to grow and emerge as leaders in any technical area of CAADP?

An important principle in the enhancement of technical and institutional capacities is to adhere to the subsidiarity principle and focus on fostering the required capacities at every level that is political leadership, advocacy, mobilization of technical and financial capacities at continental level, coordination capacities at the regional level, and planning and execution capacities at the country level. If properly established and governed, the technical networks would be well positioned to bring together global and local expertise to play the necessary catalytic role.

Strengthening Participation of Non-state actors

Significant progress has been achieved in the area of non-state actor participation in CAADP at large. AUC, NPCA, RECs and countries have now solidly embraced the value of inclusiveness. The non-state actor community also has to be commended for its perseverance and capacity to mobilize and engage. The focus of all parties now should be on finding space to strengthen the capacities of non-state actors to effectively participate and to further empower the CNC and its member organizations. For instance, CNC and its members, including farmer organizations, could play a more substantive role in the MA area by going beyond simple participation to co-ownership of the review and dialogue processes.

As leaders of a continental steering committee set up to oversee ReSAKSS and the production of its ATOR, AUC and NPCA have made plans to give civil society organizations a leading role in the review of the CAADP implementation progress and performance. The idea was for civil society organizations to organize broad discussion among all key stakeholders at the continental, regional, and country levels around the main M&E findings presented in the ATOR and draw lessons to improve implementation. CNC should now take the lead in implementing the plan, which should be adapted to the current modalities of policy and program review and dialogue. For instance, CNC and its members are participants in the JSR, but their contribution could be expanded by defining and supporting a more prominent role for them in the review and dialogue processes. One possibility is for CNC to lead an annual, continental level review process to assess the findings of each ATOR. This could build on the recently signed Memorandum of Understanding between ReSAKSS and CNC. At the regional and country level, CNC and its members should be empowered to undertake their own assessments to make a more substantive contribution to review processes. The growing number of countries with regular JSRs, the initiation of regional level JSRs led by ECOWAS, and the upcoming biennial review all provide opportunities for increased leadership and more substantive participation of non-state actors in the CAADP agenda.

Strengthening Mutual Accountability Mechanisms

MA is central to the promotion of evidence-based policy planning and implementation, a key feature of the CAADP agenda. Tremendous progress has been achieved here, from the creation of an entire infrastructure, as in the case of ReSAKSS, dedicated to facilitating review, benchmarking, and peer learning, the establishment of the CAADP PP as a platform for dialogue, the systematic practice of submitting country investment plans to review by independent experts, to the mainstreaming of JSRs at the country and now regional levels.

A few areas need improvement. This includes further mainstreaming of review and dialogue instruments such as the JSRs to reach all countries and improve their practice to make them more technically robust, comprehensive in coverage and inclusive of all major non-state actors. The quality of JSRs can be strengthened by setting up independent teams to provide independent analysis of progress and carry out field visits to verify implementation progress. JSRs would also need to adjust the nearly exclusive focus on country programs and effectively address issues related to improving and modernizing private sector activities and practices in general and not just focusing on investment commitments on a self-reporting basis. Similarly, programs by development partners need to be covered more systematically by ensuring their alignment and consistency with country programs and by improving the quality of coordination among development partner agencies.

Experience on the ground also shows that good mutual accountability requires clear modalities for the elaboration and implementation of action plans, which is not always the case. If these modalities are not in place, returns to the investment in review and dialogue processes in terms of improved policies and programs and better development outcomes can be undermined. Appropriate articulation between country JSR and the biennial review will provide an opportunity to strengthen the reporting and to follow modalities of country processes by incorporating feedback loops into the sequencing of regular reviews.

MA also has to be underpinned by local data and knowledge infrastructure capable of generating high quality and relevant evidence to guide review processes. For this reason, more needs to be done to mobilize and link local centers of expertise more strategically to the policy planning and implementation processes. The interaction between the research community, policy makers, and other stakeholder organizations remains sporadic and ad hoc at best. More needs to be done to better link the domestic supply of knowledge to the demand for technical support by local institutions and organizations. This can be done through countries creating local equivalents of the knowledge networks being set up AUC and NPCA and bringing together national universities, agricultural research centers, bureaus of statistics, planning units in various ministries as well as independent think tanks. Such networks are being attempted in countries where ReSAKSS is supporting the establishment of country SAKSS platforms, but significant effort is required to bridge the fairly large divide between the various parties.

Finally, the embrace of the culture of openness and review needs to go beyond the creation of dialogue platforms and the organization of informed review processes to adherence to open access to data and other relevant technical information to all stakeholders.

Increased Funding and Investment in Agriculture

The failure to meet the Maputo budget target, which focuses on the share of public expenditure going to agriculture, masks the significant progress that has been made in this area, as shown in Section 2.2. On average, the rate of public agriculture expenditure (PAE) growth accelerated during the post-CAADP era and before the 2007–2008 global commodity price and financial crises. In contrast, countries have continued to spend an increasing share of agricultural GDP on the sector, even in the aftermath of the global crises which doubly affected PAE. Country fiscal revenues fell sharply, leading to slower expansion of overall expenditures and slightly more so in agriculture. ODA also nearly dried up, further limiting the fiscal space and capacity of governments to maintain the pace of public investments in general and in agriculture in particular.

Decades of economic stagnation before the adoption of CAADP created a large stock of unmet needs in other critical areas such as infrastructure, health, education, and other social services. Hence, instead of a lack of support for agriculture, the failure to achieve the Maputo budget target is rather a reflection of greater pressure to spend in these other sectors, as illustrated by the fastest rate of expansion of overall government outlays in these sectors in more than a generation, if not in the history of the continent, since the turn of the century.

Sizeable progress toward the Malabo Declaration goals will require countries to redouble efforts to restore and go beyond the progress in the pre-crises years. The next generation of NAIPs provides an opportunity to noticeably increase funding and investment in the sector. Several conditions would need to be met to encourage greater funding and investment levels. First, the quality of design and implementation will need to be improved significantly to ensure greater realism and readiness of the plans. Second, it is critical to develop realistic spending plans, supported by ministries of finance and anchored in medium-term expenditure plans, as part of the package. Third, policy plans are needed to align the economic governance of the sector such as to create the conditions not only for higher levels of funding but to also enable maximum efficiency of investment resources. Finally, countries need to review and align the institutional infrastructure to ensure that plans can be executed satisfactorily.

Conclusions

CAADP is an unprecedented effort to define and execute a continent-wide development agenda; the only NEPAD program that has reached a level of implementation covering more than 75 percent of African countries. It is also the only program that has not only espoused the NEPAD principles of accountable African leadership and ownership, but has also realized the ambition of changing the form and content of the partnership between Africa and the global development community. This section reviews the main components of the agenda, implementation progress, key achievements, weaknesses, and lessons for the next decade of implementation. Its findings are that CAADP has had noticeable impact in raising agriculture public investments and growth, reducing poverty, and advancing mutual accountability. There is also evidence of considerable achievements in terms of improved policy processes: more countries are moving toward evidence-based planning and implementation and systematically embracing more comprehensive and inclusive practices of policy review and dialogue. CAADP has also made significant progress in instituting African ownership and leadership of the development agenda in the agricultural sector. It has established partnership modalities to facilitate alignment by development agencies and has thereby recognizably influenced the agricultural agenda at the global level. CAADP is the first-ever development model conceived in Africa to have made its mark outside of the continent.

Despite the above achievements, several weaknesses and challenges need to be addressed to achieve the more ambitious Malabo commitments. Nearly doubling the amount spent annually on agriculture compared to pre-CAADP levels

is commendable, but more has to be done as most countries have failed to achieve the 10 percent budget share for the sector.Greater progress has been recorded in achieving the 6 percent growth target, but the design and execution of investment plans need to be improved significantly to sustain growth into the future to meet the more ambitious targets under Malabo. Review and dialogue processes need to be strengthened further to create the conditions for policy and institutional consistency and coherence that are required to sustain and broaden the progress achieved so far. Finally, coordination and facilitation processes at the continental level need to truly empower African knowledge institutions to invest in CAADP and help re-establish African leadership of the agenda.

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CHAPTER 3

Driving Economic Transformation

AUTHORS

John Ulimwengu
Julia Collins
International Food Policy Research Institute

Felix Yeboah
Michigan State University

Lulama Ndibongo Traub
Stellenbosch University

KEY MESSAGES

ONE	African economies have achieved tremendous economic recovery over the last 15 years or so.
TWO	Economic recovery is driven by exports of raw commodities, especially mining and oil.
THREE	Africa's economic recovery was associated with minimal structural transformation.
FOUR	Policies to boost structural transformation need to account for key megatrends.

Introduction

In the 1990s and early 2000s most studies painted a rather bleak picture of African economic performance. Indeed, economic writing on Africa tended to be uniformly gray and even marked by despair (Madavo & Sarbib, 1997).

For Easterly and Levine (1997), Africa's economic history could be defined as a tragedy characterized by unfulfilled potential. Artadi and Sala-i-Martin (2003) would later describe the dismal growth performance of Africa as the worst economic tragedy of the 20th century.

Expensive investment goods, low levels of education, poor health, adverse geography, and too many military conflicts are among key explanations of the economic tragedy (Artadi & Sala-i-Martin, 2003). Gallup, Sachs, & Mellinger (1998) and Sachs (2003) pointed to debilitating tropical diseases that reduce the productivity of workers and the incentives to invest in education and health in tropical countries including those in sub-Saharan Africa (SSA). Moreover, they argued that tropical countries tend to have less productive agriculture and therefore cannot benefit from the technological progress enjoyed by rich countries. Collier (2006) argued that over the past 40 years Africa has stagnated while other developing countries have grasped growth opportunities. This process of divergence has turned Africa into the poorest region, characterized by four development traps: the conflict trap, the corruption trap, the primary commodity trap and the fractionalized society trap.

However, the picture began to change in the 2000s. As highlighted by the IMF (2016d), African countries have achieved impressive economic growth over the past 15 years with the average real gross domestic product (GDP) rising from just above 2 percent during the 1980–1990s to above 5 percent in 2001–2014. In 2014 and 2015, growth has been more moderate due to weaknesses in the global economy and price reductions of key commodities. This trend is expected to continue in 2016, but strengthen in 2017 thanks to strong domestic demand, improved supply conditions, prudent macroeconomic management and favorable external financial flows. Africa's growth remained higher than world growth despite the unfavorable international economy environment (IMF, 2016d).

Africa's impressive growth performance during the 2000s is widely known. Six SSA countries were among the 10 fastest-growing countries in the world from 2001 to 2010 (The Economist, 2011), and widespread good growth performance made SSA one of the world's fastest-growing regions. The experience of the 2000s is even more remarkable considering the prior decades of stagnation or even decline in the continent. After good growth performance in the decade following the independence period, GDP per capita growth decreased during the 1970s and turned sharply negative during the 1980s. Another decade of contraction in GDP per capita followed before the return to robust growth during the 2000s. GDP per capita grew at an average annual rate of 2.1 percent during the 2000–2014 period, surpassing its 1960s growth rate of 2.0 percent (World Bank, 2016).

In this chapter, we analyze major economic trends that characterize the African economic recovery and identify policy options to consolidate, build upon and scale up the positive recent trends in economic growth, labor productivity, and employment dynamics. Sustained economic growth with substantial poverty reduction would require economic transformation beyond the current recovery being experienced across the continent. As pointed out by ECA (2013, p. 3), "economic transformation is associated with a fundamental change in the structure of the economy and its drivers of growth and development. It necessarily involves: a reallocation of resources from less productive to more productive sectors and activities; an increase in the relative contribution of manufacturing to GDP; a declining share of agricultural employment to total employment; a shift in economic activity from rural to urban areas; the rise of a modern industrial and service economy; a demographic transition from high rates of births and deaths (common in underdeveloped and rural areas) to low rates of births and deaths (associated with better health standards in developed and urban areas); and a rise in urbanization. Since agricultural transformation is a key precursor of this broad transformation process, the chapter also discusses the role of the agricultural sector in fostering African economic transformation through diversification and sophistication across agricultural value chains.

What is the pattern of economic recovery post-2000?

Trends in economic growth and labor productivity

With respect to per capita GDP, Africa as a whole has recovered from the economic downturn of the 1990s (Figure 3.1). Indeed, since 1995, despite recording high population growth, African countries have been experiencing positive per capita GDP growth reaching 6.5 percent in 1997. During the 2000–2013 period, per capita GDP increased by an average of 2.3 percent annually in Africa at the continental level compared to 2.5 percent in the world. After the 2008–2009 financial crisis, African economies demonstrated a much stronger resilience than the world economy did. Indeed, while the world per capita

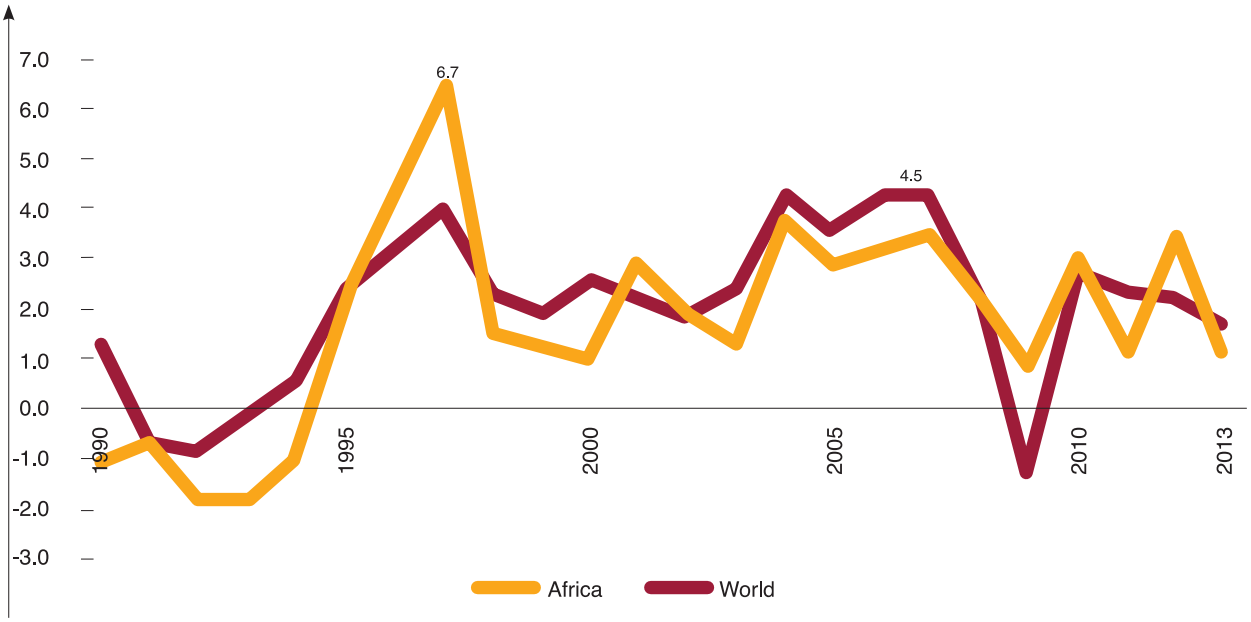
GDP declined by 1.4 percent in 2009, that of Africa as a whole grew by 0.8 percent and 3.0 percent respectively in 2009 and 2010.

As shown in Table 3.1, since the 1991–2000 period, the recovery of Africa as a whole has not been driven by a single sector. Indeed, growth in value added can be observed across all sectors. Sectors such as construction, wholesale, and transport and communication achieved value added growth rates more than two times those of the previous decade. The incredible performance of the agricultural sector was impressive: value added increased by 5.2 percent in 2000–2014 compared to less than 3 percent in previous decades.

Unlike the turnaround in growth trends, no major change was observed in the composition of value addition of African economies (Table 3.2). As in the 1970s, African economies are still dominated by the mining sector. This explains the vulnerability of African economies to the fluctuations of the world market. The share of the agricultural sector in total value added is still below 15 percent. More importantly, manufacturing did not increase as a percentage of value added.

Labor productivity shows similar trends, with good performance in the 1960s followed by sluggish growth or absolute declines in productivity during the next three decades. Starting in the 2000s, labor productivity growth

Figure 3.1. Per capita GDP growth, Africa and the World



Source: *Authors' calculations based on data from World Bank (2015).*

Table 3.1. Value added growth by sectors among African economies (percent)

	Agriculture	Mining	Manufacturing	Construction	Wholesale and retail trade	Transport and commu-nication	Other	Total
1971–1980	1.8	3.8	4.7	4.6	4.4	6.2	4.9	4.0
1981–1990	2.9	1.0	2.7	0.5	3.0	2.2	3.8	2.3
1991–2000	2.8	1.5	1.6	2.5	2.6	3.9	2.7	2.3
2001–2014	5.2	2.3	3.8	8.3	6.3	8.7	4.9	4.7

Source: *Authors' calculations based on data from United Nations Statistics Division(UNSD)(2016)*

Table 3.2: Composition of value added growth by sectors among African economies (percent)								
	Agriculture	Mining	Manufacturing	Construction	Wholesale and retail trade	Transport and communication	Other	Total
1971–1980	14.4	39.9	12.4	4.5	12.1	6.1	10.6	100.0
1981–1990	13.1	36.1	13.8	4.1	13.0	6.8	13.1	100.0
1991–2000	14.0	33.4	12.6	3.7	13.2	7.3	15.8	100.0
2001–2014	14.9	27.4	11.4	5.1	14.9	11.4	14.9	100.0

Source: *Authors' calculations based on data from UNSD (2016)*

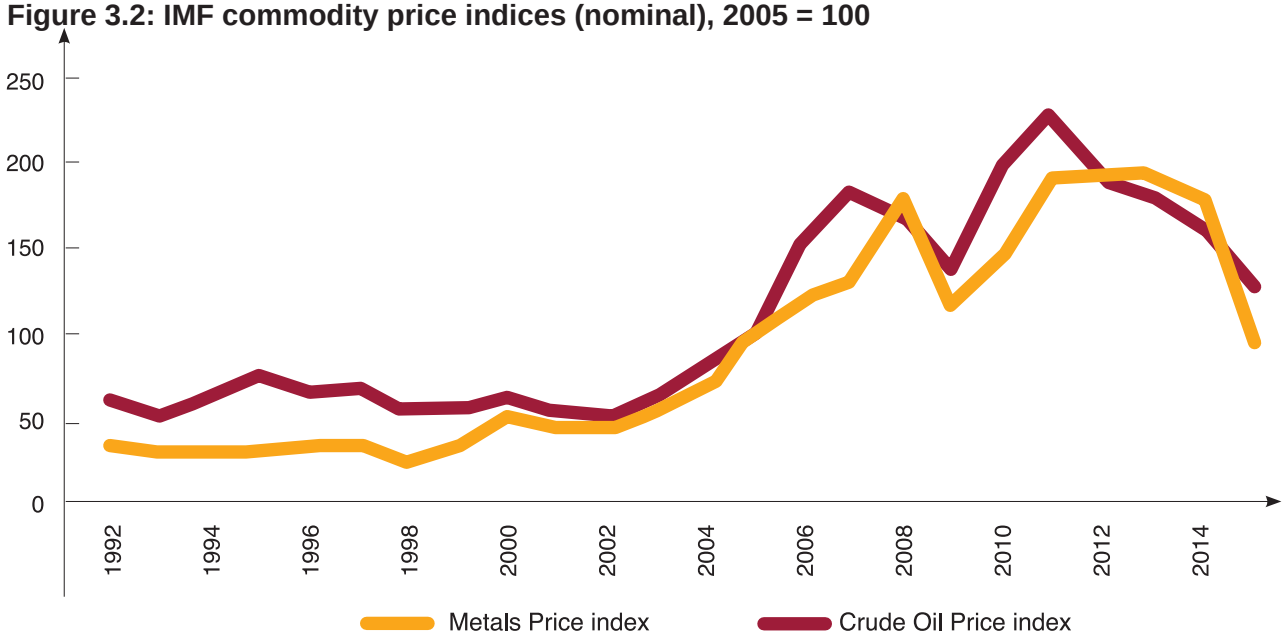
in SSA increased to an unprecedented annual rate of 2.6 percent (The Conference Board, 2016). SSA's agricultural labor productivity growth in the 2000s also far surpassed its performance in the previous lackluster decades (World Bank, 2016).

Is the African economic recovery over?

Recently, the external environment has changed markedly for African countries. Indeed, commodity prices, which had risen throughout most of the 2000s, dropped sharply in the 2010s (Figure 3.2). From mid-2014 through 2015, oil prices experienced the steepest drop in any 18-month period since 1970 (IMF, 2016b). Accompanying the commodity price slump was a general decline in demand from China, as its economic growth slowed. The long-standing trade surplus of SSA with China became a deficit as the oil price decreased, but even non-natural resource dependent African countries saw their trade deficits with China worsen (IMF, 2016b). In addition, external borrowing has become more difficult for African countries and borrowing costs have increased with the rise of US interest rates (Sy, 2016).

In addition to exogenous factors, internal shocks have had a negative impact on Africa in recent years as well. The countries affected by the Ebola outbreak beginning in 2014 continue to experience negative growth repercussions, and the Eastern and Southern Africa region is likely to suffer from food insecurity and reduced growth in 2016 due to the serious drought currently affecting the region (IMF, 2016b). In addition, the intensity of armed conflicts and terrorism has risen in the past few years. The number of fatalities

Figure 3.2: IMF commodity price indices (nominal), 2005 = 100



Source: *IMF (2016)*

from political violence, terrorism, and other conflict recorded in the Armed Conflict Location and Event Data Project (ACLED) database reached its highest level since 1999 in 2014. Fatalities declined slightly in 2015, but remained much higher than the average for the 2000s (ACLED, 2016). About one-third of the conflict deaths in 2014 and 2015 were in Nigeria, where Boko Haram has increased the intensity of its attacks. High numbers of fatalities also occurred in South Sudan, Somalia, and Sudan, and in the Central Africa Republic, Democratic Republic of the Congo, and Cameroon. Terrorism and violence have increased the cost of doing business and led to declines in tourism and foreign direct investment (FDI) in affected countries (IMF, 2016b).

The consequences of external and internal shocks have been lower growth and financial distress, especially for the countries most dependent on commodity exports. Economic growth rates in SSA were noticeably lower in 2015 than in most of the 2000s (Table 3.3). Oil-exporting countries were particularly hard hit, with growth declining from 5.9 percent in 2014 to 2.6 percent in 2015 (IMF, 2016b). Many natural resource exporters are experiencing lower export revenues and fiscal and current account deficits. In addition, currencies depreciated against the dollar from late 2014 to 2015 in almost all SSA countries, and inflation in the region is rising (Sy, 2016). Public debt rose from an average of 29.0 percent of GDP in 2010–2013 to 35.8 percent of GDP in 2015 (IMF, 2016b). Deteriorating fiscal balances and rising debt have prompted several countries to seek loans from the IMF and other institutions, including Ghana, Angola, and Mozambique (Wallace & Malingha Doya, 2016). The IMF projects continued lower growth in 2016 and 2017.

Productivity growth has also been weaker in the 2010s than it was in the 2000s. World Bank World Development Indicator (WDI) data show that overall and agricultural labor productivity growth both declined from above 3 percent per year in 2000–2009 to 1.4 and 1.7 percent per year respectively in 2010–2014 (World Bank, 2016).

Structural transformation and employment trends

Successful examples of economic development in other parts of the world have been accompanied by structural transformation, a process in which the bulk of economic activities shifts from lower-productivity to higher-productivity sectors. Historically, as labor moves from less productive traditional sectors into modern high productivity economic activities in manufacturing and service sectors, aggregate productivity tends to rise, resulting in positive income growth, improvement in living standards, and poverty reduction. The speed with which labor reallocation into productive sectors occurs is identified as a key factor of success of development strategies. During the early stage of development, the agricultural sector is often the dominant employer of the workforce. Hence, agricultural transformation is considered a necessary component of the broader process of structural transformation (Staatz, 1998).

Agricultural transformation refers to the process in which agriculture transforms over time from being subsistence-oriented and farm-centered into one that is more commercialized, productive, and off-farm centered. From the actual experiences of developed countries, the process of agricultural transformation begins with growth in on-farm productivity among millions of smallholder farmers through the adoption of new technologies that increase surplus and rural food security. The increased farm income arising from the on-farm productivity growth stimulates demand for off-farm goods and services, generating powerful multiplier effects on the rest of the economy and expanding job opportunities in the off-farm sector. Driven by commercial forces, farmers may also diversify from staple crops to higher value crops and livestock, earn more off-farm income, or leave farming altogether for better economic opportunities in the rapidly expanding and high productivity manufacturing and service sectors of the economy. The migration of labor out of agriculture also increases productivity in that sector, resulting in an economy-wide

Table 3.3: GDP Growth Estimates And Projections For SSA and Selected Countries

	Average	Average			Projections		
	1998–2007	2008–2013	2014	2015	2016	2017	2021
SSA	5.3	5.2	5.1	3.4	3	4	5
Nigeria	7.6	6.9	6.3	2.7	2.3	3.5	4.0
South Africa	3.7	2.1	1.5	1.3	0.6	1.2	2.4
Angola	10.3	5.9	4.8	3.0	2.5	2.7	4.3
Kenya	3.6	4.7	5.3	5.6	6.0	6.1	6.5
Ethiopia	6.5	10.3	10.3	10.2	4.5	7.0	7.3

Source: *IMF (2016c)*

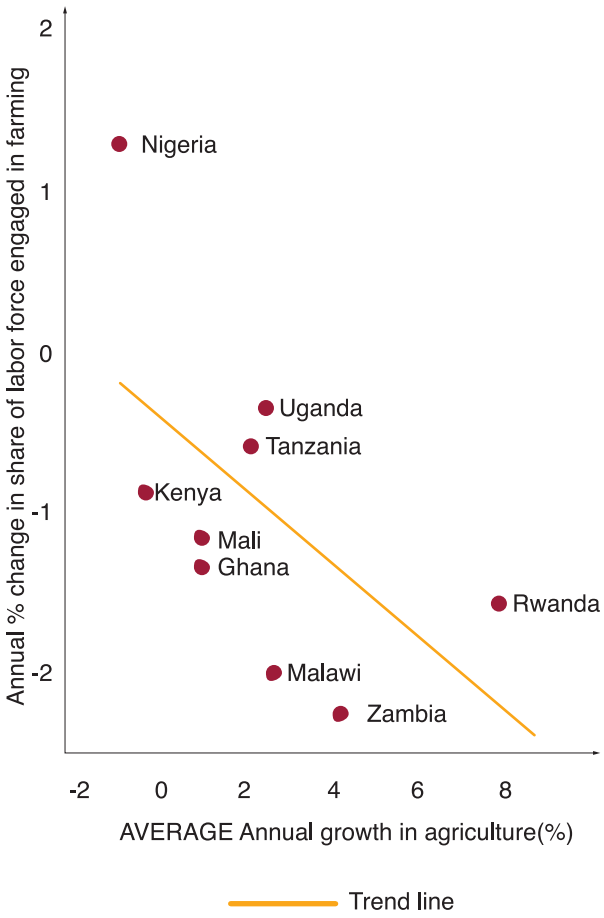
increase in average productivity and per capita income. However, the share of agriculture in total employment and overall GDP declines gradually due to much more rapid growth in the off-farm sectors of the economy. Therefore, reduction in the share of the workforce in agriculture is generally associated with the success of the agricultural sector in setting in motion the initial stages of economic transformation. Also, the exit of labor from farming and resultant consolidation of farmland causes the mean farm size to rise. Consequently, more medium-to large-scale farms become important suppliers in the agricultural sector to capture economies of scale from production, processing and marketing.

This chapter will explore the extent to which agricultural transformation has catalyzed economic transformation in Africa. We do this by exploring shifts in the labor force from farming to off-farm sectors, and patterns of crop diversification. We then discuss the other characteristics of structural transformation observed in Africa.

Employment shifts

Several previous studies using different data sets provide evidence of labor exit from agriculture to non-agriculture sectors of the economy in Africa (McMillan & Harttgen, 2014; de Vries, Timmer, & de Vries, 2015; Yeboah & Jayne, 2016). For instance, in an analysis involving 11 sub-Saharan African countries, de Vries et al. (2014) reported declines in the share of employment in agriculture from 61.6 percent in 1990 to 49.8 percent in 2010. Similarly, an analysis by Proctor and Lucchesi (2012), based on data from the International Labour Organization (ILO) revealed decline of about 3.4 percentage points in the share of agriculture in total employment in SSA between 1999 and 2009. In a more recent study documenting the evolving dynamics in Africa's workforce, Yeboah and Jayne (2016) also noted a rapid reallocation of labor between farming and off-farm employment as part of the ongoing economic transformation in the region. Despite cross-country variation, the authors observed a general increase in the absolute number of working age individuals engaged in farming in most African countries. However, in concert with stylized patterns of structural transformation, the share of farming in total employment is generally declining over time in most countries, largely due to more rapid percentage growth in the off-farm sectors of the economy, including the upstream and downstream segments of the agri-food system. As the rapid growth in the off-farm sectors of the economy is starting from a low base, farming remains a key source of employment and income for roughly 60–65 percent of the region's labor force despite its declining share in total employment. In addition, the pace of labor exit from farming over the past decade was related to agricultural productivity growth. Countries like Rwanda that experienced the most rapid growth in agricultural productivity recorded the most rapid declines in the share of their work force engaged in farming over time (Figure 3.3). While no causal

Figure 3.3: Relationship between total factor productivity growth and change in share of labor force engaged in farming



Source: *Yeboah and Jayne (2016)*

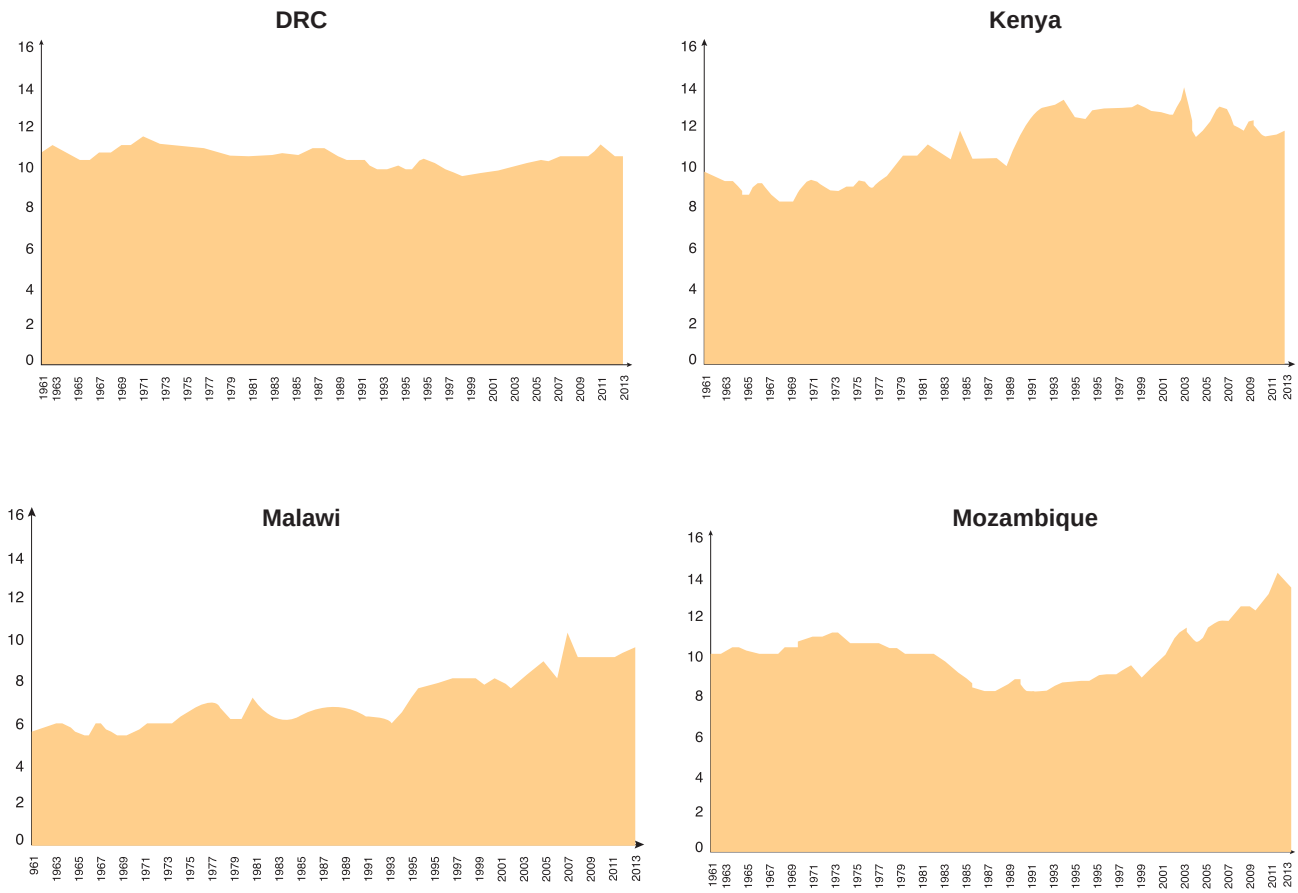
interpretation is implied, this observed pattern is consistent with historical structural transformation processes in Asia and elsewhere, where agricultural productivity growth was the primary driver of economic transformation and associated shifts in employment opportunities and the labor force to non-farm sectors among countries in their early stages of development where a large share of the work force was still engaged in farming.

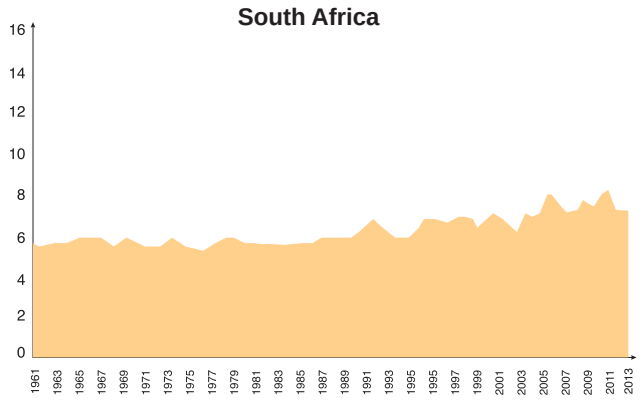
Crop Diversification

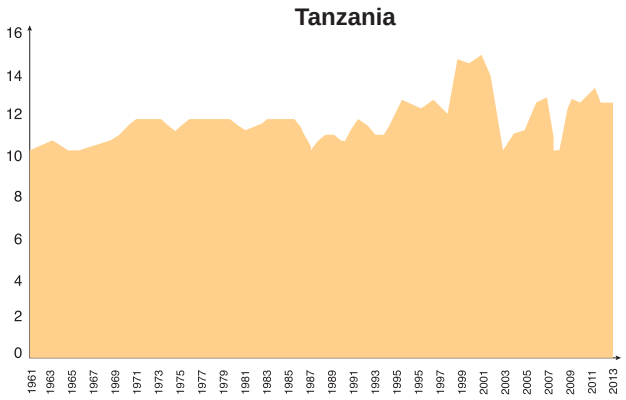
Crop diversification is an ambiguous concept when associated with subsistence farming and commercialization. In remote regions of SSA, under rainfed conditions, semi-subsistence farmers may diversify production to meet home consumption needs, reduce the risk of disease or weather-related crop failure (Minot, 2003). Alternatively, crop diversification could be associated with the transition from subsistence to commercial production of smallholder farmers, as they move away from the production of staple food commodities towards more high-valued commercial crops (Delgado & Siamwalla, 1997).

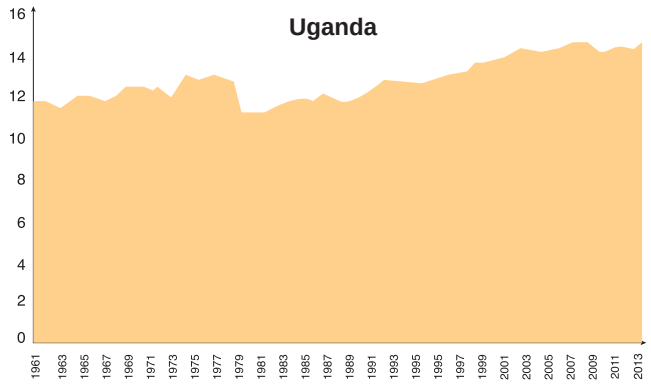
Using the Shannon Diversity Index (SDI) , a measure of the richness and evenness of crop production within a geographical location, we find evidence of rising crop diversification in primary agriculture across Eastern and Southern Africa. The SDI is often expressed as the effective number of crop species (ENCS). Analysis of changes in the SDI indicates an increase in crop diversity at the national level across the region between 1961 and 2013 (Figure 3.4). Particularly starting around 1990, we see a significant rise in the ENCS relative to the previous decades. Several factors may have contributed to the changes in crop diversity in the last two decades,for example, global market forces, such as rising demand in China and India for cash crops such as soybeans, tobacco, groundnuts, etc. Alternatively, climate change and risk mitigation strategies of smallholder subsistence farmers could also underpin the observed shift in crop diversity. It is thus unclear the extent to which the observed crop diversification has occurred in response to agricultural productivity growth. Given this initial evidence, from an economic development and policy perspective it will be important to identify the contribution of rising crop diversification to agricultural growth.

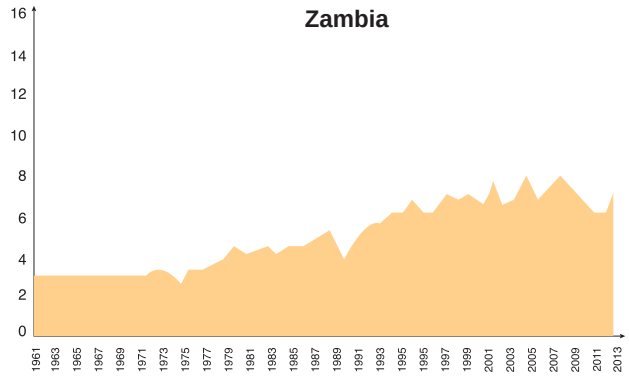
Figure 3.4: Mean effective number of crop species, selected countries

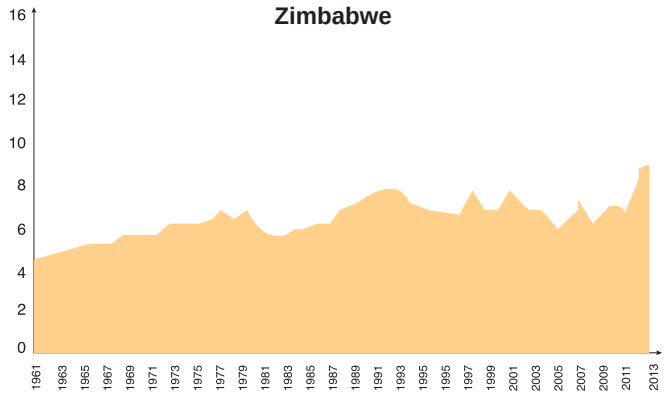












Source: *Authors' calculations based on data from FAOSTAT (2015).*

Differences in the African pattern of structural transformation

The experience of agriculture in the past few decades broadly fits the pattern of typical structural transformation in terms of declining agricultural employment share and increased crop diversification. However, other aspects of Africa's structural transformation have shown marked differences from the patterns seen in other developing regions. Badiane (2014) documents a more rapid decline in the agricultural GDP share of African countries than would be normally expected based on their modest income levels. In a typical structural transformation, increases in agricultural productivity cause the agricultural GDP share to decline more slowly than the agricultural employment share, but the stagnation of agricultural productivity in Africa over several decades before the current recovery resulted in an unusually rapid drop in the agricultural GDP share as labor exited agriculture.

The destination of labor exiting agriculture has also been markedly different in Africa than in other developing regions. Unlike East Asian countries which saw rapid increases in manufacturing, employment and production as agricultural employment declined, African countries have shown few signs of any takeoff in manufacturing (Kormawa & Jerome, 2015). Some authors document recent improvements. For instance, Diao and McMillan (2014) point to a rise in manufacturing exports as a share of total exports during the 2000s. However, other signs are more indicative of *deindustrialization* in Africa. In fact, the share of manufacturing in total SSA GDP is lower today than during the 1970s, having declined gradually throughout the past four decades (World Bank, 2016). Throughout the 2000s, the SSA, Middle East and North Africa (MENA) regions had the lowest manufacturing GDP shares in the world, even slightly below those of developed regions. The ILO estimates that the share of manufacturing employment in total employment in SSA has hovered between 9 and 10 percent since the early 1990s (ILO, 2015). This is the lowest employment share of all regions, except for the Arab States.

An important characteristic of successful structural transformation which is related to industrialization is the ability of transforming economies to produce more complex, sophisticated and high-value goods over time (Badiane, Ulimwengu, & Badibanga, 2012). Here, we analyze evidence of structural transformation among African economies, using the Economic Complexity Index (ECI) and Products Complexity Index (PCI) developed by Hausmann et al. (2014). These indices capture both diversification and sophistication of a country's production structure. Following Hausmann et al. (2014), the most complex products are sophisticated chemicals and machinery that tend to emerge from organizations where many highly skilled individuals participate. In contrast, the world's least complex products are raw minerals or simple agricultural products. It follows that countries can only increase their score in the ECI by becoming competitive in an increasing number of complex industries. Therefore, transformation occurs when a country moves from less complex to more complex products. This notwithstanding, countries endowed with abundant natural resources can grow relatively fast without being complex. As pointed out by Hausmann et al. (2014, p.21), "economic complexity might not be simple to accomplish, but the countries that do achieve it, tend to reap important rewards."

We assume that successful transformation must be gradual and cumulative. Therefore, we compare measures of economic complexity among African economies between 1995 and 2013. These measures can be negative (reverse transformation), zero (stagnation) or positive (progressive transformation). Out of the 41 African countries for which data are available (see Table 3.4) only 19 (46.3 percent) recorded a higher economic complexity measure in 2013 than in 1995. This suggests not only limited transformation but also significant heterogeneity among African economies in terms of economic transformation. In 2013, only one country (Seychelles) posted a positive ECI. With respect to PCI, the structure of African economies is still more or less the same when we compare1995 and 2013. Indeed, agricultural products are still less sophisticated than non-agricultural products. As it stands, Africa may well be a case of strong growth with limited structural change, which is consistent with the fact that much of its growth originates from extractive industries.

With the undersized manufacturing sector unable to provide large numbers of jobs, much of the labor exiting agriculture has entered the service sector, particularly the informal goods and services sector. In addition to the smaller than expected agricultural contribution to GDP, many African countries show a larger service sector GDP share than would be expected based on their income levels (Badiane, 2014). The service sector share is larger in SSA than in South Asia, and almost as large as shares in East Asian and Pacific and Latin American and Caribbean countries with much higher incomes. The service sector is highly heterogeneous and combines both high-productivity and low-productivity occupations. However, in Africa it is often characterized by a high degree of informality and low productivity.

During much of the preceding decades Africa seems to have missed out on the growth-enhancing impacts of structural transformation. As economies develop, incomes grow due to labor productivity growth. Part of this productivity growth

Table 3.4: Economic Complexity Index and growth rates in selected African countries				
Country	ECI (1995)	ECI (2013)	Ag._growth (%)	Per capita GDP growth (%)
Algeria	0.18	-1.59	5.36	0.97
Benin	-0.72	-0.86	4.58	1.24
Burkina Faso	-0.59	-0.79	3.49	2.66
Cape Verde	-0.27	-0.75	5.67	5.86
Cameroon	-1.18	-1.84	4.08	-0.36
Comoros	0.65	0.33	3.04	-0.24
Côte d'Ivoire	-1.01	-1.15	1.65	-0.29
Djibouti	0.58	0.08	1.17	-0.14
Eritrea	0.83	0.11	3.11	0.74
Gabon	0.21	-0.94	1.69	0.06
Guinea	-0.22	-0.36	4.12	0.30
Guinea-Bissau	0.23	-0.25	2.52	-0.15
Kenya	-0.86	-1.10	2.45	0.60
Liberia	-0.11	-1.22	6.01	2.79
Mali	-0.73	-1.75	3.91	1.44
Mauritania	-0.93	-1.63	1.06	0.63
Mozambique	-1.10	-1.71	4.97	3.61
Niger	-0.64	-1.91	3.29	-0.28
Rwanda	-0.34	-0.92	4.60	3.09
Uganda	-0.79	-1.03	2.96	3.31
Zambia	-0.22	-0.24	1.61	1.87
Zimbabwe	-0.26	-0.94	-0.08	-1.02

Source: *Authors' calculations based on data from Hausmann et al. (2014)*

results from increases in the productivity of each sector, but part arises from the movement of workers from lower-productivity to higher-productivity sectors—i.e., structural transformation. Badiane (2014) and McMillan and Rodrik (2011), however, document an effect in the wrong direction, in which labor moved from more to less productive sectors, so that structural transformation was a drag on average labor productivity. Badiane and McMillan (2015) suggest that this trend reversed itself during the growth recovery, finding that structural transformation made a negative contribution to overall labor productivity growth during the 1990s, but contributed positively during the 2000–2005 period, adding around one percentage point to total labor productivity growth.

Ultimately, the patterns of structural transformation observed in Africa have resulted in the inability of African economies, even during the growth recovery, to generate sufficient well-paying jobs for the growing labor force. In some cases growth seems to have been completely divorced from employment gains: Page and Shimeles (2015) found that rates of growth in employment tended to be lower in the African countries with higher economic growth rates. Some areas of improvement have been recorded in the labor market: unemployment in SSA decreased slightly from an average of 8.7 percent during the 1990s to an average of 8.3 percent during the 2000–2014 period (ILO, 2015). Although not excessive, the rates were somewhat higher than the world average and the average for most other developing regions. However, the relatively moderate unemployment rate masks very high rates of underemployment and informal employment. The ILO measure of vulnerable employment, comprising self-employment and unpaid family labor, reached nearly 70 percent of total employment in 2014 (Table 3.5). ILO (2015) estimates for wage and salaried employment showed impressive growth in percentage terms, with the number of wage and salaried jobs increasing nearly 70 percent between 2000 and 2014. However, the small number of wage and salaried employment opportunities relative to the total meant that this was not enough to significantly change the character of overall employment: the share of wage and salaried employees rose only slightly from 25 percent to 28 percent of all employees. Most new jobs created during the

Table 3.5: Trends in types of employment in SSA, 2000–2014				
Type of employment	Percent growth 2000–2014	Share of total jobs		Number of new jobs, 2000–2014 (thousands)
		2000	2014	
Wage and salaried	69.7	25.1	28.3	39,589
Vulnerable	43.7	73.3	69.8	72,359
Employers	89.6	1.5	1.9	3,071

Source: *Authors' calculations based on ILO (2015)*

2000s to 2014 were vulnerable ones, with nearly twice as many new jobs in the vulnerable category than in the wage and salaried category. The impressive economic recovery of the 2000s was not able to significantly increase the number of formal jobs in the economy.

After a decade and a half of economic recovery, African countries find themselves much better off on several fronts. However, serious problems remain that will affect the sustainability of economic growth. These problems include an important but underperforming agricultural sector and an oversized service sector, both hampered by low productivity; a relative absence of high-productivity manufacturing jobs; and a high degree of informality and vulnerability in employment, with high underemployment.

Drivers of the observed economic recovery and the role of agriculture transformation

Drivers of African economic recovery

A comparative analysis of economic performance in SSA with respect to economic cycles by Arbache and Page (2007) provides insights into the factors behind Africa's economic recovery. Their study highlights saving and investment, domestic consumption, the share of agriculture in the economy, inflation, trade, the real effective exchange rate, official development assistance (ODA) per capita, and the country policy and institutional environment as key factors behind African economy recovery.

Almost 10 years later, Badiane, Collins and Diao (2015) confirm many of the findings of Arbache and Page (2007). Indeed, their findings suggest that higher inflation has a negative impact on per capita GDP growth among African economies, while ODA and the shares of FDI and savings have a positive impact on economic growth. Human capital variables such as life expectancy and schooling positively affect growth trends. Similarly, improving governance does have a significant potential to boost growth.

Official Development Assistance. All three types of ODA examined have a significant positive effect on the growth process, particularly ODA allocated to "Economic infrastructure and services". This category includes much of what is commonly referred to as infrastructure, such as transport, storage, and communications, as well as financial and other business services. Disbursements of each type of ODA increased considerably throughout the recovery period (Badiane et al., 2015), but the amount of ODA for social infrastructure and services (including health, education, etc.) was consistently two to three times that of ODA for economic infrastructure. Despite conflicting results on the effects of aid on economic growth, with many studies unable to find a positive relationship, the reanalysis of several previous studies performed by Clemens et al. argues that aid does have a modest positive effect on growth on average, although effects differ by country. Badiane et al. (2015) suggest that Africa is a region in which aid has had, at least in the past decade, a positive growth impact.

Governance. Quality of institutions along with human capital are the foundation of any successful economic transformation process (Rodrik, 2013). As argued by Ugur and Dasgupta (2011), there is a wide consensus that good governance in general and the related concepts of rule of law and control of corruption in particular are vital for economic growth. As pointed out by Badiane et al. (2015), it is rather surprising that governance indicators such as rule of law and control of corruption have had a positive effect on the African growth recovery despite the general lack of progress made in these areas during the period of analysis. However, they are quick to point out that some fast-growing countries, such as Rwanda, showed remarkable improvements in both measures.

Inflation. There is a consensus that macroeconomic instability characterized by high inflation, unsustainable debt levels and volatility in exchange rates and financial markets can all contribute to job losses and increasing poverty, endangering progress towards achieving development goals. It is therefore encouraging that the recent study by Badiane et al. (2015) found that low inflation

creates a favorable investment climate that promotes economic growth. Indeed, for years, macroeconomic instability has been among the factors impeding growth in SSA. However, over the past decade, thanks in part to institutional reforms, the macroeconomic environment has improved significantly. Hence, inflation among Sub-Saharan African countries, after reaching a peak high of 51.84 percent in 1994, has been since declining steadily, and was 2.6 percent in 2004 and 5.6 percent in 2013 (World Bank, 2015).

Human capital. Over the past few decades, SSA has experienced increases in educational attainment and access to education among its populace. Primary school completion rates for children increased from about 50 percent in 1991 to 70 percent in 2011 as several countries in SSA moved towards achieving universal primary education under Millennium Development Goal 2. The gender gap in educational attainment is also narrowing, at least at the primary school level (Filmer & Fox, 2014).The region's gross enrollment ratio for upper secondary school grew from 19 percent in 1999 to 27 percent in 2008, while that of tertiary education increased from 4 to 8 percent between 1999 and 2012 (UNESCO, 2014).

Despite these increases, the continent still lags behind other regions of the world at all educational levels. Only 8.1 percent of the tertiary education age cohort in SSA was enrolled in tertiary institutions in 2012, compared to 63.1 percent in Europe and Central Asia and 43 percent in Latin America (UNESCO, 2014). The current primary school completion rate of 70 percent is also the lowest in the world. There are also concerns about the quality of education. Learning assessments demonstrate that Africa's schools are not effectively imparting to its students basic numeracy, literacy and/or cognitive skills, including problem solving and critical analysis (Boone et al., 2014; Cloutier, Reinstadtler, & Beltran, 2011; Mullis, Martin, Foy, & Arora, 2012) . Those with some secondary school education also tend to lack key behavioral and socio-emotional skills (soft skills) required to get, keep, and be productive in a job (Filmer & Fox, 2014). Consequently, the expected impact of education on economic growth has not been fully realized. In fact, Glewwe, Maïga and Zheng (2014) show that the contribution of education to economic growth is generally lower in African countries than it is in other parts of the world.

Education and the skills acquired influence the range of employment opportunities available to youth and their earning potential. Addressing the shortfalls in enrollment and quality in the educational system is critical to sustainable and inclusive growth in the long run. Educating and equipping Africa's expanding labor force with the needed skills could help raise labor productivity, increase income and consumption levels, and facilitate economic transformation. We expect this trend of increasing educational attainment to continue in the next few decades as some studies have projected (see Filmer & Fox, 2014), but to varying degrees across countries depending on government policies and investment decisions.

With respect to health, continent-wide, African countries have made substantial progress towards reducing mortality. Indeed, 43 African countries experienced more significant decreases in child mortality during the 2000–2013 period than they did during the 1990–2000 period (ECA, 2015). The infant mortality rate fell from 90 deaths per 1,000 live births in 1990 to 54 deaths per 1,000 live births in 2014, an average decline of 40 percent. The ECA report also concludes that "efforts to combat HIV/AIDS, malaria and tuberculosis in Africa have yielded impressive results since 1990 and are placing the continent on a solid path to reversing the spread of these diseases" (p. xvi).

Megatrends impacting Africa's agriculture

The deteriorating external environment emphasizes the need for structural reforms that will transform African economies from a dependence on primary commodities to reliance on a much more diversified economic base. As the predominant source of employment and livelihood in much of Africa, the agricultural sector is vital to creating a much needed diversified economic base. Strong economic growth linkages between agriculture and other segments of the economy mean that expanding the productive capacity and economic returns of agriculture could promote an inclusive pattern of economic growth with stronger multiplier effects on employment creation and poverty reduction. However, realizing this potential will depend on how well the enabling environment through policies and programs would respond to key patterns of change in the economic landscape

[6] Since "middle class" is a multi-dimensional term, definitions vary and comparable statistics across countries are rare. The African Development Bank (AfDB) defined the middle class as a family having per capita daily consumption of US$2–20 in 2005 purchasing power parity. Further, it found that this group had risen from 27 percent to 34 percent of the population between 1990 and 2010. However, about 60 percent of the middle class in 2010 were in the US$2–4 per capita consumption group—barely out of the poor category and in constant threat of falling back into it (AfDB, 2011). If this group is excluded, the rise in Africa's middle class over the past two decades would appear to be quite modest. There is evidence of rising incomes at least among a small segment at the top end of the income distribution.

that would likely affect the contribution of agriculture to the overall economic transformation agenda. Hence, the rest of this section discusses five overarching megatrends in the African economic landscape that would likely affect agriculture's contribution to future economic transformation in the region over the next decade. Secondly, with the understanding that the trajectories of these megatrends are not inevitable and are amenable to policy investments, we discuss key areas for intervention that would allow African policymakers to bend these trends in socially desirable directions.

The following five trends are highlighted as among the megatrends affecting Africa's agriculture in the next few decades.

a. Labor force expansion and youth bulge

Africa is a youthful continent with over 60 percent of its population below the age of 25 (World Bank, 2009). With its labor force growing roughly 3 percent per year, over 8 million young Africans are entering the labor market each year, amounting to about 220 million new people in the labor force by 2035 (Fox, Haines, Muñoz, & Thomas, 2013; Losch, 2012). The continent is thus projected to be home to one in five of the world's young and the world's largest working age population by 2040 (World Bank, 2009).

Even under the most favorable policy and growth scenarios, less than two-thirds of this youthful workforce will find wage jobs in the urban and non-farm sectors of the economy (Fine et al., 2012). Most projections indicate that the viability of farming and informal sector jobs (which are also heavily dependent on agriculture) would determine whether the remaining people in the labor force would be gainfully employed or join the ranks of the unemployed (Filmer & Fox, 2014; Yeboah & Jayne, 2016). The unemployment scenario would surely lead to political and/or social unrest. The growing young population is resourceful, innovative, and adventurous and thus represents a great asset for improving productivity and economic growth in all sectors including agriculture.

The sheer size of the youth population makes it a critical force in creating an effective demand for agricultural products in the region, if their purchasing power is enhanced. Also, as the largest share of the workforce, youth are an important source of agricultural labor. Their dynamism and adaptability could also be harnessed to implement the technological changes required to transform Africa's agriculture. However, the youth are typically viewed as uninterested in agriculture, as they find the existing form of back-breaking and low productivity agriculture extremely unattractive.

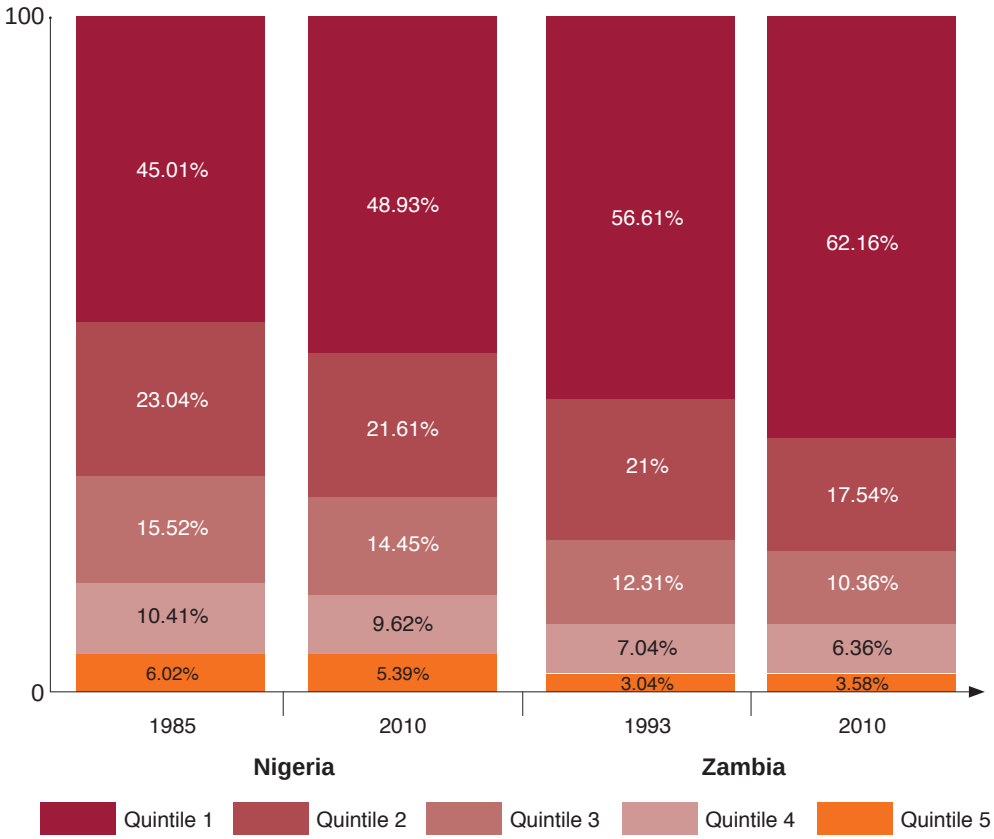
Those with a predilection for agriculture also face significant barriers to entering agriculture, including a lack of access to land and financial services (Bezu & Holden, 2014). Fortunately, policy and public investments can create an enabling environment that improves the profitability and attractiveness of agriculture and agri-food value chains to position the continent to reap a demographic dividend from its growing youthful workforce.

b. Rapid urbanization, emergence of a middle class, and diet transformation

Africa's urban population is growing rapidly, but the rate at which the region is urbanizing is slowing down (United Nations, 2016). Despite considerable country-specific variability, a major underappreciated demographic fact over the past few decades is that Africa's urban population growth is mainly due to natural growth of the urban population (birth rates minus death rates of people residing in urban areas) and reclassification of formerly rural towns as urban once a threshold number is reached (Bocquier, 2005; Moriconi-Ebrard, Harre, & Heinrigs, 2016; Potts, 2012; United Nations, 2016). Rural-to-urban migration appears to have slowed down considerably in most of SSA, and is no longer as important a driver of urbanization as it was between the 1960s and the 1980s. Also, with rapid population growth, another key source of urbanization is the proliferation of secondary towns and cities, which are also growing at least about the same rate as the larger cities (Christaensen & Todo, 2015). Despite urbanizing rapidly, SSA will still be the least urbanized region of the world by 2050 (United Nations, 2014).

At the same time, some studies provide evidence of a rising middle class in Africa estimated at about 350 million people in 2010 (AfDB, 2011; Deloitte and Touche, 2013; Kearney, 2014; Tschirley et al.,2015). On this basis they project a rapid modernization of Africa's food systems and diets, with major employment growth being envisioned in the downstream stages of the food systems. However, these conclusions are highly sensitive to how middle class is defined. Some scholars argue that urban income growth is quite narrow in most African countries and hence may generate weaker growth and employment multiplier effects than if it were broad-based (Gollin, Jedwab, & Vollrath, 2013; Jedwab, 2013; Potts, 2013). For instance, Figure 3.5 shows that the third and fourth income quintiles, ostensibly the "middle class",are declining in terms of their share of total income in Nigeria and Zambia over the past 25 and 17 years respectively. This skewed distribution of wealth raises the question of whether Africa is really making progress toward a rising middle class, or whether we are really seeing rising incomes at the top, and a declining share of income for not only the bottom 2 quintiles but the 3rd and 4th as well.

Figure 3.5. Share of total income by income quintiles: Nigeria and Zambia



Source: *World Bank (2015)*

The potential for urbanization and income growth to stimulate job expansion in downstream segments of the food system, and contribute to overall economic transformation, of course depends on where the primary agricultural products come from. If domestic farm production, mainly due to farm commercialization, is able to keep up with rising urban demand, obvious growth of jobs will occur in food assembly, wholesaling, and meeting the demand for food away from home, in addition to processing and retailing. In contrast, if domestic production cannot keep up with food demand, imported food (both processed and raw) will take an increasing share of consumers' expenditures. The importation of processed foods may still stimulate job growth in food retailing, but will cause loss of potential job expansion at the upstream stages of the food system, including agricultural input supply and agri-business services, farm production, financial services for the farm sector, storage, and local trading, which can otherwise occur if consumer demand is met through domestic production.

Capturing the potential of urban growth to stimulate employment growth in the agri-food system will hence depend on stimulating the domestic production base—itself a potentially major source of growth in wage employment and self-employment in the coming decades (Filmer & Fox, 2014; Losch, 2012). Also, the rates of migration and urbanization are responsive to public sector actions that affect the relative cost of living in rural and urban areas and the relative returns to labor in agriculture and non-farm employment.

The extent to which public policy could foster broad-based income growth and reduce income vulnerability of urban households would greatly influence future economic transformation patterns in the region.

[6]SSA countries are urbanizing at different rates. For instance, while over 50 percent of people in Ghana, Angola, and Cape Verde live in urban areas, the share of the urban population in several countries (e.g., Niger, Uganda, Malawi, Rwanda, Ethiopia and Burundi) is still less than 20 percent.

[7]Some scholars contend that most migration in the region is rural-to-rural, with young people accounting for most of it (Bilsborrow, 2002).
[8]Since "middle class" is a multidimensional term, definitions vary and comparable statistics across countries are rare. The African Development Bank (AfDB) defined the middle class as a family having per capita daily consumption of US$2–20 in 2005 purchasing power parity. Further, it found that this group had risen from 27 percent to 34 percent of the population between 1990 and 2010. However, about 60 percent of the middle class in 2010 were in the US$2–4 per capita consumption group—barely out of the poor category and in constant threat of falling back into it (AfDB, 2011). If this group is excluded, the rise in Africa's middle class over the past two decades would appear to be quite modest. There is evidence of rising incomes at least among a small segment at the top end of the income distribution.

c. Concentration of farm structure and marketed surplus from agriculture

Farmland ownership patterns in SSA are also changing rapidly. Since 2007, the region has experienced rising demand for agricultural land by both international and national companies (Jayne, Chapoto, 2014; Deininger & Byerlee, 2011), and by urban investor farmers (Jayne et al., 2016; Sitko & Chamberlin., 2015). While farms under 5 hectares still account for 90 percent of all farms in the region, an increasing portion of agricultural land is controlled by medium- and large-scale farms owned by African investor farmers. Although most survey datasets are unable to provide accurate estimates, recent studies indicate that medium-scale farms between 5 and 100 hectares control between 30 and 50 percent of total farmland in Ghana, Kenya, Zambia and Malawi (Jayne et al., 2016; Lowder, 2016). Farmland ownership patterns are also shifting between rural and urban areas. Evidence now indicates that urban people control between 15 and 35 percent of national agricultural land and an even greater portion of farm holdings over 20 hectares. Moreover, the share of urban households' control of national agricultural land is rising rapidly in some countries (Jayne et al., 2016).

Driving these changes, in part, are population pressures and increased world food prices, which in turn increase demand for land (Landesa, 2012; Otsuka & Place, 2014). Increased interest in African farmland may also be explained by the perception that Africa has large areas of unclaimed "available" arable land for investment. However, recent approximations estimate a much smaller amount of available land (Chamberlin, Jayne, & Heady, 2014; Sitko & Chamberlin, 2015). The rise of the investor farmers could influence how agricultural transformation unfolds in the region. These investors could be the source of dynamism in agriculture, bringing in needed capital and new technologies to farming. They could also drive up land prices, limit smallholder farmers' access to land, and in some cases make area expansion more difficult in densely populated smallholder farming areas. In addition, the investor farmers are increasingly dominating farm lobbies and using their political clout to steer agricultural policies and public budgets in their favor through input subsidy and commodity price support programs and import tariffs that reward those with the greatest surpluses to sell. Ironically, most small-scale farms are net staple-food buyers and are adversely affected by the lobbying of national unions of farmers aimed at raising grain prices (Jayne & Muyanga, 2012). However, these trends reflect the incentives embodied in land and agricultural policies over the past several decades. Future farm structure and income growth from agriculture are highly malleable to alternative land and agricultural policies.

d. Widespread soil degradation

Rising rural populations and associated land pressures in densely populated farming areas of Africa are causing a gradual shrinking of farm sizes over time (Headey & Jayne, 2014). Smallholder farmers are responding by continuously cropping their fields every year, without crop rotation or any sustainable practice to maintain or improve soil quality. Growing evidence has been reported of widespread soil degradation across the continent arising from such unsustainable cultivation practices (e.g.,Drechsel, Gyiele, Kunze, & Cofie, 2001; Stoorvogel & Smaling, 1990; Tittonell & Giller, 2012). Common forms of soil degradation include declining nutrient balances ("soil mining"), erosion and loss of topsoil, acidification, and loss of organic matter. An important contrasting study by Tiffen, Mortimore and Gichuki (1994) argues that population pressures between 1950 and 1980 in the Machakos District of Kenya induced households to make land-augmenting investments that contributed to sustainable intensification. However, in a more recent revisit to these same areas in 2014, Kyalo and Muyanga (2014) note that population densities during the period studied by Tiffen et al. (1994) were generally below 400 persons per km^2, that densities of some divisions have risen well over 800 km^2, and that there is now widespread evidence of soil degradation and unsustainable forms of intensification.

An estimated 65 percent of arable land in SSA is already degraded, costing farmers about US $68 million of lost income annually. This loss is estimated to affect over 180 million people, mostly smallholder farmers (Montpellier Panel, 2014). Loss of micronutrients and soil organic matter pose special problems, both because they cannot be ameliorated by the application of conventional inorganic fertilizers and because they tend to depress the efficiency of inorganic fertilizer in contributing to crop output (Shaxson & Barber, 2003; Marenya & Barrett, 2009; Vanlauwe et al., 2011). Consequently, smallholder farmers cultivating these depleted soils that are unresponsive to inorganic fertilizer are unable to benefit from yield gains offered by plant genetic improvements (Giller, Rowe, de Ridder, & van Keulen, 2006; Tittonell et al., 2007). For instance, a recent analysis revealed that area expansion was the largest contributing factor to growth in maize output in most countries in Eastern and Southern Africa despite government input subsidy programs promoting greater use of inorganic fertilizer and improved seeds (Table 3.6). Fortunately, a more holistic approach to sustainable agricultural intensification can succeed in reversing these trends, creating the potential for productivity growth if public policy could incentivize farmers to adopt these practices (Powlson et al., 2011; Snapp, Blackie, Gilber, Bezner-Kerr, & Kanyam-Phiri, 2010).

Table 3.6. Decomposition of maize production growth by area and yield		
	Contribution to maize output growth of 2010–2013	
Country	**Area Growth (percent)**	**Yield growth (percent)**
Kenya	87	13
Tanzania	51	45
Malawi	104	-4
DRC	-	-
Zambia	76	24
Zimbabwe	-79	24
South Africa: commercial	38	59
South Africa: subsistence	-34	136

Source: *Authors' calculations based on official Ministry of Agriculture statistics*

e. Climate change

Agriculture and climate change exhibit a feedback relationship; agriculture contributes to but is also affected by climate change. Most projections indicate that climate change will have a devastating impact on agriculture, particularly in SSA where the livelihood of smallholder farmers and pastoralists are subject to the vagaries of the weather. While the precise impacts of climate change on African farming systems are likely to vary spatially, two general predictions are greater variability in agricultural production and possibly a decline in crop productivity arising from more erratic and extreme weather patterns (Schlenker & Lobell, 2010). Despite the negative effects of climate change, Africa's agriculture still has enormous potential for growth. Unlike the developed world where yields for major cereals have already plateaued, Africa's low levels of yields indicate the potential to experience continued growth in food production before reaching the region's biophysical limits (Grassini, Eskridge, & Cassman, 2013). However, realizing this potential for increased agricultural growth and food security would require some investment in integrated approaches that will enable smallholder farmers to adapt to and rapidly respond to the negative impacts of a changing climate in the agricultural environment. For instance, given the rising competition for water, policymakers may need to focus on developing irrigation technology that improves water use efficiency and enhances farmers' ability to adapt to climate change (Cassman, Grassini, & van Wart, 2010).

Land use and cover change associated with agricultural production is also a principal contributor to climate change, accounting for about 24 percent of greenhouse gas emissions yearly. Africa presently accounts for about 15 percent of global agricultural emissions, at an average annual growth rate of about 2 percent (Tubiello et al., 2014). Africa and Latin America are also experiencing the world's fastest growth in the share of global farmland under cultivation (Headey, 2015). The continent's share of global agricultural emissions is thus projected to rise to about 30 percent by 2030 given the need for agricultural growth for food security (USEPA, 2012). However, feeding the global population through expansion of agricultural land will involve degradation of natural ecosystems. The alternative is ecological intensification of agriculture.This would require minimizing the constraints to appropriate technology adoption; focusing on sustainable water use through irrigation; and implementing best farming practices.

While the effects of climate change are largely exogenous in the short run from the standpoint of African policy makers, it is possible that future land policies affecting the rate at which forest and grassland are converted to farmland may influence the degree of climate variability experienced in some parts of the region. In this way, factors affecting the supply of and demand for farmland in Africa may affect the pace of this trend in future. Moreover, if global climate change induces greater volatility in world food prices, this may induce public and private investment responses at certain stages of the food system, for example, local storage and a shift toward food self-sufficiency, or investments in water-saving technologies and adaptive farm-management practices.

Enabling policies to trigger sustainable economic transformation process

So how should African policymakers respond to these megatrends to help sustain, if not accelerate the ongoing economic recovery and successful transform their economies? We offer a few recommendations:

a. Invest in education to upgrade the skills of the youthful workforce

Education, which was critical to structural transformation in Asia, remains low among Africa's workforce. The educational attainment of the average working age individual is still below secondary education (Filmer & Fox, 2014). A large share of those employed in agriculture have less than primary school education and often lack the requisite entrepreneurial and productive assets to thrive. With such low educational and skill levels among such a large portion of the labor force, a rapid transition of the workforce into well-paying non-farm jobs is infeasible in most areas. African economic systems of the future will require upgraded and profoundly expanded skill sets relative to what education and training systems are currently producing. The skill sets required for successful farmers, entrepreneurs, employees, and professionals within Africa's agriculture and non-farm sectors are likely to shift rapidly. For instance, successful entrepreneurs in farming will increasingly require access to skilled agricultural and marketing extension workers through the use of information and communication technology (ICT). Developing the skills to move the continent towards a 21st Century Agriculture will require transforming the content and approach of agricultural education for all young people—those entering farming as a business, those entering downstream stages of the agri-food system, and those leaving the agri-food system entirely. Anticipating the nature of these shifts and strengthening local "educational supply chains" to provide these requisite skills is critical.

b. Implement policies to promote broad-based agricultural growth

The development economics literature suggests that agricultural growth, if broadly shared, has the highest impact on non-farm income and employment (Lipton, 2006; Mellor, 1976). A one percent increase in agricultural per capita GDP reduces the poverty gap five times more than a one percent increase in GDP per capita in other sectors (Christiaensen, Demery, & Kuhl, 2011). In fact, in most industrialization experiences, the rise in agricultural productivity allowed agriculture to release labor to industry; produce more food to moderate hikes in urban industrial wage; supply raw materials to support agro-based industries; increase exports to pay for industrial inputs like machinery; and enhance the domestic market for industrial products. Virtually no country in the world has ever successfully transformed its economy from an agrarian to a modern economy with low poverty rates without sustained agricultural productivity growth. Yet, productivity levels in agriculture in SSA remain low. Hence, a major source of economic transformation in the region will be to promote farm productivity growth. As most of Africa's workforce is engaged in smallholder subsistence agriculture, it is essential that strategies promoting farm productivity growth are designed in ways that allow the millions of smallholder farmers to participate in and contribute to the region's economic transition. Such investment directed at increasing productivity of smallholder farming has considerable potential to have an impact on most people and generate broad-based and inclusive agricultural growth with greater multiplier effects on non-farm job creation and poverty reduction.

Increasing and sustaining productivity growth would require creating avenues to efficiently use existing resources and technology and to develop new and improved technologies that are adaptable to Africa's particular context. To this end, a potential area of public investments aimed at improving agricultural productivity is research and development (R&D) of technologies addressing location-specific constraints to productivity growth and agricultural extension services that will facilitate access to and uptake of productivity enhancing technologies including those designed to restore long-term soil fertility. Despite rising public expenditure on agriculture due to the commitments made under the Maputo Declaration, agricultural budgetary allocation to R&D and extension remains small and has fallen over the past decade and half. Estimates from four SSA countries revealed that the share of agriculture budget allocated to R&D and extension has fallen over time and presently stands at less than 10 percent.The only exception, South Africa, has also experienced a sharp drop from 41 percent in 2000 to 21 percent in 2014 (Table 3.7). It is therefore not surprising that area expansion, instead of yield increase, was the largest contributor to growth in maize output in Zambia, Malawi and Tanzania whereas, for South Africa yield increases for both commercial and subsistence farmers has driven growth (Table 3.6). Prioritizing R&D and implementing innovative extension practices could create the potential for productivity growth through sustainable agricultural intensification.

A growing domestic and regional market for African food and agricultural products arising from population growth, urbanization and rising per incomes with its consequent diet transformation offers an important avenue for economic transformation. Recent studies document an increasing demand for food products with differentiated quality including meat, fruit and vegetables, which offers enormous potential for value addition (Tschirley et al., 2015).Unfortunately, evidence suggests that a rising share of Africa's growing demand for semi-processed, processed and high value foods is increasingly being supplied through imports (ACET, 2014; Hollinger &Staatz, 2015). Indeed, the total value of agricultural imports rose by 62 percent between 2007 and 2011 to reach $37 billion, and the fastest growing products are poultry, meat and associated inputs such as soybean cake (ACET, 2014). This trend is expected to continue as

Table 3.7: Agriculture budget allocation by programs (2000–2014; percent)

Programs	Zambia		Malawi		Tanzania		South Africa	
	2000	2014	2000	2014	2000	2014	2000	2014
Input Subsidy Program	10.9	16.2	8.3	35.8	26.2	8.2	0.0	0.0
Agricultural support program	-	-	-	-	-	-	8.4	21.2
Research and Extension	1.3	0.9	6.6	1.4	0.04	0.5	40.7	21.2
Infrastructure Development program	0.02	7.5	4.2	52.2	51.4	6.3	7.1	10.6
Price Support Programs	0.0	34.9	8.6	3.5	n.a.	n.a.	0.0	0.0
Other programs	87.8	40.5	72.4	7.1	22.4	85.0	43.7	47.0

Source: Authors on calculation based on national budget expenditure data. Zambia (GRZ, various years; Govereh, et. al., 2006; Govereh, et. al., 2009); Malawi (Ministry of Finance, various years; SARPN, 2015; World Bank, 2013); Tanzania (Ministry of Finance, various years; ASDP; World Bank, 2013); South Africa (National Treasury, various years)

income and consumption of meat among the growing middle class rises. Policy makers could help unlock the potential gains from these trends to foster economic transformation by instituting well designed policies to increase productivity in the domestic agri-food supply chains and put local producers and agribusinesses on a competitive footing with imports. Such policies may include strategies that promote on-farm productivity growth to expand domestic farm production, and facilitate the development of well-functioning markets with efficient packaging and distribution channels. In addition, the policy may also promote the domestic processing of traditional export commodities like cotton, cocoa, and coffee, where Africa has demonstrated its global competitiveness in production, and facilitate entry of local businesses into global markets. Doing so would enable local producers to recapture the domestic market currently being lost to imports and generate employment in both upstream (agro-input supply) and downstream (agri-food trading and processing) for the workforce.

c. Develop and implement industrial policy aimed at reducing costs, improving competitiveness and diversifying the economic base

Reaping the greatest benefit from agricultural growth requires strengthening its linkages with other sectors of economy. Hence, efforts promoting on-farm productivity increases the need to be complemented with increased links with other sectors of the economy through the development of agro-based industries and/or investments in programs that increase farmers' access to local and regional markets for their agricultural products. To this end, African governments may need to institute an industrial policy that promotes private investment and job growth in the non-farm sectors, which simultaneously acts as a stimulus to investment in local agri-food systems (see EIU, 2008; Hausmann,Rodrik, & Sabel, 2008; Rodrik, 2007a). Of particular importance are those policies that reduce the cost of doing business (e.g., improvement in physical infrastructure to link rural hinterland to secondary towns and cities; provision of low-cost and reliable supply of energy, streamlining property right regimes especially those concerning land) and improve competitiveness of local industry (e.g., remove or reduce trade restrictions and taxes on imports of inputs to the industry and service sectors such as trucks, tractors, and spare parts, and minimize border-crossing bottlenecks). Improving the quality of infrastructure is crucial. Not only is the coverage and quality of much of Africa's transport, communications and energy infrastructure deficient, the costs paid to access services are very high compared to those in other regions (Kormawa & Jerome, 2015). Rodrik (2007b) proposes a model of industrial policy as a collaborative process in which governments and the private sector work to identify barriers to new activities and formulate policies and investments to address them. Because entrepreneurs who undertake new activities face private costs and risks but provide a public benefit by demonstrating their feasibility, these activities should be subsidized or otherwise encouraged. New activities can be incentivized with subsidies, trade protection or venture capital, and governments can also assist by playing a coordinating role. Because not all new activities have the potential to be profitable, performance requirements and phase-out plans should be built into all incentives (Rodrik, 2007b).

Furthermore, such industrial policy intervention should ensure that incentives and/or public goods aimed at improving the function of markets are equally available to both formal and informal sectors and provide a level playing field for both sectors to promote competition and growth.

These could include policy measures that would facilitate linkages between the formal and informal sectors such as those that assist informal enterprises to upgrade their capabilities to become competitive suppliers to modern firms as well as programs that encourage modern firms to source their inputs from informal enterprises including smallholder farmers. In addition, industrial policies should promote the expansion of the range of goods and services produced to diversify economies from a dependence on primary commodity exports. ACET (2014) recommends that African governments support domestic firms to learn about and introduce new technologies, processes, products and services that leverage the continent's relative advantages in labor and natural resources, and allow them to break into new international markets.

d. Continue to improve macroeconomic management

Improved macroeconomic management was a contributing factor to Africa's growth recovery (Badiane, Collins, Diao, & Ulimwengu, 2015), and continuing prudent management today and into the future will be vital for weathering the current change in external conditions and returning to strong growth. Natural resource-exporting countries that have been negatively affected by the drop in commodity prices may need to intensify their responses to avoid disorderly adjustment (IMF, 2016b). Where possible, countries should let exchange rates depreciate to absorb part of the shock (Sy, 2016); countries with more flexible exchange rates fare better after commodity price shocks (IMF, 2016b). Countries should reduce fiscal deficits by reducing spending and increasing revenues, in particular through improving tax administration and collecting more domestic taxes (Sy, 2016).

Countries that have been less negatively affected should build up buffers to protect against future changes in the external environment (IMF, 2016b). In the medium term, all countries should strive to increase resilience to shocks by accumulating foreign exchange reserves and food reserves, oil reserves (for oil-importing countries), and funds to respond to commodity price declines (for commodity exporters) (Ndung'u, 2016).

e. Improve governance and implement institutional reforms

Improvements in governance also contributed to the growth recovery (Badiane et al., 2015) and needs to be sustained. However, progress in advancing governance gains may be slowing (Ibrahim, 2016). The 2015 Ibrahim Index of African Governance showed overall declines in the Safety and Rule of Law and the Sustainable Economic Opportunity categories, which outweighed improvements in the Participation and Human Rights and Human Development categories. A strong civil society is essential for sustaining progress in governance. Donors should consider funding capacity building efforts to help civil society better monitor government actions and advocate for improvements. In addition to non-governmental organizations (NGOs) and the media, private sector organizations can be important players in encouraging good governance. For example, Gelb and Glasmann (2010) found that resource-rich countries that had been successful at managing resource wealth tended to have influential constituencies from non-resource sectors that helped to advocate for cautious spending.

A social contract in which national stakeholders agreed on the need for stability was another success factor identified by Gelb and Glasmann. African governments could benefit from efforts to build national consensus on the importance of pursuing development goals and meeting broad targets, such as the Comprehensive Africa Agriculture Development Programme (CAADP) goal of raising agricultural expenditures to 10 percent of total public expenditures. African leaders committed to achieving the expenditure target at the launch of CAADP in 2003 and again in the Malabo Declaration o 2014, but relatively few countries have met the target.

In addition to renewing progress in improving governance, African governments need to implement institutional reforms to improve government effectiveness. Poor inter-ministerial coordination hampers the ability of countries to allocate limited funds efficiently. The 2014 African Transformation Report recommends that governments establish a senior office above other ministries charged with strategic planning and staffed with high quality professionals, as successful transformers in East and Southeast Asia have done in the past (ACET, 2014). Gelb and Glasmann (2010) found that the presence of a stable group of technocrats working closely with elected officials was another factor common to countries that had been successful in managing natural resource revenues.

f. Increase intra-regional trade

Efforts should also be made to advance regional trade integration. Increased intra-regional trade would help the development of enterprises by providing them with larger markets. A higher volume of intra-African agricultural trade would raise food security and resilience to shocks; regional food production levels tend to be less volatile than national production, indicating the potential for regional production to mitigate the effects of shocks in a particular country (Badiane, Odjo,&Jemaneh, 2014).

In the Malabo Declaration, African Heads of State committed to tripling intra-African agricultural trade by 2025 and to accelerating the establishment of a continental Free Trade Area and a Common External Tariff. Intra-regional trade is growing, but remains at very low levels, and a large percentage of cross-border trade is informal. Regional trade could be significantly increased through moderate reductions in trading costs (Badiane et al. 2014); this can be achieved by improving infrastructure quality and by reducing road harassment and corruption, which is often a significant part of trading costs. Cross-border trade regulations should be simplified where possible and fees and delays reduced; technical assistance can be provided to help traders comply with regulations (Lesser &Moisé-Leeman, 2009).

Concluding remarks

Our findings confirm that African economies have indeed recovered from the economic downfall of the 1990s. The trend of growth recovery is observed across all sectors although with significant differences from one sector to the other. However, no major change is observed in the composition of value added as African economies are still dominated by the mining sector. For labor productivity, we found evidence of good performance in the 1960s followed by sluggish growth or absolute declines in productivity during the next three decades.

Regarding diversification and sophistication, African economies have experienced limited structural change with respect to the complexity of the production system. It is fair to say that so far Africa seems to have missed out on the growth-enhancing impacts of structural transformation.

Results for agriculture show that labor productivity growth increased to an unprecedented annual rate of 2.6 percent after the 2000s. In line with most stylized patterns of structural transformation, a declining trend in the share of farming in total employment is observed in most countries, largely due to a much more rapid percentage growth in the off-farm sectors. However, the destination of labor exiting agriculture has also been different in Africa than it has in other developing regions. Indeed, there is no significant evidence of agricultural labor moving from agricultural sector to manufacturing.

As pointed out by Arbache & Page (2007), Africa has had numerous growth acceleration episodes in the last 30 years, but also nearly a comparable number of growth collapses, offsetting most of the benefits of growth. The main challenge facing Africa is how to accelerate and sustain the current growth trend to avoid another collapse. This means broadening and intensifying the current growth performance, and ensuring that development processes are sustained over time.

To consolidate the growth recovery trend through structural transformation that ensures rapid, sustainable and inclusive growth, African countries need to design and implement relevant policies that account for key megatrends such as labor force expansion and youth bulge, rapid urbanization, concentration of farm structure and marketed surplus from agriculture, widespread soil degradation, and climate change. According to ECA (2013), African economies must establish favorable conditions by ensuring macroeconomic stability and the rule of law and protecting property rights, but must also actively pursue development outcomes through targeted interventions to promote economic transformation.

Firstly, governments should develop coherent and credible development policy frameworks and industrial policies aimed at facilitating movement to downstream segments of value chains. The alignment of development partnerships, including with trade partners, investors and donors, with economic transformation goals should be improved by developing common positions during trade negotiations and requiring investors to partner with local firms or incorporate local content. Local content policies should be accompanied by interventions to strengthen local capacities through skills development, R&D, technology dissemination, and increasing access to finance and capital. Industrial partnerships with firms in other emerging markets, as well as technology cooperation agreements, should be encouraged to promote skills and technology transfer.

It is vital to upgrade infrastructure, particularly energy infrastructure, but policymakers must invest strategically and avoid projects that only facilitate commodity production and export. Governments should adopt regulatory regimes that incentivize private sector investments and promote intra-regional trade. Finally, governments should continue to build human capacities by providing health services and education to the population, and should make special provisions for underserved groups including women and youth. Government capacity to formulate and implement effective development policies is central, and efforts must be made to strengthen public sector institutional capacities and governance.

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CHAPTER 4

Sustainable Intensification For Resilience

AUTHORS

Yemi Katerere
World Wide Fund for Nature

Aslihan Arslan
Food and Agriculture Organization of the United Nations

Cuthbert Kambanje
Food and Agriculture Organization of the United Nations, South Africa

Bashir Jama Adan,
Islamic Development Bank

Milu Muyanga
Michigan State University

Abednego Kiwia
Qureish Noordin
Alliance for a Green Revolution in Africa

KEY MESSAGES

ONE

Although sustainable intensification is a promising pathway to food and nutrition security it is not a silver bullet to resolving food challenges in SSA. To be successful, it should go beyond top-down technologies for production and embrace holistic approaches including indigenous knowledge, practices and solutions. The use of improved seeds and fertilizers, within the framework of Integrated Soil Fertility Management (ISFM), is essential for sustainably increasing Africa's agriculture which is largely dominated by smallholders.

TWO

National institutions need to be strengthened to provide up-to-date extension services and information on location-specific appropriate sustainable intensification technologies, to articulate and implement transformative policies, and to identify what is working well for successful up scaling.

THREE

Government agencies should adopt policies to support improved risk management tools, links to dynamic value chains, and safety nets and livelihood diversification. These interventions should be complemented by policies that promote regional integration in a manner that reduces the costs of doing business and migration of skills.

FOUR

Rural livelihoods depend strongly on diverse and healthy ecosystems and the services they provide such as food, fuel, water purification and disease regulation. Given such a dynamic state, policies to promote diversification strategies are essential to making the system less vulnerable by reducing the risks associated with over-reliance on limited input-output markets and a single commodity or technology.

FIVE

Improved access to information increases farmer resilience. Farmers need access to targeted, local and timely information on climate/weather and marketing opportunities from reliable sources, which would enable them to take better decisions to improve their welfare in a sustainable way.

Introduction

SSA faces many challenges, not least the high prevalence of chronically hungry people. FAO (2015) reports that 220 million people on the continent are undernourished (consuming less than 2100 kcal/day), while over 50 million African children suffer from stunting (UNICEF, 2016). The global demand for food is expected to increase by 60 percent, as the world's population reaches 9.1 billion by 2050 (Alexandratos & Bruinsma, 2012). The supply of food is struggling to meet the increasing demand, resulting from the rapidly growing and urbanizing population. Using a new estimate of population of 9.6 billion by 2050, WRI (2014) estimates that food calories will have to increase by 65 percent between 2006 and 2050 to feed this population (using a rate of 3,000 calories per person per day). The food demand situation is also transforming. Not only is demand for quantity increasing as the population increases but also consumer preferences are changing, resulting in increased demand for diversity and for processed fast foods. Africa's growing human population, which is now over 1.1 billion (World Population Statistics, 2014), is exacerbating the demand for forest resources such as firewood and land for large-scale commercial and small-scale agriculture, leading to deforestation and forest degradation. The low productivity of Africa's smallholder agriculture contributes to this phenomenon that necessitates expansion of agriculture into the remaining forests and marginal lands.

Family farms make up the majority of agricultural producers in SSA, where there are approximately 33 million smallholders farms (IFC, 2013). Eighty percent of all farmers are smallholder farmers. Family farming produces 98 percent of the food crops in SSA. Of the 14 major farming systems, 5 host over 70 percent of Africa's rural poor, and most of it's cultivated area and livestock. According to Rukuni (2014), these farming systems are: a) maize-mixed; b) agropastoral; c) highland perennial; d) root and tuber crop; and e) cereal–root crop. What should be avoided is a one size fits all approach.

Given the nature of the challenges facing the continent, a key question addressed in this chapter is how to get to a more resilient agricultural production system. Doing this will require combining the components of sustainable intensification (SI) into a framework that can provide solutions to Africa's food and nutrition crisis while carefully managing the trade-offs between the numerous components.

The defining components of sustainable intensification in Africa

This chapter discusses how SI can be delivered to build resilience of the agricultural systems in SSA. Agriculture is a type of socio-ecological system or an ecosystem managed to produce, distribute, process, and consume food, fuel, and fiber (O'Connell, 2015). Consequently, agricultural resilience must be built on and go beyond the farm. These systems are defined not only by the physical space of production but also encompass socio-economic attributes that affect resilience. These include decision making, tenure of land and other resources, the functioning (or lack thereof) of markets, price volatility, and the relationships between different actors. Other socio-economic dimensions such as poverty, health, social relations (whether harmonious or conflictual, inclusionary or exclusionary), and the diversity of assets held are also important in shaping resilience. Consequently, a parallel goal to improved agricultural production through SI must be to maintain, or even enhance, multi-functionality in the landscape and the resilience of people and the institutions that define social spaces (Enfors, 2013).

SI is seen as one pathway to food and nutrition security that can spare the environment while enhancing social and economic welfare. It recognizes that production of food cannot continue as it has been done in the past because the context has changed dramatically. Further, the context varies from region to region, country to country, village to village; policies and technologies have to consider this and help us understand where SI is desirable and whether intensification is actually necessary. Additionally, selecting the pathway to intensification is critical to determining the capacities and inputs that are necessary.

SI is broadly defined as increasing production, income and other benefits, from the same land or less with prudent use of inputs such as water, fertilizers and pesticides while reducing the negative environmental impacts associated with clearing forests, water extraction, and soil usage, and at the same time enhancing the flow of environmental services (Godfray et al., 2010; Pretty, Toulmin, & Williams, 2011) (see Box 4.1). The Montpellier Panel (2013) defines three mutually reinforcing practical approaches to SI that are grouped into ecological, genetic and socio-economic intensification. The first

[1] Most smallholder farms are also family farms.

BOX 4.1:
Components of Sustainable Intensification

Increased production, income, nutrition or other returns:

- On the same amount of, or less, land and water
- With efficient and prudent use of inputs—there are no blueprints of which inputs to use
- Productive use of knowledge and capacity to adapt, innovate and scale up

Minimizing greenhouse gas emissions:

- While increasing natural capital and the flow of environmental services
- Reduce impact on forests including through alternative energy sources

Strengthening resilience and reducing environmental impact:

- Through innovative technologies and processes
- Minimizing the use of technologies or inputs that have adverse impacts on people and the environment

Adapted from Pretty et al. (2011)

two are technological and the third provides an enabling environment to support technology uptake.

The "resilience approach" enables a holistic and long-term perspective to address the challenges faced by food production systems while benefiting from the opportunities they bring along. A holistic approach is necessary because food production systems are complex and are exposed to multiple internal and external drivers such as climate change and weather variability, population growth, soil degradation, economic and political uncertainties (Godfray et al., 2010; Pretty et al., 2011).

The dimensions of the SI goal help us understand the linkage between SI and climate smart agriculture (CSA), which is complex. SI and CSA are closely interlinked and are only part of a multi-pronged approach toward global food security goals (Campbell, Thornton, Zougmoré, van Asten, & Lipper, 2014). These authors also noted that the main difference between the two is on the focus in CSA on outcomes related to climate change adaptation and mitigation while SI contributes to adaptation, building ecosystem services and increasing farm incomes. SI is therefore regarded as being crucial for reduced emissions per unit of output, through lower direct emissions and less land cover change.

Box 4.1 shows the components of SI. This brings to the fore the debate on how to combine these components into a framework that can deliver SI and resilient and sustainable agricultural solutions to the food security challenges in SSA. Given the multiplicity of challenges in SSA, SI should lead to an agricultural production system that is more socially, economically and environmentally resilient. We should recognize that production alone will not solve current and future food needs of SSA and we have to examine the entire food system that includes how food is grown, stored, processed and consumed.

Resilience and sustainability as complementary concepts

If a food production system is not able to continue to produce food and other benefits in the face of shocks and disturbances, then it is unlikely to be resilient. Similarly, for a food production system to be sustainable it must be able to meet today's food production goals without compromising the system's capacity to do so in the future. Resilient systems require supportive policies, institutional arrangements and governance that allow them to evolve in response to new challenges, drivers, and stressors. From this perspective the concepts of resilience and sustainability are complementary as shown in Figure 4.1 (Tendall et al., 2015).

This chapter focuses on deepening the analysis of environmental, social and economic aspects of SI and the interconnectedness between them. Transformation of any one part of the system will have an impact on the other two. Environmental, social and economic resilience is essential to the goals of SI since the form of intensification can be shaped by climate change and weather variability, land tenure, household wealth and socio-economic issues like access to loans, markets and technology. Section one provides the context of the chapter focusing on the challenges facing SSA, the uniqueness of Africa's agricultural systems and why SI is needed.

Section two focuses on environmental resilience that is defined as the ability of environmental systems to absorb disturbances and still retain their basic functions and structure. In addition, the section explores land and soil degradation, deforestation and its drivers in Africa as well as analysis of how to build environmentally resilient production systems while pursuing SI objectives.

Figure 4.1: Resilience and sustainability as complementary concepts

Source: *Tendall et al, 2015*

Economic resilience, the focus of section three, is the ability of the agricultural system to recover from or adjust to the negative impacts of external economic shocks. The analysis focuses on the impact of several factors such as climate change and variability, price fluctuations and political instability (insecurity, disruption of transport networks) that periodically and frequently shock the agricultural sector in Africa. In addition, the opportunities for and challenges to the resilience of African agriculture caused by the increasing inter-regional and international interactions including factor and product markets, value chains, and markets under the umbrella of globalization and regional integration, are also discussed.

In section four, we analyze various aspects of social resilience. The section seeks to deepen the understanding of the roles of governance of resources and value chains, tenure on land, forestry, fisheries and other productive resources (e.g., water). It also deals with the role of social preferences in shaping social resilience under projected economic pathways.

The fifth section focuses on the practical approaches that can deliver SI. These including good agronomic practices such as intercropping, agroforestry technologies and conservation farming collectively referred to as ecological intensification; plant and livestock breeding referred to as genetic intensification; and the enabling environment for SI to be delivered, termed socio-economic intensification. This section provides examples of interventions of SI that have worked and lessons from success stories. The section also considers incentives for policy makers to help bring about the desired shift towards resilient food production systems. The final section of the chapter provides conclusions.

Environmental Resilience

Environmental resilience is the ability of environmental systems to absorb disturbances and still retain their basic ecological functions and structure. With respect to SI, the challenge is how to achieve sustainable and resilient agricultural productivity with more efficient use of all inputs while reducing environmental damage. Since agricultural production systems are parts of larger landscapes, they play an important role in the conservation of natural landscapes to enhance the flow of environmental goods and services and cultural values while minimizing negative externalities (Pretty et al., 2011).

Analyzing coping strategies and capacities including indigenous and traditional strategies is very important in the African setting. Agriculture in Africa is under threat of low productivity due to limited use of yield-enhancing inputs (especially improved seeds and fertilizers), increasing water stress in many countries, and disasters such as flood and drought that are affecting crop, livestock and fish production. Forests are being affected in different ways such as unsustainable logging, slash and burn, and domestic and commercial firewood and charcoal production. The impact of these activities is highly location specific. Coastal and low-lying areas are at risk of flooding due to rising sea level and soil erosion. In some areas, infrastructure such as settlements, roads and bridges, and industries are at risk of disasters such as floods and landslides. To understand how to adapt to the increasing frequency of extreme events, we must understand the central concept of adaptation, which is vulnerability (Locatelli et al., 2008).

Land and Soil Degradation

Thiombiano and Tourino-Soto (2007) report that Africa is seriously threatened by land degradation which is being caused by inter alia, population growth, conflicts and wars with expanded refugee settlements, inappropriate soil management, deforestation, shifting cultivation, insecurity in land tenure, and variation of climatic conditions as well as intrinsic characteristics of fragile soils in diverse agro-ecological zones. As a consequence, Africa accounts for 65 percent of the total extensive cropland degradation

of the world. These authors also report that at least 485 million Africans are affected by land degradation, and the continent is burdened with a US$9.3 billion annual cost due to this phenomenon. Land degradation affects the poor in rural areas. Barbier and Hochard (2016) note that between 2000 and 2010, SSA recorded the highest increase (17–18 percent) in the number of rural poor living on degraded agricultural land (see Table 4.1).

Estimates of the global extent of land degradation (Table 4.2) show that Africa is the second most affected continent (after Asia), and Europe is the least affected (Barman, Mandal, Pampa Bhattacharjee, & Ray, 2013). AfDB (2013) reports that 4 to 12 percent of Africa's GDP is lost due to environmental degradation, with 85 percent of this loss attributed to soil erosion, nutrient loss with crop harvests without replenishment, and changes in cropping mixtures.

Agricultural lands used for cropping and livestock rearing are more susceptible to degradation than non-agricultural lands (Nachtergaele, Biancalani, & Petri, 2010). In addition, Nachtergaele et al. (2010) highlights that land use, and associated inputs and management, are indeed the main direct causes of land degradation. In this regard, land use in itself is determined by natural conditions and cultural and socio-economic aspects including institutional settings, infrastructure, information and market availability.

Closely linked to land degradation, Africa faces an escalating soil fertility crisis (Morris, Kelly, Kopicki, & Byerlee, 2007; The Montpellier Panel, 2013) costing the continent more than US$4 billion worth of soil nutrients per year (IFDC, 2006). There is mounting evidence that at very high levels of rural population density, the well accepted positive relationship between population density and land intensification breaks down (Josephson, Ricker-Gilbert, & Raymod, 2014; Muyanga and Jayne, 2014; Ricker-Gilbert, Jumbe, & Chamberlin, 2014). The declining fertility of African soils because of soil nutrient mining is a major cause of decreased crop yields and per capita food production and, in the mid to long-term, a key source of land degradation and environmental

[2] http://www.worldenergyoutlook.org/resources/energydevelopment/africafocus

Table 4.1: Distribution of global rural population on degrading agricultural land, 2000-2010

	Population in 2000 (millions)				%change from 2000 - 2010			
	Rural population (1)	Rural population on all DAL (2)	% share (2)(1)	Rural population on all remote DAL (3)	% share (3)(1)	Rural population (4)	Rural population on all DAL (5)	Rural population on all remote DAL (6)
Developing country	**3,706.8**	**1,258.7**	**32.4**	**202.2**	**5.5**	**14.6**	**13.3**	**13.8**
East Asia & Pacific	1,398.4	71.03	50.8	125.2	9.0	7.2	8.4	6.8
Europe & C. Asia	173.8	67.0	38.5	6.2	3.6	4.0	1.0	4.0
Latin America & Caribbean	294.1	38.3	13.0	5.6	1.9	14.3	18.4	17.1
Middle East & N. Africa	294.1	38.3	13.0	5.6	1.9	14.3	18.4	17.1
South Asia	1,090.4	285.2	26.2	27.4	2.5	17.8	17.8	18.9
Sub-Saharan Africa	554.6	114.1	20.6	32.4	5.8	28	37.8	39.3
Developed Country	**440.7**	**72.6**	**17.9**	**3.2**	**0.8**	**2.6**	**-2.8**	**-1.8**
World	**4,111.5**	**1,331.3**	**34.0**	**205.4**	**5.0**	**13.4**	**12.4**	**13.6**

Source: *Barbier, E. B., & Hochard, J. P. (2016).*

Table 4.2: Global trends of land degradation

Estimates of all degraded lands (in million km in dry areas			
Continent	**Total Area**	**Degraded Area**	**Degraded (%)**
Africa	14.33	10.46	73
Asia	18.81	13.42	71
Australia and the Pacific	7.01	3.76	54
Europe	1.46	0.94	65
North America	5.78	4.29	74
South America	4.21	3.06	70
Total	51.60	35.92	70

An overview of deforestation figures around the Globe		
Global Region	**Period**	**Net loss hectare/ year**
South America	2000-2005	4.3 million
Africa	2000-2005	4.0 million
Oceania	2000-2005	356,000
North & Central America	2000-2005	333,000
Asia	1990s	800,000
Europe	1990s	Expanding

Source: *Barman et al., 2013*

damage (Henao & Baanante, 2006). Soil nutrient mining is the result of overexploitation of agricultural land. It is the consumption of a key component of the soil's natural capital. The propensity for nutrient mining of Africa's agricultural land and the severity of its consequences are the highest in the world. Soil nutrient mining is usually associated with low agricultural and land productivity under severe constraints of poverty in terms of physical capital (infrastructure) and human capital (health and education). Continued nutrient mining of soils would mean a future of even higher levels of poverty, food insecurity, environmental damage, and social and political instability.

Although most farmers do their best to maintain soil quality through soil and water conservation practices (Mando, 2000; Ogunkule, 2000), pervasive poverty and market imperfections combined with climate change and ineffective institutions in the continent make it difficult to ensure that these are enough to prevent large-scale land degradation. Various technologies such as composts and organic manure, mulching techniques, conservation agriculture, agroforestry, stones and earth bunds, rock dams, vegetation strips, and "zai" techniques are used to conserve soil and water and to restore degraded lands.

Forest Degradation

Africa has an estimated 650 million hectares of forest and woodland cover, which constitutes 21.8 percent of its land area and 16.8 percent of the global forest cover. It is also home to the Congo Basin, the world's second largest tropical rainforest. East and Southern Africa has over 3 million square km of miombo woodland that forms a critical life-support system for over 65 million people (Dewees et al., 2011). More than 730 million people in SSA depend on traditional biomass as a primary energy source that invariably puts pressure on natural forests. The impacts of high dependence on biomass fuels include forest degradation and deforestation, greenhouse gas emissions, soil erosion and siltation of rivers.

These forests are under pressure from a growing and expanding human population that reached 1.1 billion in 2014 (World Population Statistics, 2014) and low productivity on cultivated lands caused by nutrient mining and low input usage. Population growth is driving the demand for forest resources such as firewood, food, fodder, medicines and extensive conversion of land to commercial and small-scale farming. According to the Millennium Ecosystem Assessment (MEA) (2005), actions to increase one ecosystem service such as food security can cause the degradation of others. For instance, using more water for irrigation and expansion of agricultural land, can lead to less water available for others, degrading water quality, decreasing forest cover and loss of biodiversity (MEA, 2005).

Land used for crops and pasture has been increasing by an estimated 10 million hectares per year since the 1960s placing pressure on tropical forests (WRI, 2014). WRI (2014) estimates that increased crop and livestock production could easily result in emissions of 9.5 gigatonnes of carbon dioxide per year in 2050 under business as usual, rising from 6.5 gigatonnes of carbon dioxide per year in 2010. Recent reviews indicate that it will not be possible to keep temperature increases to below 2°C without addressing greenhouse gases produced from changes in land use (Eliasch, 2008). Reducing these emissions would require curtailing agricultural land expansion. This would be possible only if the additional food the world needs by 2050 can be produced on today's agricultural land area.

Further, Locatelli et al. (2008) have reported that large impacts of climate change on forests and people are twofold. First, Africa's forests are vulnerable to climate change and forest conservation and management will need to adapt to future climate induced conditions. Second, the vital ecosystem services that forests deliver benefit people beyond the forests globally, especially in terms of mitigation.

Forests are a contested space because of their multiple roles locally, nationally, and globally. The biggest challenge is how to better manage the trade-offs of the competing interests and demands on forest landscapes. The complex ways in which different factors interact requires that we consider the context to inform policies, strategies and practice.

Pressure on the Commons

Why do the commons matter?

The commons are shared resources in which stakeholders have equal interest (Olstrom, 1990). The shared resources are referred to as common pool resources that include resources such as fisheries, forests, grazing systems, wildlife and water. The challenge with common pool resources is that one person's use can infringe on another's. Another challenge arises where exclusion of outside users, while necessary, may be difficult and costly. Global commons include climate change, air pollution and transboundary resources (e.g., shared river basins and migratory wildlife).

From an agricultural resilience perspective commons play a critical role in social well-being and resilience and ecosystem provisioning services. A productive activity such as livestock production (whether from agropastoral or pastoral communities) largely depends on the commons and provides manure to improve fertility and soil quality. The commons also provide high quality food, the benefits of which may go beyond the community. In addition to these productive roles, commons are often culturally important. In recognition of this, the rights to the commons are increasingly recognized at the global level including in the Voluntary Guidelines on Responsible Tenure (FAO, 2012). Human rights laws also recognize the rights indigenous peoples have to the commons as productive and cultural spaces. The global biodiversity and climate mitigation values of the commons are also important.

Challenges to the resilience of the commons

The perception that commons are poorly managed due to open access is relatively widespread amongst policy makers and the concept of the "Tragedy of the Commons" (Hardin, 1968) has shaped policy approaches. This stems in part from the idea that the commons are resources over which the governance is weak or non-existent. Based on this assumption many governments invoked policies to "nationalize" common land, which led to weakening or collapse of local common property regimes. This has in effect led to neglect, creating a "tragedy of the commons" where none formerly existed. The globally acclaimed work of Elinor Ostrom shows that some commons are governed under common property regimes (CPR) with clear rules and governance systems (even if these are flexible rules) (Olstrom, Gardner, & Walker, 1994). These systems, even when under flexible access regimes, are generally where local institutions are maintained (Davies et al, 2016). These CPR management systems may also face challenges from changing social values.

Often the role of the commons in terms of food security, energy, water and grazing is poorly recognized and not supported in legal policy. One consequence is that commons are often depleted through land acquisitions for conservation and parks; mineral and timber exploitation; and large-scale agricultural concessions, often creating sizeable holes in customary areas. Opportunities for citizens to formalize or enforce their rights might be extremely limited and in effect unavailable to family farmers.

The importance of strengthening the resilience of the commons

Restoring resilience in the commons can benefit from ecosystem restoration and strengthening governance as discussed in section 4 (social resilience). These strategies may be complemented by improving mechanisms for governance in the commons and also between different levels (polycentric governance). Institutional and governance arrangements that facilitate this must respect and allow for: a) many autonomous units formally independent of one another; b) choosing to act in ways that consider others; and c) processes of cooperation, competition, conflict, and conflict resolution (Olstrom, Gardner, & Walker, 1994). For example, central governments in the Chad Basin have been supportive of open access to common pool resources for pastoral communities. This system recognizes the pastoralists own customary systems, which are based on an ethos of open access to all pastoralists who, regardless of class, ethnicity or nationality, have free access to CPR (Davies et al., 2016). Given the reserves that cannot be grazed which are created by seasonal flooding of these wetland pastures, there is no "tragedy of the commons" (Moritz et al., 2014). Strengthening tenure to secure rights for poor and marginalized people, including women can help improve management.

Table 4.3: A typology of the main land tenure systems in SSA

LAND TENURE SYSTEM	DESCRIPTION	PROS/CONS
Statutory	Public tenure systems – the state assumes responsibility for ensuring access to secure land.	Can be riddled with bureaucratic inertia, inequity in accessing land and corruption. The poor and vulnerable may have access to land but do not have tenure security because the government can expropriate the land at any time.
	Private tenure systems vest ownership in the hands of individuals, companies or non- governmental organizations.	May in principle be transparent and efficient if backed by effective land governance and administration frameworks, but may result in land being accessed by only the elite and influential people. Most rural women cannot afford to buy land.
Customary Land Tenure	Refers to the communal possession of rights to use and allocate agricultural and grazing land by a group sharing the same cultural identity. A single person usually administers on behalf of the group.	Customary tenure may result in access to land by most individuals in a community; it can be influenced by commercial pressures that erode social cohesion, from which the system derives its legitimacy. Some customary norms discriminate against women.
Hybrid Systems	Several tenure categories co- existing on the same piece of land. For example, formal and informal rights may exist for the same holding.	May result in access to land by most individuals in a community but may not enjoy full legal status. Riddled with land tenure insecurity.

Source: *FAO (2013a)*

Challenges of Tenure

Land is clearly a fundamental resource in agricultural production, especially for smallholder farmers. In countries like Kenya, Tanzania, Ethiopia and Uganda, over 75 percent of total agricultural output is produced by smallholder farmers with average farm sizes of about 2.5 hectares (Salami, Kamara, & Brixiova, 2010). Therefore equitable access to productive land and secure tenure systems are fundamental to SI and sustainable development. In SSA the State plays a central role in determining access, control and management of rural land irrespective of the tenure category under which it is held or owned. Consequently most land policies are not inclusive or consultative and are promulgated through parliament or the executive. The United Nations Economic Commission for Africa (2004) reports that where land tenure policy reforms have been developed from more participatory processes, they tend to be more comprehensive and make provisions for more rights for individual citizens than for the State.

Overlaps between customary/traditional and state/ statutory land tenure are common in SSA, although the dominance of these tenure regimes varies from country to country. This has resulted in a form of hybrid tenure system where several tenure categories coexist on the same piece of land (AGRA, 2014a) without clear hierarchy and coordination (see Table 4.3). The arising confusion causes tenure insecurity (AGRA, 2014a)

The significant role played by women farmers in SSA, means that food security and livelihood outcomes are more likely to be realized when women have equitable and secure access to land. Studies in Zimbabwe show that many women who have received land title, either individually or as part of a family, have had their lives transformed (Farnworth, Sundell, Nzioki, Shivuste, & Davies, 2013). In many sub-Saharan African countries, land reforms have consistently failed to develop innovative ways of securing women's access to use of, and control over land.

Despite the role played by women in food production, very few women have statutory land title. The discourse around land continues to be defined through a patriarchal narrative with African women being dependent on their relationships with fathers, husbands, sons and other male relatives to access land. Once these relationships fail, women may lose their land.

Climate and Weather Variability

The last IPCC 2014 report states that "climate change will interact with non-climate drivers and stressors to exacerbate vulnerability of agricultural systems, particularly in semi-arid areas [of Africa]" with a high confidence (IPCC WGII AR5-Part B, p. 1202). This puts climate change and the changes in weather patterns associated with it among the major external stressors that need to be addressed, as part of building environmental resilience into agricultural systems. The concept of climate change and projections on changes in the average climatic variables usually refer to observations for 30 years or more given that average values change very slowly in a complex system. The weather extremes (the lowest and highest ends of the distribution of weather occurrences), however, have increased faster than the overall averages in the last 30 years and have a much stronger impact on agriculture and food security (Robeson, Willmott, & Jones, 2014).

The African Agriculture Status Report (2014) summarizes the evidence on the increases in the frequency and severity of extreme events, the increased unpredictability of rainy season onset, and the increased length and intensity of dry spells in the continent. Policies that aim to improve the environmental resilience of the agricultural system need to consider the ways in which the increasingly more frequent and severe extreme events interact with the proposed solutions. For example, yield-increasing inputs (e.g., fertilizers and improved seeds) under average climatic conditions may become risk-increasing under drought/flood, just as some practices (e.g., legume intercropping) may have productivity improving effects that are resilient to such shocks (Arslan et al., 2015). Another effect of increased frequency of extreme events (that translate into increased variability in seasonal rainfall) is the creation of barriers to the adoption of new technologies that can improve resilience (Arslan, McCarthy, Lipper, Asfaw, & Cattaneo, 2014; Asfaw, McCarthy, Lipper, Arslan, & Cattaneo, 2016). Policies for environmental resilience also need to consider the effects of extreme events on farmer incentives to ensure effective targeting.

Droughts and floods alone have significant impacts on the economies of many African countries, especially in SSA. Regions of highly variable rainfall in Africa include the Sahel, the Greater Horn and Southern Africa. These regions experience severe and frequent droughts that result in famine exacerbated by inadequate socio-economic entitlements (assets, employment, land) (Hansen, Dilley, Goddard, Ebrahimian, & Ericksen., 2004). In the past five decades, drought has been associated with a depletion of assets, environmental degradation, impoverishment, unemployment and forced migrations (Bhavnani, Vordzogbe, Owor, & Bousquet, 2008; Hellmuth, Moorhead, Thomson, & Williams, 2007). Frequent droughts have reduced the GDP growth of many African countries (Brown, Meeks, Hunu, & Yu, 2011; World Bank, 2005) and threatened their development gains (Hellmuth et al., 2007). Drought directly affects production, lives, health, livelihoods, assets and infrastructure that contribute to food insecurity and poverty. Some authors estimate that the indirect effects of droughts on crop and livestock prices and environmental degradation could be larger than their direct effects (Holden & Shiferaw, 2004).

Mitigation and Adaptation in the agriculture sector

As highlighted in Chapter 1, while the agricultural sector is increasingly vulnerable to climate change and extreme weather events, especially in SSA, it also contributes to climate change through increased emissions. Campbell et al. (2014) note that climate change adaptation and mitigation can be generated through various means that are all components of SI. These include enhancing soil quality, generating vital regulating services of buffering, filtering and moderating the hydrological cycle; improving soil biodiversity; and regulating the carbon, oxygen and plant nutrient cycles, enhancing resilience to drought and flooding, and carbon sequestration, for example. Box 4.2 is an example of CSA practice in the livestock sector.

Given the above, countries in SSA need to be clear about how agriculture fits into their national strategies such as climate change response strategies, intended nationally determined contributions (INDCs) and mitigation efforts such as REDD+ and implementation of the SDGs. The reverse is also true, as climate change needs to be clearly integrated into the national and sectoral development plans. A holistic and integrated approach is needed to achieve this, especially related to adaptation and mitigation related policies (Leonard et al., 2016). One example for enhancing productivity and resilience of the agricultural production systems while conserving the environment is the Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) project. The project is designed to increase food security and incomes while conserving the natural resource base (Godfray et al., 2010; Pretty et al., 2011).

Economic Resilience

Definition and typology of economic resilience

Economic resilience can be defined as "the ability of an economy (local, national or regional/international) to withstand, absorb or overcome an internal or external economic shock" (Bristow et al. 2014). Environmental

BOX 4.2:
Livestock systems intensification

Sustainable intensification of livestock production systems could contribute enormously to both adaptation and mitigation. These systems are highly variable, spatially as well as productivity-wise and efficiency-wise. Based on a global modeling study by Havlik et al. (2014), Campbell et al. (2014) posit that transitions toward more efficient, intensified systems would result in considerable meat and milk productivity gains both per hectare and per kilogram dry matter of feed—up to 30 percent depending on the region—and similar increases in household income.

Such changes would also decrease emissions by 736 million tons of CO2 equivalent per year (nearly 10 percent of all agricultural emissions), mainly through emissions avoided by not converting 162 million hectares of natural land. Transitions may be hampered by constraints such as inadequate access to markets and credit, but supporting shifts to more productive systems in appropriate areas has considerable potential for delivering desirable mitigation, adaptation and food availability outcomes.

Adopted from Campbell et al (2014)

resilience, as discussed in earlier sections, has to be combined with economic resilience to make the whole food system resilient. This is especially important in the light of Africa's agricultural transformation discussed in detail in Chapter 1, leading to increased commercialization in the agri-food system, intensified connectivity between rural and urban centers and the needed interventions to connect more farmers to markets (discussed in chapter 6).

Africa used to be characterized as suffering from "double exposure" before the turn of the century, as it was significantly affected by climate change and could not benefit from economic globalization to its fullest (O'Brien & Leichenko, 2000). Before 2000 SSA was marginalized vis-à-vis the global economy with low growth rates and a low share in global trade that declined further throughout the 1990s (Dohlman & Halvorson-Quevedo, 1997). Since 2000, however, the average growth rate in Africa has picked up and by 2010 the continent had achieved the second highest (after East and South Asia) regional growth rate (at 4.8 percent) globally (UNECA, 2015). Although Africa's share in global trade in value added still remains low (around 2.2 percent in 2011, up from 1.4 percent in 1995), there has been a significant increase in regional trade, especially in terms of agricultural exports (Badiane, Makombe, & Bahiigwa, 2014). These processes helped to turn around one of the components of the "double exposure" of the continent by including it in the globalization process. In addition to the opportunities this process creates, it also presents new challenges to the economic resilience of producers, nations and regions by exposing them to volatility. Given this background, this section discusses the conditions that need to be satisfied to ensure economic resilience after providing a brief definition and a typology.

Hallegatte (2014) divides economic resilience into two components: microeconomic and macroeconomic resilience. Although this typology is developed for economic resilience to disasters particularly, it also provides a useful framework to discuss resilience to economic shocks. Microeconomic resilience is attributed to individuals/households (potentially connected through producer organizations and value chains), whereas macroeconomic resilience is attributed to the whole food system (national, regional and international systems connected through trade). We discuss these in turn.

Microeconomic resilience

Agricultural economics literature recognizes diversification as one of the fundamental ways of smoothing consumption and incomes in the face of multiple shocks, making diversification (of income/consumption) the backbone of microeconomic resilience (Adger, 1999; Bryceson, 1999; Delgado & Siamwalla, 1999; Barrett, Reardon, & Webb, 2001; Folke, 2006; Toulmin et al., 2000). Agricultural households diversify their livelihood activities ex ante to manage risk and improve their resilience and ex post to smooth consumption after a shock when ex ante risk management strategies are insufficient (Davies, 1993; Murdoch, 1995; Smit & Wandel, 2006).

Diversification can be driven by push factors (imperfect credit and insurance markets, stagnation in the agricultural sector, high transaction costs, and adverse shocks) or pull factors (a booming non-farm sector or improved technologies in the farm sector), with different implications for resilience. When pull factors dominate, livelihood diversification tends to support the transition from subsistence to commercial agriculture or non-farm activities, decreasing poverty (Pingali & Rosengrant, 1995). What this means for resilience needs to be assessed empirically for each case and fed into evidence-based policy design in support microeconomic resilience.

Resilience of livelihoods is determined by a multitude of factors including income sources, assets, endowments, access to markets and services, and safety nets. Given these multiple dimensions, a resilience measure needs to capture all observable indicators. Although the issue of measuring resilience is still in its infancy, there are a couple of ways to proxy/measure household resilience to identify the types of policies to improve it (Hoddinott, 2014). One example is the Resilience Index Measurement and Analysis (RIMA) of FAO, which can highlight the types of livelihoods that are most resilient and the contributions of different pre-determined dimensions to household resilience in a given country (Alinovi, Mane, & Romano, 2010). D'Errico and Zezza (2015) analyze resilience in six African countries and find that in most instances policies and investments that reinforce productive assets and the growth in income generating activities would contribute to improved household resilience. In a different framework that allows comparisons across countries, Alfani, Dabalen, Fisker and Molini (2015) implement an approach based on the "ability to recover from a shock" definition of resilience using readily available data (this approach can be easily expanded to use in a dynamic setting in cases where panel data are available). This approach can be used to classify households into resilient and non-resilient groups to analyze the contributions of different characteristics (such as education, assets, income sources), which can improve the targeting of policies to increase resilience. A clear resilience definition and measure should be adopted to improve policy targeting and monitoring at all levels.

Most of the policies outlined in Chapter 5 have the potential to improve the biophysical resilience of agricultural households, however, different policies are needed to improve resilience to economic/financial shocks that are bound to increase in importance in the light of the structural transformation of the continent (McMillan, Rodrick, & Verduzco-Gallo, 2014). Most farmers in Africa are already diversifying both their activities on farm as well as out of agriculture, where around 35 percent of rural household income comes from non-farm activities (Reardon et al., 2007). Given that some diversification is "distress diversification" that may lock households in poverty, policies are needed to support the pull factors into diversification to prevent a trade-off between resilience and poverty. Integrating livestock and mixed cropping systems on farm increased resilience in SSA (Baudron, Moti, Oriama, & Asheber, 2013; Herrero et al., 2013); access to extension services increased diversification both on and off farm in Malawi and Zambia (Arslan et al., 2016; FAO, 2015b); education-led diversification led to higher and more stable incomes in Kenya and Ghana (Abdulai & Delgado, 1999; Marenya et al., 2003); and migrant remittances were successfully invested in non-farm activities in western Kenya (Francis & Hoddinott, 1993). The enabling environment for these types of diversification includes the obvious interventions to improve education, access to insurance (Chapter 7) and information (Chapter 8), and additional public support to coordinate value chains that do not work adequately; improve the procurement and distribution of fertilizers; manage volatility and risk in value chains; and help smallholders link to value chains (Hazell, 2013).

In the short to medium term, there will always be many subsistence smallholders who are unlikely to commercialize and benefit from the types of interventions mentioned above. Supportive policies to train and assist smallholders to diversify or exit farming and safety net programs will continue to be important in supporting the resilience of households (Hazell, 2013). Some safety net programs already exist, such as the Productive Safety Net Program (PSNP) in Ethiopia that can provide lessons for the design of similar programs to improve the food security of this group (Badiane et al., 2014). PSNP reaches more than seven million poor Ethiopians to help them accumulate productive assets through a targeted combination of food-for-work, cash-for-work, and cash transfers. The program has enabled significant improvements in food security even for those that received less than the full intended benefits (Gilligan, Hoddinott, & Taffesse, 2008). Similarly, cash transfer programs can be used to improve resilience, as in the case of Zambia Child Grant Programme (Asfaw et al., 2016). The types of policies needed to improve macroeconomic resilience discussed in the next sub-section would also improve the microeconomic resilience of households through stabilized input and output prices.

Macroeconomic resilience

Given the increasingly commercialized and connected food systems under the agricultural transition the continent is going through, the microeconomic resilience defined above needs to be combined with a resilient macroeconomic

[5] RIMA is a static approach and it does not allow inter-country comparisons of resilience indices.

environment to ensure sustainable and equal distribution of the benefits of the transition. The components of a resilient system include diversity, connectivity, knowledge systems to anticipate and manage change, level of redundancy, equal inclusion of all parts and social cohesion (Mitchell & Harriss, 2012).

Increasing the diversity of agricultural production and exports, and regional trade would provide significant opportunities to stabilize domestic food markets (Badiane et al., 2014). Regional trade can reduce price variability by buffering shocks from individual country production gaps that may arise from economic as well as climatic shocks. The small size of many African countries cannot support the needed agricultural growth without significant price reductions for producers, especially when the climatic conditions are favorable (Hazell, 2014). One way of dealing with this is through greater intra-regional trade, which would also enable countries to benefit from differences in comparative advantage and economies of scale in marketing and processing, while stabilizing food supplies and farm incomes. Policies to decrease regional transportation/transaction costs and to develop and strengthen regional value chains through regional clusters would be a good step towards this goal (UNECA, 2015). These dynamics underline the importance of decreasing the regional barriers to trade for both environmental and economic resilience.

Since agricultural transformation may involve decreases in the number of people engaged in agriculture and a significant increase in the share of the population living in urban and coastal areas, policies to facilitate the movement of people across sectors and countries would help in speeding up the process (Collier & Dercon, 2014; UNECA, 2015). Migration also has the potential to improve the economic resilience of the system, as it would support the integration of regional economies through trade in services as well as supporting microeconomic resilience by facilitating the diversification of livelihoods for individuals/households.

Other policies that can successfully contribute to the system resilience include improvements in the agricultural market information systems, which can exploit the technological developments discussed in Chapter 8, and increased use of contract farming that can decrease the marketing risk for the producers of high value products. More systematic use of futures markets for staple food products is also an important strategy to manage price risk by countries, as in the successful case of Malawi's use of the South African Futures Exchange (SAFEX) in 2005 to save US$2 million in maize import costs (Rohrbach, 2010). Futures markets, however, remain unexploited in Africa, but looking forward to the medium to long term, they should be at the center of the regional policy debate. Overall, all of these interventions aim to create a dynamic agricultural sector responsive to incentives for growth that can contribute to regional integration and resilience.

Social Resilience

Defining social resilience

Early definitions of social resilience focused on "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change" (Adger, 2000: page 347) Current thinking is that resilience is not simply about stability through adaptation and coping capacities, but also about transformative capacities. Keck and Sakdapolrak (2013) define resilience as a system's capacity to persist in its current state of functioning while facing disturbance and change, to adapt to future challenges, and to transform in ways that enhance its functioning. They note that viewed in this way the search for ways to build social resilience is not only a technical, but also a political issue.

African populations experience high levels of vulnerability in multiple dimensions related to the agricultural system. For example, the economic and ecological impacts of droughts at local and national scales (such as the loss of production, assets and savings) have direct and indirect impacts on key capabilities—health, education, social coherence and stability—consequently reinforcing cycles of food insecurity and poverty, and migrations. Droughts and floods alone account for 80 percent of the loss of life and 70 percent of the economic losses in SSA (Bhavnani et al., 2008), making them the most important natural factors contributing to food insecurity, malnutrition and famine, especially for the most vulnerable (i.e., women, children and the elderly).

[6] SAFEX now operates under the name of Johannesburg Stock Exchange: https://www.jse.co.za/redirects/safex.

While acknowledging successes of SI, Shiferaw et al. (2014) point to a need for some minimal ecological baselines that must be respected. Similarly, given the difficulties in making trade-offs necessary to achieve SI, there needs to be some minimum social fundamentals that must not be sacrificed. These include the cornerstones of resilience (adaptation and transformation) as discussed in section 4.2.

The challenge for achieving social resilience must be understood as a product of the interaction between and within global and local forces (Olwig, 2012). For example, international price hikes of cash crops has resulted in political transitions, civil unrest and conflict, and changes in land tenure systems that have affected the political stability needed for food production and food security (Mohamed-Katerere & Smith, 2013).

Why social resilience matters for sustainable intensification

Some key characteristics of vulnerability include extreme poverty, natural resource dependence, poor health services, economic growth rates that lag behind population growth, political exclusion and civil unrest. To cope with frequent crop failures, farmers are forced to draw on their asset holdings. This results in depletions in accumulated capital every other year. Direct and indirect impacts arise from frequent droughts such as losses on key capabilities—health, education, social coherence and stability—reinforcing cycles of food insecurity and poverty including migrations. Greater agricultural intensification may partially reduce the risk of asset depletion by increasing yields. Many farmers may also cope through the use of off-farm resources that provide 42 percent of the incomes during droughts (Enfors, 2013).

Finding solutions to these kinds of complex problems requires integrated approaches and innovative solutions including the maintenance of ecosystems and their governance. From a social perspective motivating innovation, risk taking, long-term investments and systems requires learning, respect for indigenous knowledge and experience, local empowerment, a favorable policy and political environment, clear resource use rights and governance systems, inclusive planning amongst other things (Davies et al., 2016; O'Connell et al., 2015). The rebuilding of the fisheries sector in Somalia is an excellent example of how coordinated and targeted diverse support, ranging from building safe fishing boats and working with women's associations to improved post-harvest techniques, can contribute to food security in a socially resilient way (see Box 4.3)

BOX 4.3:
Rebuilding the fisheries sector to promote food security and livelihoods:
The case of Somalia

The value added by the fisheries sector in Africa in 2011 was estimated at more than US$24 billion, 1.26 percent of the GDP of all African countries. Fishing and aquaculture contribute 6 percent of agricultural GDP in Africa. Despite greater understanding about the nutritional benefits of fish, particularly for children and women of child-bearing age, fish consumption remains relatively low in Africa. Of the 130.1 million tonnes of fish available for human consumption in 2010, fish supply was lowest in Africa (9.7 kg year), measured against a global average nearing 20 kg annually. The Fisheries and Aquaculture Department of FAO is supporting member countries to promote food security and livelihoods that depend on fisheries. Somalia, like many African countries, has opportunities to expand the sustainable management of fisheries and aquaculture to support food security and livelihoods.

Rebuilding the fisheries sector in Somalia, following years of conflict, is crucial for strengthening food security and nutrition and for generating employment in the sector. In Somalia today, over 1 million people face severe food insecurity, while an estimated 307,800 children under the age of 5 years are acutely malnourished, according to FAO data.[1] Rebuilding the fisheries sector in a sustainable manner provides better food security and nutrition for vulnerable coastal communities, while simultaneously creating employment opportunities.

Building safer vessels: With its 3330 kilometers of coastline, Somali fishermen have access to rich marine resources. But the boats that small-scale fishers use are often of poor quality, fuel inefficient, and unsafe. FAO, through a Norwegian-funded project, is working in the country on a Somali fleet renewal program, training Somalis as boat builders to construct small, unsinkable vessels, built entirely to FAO safety specifications.

Working closely with local women's associations, the project has also recruited female trainees, who are training as boat builders alongside their male counterparts. The women are excited to take part in training not generally offered to them. One of the female trainees, Samsam Ismail Aar, spoke of her pleasure in having been selected, "I want to be an engineer, and I am hoping the boat building training I'm receiving will help this to become a reality."

Following sea trials in which the fishermen were amazed to discover that the vessels truly were unsinkable, word quickly spread and demand is growing for these vessels by small-scale fishermen. Boat building is currently taking place in Mogadishu, Berbera and Bossaso, and will be expanded to Hobyo and Eyl.

Launching fish-aggregating devices along the Somali coastline: Industrial fishing off the Somali coast has access to migrating fish such as tuna and mackerel. But when small-scale Somali fishermen attempt to do the same, travelling long distances in the open sea in rickety, often unsafe boats, the consequences can be disastrous. To provide opportunities to small-scale fishing communities to access these income-generating catches, FAO, with support from Japan, Switzerland and the EU, deployed 25 fish-aggregating devices (FADs) along the Somali coast.

According to Charles Kilgour, FAO Fisheries Expert, "FADS are a deep-water mooring, which works by being out there in the ocean and attracting fish, primarily oceanic fish like tuna that are migrating through the area. This gives the fishermen time to access these fish when they're moving through that location."

On-the-ground training was held with local fishers and fishing cooperatives to ensure that the FADs were fully understood by the fishermen, could be well-maintained by fishing communities and support sustainable fisheries management. Fishing communities and their elders established rules, regulations, and quotas for fishing families, ensuring the equitable benefit-sharing of the catches within the communities. The exercise has proven highly successful. Thanks to the FADs, small-scale fishermen have caught tuna fish, king fish, tuna yellow fin and mackerel, allowing fishermen to earn between US$2–3 per kg for their landings, a good income for Somali fishermen.

Promoting better post-harvest practices:
Worldwide, women account for over 90 percent of post-harvest fisheries workers. This is also true in Somalia, and FAO is working with Norwegian and US-financed projects in 10 Somali communities to promote safe techniques for fish handling, including fish drying, creating a use for surplus fish that would otherwise spoil quickly in the 45˚C temperatures regularly encountered in north Somalia.

Fish landed in the morning are filleted, thinly sliced and marinated then spread out on drying racks by 10 am to allow the sun drying and to avoid spoilage. Late afternoon catches are salted and spiced to prevent spoilage overnight. The catch is placed on the drying racks the following day. These techniques for handling fish have been quickly adopted and have decreased spoilage. All processed and dried products are packaged in retail-ready pouches. The training activities also provide participants with appropriate business training to carry out these activities, including training in sales, marketing and financial management.

Given the importance of fisheries and aquaculture for food security in Africa, other countries in the continent can draw on the experiences of Somalia to develop national sectoral development plans and build partnerships to improve the sustainable intensification of their fisheries sector.[2]

Source: *Kimberly Sullivan, Fisheries and Aquaculture Department, FAO*

Entry Points For Sustainable Intensification To Achieve A More Resilient Agricultural Production System

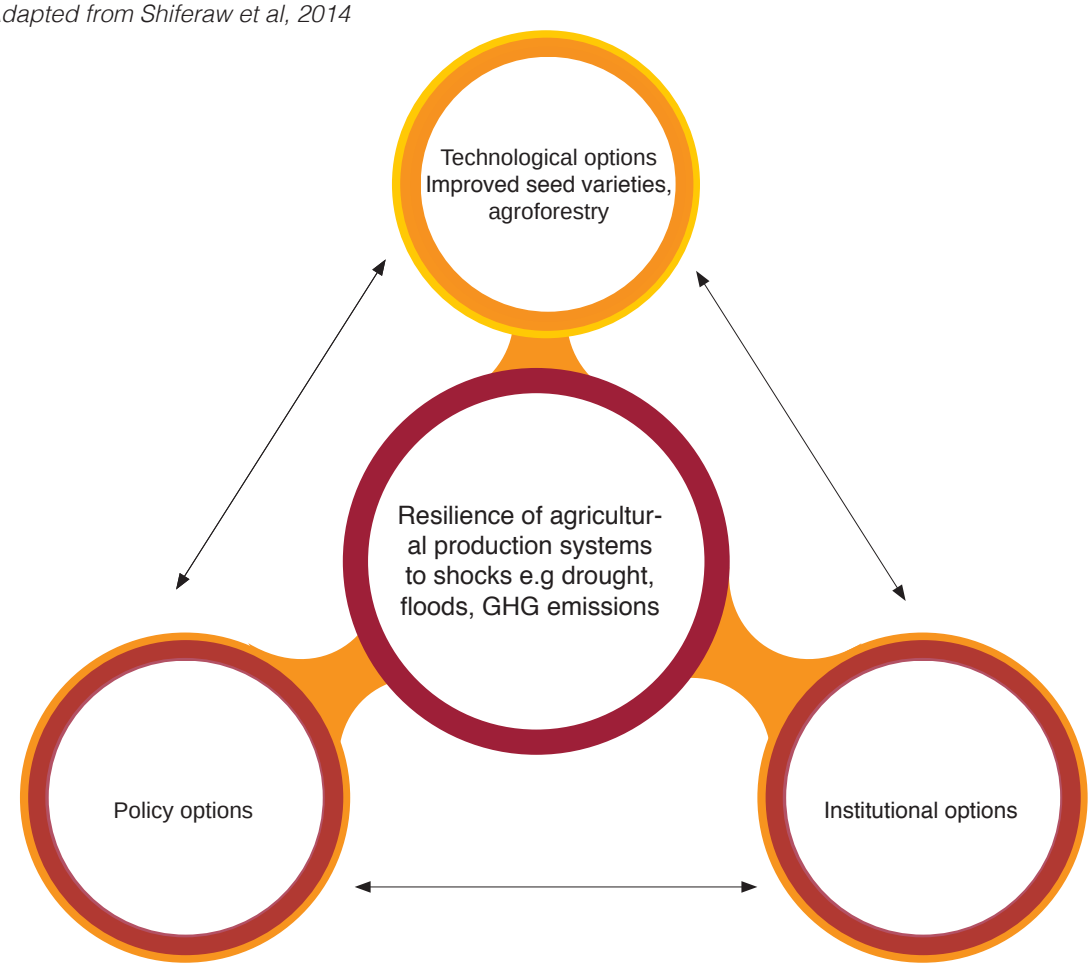
In this chapter, we show that SI is about developing more productive and resilient agricultural systems, which are able to feed the world in the context of new economic, demographic, and agro-ecological challenges and opportunities. SI strategies for enhancing resilience of agricultural production systems along the three dimensions (economic, social and environmental) already discussed require an approach that integrates technological, institutional and policy options (Figure 4.22). An integrated approach will have direct positive effects on reducing sources of risk (e.g., production and market) and vulnerability, thereby increasing livelihood resilience (Shiferaw et al., 2014). While presenting challenges in terms of complexity and practice, this approach offers the best option for strengthening livelihoods, improving agricultural productivity, and building the capability of households to diversify practices and incomes. It can offer SI strategies for reducing vulnerability and effectively managing climate variability and extremes (Hellmuth et al., 2007).

CSA provides a useful conceptual framework of how a more resilient and sustainable agricultural system might be achieved by bringing together the components of the integrated approach outlined in Figure 2 under a specific climate change lens.

FAO (2010) has described CSA as agriculture that sustainably increases productivity and resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals. It is regarded as a necessary approach for coping with climate change in the agricultural sector to support the needed transformation of agricultural systems to support food security under climate change. A CSA approach to agricultural development policy addresses the interlinked challenges of food security and climate change by promoting the adoption of appropriate field/landscape level practices, developing enabling policies and institutions and mobilizing needed finance (FAO, 2013b; Lipper et al., 2014).

Figure 4.2: Strategies for managing drought and enhancing resilience

Source: *Adapted from Shiferaw et al, 2014*



CSA is not just a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts (FAO, 2013b, 2014a). The approach relates to actions both on farm and beyond the farm, and incorporates technologies, policies, institutions and investment. Different elements that can be integrated into a CSA approach include:

1. Management of farms, crops, livestock, aquaculture and capture fisheries to manage resources better, produce more with less while increasing resilience.

2. Ecosystem and landscape management to conserve ecosystem services that are key to increase resource efficiency and resilience.

3. Services for farmers and land managers to enable them to implement the necessary changes.

4. Institutions that can support food security now as well as under the expected impacts of climate change, hence build adaptive capacity.

5. Financing mechanisms at all levels to support evidence-based CSA policies and programs.

However, technologies alone will not increase resilience or improve livelihoods of significant numbers of smallholders, who survive within complex systems (Sullivan, Mwamakamba, Mumba, Hachigonta & Sibanda, 2012). Technology transfer focused approaches that have been tried for decades with hundreds of millions of dollars invested in research, have not transformed the livelihoods of African smallholders as intended. An integrated approach such as CSA that has an explicit focus on improving food security under the challenges brought about by climate change including all aspects of the food system, enabling environment and financing is needed to make a step towards the needed transformation. Box 4.4 summarizes a science-based decision support tool for CSA to address the lack of comprehensive evidence on CSA contributions of a comprehensive set of field level practices, which are the starting point of discussions on CSA approach.

Many of the interventions that are mentioned in the other sections of this publication (especially chapters 5, 6 and 8) have the potential to build environmental, economic and social resilience. They also have the potential to be part of a CSA approach when designed and targeted though a climate change lens. Whether or not they can be considered CSA in a specific agro-ecological and socio-economic setting, however, needs to be assessed case by case considering all three objectives at multiple scales (local to global) and over short and long time horizons, to derive locally acceptable solutions (Lipper et al., 2014). In the next sub-sections, we first discuss several technological entry points for SI with examples where relevant, which need to be assessed for implementation. We then provide social, institutional and policy entry points that need to be combined with the technological options to be part of a CSA approach to improve the overall resilience of agricultural systems.

Technological entry points for sustainable intensification

Intensifying good agro-ecological practices-ecological intensification

Increased uptake of good agro-ecological practices can contribute to one of the important aspirations of SI, which is sustained increases in total factor productivity (TFP) reflecting more efficient use of various factors of production (World Bank, 2000). Increases in TFP are needed to close the large yield gaps between agronomic potential (what is attainable with good management practices under rainfed conditions) and what farmers currently receive. Increases in TFP reflect improvements in the efficiency in the use of the aggregate bundle of inputs. The technological entry points for SI discussed under the good agro-ecological practices in this section have the potential to increase TFP by raising productivity from existing cultivated land using improved crop varieties, soil and water management practices, while protecting the environment and delivering acceptable rates of economic returns to farmers (Cassman, 1999).

Africa has large agro-ecological diversity and farming systems. A one-size-fits all approach should therefore be avoided. SI examples below should offer options across all major farming systems including those for large-scale farmers. It is therefore critical for SI pathways to be context specific in this highly heterogeneous environment.

Increasing uptake of Agroforestry interventions

When designed and implemented correctly, agroforestry combines the best practices of tree growing and agricultural systems, resulting in more sustainable use of land (Buttoud, 2013). This author also notes that combinations of trees, crops and livestock mitigate environmental risk, help create a permanent soil cover against erosion, minimize damage from flooding and enhance water storage, benefitting crops and pastures. In addition, trees bring nutrients from deeper soil layers or in the case of leguminous trees, through nitrogen fixation, which can convert leaf litter into fertilizer for crops. Agroforestry can also complement forestry sector efforts in sustainable forest management by providing a set

BOX 4.4:

The CSA Compendium: A science-based decision support tool for Climate-Smart Agriculture

The CSA concept has come a long way since FAO created it in 2009, when the role of agriculture was barely recognized in the international climate change discourse (FAO 2010). It has quickly been integrated into the global development agenda and in the climate change discourse, where it culminated in the establishment of the Global Alliance for CSA (GACSA) at the UN Climate Summit in New York in 2014. There are now multiple regional and sub-regional CSA Alliances that aim to guide policy and investments to improve food security and resilience to climate change.

However, given the multiple objectives and context specificity, the scientific evidence to evaluate all three pillars of CSA has been scant, which complicates translating it from concept to concrete actions. To address this need for field level practices, which are one of the entry points to a CSA approach, the World Agroforestry Centre (ICRAF) partnered with the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS), FAO, and the International Center for Tropical Agriculture (CIAT) to conduct a meta-analysis of all published scientific literature to date on potential field level CSA practices.

The CSA compendium aims to evaluate current knowledge on the effectiveness of a large set of (more than 100) management practices (extracted from more than 2,000 published papers) on productivity, resilience and climate change mitigation in farming systems of Africa. It also allows an assessment of synergies and trade-offs amongst the three pillars to enable prioritization of different policy initiatives. Currently, a web-based platform is being developed to make the CSA Compendium available to policy makers (as well as scientists aiming to fill research gaps) as a decision tool, which will allow searches and simple analyses of CSA pillars under specific soil types, agro-ecological zones, and categories of practices (e.g., agronomy, agroforestry, livestock, post-harvest systems, and energy systems). It is the most comprehensive review of scientific evidence to date that feeds into current and future CSA prioritization tools, which incorporate evidence base with conceptual approaches to support national prioritization efforts among multiple objectives.

Many agricultural practices have been labeled as "CSA" (e.g., see AGRA, 2014b; CCAFS, 2013; FAO, 2014a)., This creates confusion because although many of these practices are likely to be CSA in some places, none of them are likely to be CSA everywhere. An additional challenge comes from the time dimension, as under the dynamic effects of climate change, what is CSA today might not be by 2030, and policies need to include these dimensions into account before promoting interventions for food security and resilience. Given that CSA is an approach to policy making, rather than a set of practices, the CSA compendium will shed light on such uncertainty and confusion to support policies that can create resilient food systems in Africa in spite of the challenges of climate change.

Source: *Rosenstock et al. (2015)*

of tree-based conservation and production practices for agricultural lands. Some important sustainability issues on which agroforestry can assist forestry are: biological diversity, wood and non-timber products, ecosystem integrity, soil and water quality, terrestrial carbon storage, and socio-economic benefits (Ruark, Schoeneberger, & Nair, 2003). Agroforestry therefore serves to improve the resilience of farmers and increase their household income through harvesting diverse products at different times of the year. It also brings job opportunities from the processing of tree products, expanding the economic benefits to rural communities and national economies. Agroforestry systems can be conceived for spaces varying from plots to farms to landscapes.

In terms of scaling up, WRI (2014) reports that within SSA, agroforestry and water harvesting could potentially be implemented on more than 300 million hectares. If improved soil and water management practices were implemented on just 25 percent of this cropland and resulted in increasing crop yields by an average of 50 percent, farmers would produce an estimated 22 million more tonnes of food per year (WRI, 2014).

Using agroforestry trees does not only increase carbon sequestration (Albrecht & Kandji (2003) but also widespread adoption of this option has substantial mitigation potential because intensified diets would considerably reduce the number of ruminants needed to satisfy future demand for milk and meat. Box 4.5 shows livestock diet intensification through agroforestry.

Agroforestry technologies need to be brought strongly into efforts to sustainably intensify smallholder production systems and enhance their resilience to both climate change and market failures (AGRA, 2016). Trees and agroforestry can contribute to climate change adaptation and mitigation at the local and national levels including reducing soil erosion, control and rehabilitation of degraded lands. Greater investments from the public sector and development sector are needed to realize the potential of agroforestry technologies in Africa. In particular, constraints to land tenure need to be addressed since this provides incentives for the adoption of agroforestry technologies that require longer-term perspectives. There is also need to address the challenges associated with the supply of seeds and planting materials (AGRA, 2016; AGRA & IIRR, 2014).

Promoting Integrated soil fertility management (ISFM)

Soil degradation is pervasive in Africa, with some studies suggesting over 80 percent of the potential agricultural land having biophysical and chemical constraints that limit food production (World Bank, 2013). In some areas, the lack of immediate response to increased inputs of fertilizers and labor constitutes a chronic poverty trap for many smallholder farmers in Africa (Tittonell & Giller, 2012). Unless these challenges are addressed, smallholder farmers cannot benefit much from the current yield gains offered by plant genetic improvement programs of both national and international agencies (World Bank, 2013). Because of low use of inputs for enhancing soil fertility, yield increase with improved crop varieties is estimated at only 28 percent in Africa compared to 88 percent in Asia (IFDC, 2013), although this has certainly improved in some countries lately.

There is consensus among agricultural experts that an ISFM approach, one that combines organic and inorganic fertilizers, is the most practical mechanism to sustainably and profitably restore soil health (Vanlauwe et al., 2011, 2015). By definition, ISFM entails a set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs and improved germplasm combined with the knowledge on how to adapt these practices to local conditions. The aim is to optimize agronomic use, efficiency of the applied nutrients and improving crop productivity (Vanlauwe et al., 2015). As it is, knowledge and location specific, adaptation and experimentation with farmers is essential.

BOX 4.5:
Livestock systems intensification

Ruminant diets that are higher in quality result in reduced methane output per unit of milk and meat as well as in higher meat and milk productivity. One way in which livestock production can be intensified is through feeding the leaves of trees such as Leucaena leucocephala, which is widely grown in the tropics. Adding even a small amount of Leucaena leaves to dairy cattle can treble milk yield per day, quadruple weight gain per day, thereby increasing farm income considerably, and reduce the amount of methane produced per kilogram of meat and milk by factors of two and four respectively.

Source: *Thornton and Herrero (2010)*

[9] Albrecht, A and Kandji, S. (2003): Carbon sequestration in tropical agroforestry systems: Agric Ecosyst Environ.

However, ISFM is a rational approach and not a technology. It is designed to guide farmers and extension staff to tailor the different options suitable to the farm soils and socio-economic conditions. In many areas, fertilizers would be an entry point because the amount of organic fertilizers (livestock manure and crop residues) used currently is limited. In some cases, the entry point would be organic fertilizers because of lack of meaningful response to mineral fertilizers. This is certainly the case with degraded lands and soils that are non-responsive to chemical fertilizer application for one reason or another.

Reducing sensitivity to climate change and weather variability through diversification

To adapt to changing climate and weather variability, farmers need to diversify whilst enhancing the productivity of their individual livelihood components. Diversified agricultural systems contribute to resilience in a multitude of ways, ranging from pest/disease suppression to increased production and climate change buffering (Table 1 in Lin, 2011). Diversification can also occur at the livelihood level by incorporating livestock and non-farm activities in household portfolio to create a buffer for economic as well as climate shocks.

Successful interventions include foremost a reorientation of extension systems towards promoting more diversified livelihoods—both on farm and through better value chain management. Households diversify more in places where rainfall variability is higher and those who receive extension information and input subsides had significantly higher crop diversification in both Malawi and Zambia (FAO, 2015b; Arslan et al., 2016). The higher crop diversification is thanks to the improved design of input subsidy programs to cover a wide variety of maize and legume seeds, underlining the importance of careful design of such programs to foster resilience (rather than narrow focus on increased maize production).

There is overwhelming evidence that the more educated and wealthier households diversify more in most countries in the continent (Barrett et al., 2001; Davis et al., 2014). Given the fact that the agricultural transformation of SSA is bound to create more opportunities for diversification and climate change is expected to have ever more visible impacts, initiatives to support diversification should target the more vulnerable (including women) to improve their overall resilience.

Promoting a Flexible Approach to Conservation Agriculture

Conservation agriculture is another example of good agronomic practices that has the potential to enhance smallholder productivity in some environments. Conservation agriculture has been promoted to achieve this goal by decreasing soil degradation, based on three principles: minimum tillage, soil surface cover, and diversified crop rotations (Giller, Witter, Corbeels, & Tittonell, 2009; IIRR & ACT, 2005; Mazvimavi, 2011). In its original definition, conservation agriculture is shown to increase productivity in dry areas where it is primarily a water-harvesting technology (Rockstrom et al., 2009), underlining the importance of understanding the contributions of each component on yields and their stability under various stress conditions (Giller et al., 2009).

In response to decades-long discussions on its suitability under various conditions, the definition of conservation agriculture is continuously being updated by the inclusion of agroforestry or the judicious use of fertilizers as a fourth principle in the African context (Vanlauwe et al., 2014). This intervention, under the overall framework of good agronomic practices and given the low adoption and high dis-adoption rates of conservation agriculture in many cases (including Zambia, which has the longest story of the practice in SSA, see Arslan et al., 2014; Ngoma, Angelsen, Gumbo, & Mulenga, 2014, Whitfield et al., 2015) is essential to improve the productivity of the smallholder production system (AGRA & IIRR, 2014). Given the complexity of the interactions between conservation agriculture components under different soil types, residue practices and agro-ecological conditions in African systems, the evidence is still weak and needs to be expanded to support scaling-up interventions (Whitfield et al., 2015). Additionally, there is a need to improve the evidence base to understand the contributions of conservation agriculture to adaptation to climate change.

Intensifying breeding for improved varieties and genetic intensification

An important aspect of the technological levers of SI is the intensification of modern breeding to increase crop yields, enable nitrogen uptake and fixation, improve nutrition and enhance resilience to pests and diseases and climate change etc. According to the Montpellier Panel (2013), some of the priorities for modern breeding are: (i) increased productivity; (ii) improved nutritive value; (iii) crops and livestock that are resilient to pests and disease attack; (iv) crops and livestock that are resilient to the effects of climate change; and (v) greater efficiency in taking up nutrients from the soil, and fixing nitrogen from the atmosphere. The same report also noted that achieving these targets is a tall order, but the potential benefits are considerable. This is why building desirable characteristics—high yields coupled with stability and resilience—into the seed is so attractive. The seed, in a sense, can be a "package of desirable and appropriate technologies". Box 4.6 shows some examples of genetic intensification in practice as reported in the Montpellier Report (2013).

Policy, Institutional and social entry points and pathways of sustainable intensification

This section considers how to enhance social resilience in the transitions to sustainable agricultural intensification. Certain policy and institutional adjustments are required to create the appropriate environment for SI. The section emphasizes developing resilience strategies including adaptive and transformative capacities. This includes the ability to learn from past experiences, adjust to future challenges at local and national scales, craft new institutions and innovate while fostering individual welfare and sustainable societal robustness towards future crises that lie at the heart of the SDGs.

Improving and promoting inclusive governance

Governance refers to how resources (including natural resources), benefits and opportunities, and responsibilities are shared in society and how different actors have their say in decision making and management of these resources. Governance is about who has power to act as well as

relations of power, that is, who has power over another. At both global and national levels a growing emphasis has been placed on governance that is inclusive, equitable and just. In policy and civil society domains there is wide acceptance that this should be based on respect (and fulfillment) of human rights and/or development goals.

Several governance challenges that affect the productivity of the agricultural sector include inequality, inequity, insecure tenure regimes, the lack of inclusive governance, etc. These challenges are unlikely to disappear soon without dedicated efforts to address them. There is also the risk that agricultural intensification, if successful, could exacerbate some of these efforts. For example, in the face of growing productivity, levels of inequality may become entrenched as elite interests in agriculture grows and more people are displaced. Further, challenges that remain unresolved can work counter to intensification.

Despite the growth of representative democratic institutions, many groups continue to feel alienated from decision making, particularly at the local level. Growing civil unrest provides evidence of this. Moving towards nested governance approaches in which local citizens are able to respond to and initiate change can contribute to more effective local responses and decisions. This is especially so when coupled with effective learning spaces and methods.

Enhancing access and use of information

Improving farmer decision-making using climate information, early warning systems and monitoring information to forewarn farmers can encourage optimal and proactive strategies and the creation of resilient agricultural production systems. This is discussed in more detail in Chapter 8.

Various studies have looked at the type of information sought by farmers to enhance resilience. In terms of the types of agricultural information frequently requested by farmers, GSMA (2015) found that market and crop advisory information are two of the main types sought. With respect to cropping, most small-scale farmers would like information about what crops to plant and when (improved seed varieties that are drought tolerant and high yielding, fertilizer application recommendations), market prices, and plant disease and pest control. In drought-prone SSA where small-scale farmers are dependent on rainfed agriculture, weather conditions are important. In terms of timing, farmers want key weather and climate information throughout the crop cycle from planting, application of fertilizers, during harvesting and storage. In Tanzania, farmers wanted to know when the rains will start to help them decide when to plant seeds (Palmer, 2014).

BOX 4.6:
Some examples of genetic intensification in practice

1. Orange-fleshed sweet potatoes have been conventionally bred in Mozambique to contain higher levels of beta-carotene, the pre-cursor of vitamin A, which is often lacking in staple diets. The breeding program, begun in 1997, had distributed improved planting material to half a million households by 2005. In response to a severe drought in the country, the program began to accelerate breeding to incorporate drought tolerance. By 2011 a total of 15 new drought-resistant varieties had been released, capable of producing 15 tons per hectare.

2. One ongoing project, the Water Efficient Maize for Africa (WEMA) partnership, aims to develop some 15 new drought-tolerant maize varieties using a whole range of conventional and biotechnological breeding processes, including genetic modification. The resulting varieties will be marketed royalty-free to smallholder farmers in Kenya, Mozambique, South Africa, Uganda and Tanzania. The next phase of the project is developing drought-tolerant maize varieties also resistant to pests such as stem borers, which may present even more of a barrier to increasing agricultural productivity in a changing climate.

3. In East Africa, bananas are an important crop that has been devastated by Black Sigatoka fungus, a leaf spot disease which decreased productivity by as much as 40 percent. Because new plants are grown directly from cuttings from a “mother plant”, any diseases present are transferred to the new plant. Since 1995 the Kenya Agricultural Research Institute (KARI, now KALRO) has made available rapidly cloned disease-free banana plants. As a result, banana production doubled to 2004 and average yield more than tripled. In the last decade over 6 million tissue cultured banana stems have been planted in Kenya, producing an additional income of some US$64 million to banana farmers.

Open data combined with agricultural knowledge, remote sensing, and mapping can support advice and early warnings for farmers (World Bank, 2013). This can be critical to protecting crops from pests and extreme weather, increasing yields, monitoring water supplies, and anticipating changes brought on by climate change. For example, across Uganda's banana plantations, a devastating infection has been attacking the fruit, killing off entire crops and threatening food security. There are prevention methods to keep banana bacterial wilt at bay, but the government faced a challenge: how to pinpoint the most vulnerable regions of the country and get prevention and treatment information into the hands of growers. A team from the World Bank found an answer in open data built and spread by ICTs. The project tapped into a system called Ureport—a network of 190,000+ volunteers across Uganda who use mobile technology to report on various issues of interest to UNICEF. Within days, the team was able to leverage Ureport to raise awareness, visualize the spread of the bacteria, and disseminate symptom descriptions and treatment options. More than 52,000 U-reporters either provided information about banana bacterial wilt, requested information, or both via SMS (World Bank, 2013).

The delivery approaches and methods of communicating weather and climate information are also important. With an estimated 69 percent SSA penetration rate in 2014, (ITU, 2014), the mobile phone plays a critical role in the dissemination of weather and climate information. Extension workers and radio programs can also play a key role in assisting farmers understand the weather and climate information.

Recognizing, modernizing and up scaling indigenous coping strategies and technologies

Knowledge of how vulnerable people respond to threats and shocks is essential. External interventions can then be built on these coping strategies. Natural hazards are not new and people have been living in hazard-prone areas for centuries. They have, inevitably, devised their own methods for protecting their livelihoods. These methods are based on their own skills and resources, as well as their experiences. People in hazard-prone areas have acquired considerable knowledge and technical expertise for managing risk, and their knowledge systems, skills and technologies are usually referred to as "indigenous knowledge". According to Stigter et al. (2005), indigenous knowledge is wide-ranging, and includes technical expertise in seed selection and house building, knowing where to find certain wild foods, economic knowledge of where to buy or sell essential items or find paid work, and knowledge of whom to call upon for assistance. Indigenous knowledge is affected by changes in the economy and society at large, and is often undermined by these changes. Climate change also creates a challenge for indigenous knowledge, which is built over long periods of time that may be very different from what communities will face in the future under the effects of climate change. Indigenous knowledge and coping strategies are often overlooked and undervalued by governments, the private sector, civil society and international/donor agencies. Coping strategies are diverse, comprising economic, technological, social and cultural elements. Looking objectively at all forms of knowledge—indigenous and external—is important for identifying the most suitable approaches for each situation.

Securing Tenure of land, forestry and fisheries

Insecure tenure is a critical factor in the vulnerability of small-scale farmers and can serve as a disincentive for making long-term investments to improve land productivity and maintain ecosystem services and off-farm resources.

Where land tenure is insecure or unclear or where the state claims all legal title, agricultural development tends to favor large-scale production. This can increase the risk of land acquisitions that are executed without due attention to internationally accepted procedures (Voluntary Guidelines on the Responsible Governance of Tenure), with indirect impacts on family farmers and rural populations. One risk is that these types of practices can lead to the loss of land for food production. For example, the rapid expansion of biofuel production is expected to contribute to an increase of up to three million in the number of undernourished pre-school children in Africa and South Asia by 2025 (Mohamed-Katerere & Smith, 2013). Commercialization of agriculture can also have an impact on family farms by driving a move towards the privatization and individualization of rights to land. This can result in an increase in cash income, but a decline in food for subsistence at the household level and hence increased market vulnerability and food insecurity (UNECA, 2004).

Many issues in land and natural resources tenure result in conflict. Clarifying and securing land tenure helps clarify the rules of resource use and management and it can strength the role of custodians in decision-making processes, negotiation and mediation (Davies et al, 2016). Securing land tenure creates opportunities to resolve disputes peacefully, both through local mechanisms of dispute resolution and through better access to formal law.

The land and tenure reforms that have been implemented in most countries have largely remained inadequate and have not resulted in more secure tenure, especially for the small-scale rural farmers.

Addressing gender inequality

Africa is among the world's most inequitable regions, where inequality has not decreased over time. One of the most pronounced forms of inequality in the continent is gender inequality in agriculture. A key obstacle to increasing agricultural productivity, food security and incomes of rural women is their lack of security of land tenure. Security of tenure affects women's ability to make decisions around several key activities such as what crops to grow, what technologies to use and what to sell. Given their limited decision-making powers over, control and access to resources including land, women cannot build an asset base, access credit and participate in associations that process and market agricultural products. Policy makers need to understand the challenges facing women to level the playing field (see Box 4.7).

FAO (2011) makes the "business case" for addressing gender issues in agriculture and rural employment that lends itself to increasing social and economic resilience of women. The report also highlights that policy interventions can help close the gender gap in agriculture and rural labor markets. Priority areas for reform include:

- Eliminating discrimination against women in access to agricultural resources, education, extension and financial services, and labor markets.
- Investing in labor-saving and productivity-enhancing technologies and infrastructure to free women's time for more productive activities.
- Facilitating participation of women in flexible, efficient and fair rural labor markets.

Promoting investment in development of inclusive value chains

Lele et al. (2013) suggest that inclusive innovative, smallholder centered business models are "drivers" for development which pick up the rural poor and move upwards with them in the transformation process. There is therefore need to identify scalable inclusive business models through which smallholder producers and entrepreneurs can hold on to their primary assets, namely land, water and labor to leverage technology, markets, jobs, and capital from larger-scale investors. Inclusive growth takes a longer-term perspective and with this term perspective, the time lag between reforms and outcomes is critical. Inclusive growth analytics is about policies and strategies that should be implemented in the short run, but for sustainable inclusive growth in the future (Lanchovichina, Lundstrom, & Garrido, 2009).

BOX 4.7:
Addressing gender inequality in land reform

The Zimbabwean fast track land reform program adopted "neutral" land reform policies that were designed not to discriminate on the basis of gender and marital status. However, experience showed that this did not work. Policy makers needed to be educated to understand that "neutral" land reform policies serve to embed the status quo, especially in a male dominated society. The allocation of land required training of staff of implementing bodies to make them gender-aware of the reality on the ground. For instance, there is a long history of gender bias in the extension services. To achieve resilience, securing women's access to land is only one step in a longer process. Women need help with inputs and training in good agricultural practices, and to access capital to increase their asset base. For example, women in Zimbabwe find it harder than men to succeed in a market-orientated farming system that emphasizes assets as collateral for accessing loans. Land policy formulation therefore needs to consider the different ways in which men and women access resources.

Source: *Farnworth et al., 2013.*

[10] http://www.fao.org/nr/tenure/voluntary-guidelines/en/

The Technical Centre for Agricultural and Rural Cooperation (CTA) and FAO teamed up to investigate 18 value chains in 11 African, Caribbean and Pacific countries. The aim was to identify and describe practices and structures best suited to ensure commercial and environmental sustainability and the inclusion of smallholder farmers. The studies reveal that the integration of farmers into value chains can have mutually beneficial outcomes for the farmers themselves and for other value chain participants, making a strong case for linkages between input suppliers, producers and players involved in processing and marketing. As value chains become more inclusive, small-scale farmers can gain access to previously inaccessible markets, receive important information to improve cultivation techniques or benefit from new sources of financing (FAO, 2014c). According to IFAD (2015), the Value Chain Development (VCD) approach should be based on a comprehensive analysis of the entire commodity chain, from producers to end-market consumers.

According to Tshibaka (2014), evidence indicates that policy makers recognize the negative impact of structural, policy, legal and institutional impediments on developmental effort. However, they pay limited attention to financial constraints limiting the ability of farmers and other agricultural value chain actors to invest. Several tools can be identified to make investment in agricultural and food value chains more attractive and to reduce the high level of risks associated to agricultural investments. These tools that are widely used in developed countries and have proven their efficiency for financing agriculture, can be adapted and further developed to meet the financing needs of African farmers. Tshibaka (2014) also highlights that the most promising mechanisms are: risk management tools and innovative credit mechanisms, guarantee funds for bank credit, development impact bonds, lotteries, migrant remittances, tobacco tax and tax on fertilizer.

Developing, nurturing and supporting a domestically-funded research and science agenda for Africa

For SI, research and science has to be better connected at the national, regional and continental levels with open portals to global science. However, for this to happen, institutional systems of science for agriculture in Africa should be strengthened. The problems of research in Africa include low and unpredictable research budgets, shortages of well-trained scientific and technical staff and lack of clearly defined research priorities. To address these challenges, Maiangwa (2010) recommends increased funding for research by international and national research centers, improving the relevance and responsiveness of research to clients, and making the institutional base for agricultural research more pluralistic. According to Rukuni (2014), to maintain basic capacities of science at the national level, each country needs its own strategy that defines its needs for science and agricultural research and a capacity to be a knowledgeable borrower of new technologies from the regional and global stock of knowledge. Weaknesses to be addressed in strengthening the national systems include poor linkages between research, education, and advisory services. Similarly at the regional level, effective national systems are the building blocks for regional, continental and global partnerships in research and science. Rukuni also notes the importance of prioritizing revenue mobilization mobilizing revenues from Africa's growing economies to support agricultural research and development in Africa.

Conclusion

The concept of sustainable intensification has the potential to contribute to transformation of the agricultural production system in a manner that enhances resilience to environmental, economic, and social stressors. However, addressing one of these three dimensions without considering the other two can undermine the goal of SI. For example, land tenure systems in SSA are generally insecure and therefore do not provide incentives, especially for small-scale farmers to invest in productivity enhancing practices or technologies that require significant investments. Further, insecure tenure also decreases incentives to adopt SI practices that deliver positive returns with a delay, creating trade-off between environmental and economic resilience. Interventions that improve resilience to climatic/environmental shocks may fail to deliver resilience to economic shocks if value chains do not function or the system is overly reliant on one commodity/livelihood source.

All societies struggle with the need to have agricultural production systems that can provide food security and improved livelihoods to everyone while avoiding environmental degradation. To achieve this, policies that can build resilience in the whole agricultural production system are required. For Africa, the starting point is raising the productivity of smallholder agriculture. Growing evidence shows that this is possible if access to yield-enhancing inputs (especially improved seeds and fertilizers) is enhanced. This needs to be backed by improved extension services, promoting timely and efficient use of inputs and access to remunerative markets, both local and regional. It is also imperative to manage the trade-offs of a multi-functional agricultural production system in which economic, social and environmental factors can undermine food security.

SI practices such as agroforestry, water harvesting and efficient use of all inputs can enhance environmental resilience and sustainability. To ensure sustainability, we should have a broader approach to SI in the agricultural production system. The framework should endeavor to improve efficiency in the entire agricultural/food production system to cope with stresses and disturbances that include a growing population, diverse consumption patterns and climate change. Diversity in a broad sense is good for SI and environmental resilience as it can include diversity of type of crops planted, processing and nutrition. Since agricultural production systems are located within larger landscapes, they should contribute to the conservation of natural landscapes to enhance the flow of environmental goods and services, while minimizing negative externalities. In addition, analyzing coping strategies and capacities within the African setting including indigenous and traditional strategies is very important.

This chapter showed that SI is about developing more resilient agricultural systems that are able to feed the world in the context of new economic, demographic, and agro-ecological challenges and opportunities. SI strategies for enhancing resilience of agricultural production systems along the economic, social and environmental dimensions require an approach that integrates technological, institutional and policy options. An important aspect is the need for increases in agricultural TFP to close the large yield gaps between the agronomic potential and what farmers, especially smallholders in Africa, currently receive. Also critical is a consideration of the pathway for implementing SI given the highly heterogeneous context, not only from the physical environment standpoint, but also from the fact that the needs for smallholder farmers in different farming systems will be different from those of large-scale farmers.

The chapter also presents some options for SI with particular emphasis on resilience within the context of a CSA approach to agricultural policy combining technological options with enabling institutional and policy environments. Specific technology related entry points for CSA include increasing uptake of agroforestry interventions, promoting ISFM, reducing sensitivity to climate change and weather variability through diversification and promoting a flexible approach to conservation agriculture. Given the complexities of agro-ecological and socio-economic systems in SSA, this chapter urges careful assessment of all technological options for multiple scales and time horizons to develop locally acceptable options to improve food security and resilience.

The chapter also discusses and broadens the concept of intensifying breeding for improved varieties and livestock breeds that is generally referred to as genetic intensification. This is an important aspect of SI, especially through its role in increasing crop and livestock yields, enabling nitrogen uptake and fixation, improving nutrition and enhancing resilience to pests and diseases and climate change etc.

The chapter recommends some policy, institutional and social entry points and pathways of SI, emphasizing development of resilience strategies including adaptive and transformative capacities. These strategies include improving and promoting inclusive governance of resources; enhancing access and use of information; recognizing, modernizing and up-scaling indigenous coping strategies and technologies; securing tenure of land, forestry and fisheries; addressing gender inequality; promoting investment in development of inclusive value chains that particularly address systemic challenges of input and output markets for smallholder farmers in Africa; and developing, nurturing and supporting a domestically funded research and science agenda for Africa.

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CHAPTER 5

Agricultural Productivity through Intensification and Local Institutions

AUTHORS

Robert Delve
Rui Benfica
International Fund for Agricultural Development

Boaz Blackie Keizire, Joseph Rusike, Rebbie Harawa, George Bigirwa, Fred Muhhuku, Jane Ininda, John Wakiumu
Alliance for a Green Revolution in Africa

KEY MESSAGES

ONE

In SSA, sustainable intensification increases agricultural productivity quickly and helps to close yield gaps, all sufficient for generating sustainable and inclusive growth and poverty reduction.

TWO

Analysis of historical trends in agricultural productivity and intensification shows that, compared to other regions, SSA cereal yields, agricultural value added per worker and total factor productivity, are much lower than in Asia and Latin America.

THREE

Household level data for selected countries show that adoption of certified seed of improved varieties and hybrids, inorganic fertilizer and pesticides is increasing over time. Integrating these technologies generates higher payoffs for smallholder farmers.

FOUR

Strong policies and institutional arrangements are central to increasing agricultural productivity. They need to be prioritized and appropriately sequenced over time, and integrated across agricultural value chains.

FIVE

Adoption of technologies and productivity enhancements is being driven by an improved access to input and output markets, linked to increasing accessibility of rural finance.

Introduction

For centuries farmers have actively managed their farms and the land around them. They have invested in crop rotation and planting landraces of diverse crops, and in applying crop residues, composts, animal manure, and more recently chemical fertilizers, to increase productivity and produce more healthy crops and pastures. In the last few generations these approaches have come under pressure from increasing human and livestock populations, and increasing climate variability. The resulting reduction in land size, the time available for fallowing the land, and the reduced pasture area has led to increasing rates of land degradation and has forced households to farm on more marginal and less productive soils. As a result, more than half of the world's 1.5 billion hectares of arable land is moderately or severely degraded leading to low crop yields (FAO & ITPS, 2015).

Providing food, feed and fiber for a growing global population is a major development challenge. In many areas of the world the potential for increasing crop yields is limited. In others, like SSA, there are large yield gaps between what farmers get from local varieties and the yield potential of improved varieties. Reducing this yield gap is a major opportunity and challenge to address household food security and countries' food sovereignty. Most of the agricultural growth in SSA can be attributed to expansion of the land area cultivated rather than through an increase in agricultural factor productivity. For example, in the period 2001–2008, 69 percent of the observed growth in agricultural output was attributed to expansion in land area, 14 percent to favorable prices or terms-of-trade effects, and only 17 percent to increased use of enhanced inputs and to technical change (IFAD, 2016). This area expansion cannot continue forever, owing to negative environmental impacts, and land use change pressure due to an increasing global population. Therefore the continent needs increased and sustainable investments to sustainably increase agricultural productivity.

Increasing agricultural productivity is of critical importance for sustainable and inclusive growth in SSA. There is strong and clear evidence that sustained investments to enhance productivity in agriculture, and the broader rural economy, has a large impact on growth and poverty reduction (Datt & Ravallion, 1996; Christiaensen & Todo, 2014; World Bank, 2008). The challenge remains to identify what factors are behind the relatively low intensification and yields, and the persisting yield gaps in much of SSA. An additional challenge is to identify what factors allow some countries to make progress and leave others lagging behind.

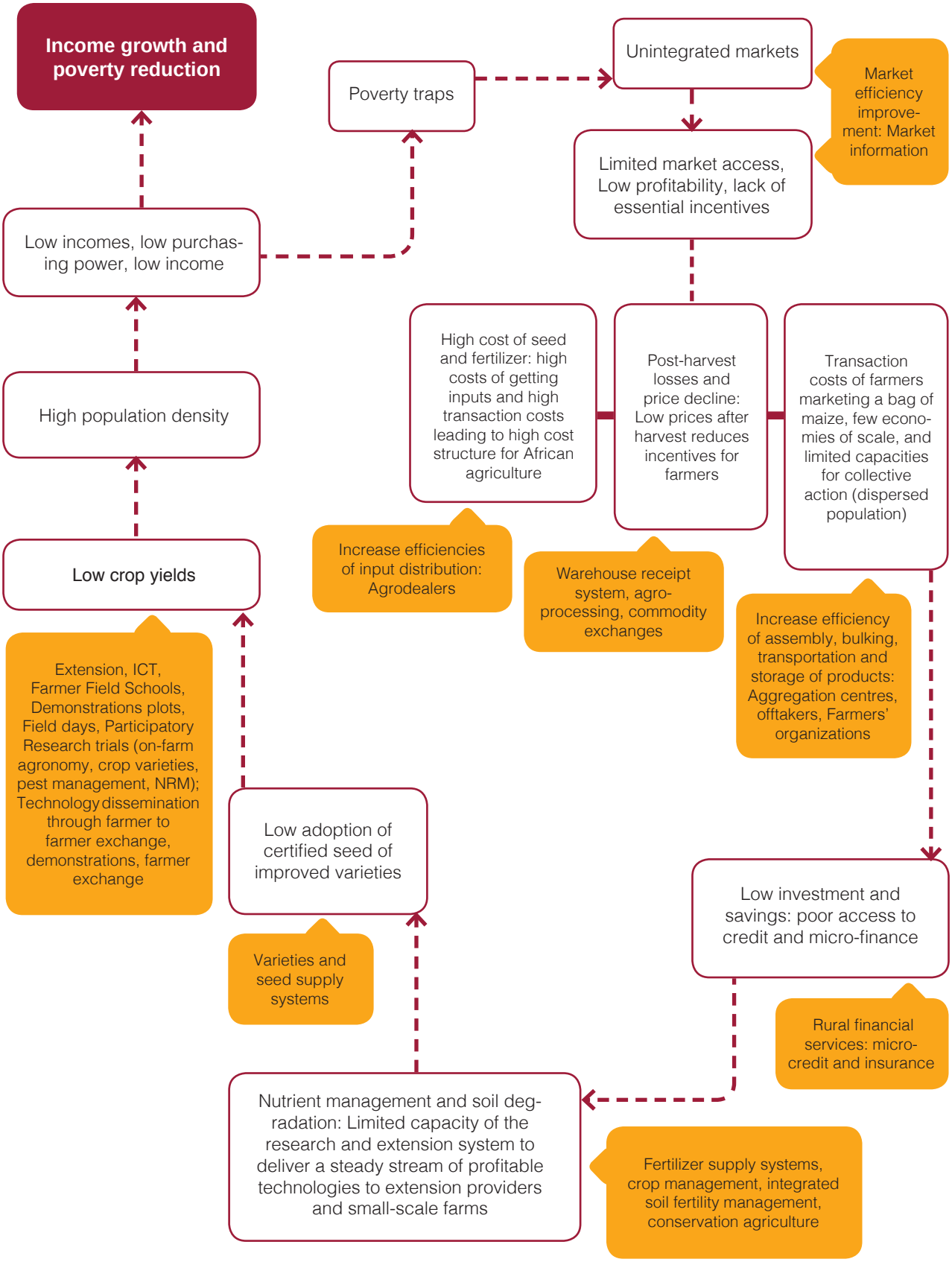
This chapter introduces a brief analytical framework and reviews the trends in agricultural productivity and intensification (and associated factors) in SSA compared with other regions, and among countries in SSA. Then, it uses country level data to undertake partial correlation analysis, complemented by household level data analysis for selected countries, to test selected propositions. The chapter finally discusses issues and draws conclusions to inform policies and interventions to support services and institutional arrangements aimed at increasing agricultural productivity, promoting inclusive growth and poverty reduction.

Analytical Framework

The analytical framework presented in Figure 5.1 is based on the poverty trap framework of smallholder farming households in development economics theory (Barrett, 2005; Sachs, 2005). For many smallholder households caught in poverty traps, land is the only significant capital asset that they have from which they can generate economic livelihoods. These households have labor, but returns to this labor use are low. In many environments they depend on exploitation of natural capital with limited improvement, resulting in degradation of these scarce natural resources. In most smallholder farming areas, the root cause of poverty and food security is limited adoption of more productive and diversified agricultural technologies. Slow technological uptake results from several interrelated and mutually reinforcing factors: inefficient agricultural input and output markets, low profitability of on-farm production, low investment, soil nutrient mining and soil degradation, lack of access to certified seed of improved varieties and quality fertilizers, low crop yields, low purchasing power and severe resource constraints, dysfunctional local institutions, and weak scientific capacity in national agricultural research, training and extension services.

Breaking the poverty traps requires delivery of science-based technological, institutional, market and policy solutions to farmers at multiple levels. Agricultural productivity can therefore be improved through more efficient agricultural input and output markets (agro-dealers, aggregators and grain traders, warehouse receipt systems and agricultural commodity exchanges); expanded farmers' access to credit (microfinance institutions and insurance companies); integrated soil fertility management; improved crop varieties; and better ways of organizing farmers for technology testing, dissemination, adoption and diffusion, seed and fertilizer distribution and product assembly. To achieve this requires not just one, but several complementary and integrated investments to translate these solutions into income growth and poverty reduction. This, in turn, requires public policies and investments to transform the rural economy, focusing on improving farm productivity and production through marketing systems, processing facilities, functional rural labor markets,

Figure 5.1: Poverty traps framework of smallholder farm households



accessible financial and rural credit markets, efficient training and extension systems, favorable land tenure policies, participatory agricultural research and developing small-scale rural industries.

Agricultural productivity and intensification

This section uses available data to explore the trends in agricultural productivity and intensification, and explores the correlation between agricultural output levels and agricultural land productivity. The analysis also looks at the levels of and trends in financing agricultural intensification and how those investment levels correlate with cereal output and yields. The analysis uses primarily country level data, which is complemented by some household level data obtained from the Living Standards Measurement Studies—Integrated Surveys in Agriculture (LSMS-ISA) (World Bank, 2011–2013) to explore the critical question of the role of intensification versus extensification in explaining the observed trends in SSA productivity.

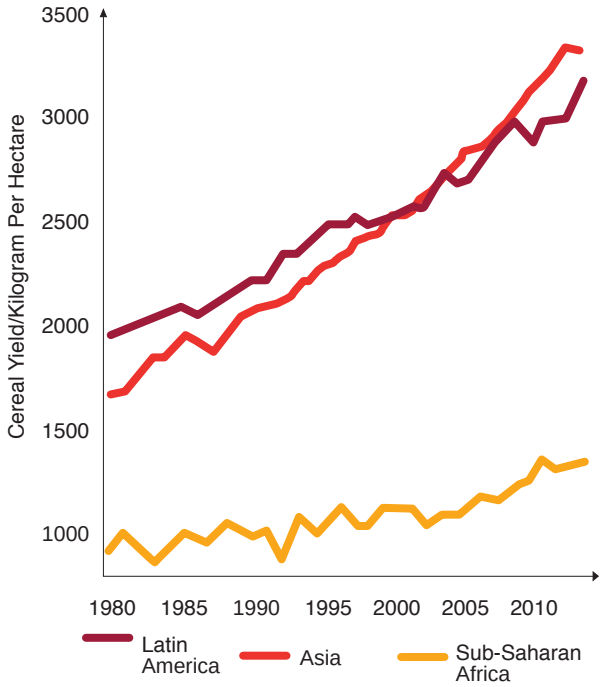
Trends and correlations of agricultural productivity and intensification

Levels and trends in agricultural productivity

This analysis was conducted using country panel data from 1990 into the early 2010s. Three specific measures were used for country agricultural productivity comparisons: (i) cereal yield, defined as cereal output per hectare, a measure of land productivity[1]; (ii) agricultural value added per worker in constant 2005 dollars, a measure of labor productivity[2]; and (iii) total factor productivity (TFP), defined as an index (1992 = 100) capturing the productivity of all factors.

The analysis focuses on the aggregate SSA, and on the disaggregation by regional economic sub-groups: COMESA (Common Market for Eastern and Southern Africa), SADC (Southern Africa Development Community), and ECOWAS (Economic Community of West African States)[3]. Several results stand out. First, agricultural land productivity is substantially lower in SSA than it is in other global regions. Second, while over time the level of cereal yields in SSA has increased, from an average of 1,123 kilograms per hectare in the early 1990s to an average of 1,445 kilograms per hectare in the 2010s, the gap between SSA, and Asia and Latin America continues to widen (Figure 5.2).

Figure 5.2: Land productivity is significantly lower in SSA

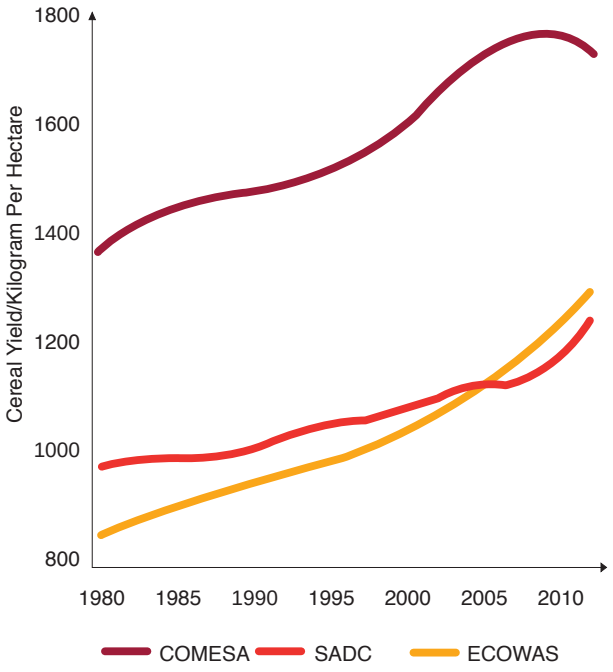


Third, looking at the regional groups in SSA, there is little difference in average yields between SADC and ECOWAS. However, average yields are higher in COMESA countries due to, for example, more favorable climate, more fertile soils, and higher use of inputs. Overall, yields have been generally stagnant in all sub-regions over time (Figure 5.3).

Contrasting results are found for labor productivity and total factor productivity (TFP) across the sub-regional groups. Agricultural value added per worker was lowest and stagnant in the SADC region, while it grew significantly for COMESA and ECOWAS countries. Since 1992 TFP has been growing in all sub-groups: at relatively slower pace in the COMESA area, a growing but slowing rate for ECOWAS, but at an increasing rate for SADC countries (Figure 5.4).

[1] Cereal yield, measured as kilograms per hectare of harvested land, includes wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded (WDI 2015).
[2] As defined by the IBRD/World Bank (2015), value added in agriculture measures the output of the agricultural sector (ISIC divisions 1–5) less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production. Data are in constant 2005 US.
[3] Note that some SADC countries (Malawi, Zambia, Tanzania, etc.) are also members of COMESA. In this analysis, those countries are classified as SADC. This allows for a relatively well-balanced distribution of countries across sub-groups.

Figure 5.3: Land productivity in SSA by regional groupings (1980–2013)



Source: *IBRD/World Bank (2015)*

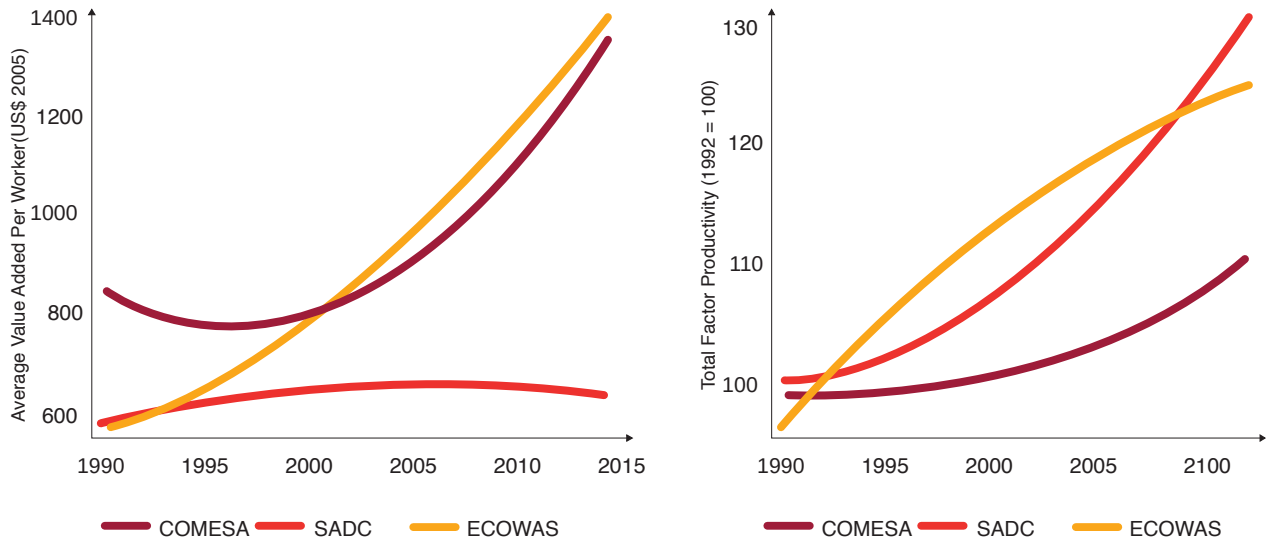
Over the period 1990–2015, significant growth was recorded in aggregate agricultural output, and cereal production in all sub-regions. The producer price indexes also grew in each region during this period.

Levels and trends in the use of inputs and factors

Data on agricultural intensification that allows for long-term international comparisons in SSA are relatively scarce. Available data, however, provide some indication on trends in intensification in SSA and other regions of the world. This section examines trends in terms of use of inputs (fertilizer and adoption of improved seeds), capital (machinery), and factors (land).

As expected, the levels of fertilizer use are considerably lower in SSA (excluding South Africa and Mauritius), averaging 14 kilograms per hectare in 2009–2012, than in Latin America (159 kilograms per hectare) and in Asia (396 kilograms per hectare) over the same time period (FAOSTAT). Between the early 2000s and 2010s, average fertilizer use per area of land in SSA remained relatively low and stagnant. As expected, significant differences exist in levels and trends across sub-regions and countries in SSA (Table 5.1). Average fertilizer use per hectare is highest and growing faster in the SADC region than in the other regions, increasing from 13 kilograms per hectare in 2001–2004 to about 20 kilograms per hectare in 2009–2012. Several governments reinstated or revitalized agricultural input subsidy schemes to promote access to fertilizer and improved seed (Minot & Benson, 2009) during this period, contributing to increased fertilizer use.

Figure 5.4. Agricultural value added per worker and total factor productivity by SSA regional groups



Source: *IBRD/World Bank (2015)*

In Malawi, for example, over the same period, fertilizer use increased from 11 kilograms per hectare to 29 kilograms per hectare. An additional reason for the increase is the increased farmer awareness on use of improved seed which acts as a pull to fertilizer use. In the other sub-regions the figure remained relatively stable, increasing from 7.0 kilograms per hectare to 10.0 in COMESA, and from 11 kilograms per hectare to 12 kilograms per hectare in ECOWAS. The apparent significant increase in tractors is mainly due to significant increases in a few SADC countries, such as Botswana and Swaziland (Table 5.1). The average for the region as a whole increased substantially from 68 to 114 tractors per 100 square kilometers of arable land between 2001 and 2008.

Adopting improved seeds, in conjunction with complementary technologies such as fertilizer and better crop production and protection practices, can contribute to improving farmers' cereal yields. Between 1960 and 2000, SSA lagged significantly behind other regions in terms of adoption of improved crop varieties and supporting technologies due to a lack of supportive government policies and subsidies to inputs and transport. Data available for that period indicate that area planted with improved varieties as a percentage of total areas harvested for maize, wheat, and rice was significantly lower in SSA than that in other regions (Gollin, Morris, & Byerlee, 2005). For instance, by 2000 the share of land area planted with maize under improved varieties in SSA was about 17 percent, a level more than double the 7.5 percent 10 years earlier. This is the same level achieved by South Asia in 1970 and Latin America in the 1980s. Similar results are found for wheat and rice. Adoption rates in SSA have increased significantly since 2000 for all crops except rice, with wide variations across countries (Walker and Alwang, 2015)[4]. However, levels are still below 50 percent in most countries, lagging behind the rates reached in other developing regions two or three decades earlier.

[4] Walker and Alwang (2015) also report the CGIAR contributions to progress. In 2010, over half (55 percent) of the area planted with modern maize varieties was related to CGIAR efforts. The proportions for rice and wheat were 51 percent and 65 percent respectively.

Table 5.1. Levels and trends in inputs and factors

	Levels and Trends					
	COMESA					
	1989–1992	1993–1996	1997–2000	2001–2004	2005–2008	2009–2012
Agricultural inputs and factors						
Fertilizer use (kg/ha)	-	-	-	6.9	8.2	9.7
Machinery(tractors/100 km^2 of arable land)	22	23	25	32	25	-
Land under cereal production (1,000 ha)	1,596	1,838	1,945	2,016	2,321	2,289
	SADC					
	1989–1992	1993–1996	1997–2000	2001–2004	2005–2008	2009–2012
Agricultural inputs and factors						
Fertilizer consumption (kg/ha)				13.4	14.2	20.2
Machinery (tractors/100 km^2 of arable land)	84	72	83	68	114	
Land under cereal production (1,000 ha)	1,023	1,044	1,073	1,179	1,399	1,584
	ECOWAS					
	1989–1992	1993–1996	1997–2000	2001–2004	2005–2008	2009–2012
Agricultural inputs and factors						
Fertilizer consumption (kg/ha)				10.7	9.4	11.5
Machinery (tractors/100 km^2 of arable land)	5	5	7	6	3	
Land under cereal production (1,000 ha)	2,372	2,583	2,587	2,674	2,939	2,911

Source: *IBRD/World Bank (2015); FAO (2015)*

Table 5.2: Correlation between factors and cereal output and yield by regional group

	Pearson Correlation Coefficient					
	Cereal output			Cereal yield		
	COMESA	SADC	ECOWAS	COMESA	SADC	ECOWAS
Agricultural inputs and factors						
Fertilizer consumption (kg/ha)	0.382**	-0.204	-0.067	0.359**	0.051	0.601**
Machinery (tractors/100 km^2 of arable land)	-0.153*	-0.446**	0.056	0.610**	-0.084	0.307**
Land under cereal production (1,000 ha)	0.851**	0.885**	0.932**	-0.262**	0.311**	0.019
Rural Population (1,000)	0.778**	0.765**	0.825* *	-0.341**	0.222**	0.136*

Source: *IBRD/World Bank (2015)*

The slow rate of growth in crop yield in SSA, despite the significant increases in the release of improved varieties, may be due to minimal adoption of complementary technologies, such as fertilizer and improved crop management practices. Moreover, while not reflected in average yields, the increased use of improved varieties may still have contributed to increased efficiency in using factors of production (IFAD, 2016).

Is output expansion a result of agricultural intensification or extensification?

Evidence suggests that, unlike the agricultural output growth path observed for Asia in the early days of the Green Revolution, which has intensified in recent decades, the increase in agricultural output in SSA has not been achieved through intensification. That is, the efficient use of non-labor, non-land inputs (such as improved crop varieties and fertilizers), but rather through extensification, relying on the expansion in cropped land area, and the use of manual labor[5]. Figure 5.5 illustrates the cases of SSA and Asia, using the cereal yields indicators referred to before and the cereal area planted index (1961 = 100).

Examining this analysis across the three sub-regions of SSA shows that SADC and ECOWAS countries experience lower and slower yield growth and have a relatively faster land area expansion than COMESA countries (Figure 5.6) Under a situation where fertilizer use remained very low, output growth has relied almost exclusively on cropped area extensification. Results in Figure 5.6 support this conclusion for the SADC and ECOWAS countries. In effect, the results show that along with output growth, there was an increase in land area cultivated and a stagnation in yield. This was less so for COMESA countries, where, although levels of fertilizer use per hectare were relatively low, intensification (including efficient use of fertilizer, improved seeds, agricultural practices, etc.) seems to have played a relatively more important role resulting in relatively higher yields.

Analysis of inputs and factors impacting cereal output and yields

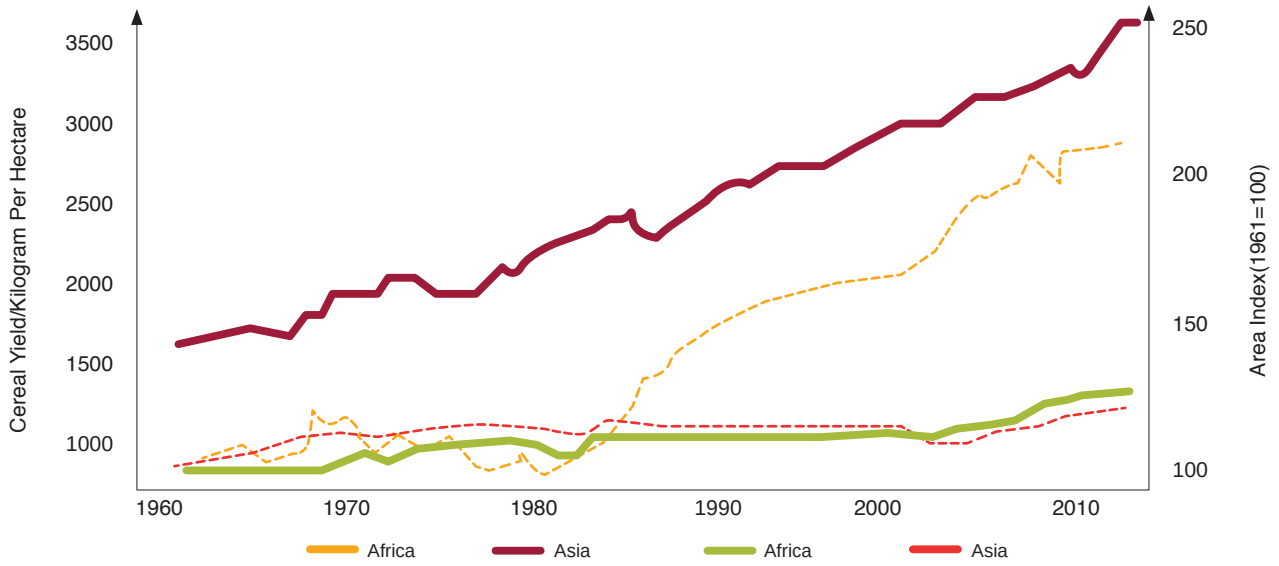
For SSA as a whole, correlations of cereal output and fertilizer consumption, land area under cereals, and size of the rural populations in the different countries reveal a strong positive and statistically significant correlation between land area planted and output (r = 0.909, 1 percent) and with rural population size (r = 0.789, 1 percent). This was not the case with fertilizer consumption, which had an insignificant correlation with output (r = 0.030). Overall, this agrees with the previous analysis that output expansion has essentially been driven by expansion in cropped land area and reliance on abundant manual labor. The use of improved seeds also increased in many countries, but remains insufficient to boost productivity, unless combined with complementary technologies, especially fertilizer in low-fertility African soils.

Looking at results by regional economic group, fertilizer was statistically correlated with cereal yield in COMESA and ECOWAS countries, but not in SADC countries (Table 5.3). Agricultural machinery was positively associated with agricultural productivity, but yielded a small but negative effect on aggregate output[6]. Overall and despite some regional differences, agricultural productivity and intensification at the household level is extremely low in SSA.

[5] Evidence, as discussed in the previous section, indicates that while the use of modern varieties in key crops have increased in SSA, most countries are still lagging behind. Disparities also exist in fertilizer use and overall increase in the levels of use have been unimpressive.

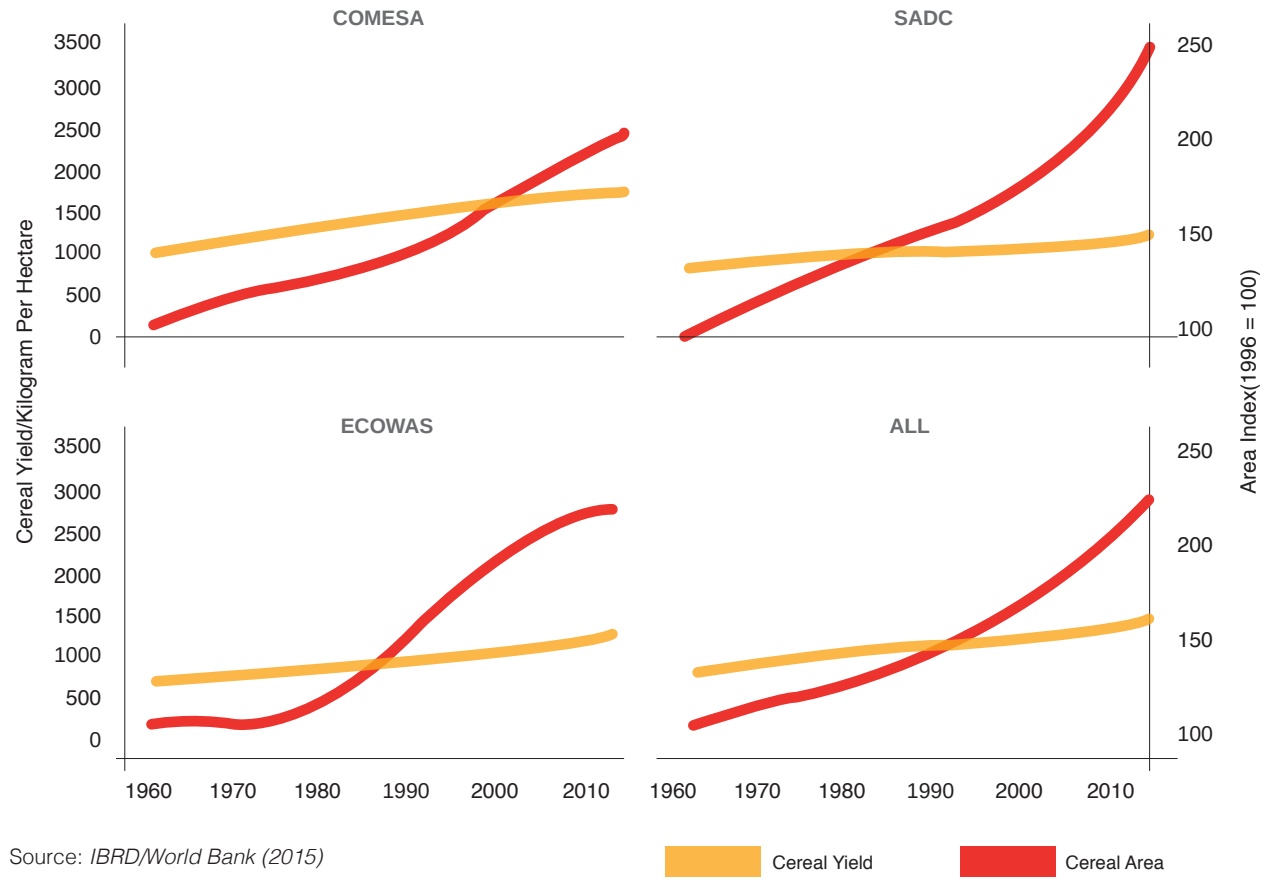
[6] The signs of these relationships hold for the sample of all countries. The relationship was not statistically significant for cereal output (ECOWAS) and cereal yield (SADC). These results should be examined with caution, due to limited variation in the tractors variables and the limited sample size.

Figure 5.5. Agricultural productivity and land use in SSA and Asia (1961–2012)



Source: *IBRD/World Bank (2015); FAO (2015).*

Figure 5.6: Agricultural productivity and land use in SSA regional groupings (1960–2013)



Source: *IBRD/World Bank (2015)*

Table 5.3: Farmer use of improved inputs and access to extension

Country	Survey year	Use of agricultural inputs and access to extension services (% of households)				
		Improved seed	Fertilizers	Manure	Pesticides/ herbicides	Accessing extension services
Tanzania	2012/13	15.8	9.4	13.3	9.4	6.3
Malawi	2013	55.7	74.2	19.8	5.7	63.1
Uganda	2011/12	27.7	5.6	15.4	14.7	27.9
Ghana	2009/10	12.8	10.9	3.8	18.2	9.8
Nigeria	2012/13	27.8	45.0	-	19.3	12.0
Ethiopia	2011/12	16.8	7.4	9.1	24.0	32.1

Source: *World Bank online data: Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) (http://www.worldbank.org/en/research Accessed June 2016)*

Note: Sample sizes (# of households) are: Tanzania (5,010), Malawi (3,219), Uganda (2,217), Ghana (5,016), Nigeria (2,964), and Ethiopia (3,779).

Micro level analysis of intensification and agricultural productivity

An analysis of SMS-ISA survey data for 2012/2013 available for Ethiopia, Ghana, Malawi, Nigeria, Uganda and Tanzania, showed that adoption of certified seed of improved varieties and hybrids, inorganic fertilizer and pesticides is increasing compared to levels reported in 2010/2011 and 2011/2012 (Sheahan & Barrett, 2014), although different countries are at different levels (Table 5.3). Access to extension services varies across countries. Proportionately more households in Malawi, Ethiopia and Uganda have access to extension agents in a year because these countries have invested in agricultural extension systems.

Micro-level statistics data show that adoption of improved seed alone without complementary inputs has not led to an African Green Revolution, as the yield performance of improved seed without complementary inputs is more or less the same as that of planting unimproved seed. The potential acceleration for an African Green Revolution depends on input intensification. Crop productivity greatly increases when households shift from using unimproved to improved seed with combinations of fertilizers (organic and inorganic), with pesticides and herbicides (Figure 5.7) and supported with the right agronomic practices. However, input intensification alone may not be the answer to an African Green Revolution. For example, adoption rates of inputs are high in Malawi, where there is good access to extension services, improved seed and inorganic fertilizers, but crop productivity performance is still lower than that reported in other countries. The finding collaborates with evidence observed at regional level in Figure 5.7 and Table 5.3. This leads to several questions: Are farmers using the right inputs and the right combinations at the rates suitable for their soils? Are farmers well informed about nutrient requirements for their soils? Do farmers receive timely and appropriate extension messages? Answers to these questions are vital for agents of input intensification programs to help spur an accelerated African Green Revolution.

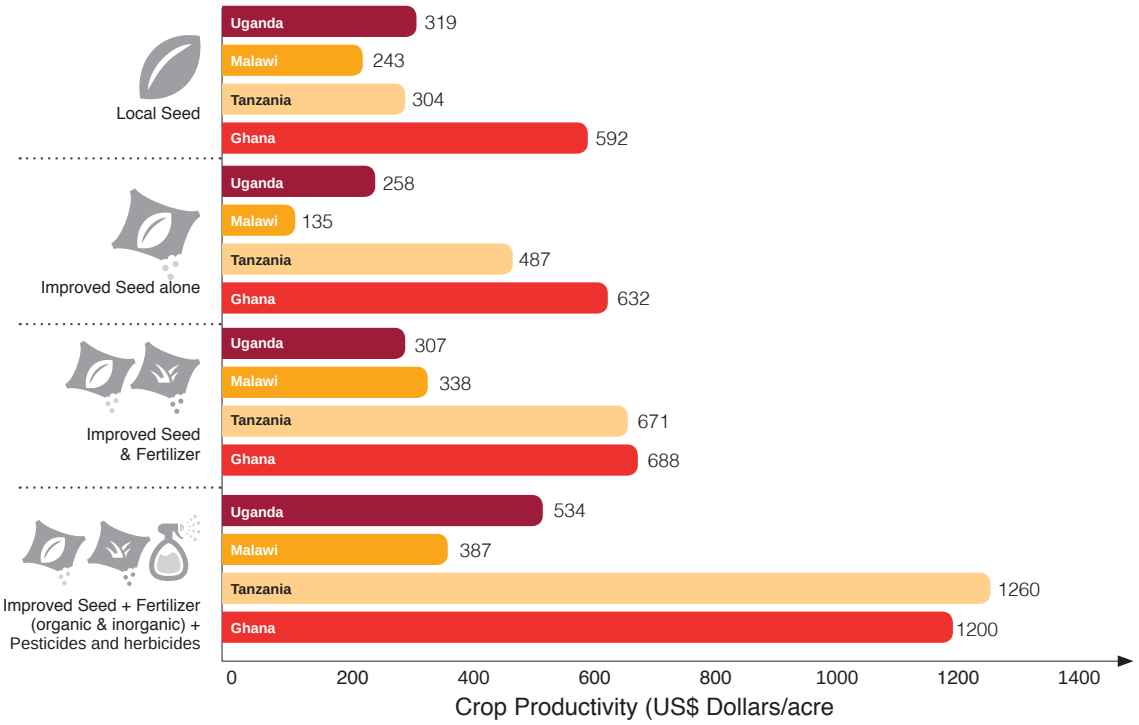
Government input subsidies facilitate high adoption rates of improved inputs (seed, fertilizers and pesticides) by poor smallholder farmers in several African countries (e.g., Malawi, Nigeria and Kenya). In the absence of input subsidies, easy access to output markets associated with favorable infrastructure and institutional arrangements can lead to increased crop commercialization through adoption of crop intensification inputs. Figure 5.8 shows that commercial crop farmers use larger quantities of fertilizers. The degree of commercialization is measured as the proportion of total crop production sold.

Financing agricultural intensification

Levels and trends in financing agricultural intensification

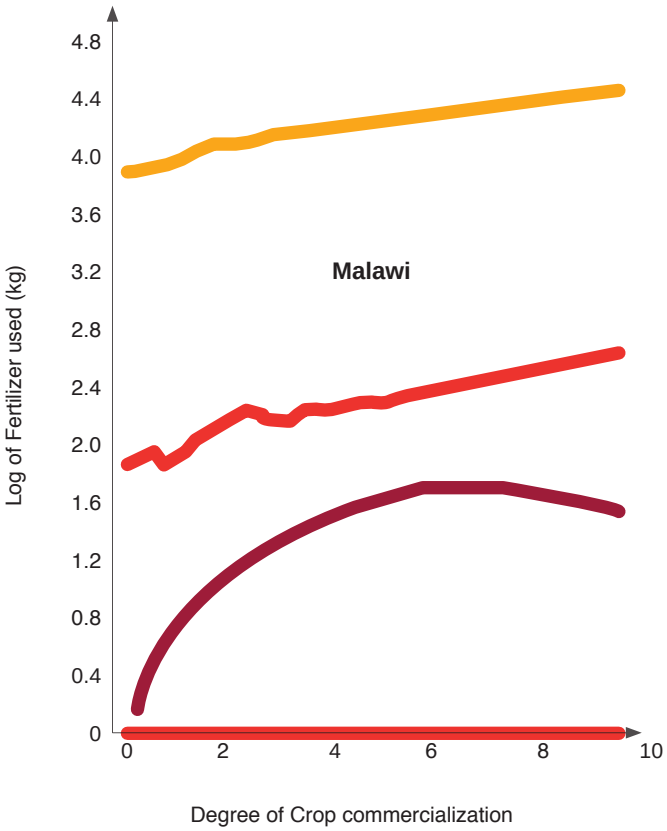
Available data suggest that provision of credit to agriculture and government spending on agriculture in SSA are relatively limited and stagnant. As a share of total credit in the economy, credit to agriculture is estimated at less than 1 percent. Government spending on agriculture, as a percentage of total government

Figure 5.7: Input intensification and crop productivity



Source: *World Bank online data: LSMS-ISA Survey years: Uganda (2011/2012), Malawi (2013), Tanzania (2012/2013), Ghana (2009/2010)*

Figure 5.8: Fertilizer application (organic and inorganic) and proportion of crop production sold

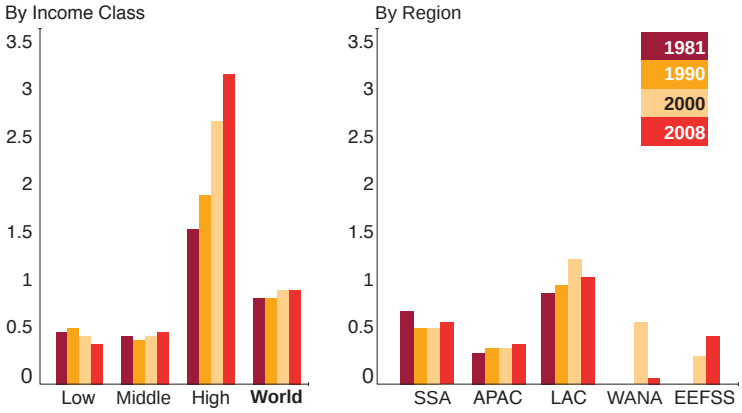


Source: *World Bank online data: LSMS-ISA. Survey years: Uganda (2011/2012), Malawi (2013), Tanzania (2012/2013)*

expenditure, remains, on average, systematically below 5 percent over the years, and is much lower in the ECOWAS region than in the other sub-regions (Table 5.4). A recent analysis reviewed trends in public and private investments in agricultural R&D (IFAD, 2016).

First, in terms of national public investment, spending on agricultural R&D as a share of agricultural GDP in Asia and the Pacific is well below 1 percent (Figure 5.9). In SSA, agricultural R&D expenditure as a share of agricultural GDP has stagnated around 1.1 percent, on average, but showed a declining trend over the last three decades (Figure 5.10). At regional level, government expenditure on agricultural R&D has been declining generally over time, but the decline is more pronounced in COMESA and ECOWAS countries than it is in SADC countries. This is largely because both COMESA and ECOWAS receive substantial funding through donor support to research, while private sector expenditure on R&D is increasing in SADC countries—a pre-condition that induces government expenditure on R&D (Pray, Gisselquist, & Nagaranjan, 2011). Overall, agricultural R&D funding in SSA is more dependent on contributions by development partners than that in other developing regions, and—linked to this—funding is also more volatile (Beintema & Stads, 2014).

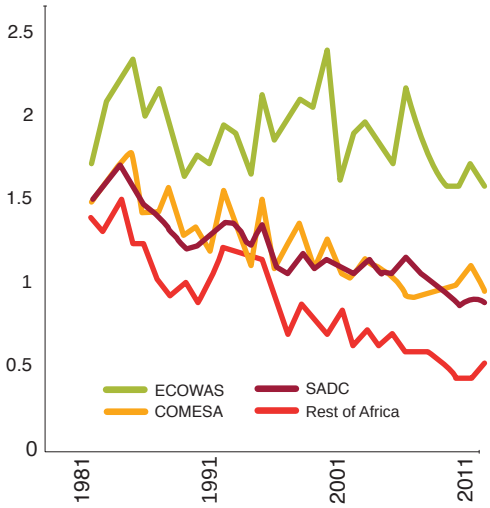
Figure 5.9: Agricultural research spending by country intensity and region, 1981–2008



NOTES: SSA = Africa south of the Sahara; APAC = Asia Pacific countries; LAC = Latin America and the Caribbean; WANA = West Africa and North Africa; EEFSS = Eastern Europe and former Soviet States. Intensity ratios by income group include estimated spending trends for WANA and EEFSS. Regional growth rates exclude high-income countries within that region(for example, Japan and South korea in the APAC region). Data for 1981 and 1990 were not available for WANA and EEFSS.

Source: *Beintema, Stads, Fuglie, & Heisey (2012)*

Figure 5.10 Agricultural research spending as share of agricultural GDP, 1981–2011, SSA sub-regions



Source of data: *Agricultural Science and Technology Indicators (ASTI) database, http://www.asti.cgiar.org/data (accessed 6 July 2016)*

Table 5.4. Levels and trends in financing to agriculture

	Levels and Trends					
	COMESA					
	1989 –1992	1993 –1996	1997 –2000	2001 –2004	2005 –2008	2009 –2012
Credit and government spending						
Credit to agric. as share of total credit (%)		0.17	0.11	0.07	0.07	0.06
Agriculture spending (% of total)				4.2	5.7	3.2
Agricultural researchers						
Number of ASTI researchers			361	418	438	501
Number of ASTI researchers/10^4 farmers			41	45	48	42
	SADC					
	1989 –1992	1993 –1996	1997 –2000	2001 –2004	2005 –2008	2009 –2012
Credit and government spending						
Credit to agric. as share of total credit (%)		0.07	0.04	0.12	0.10	0.08
Agriculture spending (% of total)				4.1	4.5	3.8
Agricultural researchers						
Number of ASTI researchers			188	181	195	202
Number of ASTI researchers/10^4 farmers			8	11	11	12
	ECOWAS					
	1989 –1992	1993 –1996	1997 –2000	2001 –2004	2005 –2008	2009 –2012
Credit and government spending						
Credit to agric. as share of total credit (%)	0.08	0.07	0.08	0.06	0.03	0.03
Agriculture spending (% of total)				1.3	2.7	2.7
Agricultural researchers						
Number of ASTI researchers			307	291	330	325
Number of ASTI researchers/10^4 farmers			8	8	7	12

Source: *IBRD/The World Bank (2015)*

Note: Regional groups are COMESA, SADC and ECOWAS

During the Asian Green Revolution countries seem to have maintained large public extension systems, while few countries in Africa (such as Ethiopia, Kenya, and Rwanda) have made major efforts to increase the number of their public agricultural extension agents (Swanson & Davis, 2014). ASTI data show that the average number of agricultural researchers has increased from an average of 271 in 1997–2000 to about 300 in 2009–2012 (Table 5.4). Over the same period, the number of researchers per 100 thousand farmers varied by region. COMESA countries have the highest numbers of ASTI researchers (in total and per 100 thousand farmers) compared to the other regions.

Globally, the private sector[7] contribution increased by more than 40 percent between 1997 and 2010, with by far the largest share invested in crop seeds and biotechnology (Fuglie et al., 2012). Private investment is mostly concentrated in industrialized countries, but developing countries can benefit from it, especially if they create a business environment that assists agribusinesses. Also, private agricultural R&D tends to focus on specific types of commodities for which returns are easily appropriable, and many of those are not essential to smallholder livelihoods (IFAD, 2016).

Analysis of investments in agriculture impacting cereal output and yields

Correlation analyses indicate a positive and statistically significant association between share of credit to agriculture in total credit and the levels of cereal output and cereal yields. Likewise, a positive and statistically significant association is found between the share of agriculture spending in total spending and cereal output and yields. For both variables there is a stronger and more statistically significant positive association with cereal yield, which underscores the role of financing in increasing productivity. Credit to agriculture is particularly strongly associated with cereal output increases in the three regional groups, but is more strongly associated with agricultural productivity in the SADC region. Government spending is particularly strongly associated with cereal output in COMESA and ECOWAS, and with cereal yield in the SADC region (Figure 5.6).

The analysis showed a strong positive association between the number of ASTI researchers and the levels of cereal output and yields. This relationship association yields strongly in every regional group. When considering the number of ASTI researchers per 100 thousand farmers, no statistically significant

[7] The private sector can play a major role in areas of research that are not in themselves subject to market failures, such as seed multiplication and distribution, agrochemicals and agricultural machinery (Byerlee & Haggblade, 2014).

Table 5.5. Correlation between factors and cereal output and yield by regional group
Pearson Correlation Coefficient

	Cereal output			Cereal yield		
	COMESA	SADC	ECOWAS	COMESA	SADC	ECOWAS
Credit and government spending						
Credit to agriculture as share of total credit (%)	0.279*	0.394* *	0.140+	-0.396* *	0.824**	0.037
Agriculture spending (% of total)	0.729**	-0.110	0.470**	-0.175	0.263*	0.212
Agricultural researchers						
Number of ASTI researchers	0.888**	0.846* *	0.934**	-0.172	0.283**	0.215*
Number of ASTI researchers per 100,000 farmers	-0.272*	-0.590**	0.140	0.937**	-0.575**	-0.430* *
Income and poverty						
GDP per capita (US$)	-0.144**	-0.306**	0.297* *	0.787**	-0.335**	0.084*
Rural poverty headcount at national line (%)	-0.306	0.171	-0.580	-0.665	0.106	-0.865*
Income Inequality index	-0.020	-0.524*	-0.258	0.295	-0.163	-0.147
Producer price index—Maize	0.413**	0.184*	-0.102	-0.016	0.151+	0.003

Source: *IBRD/The World Bank (2015).*

Notes: Significance level of the point estimates and differences: 1% (**), 5% (*), and 10% (+).

association is found for cereal output. However, a relatively strong positive association is found with the level of yields, signaling the importance of agricultural research capabilities and coverage in influencing productivity outcomes.

Finally, we examined the associations between economic growth, poverty and inequality and the levels of cereal output and yields. Results indicated the expected sign on the relationship between rural poverty and the levels of cereal output and yield. This means higher yields associated with lower levels of poverty, but the association was not statistically significant. National inequality showed a similar result: higher cereal outputs and yields were closely associated with lower levels of economic inequality, but the relationship was only statistically significant for cereal output[6]. While not statistically strong, these relationships provide some indication of the basic associations across these important variables.

Supporting services and institutional arrangements for increasing agricultural productivity

Rural households face a range of challenges in accessing, affording, and therefore adopting improved technologies. This section reviews some of the initiatives to overcome these challenges, drawing largely on programs supported by the Alliance for a Green Revolution in Africa (AGRA) and other development partners.

Agro-dealer network support

For many smallholder farmers, agro-dealers are the sole source of farm inputs (e.g., seeds, fertilizer, agro-chemicals, and farm implements) and in many instances even agriculture advisory services. In many SSA countries, smallholder farmers spend more money on transport costs to the nearest agro-dealer than on the cost of the inputs they buy. AGRA and its partners support agro-dealer development to bring these services closer to the farmer. The AGRA model of intervention closely follows the World Bank program of Benchmarking the Business of Agriculture in which AGRA plays a big role (Adesina, 2009; World Bank, 2014). The intervention model works on the premise that a network of small-scale entrepreneurial agro-dealers transforms the currently fragmented input distribution systems into an efficient, commercially viable input infrastructure, giving farmers better access to productivity enhancing inputs and technologies.

Since its inception, AGRA has been supporting agro-dealers and their networks in 13 countries in SSA through providing training in: technical knowledge, marketing and management of input shops, storage requirements, and agro-input market information intelligence. In a period of 8 years (2007–2015), AGRA supported the development of 38,482 agro-dealers in 13 countries[8]; the agro-dealers sold accumulated quantities of 1.4 million metric tonnes of inorganic fertilizer and 475,805 metric tonnes of improved seed to smallholder farmers (AGRA, 2016). To achieve these input sales, AGRA uses several strategies. For example, after training agro-dealers, AGRA facilitates them to access start-up and inventory finance to open input shops nearer to the farmers. For example, the average distance travelled by smallholder farmers reduced from 27 to 20 km in Burkina Faso, 15 to 9 km in Rwanda and 41 to 15 km in Niger in a period of three years (AGRA, 2015). Inputs are not only brought nearer to the farmers, but agro-dealers also engage in demand creation activities including correct input use through demonstration plots, hosting field days and providing extension advisory services. Beyond supporting development of local agro-dealers, AGRA partners with other development partners by providing grants or establishing a corroboration to create an enabling agribusiness environment. These partnerships are yielding unprecedented results. A good case study example is the partnership between AGRA and the African Fertilizer and Agribusiness Partnership (AFAP) in which seven million farmers have been able to access fertilizers in a space of three years (Box 5.1).

Impact of government subsidies on private sector agro-dealers

Fertilizer subsidies generally depress market prices and lead to a crowding-out of private suppliers in SSA (Ricker-Gilbert, Jayne, & Chirwa, 2011; Xu, Burke, Jayne, & Govereth, 2009), thereby negatively affecting the number and viability of agro-dealers. There is therefore urgent need to develop a policy and institutional framework for the agro-dealership initiative that would outline legitimate practices and expectations (Chinsinga, 2011). Over the past 10 years several lessons have been learned about how to conduct a subsidy program:

- **Subsidies reduce effective demand.** Farmers delay fertilizer and seed purchases as they wait for the subsidized products to become available. This often fails to happen completely, or happens at levels that do not allow farmers to access enough.

- **Subsidies generate sustainable demand.** Subsidies encourage farmers to use improved seeds and fertilizers and to buy larger volumes. However, when the subsidies are reduced or suspended, farmers are unable to continue buying the same quantities of inputs which negatively affects the agro-dealer businesses and their farm productivity.

BOX 5.1:
Support to bulk fertilizer imports

The African Fertilizer and Agribusiness Partnership (AFAP) was established in 2012 to support large volume fertilizer suppliers and hub agro-dealers. AFAP uses an Agribusiness Partnership Contracts (APC) model to support private sector firms involved in the fertilizer trade. APCs are agreements under which eligible international, regional and local agribusinesses apply for AFAP assistance, as they invest in the African fertilizer and agribusiness markets. AFAP assistance can include payment and/or credit guarantees; matching grants; technical, logistical and marketing support; and training and organization of local entrepreneurs and farmers. In return for this assistance, agribusinesses agree to perform significant market development activities with local farmers and/or local agribusiness (demand creation, extension support, and farmer organization).

AFAP uses the hub and spoke model to reach farmers. The hubs are the larger, better resourced agro-dealers based in the main towns. Each hub agro-dealer is linked to many rural based retail agro-dealers (the spokes) who are based closer to farmers. Hubs have become important players in aggregating produce for onward sale to output markets. Key improvements in the input supply chain are: (i) suppliers provide fertilizer on better terms, often 50 percent of the order cost upfront, with 50 percent payable within 60 days; and (ii) the hub agro-dealers get fertilizers at their preferred delivery schedule depending on one's agro-ecological zone, thereby availing fertilizers to farmers at the right time and in the desired quantities.

Over the last three years, the AFAP fertilizer credit guarantee of US$6.4 million has allowed beneficiaries to move more than 600,000 metric tons to around 3,700 agro-dealers, reaching 7 million smallholder farmers in Mozambique, Tanzania, and Ghana. One result of this initiative is lower occurrences of the common complaint farmers have about untimely availability and inadequate quantities of fertilizers in the areas where AFAP operates.

Source: *AFAP (2015)*

[8] Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Malawi, Mozambique, Niger, Nigeria, Uganda, Rwanda, Tanzania, and Zambia.

- **Non-payment of suppliers.** In many cases governments have failed to honor their payment promises and have either paid late or not at all. This has had disastrous consequences on the companies and agro-dealers involved in the initiative, driving many into bankruptcy. For example, in Tanzania, several agro-dealers had borrowed money from the National Microfinance Bank. When the government failed to honor its payment promise, some agro-dealers had their property confiscated by the bank and others became bankrupt.

- **Subsidy schemes are open to corruption.** Inefficiencies and corruption in government procurement systems have also had a negative effect on agro-dealers and farmers, as elite capture or diversion of inputs means that smallholders cannot access them on time, or in sufficient quantities.

The way forward—Proposed government actions for increasing agricultural productivity

The analysis and review in the previous sections presents evidence confirming the low levels of intensification in SSA and in the three regional economic sub-groups. The evidence is based on country level statistics, and it shows some differences across sub-regional groups (COMESA, SADC, and ECOWAS). The result is low and stagnant agricultural productivity. Analysis confirms the proposition regarding the sources of output expansion, extensification rather than intensification and acknowledges its limitation as a sustainable pathway out of poverty, given the physical limitations of land, labor and financial resources. Evidence also shows that labor productivity has stagnated considerably. Finally, many countries in SSA have had low and stagnant rates of input use (e.g., irrigation, improved varieties, and fertilizers) over the past decades. Complementary analysis reasons that the low levels of investment by smallholders in SSA that drive low and stagnant yields has to a great extent to do with the failure of private markets (inputs, factors, outputs, and insurance) and the inadequacy of public investments and interventions designed to minimize the implications of those failures.

In the following sub-sections we propose a series of actions by governments and their development partners to address the key constraints to increasing agricultural productivity.

AGRA's Experience

The observations and findings in this chapter reinforce the choice of AGRA interventions, as outlined in the new strategy. The evidence provided shows that smallholder farmer productivity enhancements will not be realized by use of inputs (seeds, fertilizer and agronomic practices) alone. Rather, adoption of technologies and productivity enhancement will be driven by a combination of input packages, coupled with well-developed output markets to drive productivity. Smallholder farmers require guaranteed markets as incentives to purchase inputs from agro-dealers. These market guarantees will further incentivize farmers and SMEs to seek credit from financial institutions.

The experience of AGRA work over the last 10 years has also shown that the efficiency of both input and output markets has been compromised by inadequate policy and regulatory environment. For example, technology adoption in SSA has been characterized by policies, laws and regulations that inhibit, rather than promote, access and commercialization of these technologies.

AGRA's work to support the recommendations in this chapter will therefore be driven by the following five key approaches.

i) **Prioritizing integration as a key for success.** AGRA is taking a bold step towards delivery of integrated solutions at smallholder level, as the only clear pathway to sustainable agriculture transformation.

ii) **Balancing technology development with its increased accessibility and adoption.** This chapter clearly shows that productivity-enhancing technologies and practices are an important starting element for agricultural transformation. However, even once they are on the market, AGRA has found that major gaps remain in farmer access to and adoption of these solutions, particularly for women, who comprise most smallholder farmers and who would benefit the most. AGRA and its partners should redouble efforts to create the conditions for smallholder farmers to adopt new inputs and practices through raising awareness, and increasing access through better access to markets and to finance. All of these contribute to the decision to invest or not to invest in yield increasing technologies.

iii) **Prioritizing improved seeds availability.** Despite the finding that improved seed alone is not a solution to increasing productivity, AGRA believes that limiting access to foundation seed will compromise increased crop productivity. As such AGRA has committed to work with governments, the private sector, and other competent groups to proactively facilitate the availability of foundation seed for use by growing seed sectors.

iv) **Better and stronger focus on the role of markets and reducing post-harvest losses.** Increasing productivity while losing much after harvest continues to undermine household food security. Most interventions focus on production that leads to improved yields, but this value is eroded by high post-harvest losses in grains. Going forward, AGRA will seek to catalyze efforts for post-harvest loss reduction.

v) **Prioritizing an enabling policy, regulatory and institutional environment.** Over the last 10 years of investments, AGRA has learned that policies, regulations, and institutional bottlenecks potentially stifle rather than promote farmers' or SMEs access to seeds, fertilizers, and finance markets among others. AGRA is now identifying specific policy and regulatory constraints and partnering with governments and other actors to proactively change and reform these policies and regulations. This approach has significant potential for impact on smallholder farmers' productivity and income through the creation of an enabling business environment for actors in seeds, fertilizers, markets and finance.

Invest in increasing the availability of agricultural technologies

Investment in technology development and transfer made by the public (national and international) and private sectors in the region are not negligible, but they are still very low. CGIAR investments increased significantly over the years, almost doubling between 2006 and 2013 (Ufer & Birner, 2015). However, they have reduced dramatically in recent years. This lack of investment is undermining progress in achieving government and international targets.

Actions by government and partners:

- Meet the 2014 Malabo Declaration commitment to increase investment finance in agriculture to 10 percent of public expenditure.
- Provide an enabling environment for small and medium size businesses to operate, for example, reduce the burden of company registration, and provide tax breaks in the first few years of operation and access to low interest rate government loans, etc.

The sustainable adoption of agricultural technologies is to a great extent conditioned by its profitability, which in turn is affected by access to input and output markets and the set of relative prices farmers face. Why are relative prices of outputs to inputs and factors low, that is, why are input prices relatively high and farm prices relatively low? One reason points to inadequate infrastructure, particularly roads and poorly developed marketing systems that keep the cost of fertilizer and other productivity enhancing inputs and services high relative to the price of output (Udry, 2010). Likewise, poor infrastructure is related to expensive irrigation and electricity, inputs that cannot therefore be used intensively.

Actions by government and partners:

- Increase investment to rural infrastructure, for example, feeder roads and local storage structures.
- Increase investment and incentives for smallholders to invest in small-scale irrigation.
- Increase support to market information systems via Internet, newspapers and SMS services so that farmers have better price information and can access better prices at the farm gate.

Another important failure that affects the levels of technology use is imperfect access to information, which limits farmers' awareness about new or improved technologies that are available. For a detailed review of the role of information see Foster and Rosenzweig (1995). With stagnating investment in this area, little potential exists for increasing the number of extension agents employed by governments in SSA.

Actions by government and partners:

- Increase investment to public extension services to allow recruitment of more extension agents, and their retraining to equip them with current information and approaches to support agricultural production.
- Support development of private sector extension services, beyond contract farming by large companies, to complement public extension.
- Support new ICT approaches for provision of extension services and market information services.

Invest in increasing access to rural financial services

Despite developments in rural financial services in the region over the years, most smallholder farmers cannot, or do not access these services. This is due to several reasons: (i) the high risk financial institutions face when they lend to smallholders; (ii) low population densities in rural areas; and (iii) poor infrastructure. All these result in high transaction costs for financial institutions for relatively small loan sizes.

Actions by government and partners:

- Develop supporting policies to promote an enabling environment for rural finance.
- Promote a wide range of financial institutions, models and delivery channels, tailoring each intervention to the given location and target group.
- In collaboration with private-sector partners encourage investment in market-based approaches that strengthen rural financial markets.

Increase access to affordable crop and loan insurance

In an environment where input markets perform poorly, output markets are uncertain, weather and other risks are simply too high relative to the uncertain expected benefits. These other risks include the costs of investing in productivity enhancing technologies, such as modern inputs, machinery or other investments. As highlighted in the 2008 World Development Report (World Bank, 2008), risk distorts investments and puts assets in jeopardy. The poorer the farmer, the less likely he or she would be to prefer riskier choices—trading-off potential longer-term gains to achieve more certain short-term food security outcomes. Over time, that persistent/perpetuated risk avoidance will aggravate poverty traps, as lack of investment and materialization of returns will not allow households to increase their incomes and move out of poverty.

Actions by government and partners:

- Support the development of insurance mechanisms that encourage farmers to take risks in production investments and prevent shocks from depleting their scarce assets.
- Encourage the development of appropriate loan product for smallholders, for example, seasonal loans, small equipment loans, etc.
- Increase awareness of climate risks and the value of investing in insurance.

Ensure all households have secure access to their land

Insecure property rights limit investments by farmers in their land, leading to low levels of investment and unsustainable use of their natural resources. In environments where there are also constraints to access finance, farmers without security of tenure cannot use the land as collateral, which makes it difficult to access credit they need to make the much-needed investments.

Actions by government and partners:

- Develop appropriate laws and mechanisms that give some form of land titling to households to increase tenure security and the propensity to invest in it.
- Develop policies that allow, and protect, households in the use of their land title as security for loans.

Conclusion

This chapter has reviewed trends in agricultural productivity and intensification in SSA compared with other regions, and among countries in SSA, analyzed country level and household level data analysis for selected countries to test selected propositions. It has found that increasing agricultural productivity in Sub-Saharan Africa through intensification and closing yield gaps is critically important for generating sustainable and inclusive growth and poverty reduction.

Analysis of historical trends in agricultural productivity and intensification using macro level data shows that compared to other regions cereal yields, agricultural value added per worker and total factor productivity in SSA are much lower compared to Asia and Latin America and that differences exist among the three regional economic groups. Analysis using household level data for selected countries shows that adoption of certified seed of improved varieties and hybrids, inorganic fertilizer and pesticides is increasing over time and integrating at the farm level new agricultural seed, soil fertility, agrichemical technologies, extension, and markets innovations results in payoffs to investments.

Policies to support services and institutional arrangements to increase agricultural productivity need to prioritize and appropriately sequence over time interventions that are integrated across agricultural value chains in agricultural research, technology development and exchange, agricultural processing and marketing firms, seed multiplication and distribution firms, fertilizer supply firms, agro-dealer network, agricultural extension, near farm aggregators, structured off-takers and markets, commodity traders, microfinance institutions, agricultural insurance, land access, registration and titling, infrastructure, irrigation and ICT market information systems.

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CHAPTER 6

Getting More for Farmers from Post-Harvest to Market

AUTHORS

Antony Chapoto
Indaba Agricultural Policy Research Institute

Mulat Demeke
Food and Agriculture Organization, Nairob

Gideon E. Onumah
University of Greenwich, Natural Resources Institute

Herbert Ainembabazi
Alliance for a Green Revolution in Africa

KEY MESSAGES

ONE

Smallholder farmers in Africa are failing to take advantage of existing and emerging opportunities because of many market-related constraints that require urgent attention.

TWO

Three interrelated solutions are required to ensure that smallholder farms in Africa become more commercialized and profitable:

- Increased uptake of improved technology.
- Increased investment in physical infrastructure through prioritizing public investment in rural roads and promoting incentives for private investment in storage, marketing and processing infrastructure, and reducing the fiscal burden associated with such investments.
- Addressing policy barriers by creating a predictable and rules-based enabling policy and regulatory environment to attract much greater private investment in agricultural value chains in a way that serves smallholder farmers.

Introduction

Africa's economic and demographic landscape is changing profoundly. Over the past 30 years, the population of SSA has doubled, and in urban areas it has tripled (NEPAD, 2013). Rapidly rising urban populations, changing consumption patterns and growth in per capita incomes in SSA are creating major opportunities for local farmers by driving vigorous growth in domestic and regional market demand for food and rapid changes in food systems (Pingali, 2006; Reardon, et al., 2013; Tschirley, Haggblade, & Reardon, 2013). Urban diets are diversifying, with more animal products being consumed. The change in consumption demand is creating new marketing options as witnessed by the growth in the number of supermarkets in Africa (Beyene, 2014; NEPAD, 2013)

Most farms in Africa are smaller than two hectares, and with rising population, they are likely to get even smaller. This implies that the number of smallholder farmers in Africa will continue to grow and hence should be part of the solution to meeting the food demand of the growing urban population and changing consumption patterns (Fan, Brzeska, & Halsema, 2013). At the same time, the number of indigenous medium- and large-scale farmers has increased in the past decade, a situation that will help fill the emerging demand as most of these farmers are commercially oriented (Jayne et al., 2015).

Africa has also seen a rise in more sophisticated retail outlets and supermarkets providing additional marketing channels for commercial farmers. However, most smallholder farmers are currently unable to keep up with the demands of rapidly rising urban populations (Shepherd, 2007). The continent has witnessed a surge in imported cereals such as rice and wheat and processed products with the annual food import bill in excess of US$40 billion (Beyene, 2014). The food import shares of most African countries still remain moderately low, between 5 percent and 25 percent of total food expenditures, but these import shares are rising (Rakotoarisoa et al., 2012). Per capita food consumption in Africa has been rising 10 times faster than per capita food production, leading to an increase in food imports (Rakotoarisoa et al., 2012). However, despite the increase in imported food products, most domestic food needs are still supplied by local producers (NEPAD, 2013).

These trends indicate that there are major opportunities for African farmers to meet the demands of the rapidly growing urban population. However, most smallholder farmers in SSA face major constraints and challenges in responding to these opportunities, such as: (1) limited access to land and tenure insecurity; (2) weak public agricultural research and extension programs, contributing to low productivity; (3) high post-harvest losses; (4) weak and uncertain input and output markets; (5) unpredictable weather; (6) liquidity constraints; (7) high transport costs; and (8) questionable agricultural policies, to mention a few.

The main premise throughout this chapter is that raising farm incomes is key for improved well-being of smallholder farmers and to attract investors (emerging and commercial farmers and youth). To be successful, most countries in SSA will need to develop efficient and transparent marketing systems to raise the returns to labor in farming. Against this backdrop, this chapter summarizes the progress made in transforming Africa's agriculture in terms of reducing post-harvest losses and improving market linkages. In addition, the chapter outlines the underlying causes of inefficiencies and uncertainty in food markets, drawing from experiences in East and Southern Africa, and then identifies strategies that African governments may consider to address these challenges.

The main conclusion is that if these inefficiencies and uncertainties are not creatively addressed, then most smallholder farmers will continue to lag behind and will remain poor as the opportunities generated by the region's rapidly rising demand for food are filled by imports. Fortunately, we believe that a solid policy enabling environment coupled with well targeted public expenditures to promote the performance of local food markets can turn these trends around and contribute greatly to agricultural transformation in Africa. Ensuring that African farmers get more from post-harvest to markets requires at least three interrelated solutions, namely: 1) improved farm productivity to close the huge yield gap across all commodities and across African countries (with a focus on more effective agricultural research and extension programs); 2) raising smallholders' ability to generate marketable agricultural surplus production, especially for food crops—including through reducing harvest and post-harvest losses; and 3) investing in physical infrastructure to improve smallholders' market access conditions. The chapter ends with some policy options and recommendations.

Progress towards agricultural transformation in reduction of post-harvest loss and market linkage systems

Recognizing the importance of attaining food security for long-term sustainable development to take root, African Heads of State and Government ratified the CAADP initiative, as part of NEPAD at the AU's Second Ordinary Assembly held in July 2003 in Maputo, Mozambique. The explicit goal of CAADP is to "eliminate hunger and reduce poverty through agriculture". Four pillars for priority investment were identified to drive agricultural

transformation in Africa. The achievements of CAADP to date have been modest as discussed in Chapter 2.

This section presents a summary of some positive trends towards agricultural transformation in the reduction of post-harvest losses and market linkage systems that have been helping smallholder farmers receive more from their farm produce.

Adoption of innovative post-harvest technologies

Despite the recent high growth rates in many African economies, agricultural production is still based on traditional low-productivity methods with limited processing and value addition activities. Post-harvest losses, variously estimated at 10–40 percent and as high as 50–70 percent, occur: (i) at harvest; (ii) during preliminary processing; (iii) at handling; (iv) during transportation and distribution; (v) at storage due to pests, spillage, spoilage, and contaminations; (vi) during processing due to inefficient technologies; and finally (vii) during commercialization (Affognon, Mutungi, Sanginga, & Borgemeister, 2015). As a result, farmers receive low net prices and revenues for their produce. At country level, Malawi and Uganda show a 1 percent and about 6 percent level of post-harvest losses respectively (Kaminsky & Christiaensen, 2014), while post-harvest losses of fruits and vegetables and can reach 35 percent (ILRI, 2011). In particular tomato losses were estimated at 10.1 percent, 10.2 percent and 13.4 percent for Kenya, South Africa and Nigeria respectively. Between 2005 and 2007, the average value of grain post-harvest losses were about US$4 billion of the estimated total value of production of US$27 billion representing about 48 million people's annual caloric requirement and more than the food aid donated to SSA over the last 10 years (World Bank, 2011). Lessening post-harvest losses can result in increased food availability thereby enhancing food security and reducing poverty leading to improved livelihoods (Affognon et al., 2015; Kiaya, 2014; Sibomana, Workneh, & Audain, 2016).

Over the years much progress has been made to reduce the overall spoilage, wastage and eventual loss of food after harvest. Some of the techniques and technologies that have been recommended and adopted in Africa include hermetic bags (e.g., Purdue Improved Crop Storage Bag (PICS)) plastic silos, and metal silos. Innovations aimed at getting more for farmers include the recently launched CIMMYT (International Maize and Wheat Improvement Center) program for reducing post-harvest losses. This has been through the supply of cheap metal silos. Metal silos are airtight and therefore suffocate any pests that may be stored along with the grain. The program has also been promoting the use of airtight post-harvest bags in four countries: Zambia, Zimbabwe, Malawi and Kenya (CGIAR, 2011). The USAID Feed the Future (FTF) Program in Kenya and Uganda has been promoting private sector provision of PICS. Improved PICS storage bags have been proven to protect farmers' harvest by hermetically sealing the grain, cutting off the oxygen supply to pests that would otherwise destroy it and limiting the use of pesticides. The use of hermetically sealing technologies allows farmers to safely store their grain for longer periods. The ability of smallholder farmers to store grain for longer periods enables them to delay the sale of their harvest and earn higher price later in the marketing season.

Although there is demonstrable evidence that these technologies can be technically effective, uptake is often constrained by several factors, key among which are lack of credit to finance procurement of the technology and consumption smoothing finance (NRI, 2014). The evidence generated from a cross-country study covering seven African countries revealed, for instance, that even if new storage technology which can be adopted at the household level is technically effective in storing grains, smallholder farmers may be unable to adopt it if they cannot access credit to ease household liquidity constraints during the harvest season. Farmers need to continue to be educated about these technologies to increase adoption. In addition, affordable financing needs to be made available to local agro-dealers to be able to procure and stock the bags from companies that manufacture and/or distribute these technologies

Emergence of contract farming:

Contract farming has considerable potential in countries where smallholder agriculture is widespread, and where agricultural processing and export enterprises are being promoted. The practice is receiving increasing attention as an institutional approach which has the potential to link resource-poor smallholder farmers with remunerative, high-value crop markets, and thus to help pull them out of poverty. Contract farming is one of the many innovations that can reduce market uncertainties, ceteris paribus. This farming arrangement ensures that output is guaranteed for one party while the other party may have a guaranteed market for their output (ACET, 2015).

Other than a readily available market for their outputs, farmers are assured of the output price and are supplied with inputs, finance and extension services before planting. Evidence has shown that adoption of contract farming models has resulted into increases in the incomes of farmers (Minten, Randrianarison, & Swinnen, 2011; Shumba, Roberntz, & Kuona, 2011). The contractor may also be contracted to supply the output to other

markets. Lecofruit, a company that contracts about 9,000 vegetable farmers in Madagascar may be a classic example of linking farmers through contract farming. The company has contracts with both local and international supermarkets (which accounts for over 60 percent of output supplied) to supply vegetables (Minten et al., 2011). Cotton out-grower schemes in Zambia are another example. Another example cited in Ethiopia (Gálvez-Nogales & Fonseca, 2014) involves agreements between farmers' organizations (e.g., cooperatives) and major buyers such as the World Food Programme (WFP) and the breweries to trade on the basis of contracts which assure a floor price . This does not involve supply of inputs and associated extension services, but the certainty of market access and of a minimum price has enabled farmers obtain farm credit, boosting their capacity to procure inputs and therefore increase output and yield simultaneously.

Contract farming and cooperative organization are among the chief instruments used to better link smallholders to emerging value chains. For instance, in Senegal, a private firm contracts 32,000 farmers to produce confectionary peanuts (Arachide de Bouche) most of which are exported to the European Union (EU). The company, which has been operational since 1990, supplies contracted growers with inputs such as seeds, fertilizer and agro-chemicals for one hectare plots, and provides agronomic and farm management services through extension agents. The incomes of participating farmers increased significantly, raising the standard of living of the peanut farmers and creating additional jobs in the local economy due to multiplier effects (Wiggins & Keats, 2013).

In Kenya a private company (Ojay Greene) uses a business model which leverages ICT to pioneer an integrated approach to link small-scale farmers to well-paying markets (Box 6.1).

The role of out-grower schemes in strengthening input and output market linkages

Out-grower schemes, also known as contract farming schemes, are increasingly receiving attention in several SSA countries. The emergence of private-led out-grower schemes, triggered by market liberalization, is helping overcome the market failures smallholders farmers experienced with state-led export cropping parastatals (Oya, 2012). In particular, private-led out-grower schemes provide reliable market outlets with guaranteed prices before harvest (Bellemare, 2012), reliable sources of financed inputs (Masakure & Henson, 2005) and sometimes technology spillovers

BOX 6.1

Ojay Greene: *Improving the Productivity and Earnings of Smallholder Farmers in Africa through an Innovative & Integrated Model.*

Despite several initiatives to improve the rural business environment, small famers in Kenya face several challenges. These include limited access to markets, high cost of inputs and inadequate advisory services. Fragmented and uncertain markets often discourage technology adoption and result in low incomes.

Ojay Green was established in 2013 as a private enterprise with a mission to transform smallholder agriculture by providing market-based services. Participating farmers are linked to well-paying markets (e.g., supermarkets and processors) and benefit from high-quality advisory services and value additions.

The company uses a unique business model, which leverages on ICT to pioneer an integrated approach that addresses all the key challenges small-scale farmers face. A mobile platform is used to allow two-way communication between farmers and the company. The data exchange includes a wide array of features and benefits such as access to quality inputs, technical advice (e.g., timely disease and pest management), guaranteed output markets and prices, finances and sales planning. The company is convinced that by using the correct business models and innovations in working with smallholder farmers, it can directly benefit from high farm incomes and transformation of agriculture. Each week, farmers receive advice via SMS updates and can respond with questions about the unique challenges they face.

In July 2015, Ojay Greene won a US$100,000 investment prize at a pitch competition hosted at Nairobi's iHub by the Case Foundation, Village Capital and the Sorenson Global Impact Investing Center. The event, "Pitch for Impact", brought together eight companies offering for-profit solutions to drive social impact, and represented East Africa's burgeoning social enterprise sector.

Source: *Interview with Ms. Yvette Ondachi, CEO and Founder of Ojay Greene; See also: http://disrupt-africa.com/2015/07/ojay-greene-wins-100k-pitch-for-impact-competition/*

from agribusiness actors to smallholder farmers such as farmers having access to farm equipment, for example, the case of sugar schemes in Kenya, Zimbabwe and South Africa (Oya, 2012).

However, the nature of out-grower schemes (specializing in particular crops) and lack of data across countries makes it difficult to assess the role of out-grower schemes in strengthening input and output market linkages. Although national data sets are unavailable, literature on out-grower schemes underscores the increasing price risks (volatility), and the transition from spot markets to out-grower (contract) markets that is resulting in full vertical integration in global agribusiness and supermarkets in many African countries (Gibbon & Ponte, 2005; Weatherspoon & Reardon, 2003).

In the Kenyan horticultural export sector, smallholder farmers operating through out-grower schemes account for 27 and 85 percent of exported fresh vegetables and fruits, respectively (Jaffee, 2003). About 60 percent of tea production in Kenya is supplied by the Kenya Tea Development Agency (KTDA), the largest out-grower scheme in Africa. KTDA guarantees output market for its members and also provides input and credit services (Oya, 2012). In Ethiopia, a horticultural export association guarantees its member farmers of output market for vegetables under contract (FAO, 2011), while Africa Fruit—an Ethiopian company—procures 50 percent of its passion fruits from out-growers (Melese, 2010). In Malawi, about 66,000 paprika and chili farmers produce under out-grower schemes; they are assured of market and input supply (Kumwenda & Madola, 2005). The same authors also show that in 2005, the Smallholder Tea Authority of Malawi contracted about 8,000 small-scale farmers, providing them with free seedlings, technical assistance, and input credit in addition to an assured output market. In Madagascar, exporters provide inputs and extension services to about 10,000 smallholder farmers who grow French beans and other vegetables under out-grower schemes (Minten et al., 2009).

These improved market linkages stimulated by out-grower schemes have huge potential for promoting high adoption rates of improved inputs and transformation of subsistence farming into commercial farming. For example, evidence from World Bank data for Tanzania shows that most out-growers are using fertilizers and improved seed; they are also using credit and subsidy services. Possibly because of easily accessible market linkages, out-growers are more commercialized than other small-scale farmers are. In Tanzania, out-growers sell more than 50 percent of their total production, which is twice as much as the proportion of production (25 percent) non-out-growers supply to the market.

Warehouse receipt programs: Current status and early lessons

The status and implementation of warehouse receipt systems (WRS) in SSA are difficult to assess because of lack of access to publicly available data and other published materials. The core elements of a well-developed WRS include: an enabling legal and regulatory framework; a regulatory and supervisory agency; licensed and supervised public warehouses; insurance and financial performance guarantees; and financing banks (Höllinger, Rutten, & Kariakor, 2009). Development of WRS into formalized institutions is gradually increasing in scope. Based on the core elements of WRS, warehouses have been fully institutionalized in Ethiopia, Uganda, Kenya and Tanzania. Elsewhere, the Government of Rwanda is collaborating with the Eastern Africa Grain Council (EAGC) of Kenya to promote WRS; in Nigeria, the Abuja Securities and Commodity Exchange is seeking Federal Government support to develop a WRS; and similar strategies are being followed in Ghana and Burkina Faso (Onumah, 2010).

Lessons from case studies show that without strong government support and a legal framework, WRS are bound to fail. Examples of failed WRS include the Uganda Commodity Exchange (UCE) and the Abuja Securities and Commodity Exchange (ASCE) of Nigeria (Jayne, Sturgess, Kopicki, & Sitko, 2014). In contrast, well developed WRC are beginning to pay off in several ways including: improving prices, linking smallholders to markets, reducing transactions costs, and improving earnings. The following discussion focuses on only one function of WRS: improving price, since price is a key incentive for smallholders to participate.

WRS play a significant role in reducing price volatility. Volatile output prices increase farmers' uncertainty that eventually leads to suboptimal production and inefficient investment decisions. In Ethiopia, depending on the time of disposal of coffee (years or seasons), WRS can reduce price dispersion by 0.86–1.78 Ethiopian Birr per kilogram (Anderson, Bezabih, & Mannberg, 2015). For example, in Malawi, by 2014, the low level of price uncertainty of soybean and sunflower sales had attracted a many farmers to trade warehouse receipts worth US$20.4 million (Jayne et al., 2014). In Mali WRS significantly reduced the inter-seasonal price gap, incentivizing financial institutions to reduce their collateral restrictions from 70–80 to 40–50 percent of warehoused maize grain (Bass & Henderson, 2000). This meant that farmers could access similar credit amounts using a small proportion of their stored grain as collateral, leaving them at liberty to sell off uncollateralized grain when prices increased later in the season. Furthermore, (Bass & Henderson, 2000), report that during the lean

BOX 6.2:

A Case Study of EAGC Warehouse Receipt System in Kenya: *A story of success*

The Eastern Africa Grain Council (EAGC) has been promoting a Structured Grain Trading System. The system involves organizing farmers into farmer groups and encouraging them to consolidate small volumes in more efficient storage facilities, guaranteeing delivery of quality commodities by warehouse operators, use of stored commodities by depositors as collateral for loans, and provision of a credible and formal market for grain commodities with inventory financing opportunities.

EAGC started implementing the Warehouse Receipt System (WRS) in Kenya in 2008 and substantial benefits have been noted after adopting the structured trading system. Since its inception, the EAGC WRS has recorded several achievements including: (a) 16 warehouses with a capacity of over 60,000 metric tons certified annually; (b) over 50,000 metric tons of grains traded through the systems; (c) total of US$4.8 million loaned out by 5 participating banks; and (d) 68 aggregation centres managed by smallholder farmers linked to the system.

One of the success stories is the Kipchamo Poverty Eradication Programme (KIPEP), a community based organization (CBO) which has benefited from WRS. The group has 815 members, 170 males and 645 females. KIPEP has been involved in producing maize which members grow individually, but market it collectively. Before engagement with EAGC the group members would harvest the crop and sell it immediately after harvest to the National Cereals and Produce Board (NCPB). Group members would sell the rest of the maize harvest directly to middlemen at farm gate. As would be expected, the farmers would receive low prices for several reasons: low individual volumes, lack of a bargaining voice as individuals, depressed prices due to market glut, poor grain quality, and lack of market information. This situation was worsened by delayed payments from the NCPB. Group members had challenges with storage space as they stored grain within their homesteads. This coupled with immediate cash needs were the reasons why the farmers preferred to sell a portion of their grain to middlemen. Faced with a myriad of challenges, especially access to finance, the farmers were unable to increase production and productivity in terms of area under cultivation and yields per acre respectively.

KIPEP engaged with EAGC in 2012. The group was trained in market price monitoring, post-harvest handling, cleaning, pest control, sorting and grading, and value addition of the grain. In 2013, EAGC certified a warehouse owned by Nafics Trading Company Ltd., in Eldoret town which is within easy reach of KIPEP, to operate the WRS. This prompted the CBO to being depositing grain in the warehouse under the WRS: 48 metric tons (2013), 75 metric tons (2015), 84 metric tons (2016). They used the warehouse receipts to access credit from the participating bank in Eldoret.

Operating under the WRS, the group has realized tremendous benefits including:

- Access to improved storage that ensures high grain quality at the time of sale.
- Support from EAGC in terms of market information on prevailing prices, scouting for buyers and even negotiating prices.
- Access to credit facilities using the warehouse receipts as collateral which is used to purchase inputs early and therefore increase production. The amount of credit obtained by the group in the 2015/2016 season was Ksh1,576,000 (US$15,760). Access to credit enabled the group to increase acreage under cultivation from 35 to 60 acres, and to buy inputs in good time.
- Deferred sale of grain resulting in better prices. For example, in 2015 the group deposited grain when the prevailing market price was Ksh2,200 (US$22.5) per 90 kilogram bag and sold the same amount at Ksh2,650 (US$27),—20 percent higher than the initial price. In 2013 the prevailing market prices at the time of deposit was Ksh2,700 (US$31.8) per bag , and the same was sold at Ksh3,300 (US$38.8), 22 percent higher, 3 months later. The trend was the same in 2014 when the prevailing market price of a bag of maize at the time of deposit was Ksh2,200 (US$29.1), but the group sold the maize at Ksh2,800 (US$22.5)—27 percent higher than the price at deposit.

Source:*Eastern Africa Grain Council*

season, maize prices could be 270 percent higher than the harvest price. The high profits maize famers obtained as a result of WRS in Mali led to warehousing of other crops including cowpeas, groundnuts and rice. In Tanzania, after accessing the remunerative cotton market and overcoming price information asymmetry through engaging with WRS, Oridoyi Rural Cooperative Society (ORCS) was able to raise cotton output from about 130 metric tons of seed cotton to a peak of over 1,100 metric tons of seed cotton in four years (Onumah, 2010). Still in Tanzania, WRS enabled coffee farmers who were members of primary cooperative societies to process their coffee and sell it at a high price that earned members an incremental income of about 70 percent (Onumah, 2010).

Despite the realized benefits in terms of price improvement, none of the countries in SSA, except South Africa, has registered a successful and well institutionalized WRS (Rashid, 2015). In some cases, for example in Zambia and Zimbabwe, progress made under WRS and exchange trading is erratic as a result of direct government interventions (Sitko & Jayne, 2012; Mezui, Achille, & Hundal, 2013). The presence of WRS in Kenya, Malawi, Nigeria, and Uganda is largely in writing with limited practical actions on ground, despite support from donors and government (Rashid, Minot, Lemma, & Behute, 2010). The success of WRS in Ethiopia is well publicized in the media, but no empirical evidence is available to back up the claimed success associated with smallholder–market linkages and increasing export earnings (Rashid, 2015). Overall, the key lesson from WRS in SSA countries is that the success of WRS requires political stability, limited government intervention, sound policy and legal framework and public/donor support (Mezui et al., 2013; Rashid, 2015). While these conditions for successful WRS are necessary and appropriate, the last condition - need for public or donor support - requires further research to analyze the structural management of WRS to understand the efficiency levels associated with each component of WRS. The research should be able to provide the structured determinants of gains or losses upon which capacity development for self-sustaining WRS can be based.

Market-friendly quantity and quality assurance systems

Enforcement of private commodity standards in agricultural trade can constitute a barrier to trade for smallholder farmers in Africa and other developing countries (Jaffee, Henson, & Diaz-Rios, 2011). This argument rests largely on farmers having limited compliance capacity and therefore failing to exploit opportunities which can catalyze upgrades in production and improve the welfare and competitiveness of producers. Emerging evidence suggests, however, that if compliance capacity is embedded in accessible market institutions which deliver quality premium on a transparent basis then "scaling the quality hurdle" becomes a financially beneficial and attractive option which smallholder farmers in Africa would be willing to take up. For example, in Burkina Faso, WRS has been promoted for a long time and has exclusively targeted smallholder farmers—often described as warrantage (which involves warehouse receipting in small-size warehouses located in rural communities) .

The primary focus of the pilots has been assuring food availability for households and therefore no quality standards were enforced in the designated warehouses. In 2014 an initiative was launched to institute a quality assurance system for receipting grains which meets quality standards acceptable to WFP, the parastatal Société Nationale de Gestion du Stock de Sécurité Alimentaire (SONAGES) and other private large-scale buyers. This process entailed adoption of the standards and equipping designated warehouses (similar in size to those operated under warrantage pilots in general). Crucially, farmers were trained in post-harvest practices to assure compliance and also directly linked buyers who bought grains stored under the warrantage by participating farmers.

Within one year depositors began to sell to these major buyers. Most of them, on average, sold about 60 percent of their deposits and retained the rest for household consumption. Hence, opening up access to formal grain markets did not increase the risk of household food insecurity. By selling graded grains they obtained incremental income ranging from 35 to 68.7 percent of farm-gate prices prevailing during the harvest season. In addition, post-harvest grain losses declined from an average of 13 to about 1–2 percent meaning the overall net increase in household income obtained by farmers was well over 50 percent.

East Africa adopted harmonized grain quality standards in June 2011, as part of the measures to foster regional grain trade under the banner "maize without borders". These standards are expected to facilitate and lower the cost of transacting for parties across the region as they will ease cost-efficient trade-by-description. However, years later this ambition of driving trade through formalized trade standards is yet to be achieved due to several factors identified by Onumah and Nakajjo (2014):

- Some of the member countries delayed gazetting the harmonized standards, and others maintained additional health-related standards which constitute non-tariff barriers to trade in quality grains in the region.

- Lack of clarity regarding the definition of some parameters, leading to subjective testing by different parties.

- Non-standardization of testing procedures and equipment leading to variable results from testing similar grain samples.

ICT and farmer extension programs

Agricultural extension services provide critical access to the knowledge, information and technology that farmers need to improve their productivity. Public sector extension workers are largely underfunded and in some cases preoccupied with running government subsidy programs instead of interacting with farmers. However, advances in ICT can help bridge the human capital requirements and funding gap. Mobile phone penetration has been growing rapidly even in the remote rural areas. For example, recent evidence suggests 60–80 percent mobile phone use in the rural areas (Aker & Mbiti, 2010). Therefore there is great potential in continuing to integrate mobile phones into providing smallholder farmers with relevant extension messages. Mobile phones have been used successfully in providing farmers with price information, money transfer, and mobile banking. The role of ICT in agriculture is discussed in more detail in Chapter 8.

Role of market Intermediaries and collective action in crop marketing

Market intermediaries: The role of market intermediaries in crop marketing in most African countries has rarely been fully understood and they tend to be described as being exploitative (Sitko & Jayne, 2014). The rather unflattering perception of the role market intermediaries (sometimes referred to as "briefcase" or "bicycle" traders) can be attributed in part to high distribution margins, which tend to squeeze producer margins while increasing food prices for consumers (Coulter & Poulton, 2001). Despite this, the intermediaries are the most accessible market channel for most smallholder farmers. Chapoto and Jayne (2011) observed that over 60 percent of maize farmers sell their produce directly to trade intermediaries at the farm gate. Severe limitations in accessing trade finance are among the constraints which undermine efficiency in this segment of most food crop value chains in Africa (Onumah, 2013a). While rural trade in food crops is largely cash-based, due partly to lack of trust, traders are often required to extend trade credit to players in urban wholesale markets. The liquidity constraints created in this way often weaken market capacity to absorb substantial surplus at the peak of the harvest. This drives down farm-gate prices. Furthermore, the predominantly informal trade at the farm gate is mainly volume-driven and provides no quality premium. As a result, steep quality discounts may occur when the crop is sold to processors or exporters, leading to even tighter margins for producers (Nakhumwa, 2015). Limited access to storage and other post-harvest handling facilities further hamper the activities of the intermediaries. Evidence exists that intermediaries can be part of the solution to these challenges, as illustrated in Box 6.3—either on their own (the traditional "Market Queens") and when their capacity is strengthened through leveraging links with other value chain actors (food crop aggregators).

Collective action: Cooperatives and other forms of farmer organization could reduce transaction costs by facilitating the bulking of both agricultural inputs and output. Most agricultural production originates from smallholder farms. These are usually geographically scattered and tend to produce small surpluses. Under such circumstances, where fixed costs are inherently high, access by smallholder market participants can be limited unless they engage in some form of collective marketing (Ton & Proctor, 2013).

Cooperatives are the most common channels for milk marketing in Kenya and other East African countries. They provide a wide range of services, including milk collection and distribution, input supply, provision of artificial insemination and veterinary drugs, offer access to credit, and deliver extension services. Kenya has the most advanced and organized cooperative structures in the region, with some cooperatives processing and marketing value-added products such as the Githunguri and Limuru cooperatives (Bingi & Tondel, 2015). The Githunguri Dairy Farmers Co-operative Society has revolutionized the Kenyan dairy industry. With about 23,000 members and 40,000 dairy cattle, the cooperative operates its own milk processing facility and its Fresha milk is now the leading fresh milk brand in and around Nairobi. By 2014 the Githunguri Cooperative had increased its capacity to 220,000 liters per day, employed a workforce of 8,000 and expanded its market beyond the borders to neighboring South Sudan and Tanzania (Business Daily, 2014). The benefits being achieved by the cooperative provide a blueprint for wider replication throughout the region.

Challenges that farmers face in the market

Farmers in most African countries face huge challenges that hinder their ability to take advantage of existing and emerging market opportunities. These marketing challenges directly depress farm incomes and thereby dampen the potential for the agricultural sector to be an engine of growth and create multiplier effects that would otherwise contribute to broader economic transformation processes. In this section, we briefly examine some of the

critical challenges and the solutions which can ensure that farmers get more for the time and effort they invest in farming activities. The challenges include low producer margins and uncertain output market prices and impediments such as high cost of and limited access to inputs and financial services. Though often unintended, government policies and regulatory interventions sometimes constrain the drive to promote sustained growth in agricultural productivity and increased farm incomes. This section discusses how addressing these problems requires concerted efforts first and foremost from governments to provide the incentives for private actors and farmers to respond in the desired manner.

Earnings from farming activities in Africa, especially for smallholder farmers, tend to be depressed by a combination of factors. These factors include high transport costs, limited access to lucrative market segments, inability to store product to take advantage of seasonal price rises, and weak bargaining position. These issues are briefly discussed in turn.

High transport/trade costs: Factors that contribute to high transport costs in Africa are poor road infrastructure, lack of competition, inefficient regulation of the freight logistics sector, and impediments to cross-border trade such as formal and informal taxes, tariffs, bribes and delays (World Economic Forum, 2015). The World Bank (2009) observed that the costs incurred to transport output from the farm gate to a primary market is on average four times higher than transporting the same quantities from the primary market to the wholesale market. This implies that most (45 percent) of the transport charges are incurred within relatively short distances from the farms. As a result, farmers are left with low farm-gate prices and low returns to their labor and capital investments into farming, which in turn acts as a disincentive for farmers to adopt technologies that enhance productivity (Porteous, 2015). Torero (2011) argues that the poor state of transport and communication infrastructure, coupled with lack of effective institutions that can reduce marketing risks and transaction costs, have undermined the process of exchange between producers and buyers and depressed and delayed Africa's agricultural transformation process. Teravaninthorn and Raballand (2009) estimated that a 10 percent decrease in rural transport costs can generate a 25 percent increase in the quantity of food traded, with consequent major benefits to smallholder farmers.

Limited access to lucrative segments in agricultural value chains: Small-scale farmers are usually unable to supply their produce directly to major buyers in formal markets including agribusinesses, supermarkets, wholesalers and exporters even though rising demand

BOX 6.3:

Role of Market Queens and Aggregators in improving crop marketing in Ghana

The tomato sector in Ghana is characterized by seasonal glut, due to the low absorption capacity of the market for fresh vegetables and underdeveloped storage and processing facilities. Market Queens in the main urban wholesale/retail markets in Ghana play an important role in regulating supply and easing liquidity constraints. There are about 5,000 Market Queens, most (about 85 percent) of whom are women (KIT & IIRR, 2008). Their role involves taking delivery of truckloads of produce supplied by rural traders and farmers; immediately paying off the transporters; distributing the produce to a network of retailers on credit; ensuring that the suppliers are paid within a specified time frame (ranging from 3–4 days to two weeks). The system ensures that aggregators can operate with significantly reduced risk of default from extending trade credit. They are also assured that their supplies will be taken on delivery. This system has even been extended to sub-regional traders (e.g., from Burkina Faso), making it possible to fill in supply gaps during the so-called lean seasons (between January and May) in a market where import finance is largely unavailable.

Some major food processing companies have also adopted a procurement model with the market intermediary (in this case the aggregator) at the center. The aggregator is trained to source quality produce—which complies with the requirements of the processor—and is offered a supply contract. The contracts tend to be flexible and match the capacity of the aggregator, who is also linked to a financier. The assured market and guarantee of a floor or fixed price reduces significant default risks and therefore allows formal financial intermediaries to lend to such borrowers. Improved access to finance and guaranteed markets with high levels of certainty about prices, enhances the competitive edge of aggregators in the rural trade. There is evidence that their role is being extended to include mobilizing and training farmers who are then linked to inputs suppliers.

Source: *Robinson and Kolavalli, (2010); and UNDP (2012).*

represents income-boosting opportunities which they could potentially exploit (Onumah, 2013a). As noted by Ferris et al. (2014), local producers are often unable to respond to the changes in consumption patterns in urban areas, which are driving growth in demand from the formal segment, leading to increased dependence on imported processed products (CSA, 2014). Most small-scale producers can only access poorly regulated markets that often lack grades and standards, traceability and a proper price setting mechanism, which all depress the value farmers receive for their produce (Ferris et. al, 2014). Smallholder growers who want to participate in global value chains are required to comply with voluntary standards. Yet compliance is difficult because it requires considerable informational and organizational resources, which many smallholders may lack (Arias, Hallam, Krivonos, & Morrison, 2013).

Inadequate market power: Lack of collective action, which limits farmers' bargaining strength, and low production levels, implies that most small-scale farmers have limited capacity to influence farm-gate prices (Onumah, 2013b). With no functional groups or associations, small-scale farmers cannot interact on equal terms with market actors who are generally larger in terms of scale, are better informed and are therefore able to bargain from a stronger position. Even when prices are higher in some areas, farmers are unable to exploit such markets. This is due to the absence of a good and reliable market information system (Fafchamps & Hill, 2007) that would allow them to take advantage of optimal trade and arbitrage opportunities. Pressing household cash needs often compel farmers to sell large volumes of output soon after harvest, creating a seasonal glut, which the severely under-capitalized small-scale aggregators are unable to absorb. As a consequence, prices of most agricultural produce are severely depressed during the harvest season and farmers cannot bargain for significantly higher prices unless sale can be delayed through intra-seasonal stockholding (Onumah, 2013c).

Unstable output prices: Price risks constitute a major challenge for farmers and other players in agricultural value chains in Africa. Volatility in the prices of agricultural commodities, especially food prices, tends to be higher in African countries than in Asian or Latin American countries (Kornher & Kalkuhl, 2013). Smallholders find it difficult to invest in productivity-enhancing and income-raising technologies and practices, which would enable them to overcome poverty traps, when output price trends are unpredictable (FAO, 2011). For instance, evidence from Ethiopia indicates that negative output price shocks dampen uptake of fertilizer and other inputs by reducing the income gains from using these inputs (IFPRI, 2011). Intra-seasonal price variation (i.e., price changes within a season) appears to be the focus of attention for policy makers and development partners who tend to invest in physical and institutional infrastructure such as WRS to provide a means by which farmers and other actors can manage this risk. However, inter-year price volatility can be much higher than intra-year price movement, making it difficult for farmers to plan for long-term investments as revenues are uncertain and profitability cannot be guaranteed.

Among the factors contributing to high price risks are inadequate infrastructure to manage seasonality of production; international price volatility; governance/political stability; unpredictable trade and procurement policies; variability of yields/production, weather, tenure security, and risks associated with pest and diseases. Climate change is likely to worsen natural and environmental risks, including pests and diseases, resulting in supply-side volatility. According to CSA (2014), farmers' demand for money changes; this affects the supply of produce on the market. For example, there is high demand for money by the farmers at planting and harvesting time, when schools open at the beginning of the year, during religious festivals, funerals, and christenings. Subsequently, unstable prices and low prices in the market do not encourage producers to invest in farming (CSA, 2014). Therefore governments need to adopt a rules-based and transparent approach to their operations in markets to improve the business environment for the private sector and to stabilize prices (Chapoto & Jayne, 2009). Further, investments in market infrastructure lower the costs of transportation, reduce price volatility, and aid in price transmission (Demeke & Balie, 2016).

High cost of production inputs: Markets which are underdeveloped due to low production volumes and high transport costs have made inputs such as fertilizers very expensive in African countries compared to other developing countries. The cost of fertilizer per ton ranges from US$600 to US$1,400 in countries like Uganda, Zambia, Malawi and Burundi compared to US$250 to US$500 for other developing countries like Brazil, Argentina and Pakistan (World Bank, 2012). Seed trade between countries is limited by repressive trade policies that create high transaction costs (World Bank, 2012). Also, rules and regulations in most African countries give rise to small and segmented markets that hamper the dissemination of new seed varieties, hence the high seed prices (Minde & Waithaka, 2006). In addition, weak regulatory enforcement sometimes leads to variability in quality and therefore performance of imported inputs, thereby discouraging uptake by farmers (IFAD, 2015).

Limited access and high cost of accessing financial services: Farmers have limited access to financial services because few financial institutions are willing to invest in remote areas (EAFF, 2013; NRI, 2014). Most commercial banks avoid rural areas due to low income levels, lack of scale economies, poor infrastructure, high risks and seasonality of agricultural production (Mahieux, Zahar, & Kherallah, 2011; NRI, 2014). Even where financial institutions are operating, the high cost of finance has hindered farmers from undertaking the requisite investments to increase productive capacity (World Economic Forum, 2015). Interest rates that range from 10 to 30 percent per annum are too high, and therefore discourage farmers from participating in the banking system to finance their agricultural operations (CSA, 2014). The high interest rates and burdensome repayment schedules are due to lack of collateral for smallholder farmers, which make smallholder farmers be regarded as risky and characterized by scale diseconomies (EAFF, 2013). Land can act as a source of collateral when farmers need to access credit, but most smallholder farmers do not have titled land (Chapoto & Zulu-Mbata, 2015).

High post-harvest losses: Post-harvest losses, which may affect quantity or quality, are substantial and the proportion of the added value that goes to the farmers is small. Quantity losses threaten food, nutrition and income security while quality losses lead to inferior nutritional value, food borne health hazards and economic losses when the produce loses market appeal. Post-harvest losses occur at various stages, from as early as harvesting to the point of sale (Affognon, et al., 2015; World Bank, 2011). The major cause of post-harvest losses in Africa is lack of quality storage infrastructure.

Low yield and production: Farmers are held back by low productivity levels with yields in Africa effectively lower than those in other regions due to: lack of access to productive inputs, machinery, and financing, and a lack of technical supervision (CSA, 2014). For example, although farmers use improved seeds and fertilizer, SSA is still a long way from using as much improved seed and fertilizer as in other regions (Livingston, Schonberger, & Delaney, 2011). The low use of fertilizer could be the result of its high cost and inaccessibility (Ndjeunga & Bantilan, 2005). These same reasons could also explain low improved seed use. To increase productivity and income will require farmers to expand their use of improved seed and fertilizer and of irrigation technologies (Livingston et al., 2011).

Variable production—rainfed agriculture: Increase in crop productivity and stable yield are directly related to water availability and irrigation (World Bank, 2008). Rockstrom and Karlberg (2009) showed there is a close correlation between poverty, hunger and water stress, and between average annual rainfall and GDP growth. But agriculture in SSA is mostly rainfed even with the region's many water sources due to low agricultural investments (World Economic Forum, 2015). The proportion of land under irrigation in Africa is about 6 percent which is only a third of the world proportion of land that is under irrigation (Svendsen, Ewing, & Msangi, 2009). SSA records a low proportion of land that is under irrigation (4 percent) compared to South Asia and East Asia (39 percent and 29 percent respectively) (World Bank, 2008).

Counter-productive government polices: Government intervention in markets is often a source of inefficiency and uncertainty for all market participants. Policy actions are often conducted in a way that crowds out private sector investment and creates disincentives for smallholder's to produce. Shifts in government policy tend to be ad hoc, especially with regards to policies on regional trade and domestic food price controls. These measures impede private sector participation in agricultural value chains (Wiggins, 2013) and deepen risk aversion among smallholder farmers, discouraging them and other actors from adopting a more entrepreneurial approach to farming (IFAD, forthcoming). Ad hoc policies also tend to increase price volatility which may deter farmers from producing for the market. In countries such as Kenya, Malawi, Zambia, and Zimbabwe where government has directly intervened to control prices of staple food crops, prices are more volatile than in countries with fully liberalized food markets (Chapoto & Jayne, 2009; Minot, 2014). Other policy distortions include subsidies, price or income support and regulations that tend to discourage private sector engagement to service smallholder farmers (Kahan, 2013).

The private sector can respond to the needs of farmers if government actions are predictable. However, government operations in markets are costly. While private trading systems will always result in some price variability, they tend not to cause the frequent food crises caused by ad hoc government actions that are commonly seen in the region (Chapoto & Jayne, 2009). It remains unclear if the costs incurred by governments in their attempts to stabilize prices through interventions in input and output markets provide any tangible improvements in price stability and food security.

Opportunities to address identified constraints/risks in markets

Investments in Physical Infrastructure

Access to markets affects smallholder participation and competitiveness in markets. Transport costs are largely associated with the state of the road network. Evidence shows that investing in road infrastructure is positively associated with agricultural productivity (Dorosh, Dradri, & Haggblade, 2012). Livingston et al. (2011) argue that there is more to transport costs than the much talked about road infrastructure. Over the last 40 years the World Bank has invested in road development. While these investments have reduced costs for trucks that carry cargo, this has not culminated in a decline in prices paid for transport by farmers in Africa, but has instead increased profit margins for trucking firms (Teravaninthorn & Raballand, 2009). Transport costs are also a function of other variables such as regulations and fuel price. The higher the level of regulation is, the higher the transport costs are. This explains why transport costs are higher in West and Central Africa than they are in East and Southern Africa (Livingston et al., 2011). The major reasoning behind improving transport costs is that by investing in the road network, transport costs would be significantly reduced by reducing the distance or time travelled by smallholder farmers to the nearest town.

Investment in construction of good quality rural feeder roads reduces transportation costs, accelerates efficient delivery of inputs, reduces post-harvest losses of perishable produce, and opens up lucrative market and trade opportunities for rural farmers. Several studies have found positive impacts of rural road development. Studies in China and India have found that investing in infrastructure contributes to productivity growth in agriculture (Fan, Zhang, & Zhang, 2002; Fan, Hazell, & Thorat, 2000). It also contributes to creation of non-farm job opportunities (Dorosh, Wang, You, & Schmidt, 2010) while reducing rural poverty (Fan et al., 2002; Fan et al., 2000). Minten and Kyle (1999) found that poor road infrastructure was responsible for high food prices in the Democratic Republic of Congo.

Better farmer access to irrigation infrastructure would also contribute to greater uptake of available technology and raise agricultural productivity. For instance, Ghana depends largely on regional imports from Niger and Burkina Faso to meet domestic demand for fresh onions. Producers in Niger and Burkina Faso have significant competitive advantage over their Ghanaian counterparts, as the cost of production per metric ton of onions in Ghana is about three times higher than in Niger. This is largely attributable to the existing yield gap. Agro-climatic conditions in northern Ghana, where onion production is concentrated, are similar to those in the onion producing regions in Niger and Burkina Faso. What accounts for the difference is cost-effective access to modern and reliable irrigation (Amekuse, Agyir, Acquaye, Asante-Dartey, & Huijmans, 2012). In the absence of access to large-scale irrigation facilities, onion producers can use available technology—treadle pumps which cost about US$100—to pump water from streams and boreholes. However, these authors noted that this is too expensive for most small-scale onion farmers in Ghana. In northern Nigeria, commercial production of sweet potatoes and vegetables experienced a major boost as a result of access to irrigation facilities (Onumah, Dipeolu, & Fetuga, 2012).

Storage and Processing Infrastructure

Efficient threshing/winnowing equipment and physical storage infrastructure would contribute to lower postharvest losses in the agricultural sector. Private investment in storage infrastructure tends to be concentrated close to ports, principally for servicing import/export trade rather than domestic trade in agricultural commodities (Onumah & Aning, 2009). Where modern storage infrastructure is available in rural communities with significant surplus production of storable commodities, it is often owned by governments or by cooperative associations. The government-owned facilities are often run by public agencies which prioritize holding strategic food reserves under conditions which limit access to the facilities by farmers for intra-seasonal stockholding (Coulter & Onumah, 2002). Fostering modern receipt-based trade and finance systems is one way of catalyzing private investment in storage infrastructure in rural areas but often the required enabling policy and regulatory framework is either missing or inadequate (Onumah, 2012).

Smallholder financing and market-supporting institutions

The share of domestic credit supplied to the agricultural sector in Africa is often minuscule compared to what other sectors are allocated. Despite its considerable contributions to employment and GDP, less than one percent of commercial lending in Africa goes to agriculture (Salami, Kamara, & Brixiova, 2010). This situation is usually attributed to the perception among financial intermediaries that the agricultural sector is risky. As a consequence, most farmers cannot afford inputs which can significantly increase farm output and household income. In the case

of onion production in northern Ghana, Amekuse et al. (2012) estimated that farmers require US$200 per hectare to cover non-labor production costs. Considering that the average plot size is about 0.5 hectares, the financing requirement per household is low. However, most farmers cannot access the required finance and therefore end up reducing the area they cultivate even further. Farmers may also choose to rely on rudimentary technology such as the "traditional calabash" to water the plants. It is therefore not surprising that yields in northern Ghana are less than half the levels obtained by smallholder producers in Niger and Burkina Faso under similar climatic conditions. Access to credit is important for inputs and in financing production costs. Credit is also important in encouraging storage and delayed sale because it offers households the means to acquire inputs for the next planting and also the liquidity to meet household consumption needs.

Several reasons contribute to the lack of finance for smallholder farmers. Miller (2011) summarized these reasons:

- The nature of the flow of capital is a challenge to both borrowers and lenders. Agricultural production (crops and livestock) generally has a slower turnover than other microenterprise ventures traditionally funded by MFIs and agricultural credit requires longer loan terms. Because of unpredictable and potentially lower returns on capital, investing in agriculture entails higher risk and is much more sensitive to interest rates than traditional microfinance.

- Agriculture in Africa is mostly rainfed. As a result, farmers face risks which are beyond their control. More frequent droughts or excessive rain lead to yield losses which affect the farmer's ability to repay loans.

- Smallholder farmers' incomes are seasonal. This coupled with weather risks make them a very risky group to lend to even for MFIs.

- Many farmers lack title deeds, hence their land is usually not considered suitable as collateral by financial intermediaries.

- Movable assets such as livestock are also considered high risk due to the absence of title or insurance to cover the livestock.

The global experience of the financial institutions and their partners that have successfully developed a growing and sustainable agricultural credit portfolio reveal that it is necessary to provide a wider set of financial services to smallholder farmers and their families. These services include savings, payments, transfers and insurance and enable smallholder households to diversify livelihoods and better manage farm and non-farm economic activities. This is because farm and non-farm economic activities and rural household consumption needs are interrelated (Carroll & Andrew, 2012; Collins, Morduch, Rutherford, & Ruthven, 2009).

The Way Forward

Trade barriers and lack of support institutions and policies that promote market development are major challenges in Africa. This section identifies important roles for governments to improve African farmers' access to markets and build on nascent agricultural transformation processes underway in the region.

Addressing policy and institutional bottlenecks (soft infrastructure)

The success of commodity exchanges or WRS requires that significant quantities are traded freely. However, most of the commodities traded on commodity exchanges are politically sensitive and governments want to keep staple food prices low to ensure urban consumers can afford them. Governments may try to influence food prices through marketing board operations, but this tends to reduce the volumes that can be sold across the commodity exchange (Jayne, Sturgess, Kopicki, & Sitko, 2014). A more effective public–private partnership approach is needed to promote the emergence of viable commodity exchanges. While the private sector has significant expertise, exchange initiatives still require appropriate government support in the form of effective legal and regulatory frameworks; commitment to stable policies (with no unpredictable interventions); empowerment of institutional investors; establishment of a clearing house that is empowered and strong to attract international/regional participants; development of the WRS (in tandem with the exchange); and support (sub-) regional rather than national models (Mezui et al., 2013).

Through comparative advantage, regional integration provides an opportunity for farmers to tap into foreign markets, especially where some countries face food deficits. But only about 10 percent of trade is between African countries. To a large extent, policies in most African countries have contributed to the status quo. They cause price instability and deterioration of food security (NEPAD, 2013). Policies such as ad hoc import and export bans, and bureaucratic procedures usually raise smuggling

costs, costs for consumers, and create disincentives for the private sector. This inhibits farmers' access to more lucrative markets.

Therefore if farmers are to get more of their produce to the market, there is need to address and create incentives for them to take advantage of regional trade. Policies should go beyond just lowering tariffs, but must aim at opening up borders to broaden markets for smallholder farmers. International and regional trade should also be promoted in mitigating price instability. Minot (2014) finds evidence that tradable products (e.g., rice, wheat and cooking oil) are less volatile than the non-tradables (e.g., maize which is in most cases subject to export restrictions). In addition, large cities have lower volatility of prices than small cities possibly due to better storage infrastructure and more competitive markets, drawing surplus food from different parts of the country and attracting commercial imports which could help stabilize prices. Efforts should therefore be aimed at reducing trade barriers so that commodities move from surplus areas to deficit areas. Other researchers have advocated for a maize without borders policy as a way of stabilizing output prices (Cummings, Rashid, & Gulati, et al., 2009; Dorosh et al., 2009).

Efficient markets require policies and institutions that facilitate exchange and address market failures and risks that undermine agricultural markets. A more transparent and predictable market and trade policy regime is needed. This includes measures such as support to market information systems that effectively serve all stakeholders, removal of road blocks, harmonization of standards and coordination between customs and phytosanitary services, support to open dialogue on food trade policies and options for reform, simplified trade and tax regimes, and support to traders' associations (World Bank, 2012). Since institutional arrangements that support markets are absent or weak, governments need to address these challenges by formulating supporting legislations, regulations and policies that will help develop markets and boost trade (Trienekens, 2011). Farmers will greatly benefit if uncertainties in regional trade are addressed by removing export and import bans, making import tariffs and quotas transparent, easing restrictions on rules of origin, and avoiding price controls (World Bank, 2012).

Removing/reducing infrastructural bottlenecks (hard infrastructure)

Literature shows that governments need to be proactive in ensuring infrastructure development and industrial upgrading are well developed to pave way for accessible and profitable market and trade (Di Maio, 2014). According to USAID (2011), weak linkages between key surplus and deficit markets in West Africa have resulted in steep price gradients along the trade corridors. The transport and logistics costs of moving maize and livestock along key trading corridors between Burkina Faso, Ghana and Benin account for approximately 59 and 18 percent of the respective end-market prices. The USAID study showed that transport costs, mainly fees paid to transport service operators and losses in transit, weigh most heavily on the end market price along the corridors studied.

Reduced transport and transaction costs are a major incentive for adoption of improved agricultural production technology and better management of natural resources, leading to increased agricultural productivity. Reducing transaction costs and linking farmers to markets, rural roads, extension services and communication infrastructure increase returns on investment and, as a consequence, make adoption and investment in better land management technologies attractive (Nkonya, Gerber, Von Braun, & De Pinto, 2011). Dercon and Hoddinott (2005) showed that improvement in road quality increases the likelihood of farmers' purchasing inputs by 29 to 35 percent, depending on the season. Better market connections are necessary to improve the availability of inputs and agricultural extension services, all of which are critical to increasing productivity and therefore the welfare of farmers (Jouanjean, 2013). Wiggins (2013) explained that variations in harvests due to the erratic rainfall can be much reduced with investment in irrigation in SSA. Investment in irrigation will become more critical in future, as climate change threatens to exacerbate the variability of climate and hence yields from rainfed farms. While public schemes have suffered from mismanagement and technical problems, small-scale irrigation schemes managed by individuals or small groups have expanded in Africa over the last two decades.

By investing in regional infrastructure such as common power pools and water storage, trade would be enhanced through economies of scale (Ahlers, Kato, Kohli, Madavo, & Sood, 2014). A regional warehouse scheme and improved access to credit to build storage facilities could encourage traders to take advantage of economies of scale and invest in equipment and storage facilities (Jouanjean, 2013). Economies of scale associated with regional fertilizer production, blending or import can also reduce fertilizer costs for farmers. Procurement prices and shipment charges are lower if larger quantities are ordered for the whole region (World Bank, 2012).

Conclusions

This chapter presents the challenges and the policy options that enable farmers in SSA get more for their produce from post-harvest to the market. In particular, the chapter highlighted that smallholder farmers are failing to take advantage of existing and emerging opportunities because of many constraints that require urgent attention from all agricultural stakeholders including government. African governments, cooperating partners and the private sector should work together to address these constraints in a more coordinated and sustainable way to create lucrative markets and a cadre of smallholders who think of farming as a business.

Three major conclusions emerge from the discussions in this chapter:

1. **Increased uptake of improved technology:** Adoption of improved technology is critical to raising crop yields and reducing post-harvest losses. It is also a requirement for establishing sustainable and competitive agricultural sectors. Increased investment in technology must be accompanied by serious investments in research and extension. But improvements in the way input and output markets function will also be necessary to encourage farmers to produce for the market and also improve their access to yield-enhancing technologies.

2. **Increasing investment in physical infrastructure:** Prioritizing public investment in rural roads can produce tangible benefits which can transform production and post-harvest activities. Further, there is need to create/ maintain incentives to promote private investment in storage, marketing and processing infrastructure, reducing the fiscal burden associated with such investments.

3. **Policy issues and institutional infrastructure:** Direct interventions in output markets can weaken private incentives for investment in activities at post-harvest level including storage, trading and processing. These actions also tend to squeeze producer margins and create even more uncertainty in output markets. Therefore, creating a predictable and rules-based enabling policy and regulatory environment are critical to successful transition from pilots to mainstream marketing, financing and market-based risk management instruments.

Several recommendations arise from the evidence summarized in this chapter:

1. Increase public investments in roads that reduce the cost of connecting smallholder farming areas with local markets.

2. Promote private investment in agricultural value chains by maintaining a predictable policy environment which does not impose sudden bans on cross-border or inter-district trade,

3. Promote competition in agricultural markets and avoid offering certain types of market action advantages through preferential access to subsidies or incentives.

4. Encourage platforms for periodic private sector–government consultations about the conditions in grain markets, needed actions and ways to improve the functioning of these markets;

5. Increase public investments in agricultural adaptive research and extension to raise farm productivity and surplus production. This will encourage value chains to promote local production as a way to feed the growing cities rather than relying on imports.

6. Conduct studies to determine feasible and profitable areas for irrigation investments.

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CHAPTER 7

New Ways Of Financing African Agriculture

AUTHORS

Benedict S. Kanu
Walter Odhiambo
African Development Bank

Augustin Wambo Yamdjeu
Erick Sile
New Partnership For Africa's Development

CONTRIBUTORS

Osman Aymen A. Ali, Enock Yonazi, Amadou Bamba Diop
African Development Bank

KEY MESSAGES

ONE

Access to finance is critical for agricultural transformation, wealth creation and long-term prosperity in Africa. Inadequate financing of agriculture has been a major impediment to the sector, especially for smallholder farmers, their organizations, and small and medium agro-enterprises which lack basic financial services.

TWO

The unmet demand for finance in agriculture, which cuts across all the agricultural value chains in Africa, is pushing for a search for new ways of financing the sector. Innovative financing approaches and instruments are being designed to mobilize additional resources and to address market failures or institutional barriers.

THREE

Private-sector led approaches to mobilizing resources are becoming increasingly important and show great promise for improving access to capital in African agriculture. After years of neglect, banks, private equity funds, impact investors, and microfinance institutions and financial cooperatives are bringing new capital to African agriculture.

FOUR

Given the importance of finance for agricultural transformation in Africa, African governments should continue to engage directly with the key stakeholders that will be involved in scaling agricultural finance. Strengthening and leveraging forward-looking partnerships involving the different actors is critical. Moreover, governments' role in creating an enabling environment is critical to avoid stifling innovation.

Introduction

Agriculture remains an integral part of the African economy. The sector provides livelihoods to more than 70 percent of the population in some African countries and contributes an estimated 25 percent to GDP. Despite its central importance much of the potential of the sector remains unrealized, with low productivity characterized by low use of mechanization and quality inputs, fragile environments and increasing land pressure. To boost agricultural productivity and achieve much needed agricultural transformation in the continent, significant financing will be required. Yet, Africa's agricultural sector today attracts less than 5 percent of the lending from formal financial institutions, leaving farmers and agricultural enterprises starved of the capital they need to operate and grow their enterprises (Snyder, 2016).

Access to finance is critical for agricultural transformation in Africa. The shift from subsistence-oriented agriculture to commercial agriculture will require resources at all levels of the agricultural value chains. However, Africa, and particularly SSA, lags behind other regions of the world in supplying financial services to the agricultural sector (IFC, 2013). In particular, smallholder farmers and agri-enterprises in Africa lack the required investment capital and access to financial services necessary for growth and productivity. The limited financial investment in African agriculture is attributed to many factors including the high risk profile of smallholder farmers, low productivity and returns, inadequate infrastructure, unclear property rights and uncertainties around land tenure, and weak policy and regulatory environments. Tackling these challenges requires significant investments on many fronts.

Indications are that there are sufficient funds in the continent and among key potential partners that can be used to achieve the ambitious CAADP transformational goals and the Malabo commitments. These resources are both in the public and private sector domains. What is required are new and innovative ways to mobilize these resources, especially through raising more catalytic funding by African governments and multilateral institutions and catalyzing greater investment from the private sector, including from African entrepreneurs, emerging southern donor countries and foundations.

This chapter examines some of the recent innovations in financing Africa's agriculture. It begins by exploring the financial needs of the agricultural sector in Africa and the sources and instruments that have been used to address these needs. The chapter then examines several promising new ways and approaches for improving access to sustainable financial services for agriculture and agro-enterprises in Africa. The focus in the chapter is on novel approaches and/or products to address existing access challenges and to attract new types of investors or sources of capital to the agricultural sector.

Rationale for new ways of financing

Why are new ways of financing African agriculture necessary now? With the enormous financial needs of the agricultural sector today, there is clearly need to explore and develop new and innovative ways to finance the sector. Approaches and tools that have been used in the past have not been very effective, or at best, not appropriate, and hence, the huge unmet demand for capital in the sector, especially for smallholder farmers and informal small and medium enterprises (SMEs). In the 1980s and 1990s, state-led lending to the sector through agricultural development banks did not achieve much because many of these institutions were not sustainable, as they were weighed down by heavy debts. This gave way to private approaches, notably microfinance, relying mainly on group lending. While microfinance helped in reaching the unbanked in the agricultural sector, the approach faced limitations in addressing agricultural financing issues. The focus in recent years has been on innovative financing, encompassing among other things, financial innovation.

Innovation is critical because the continent needs to design new and fit-for-purpose instruments that could help deal with the emerging trends, challenges and opportunities. Innovations are key to mobilizing additional resources to complement traditional resource flows in the agricultural sector in Africa. Aid and public expenditure in African agriculture have generally declined and there is little sign that this pattern is changing. Africa therefore needs to be innovative by demonstrating how proactive it is by injecting its own domestic

[1] Contributions were received from Osman Aymen A. Ali, Enock Yonazi, and Amadou Bamba Diop, all of AfDB.

resources into agriculture. This in itself would be a radical change from the mindset that has kept the continent on the receiving end of ODA for several decades.

New ways of financing African agriculture are necessary in order to engage new partners, especially those from the private sector. Innovative financing tools geared towards the private sector are particularly important, given the centrality of private investment in growth in frontier and emerging economies. Over the last decade or so, the main driver of economic progress across African countries has arguably not been ODA flows—which remain the most important source of public finance—but growth underpinned by private sector activity. This trend is likely to continue in the foreseeable future. Hence, private sector involvement is inevitable for any innovative financing effort initiated by the public sector. Likewise, innovative ways are required to mobilize resources from other sources such as philanthropies and non-traditional sources. Accordingly, new tools are required to mobilize resources to complement traditional resource flows, such as FDI, government investment and ODA.

The unmet demand for finance, which cuts across almost all agricultural value chains in Africa, is further justification for the need to pursue new ways of financing. Additional impediments to financial access include lack of collateral, complex land tenure systems, weak coordination among different actors in the value chain, and limited financial literacy among farmers. The perceived/inherent risks associated with agriculture make it less attractive to financiers vis-à-vis other sectors, and this is more so the case in Africa than anywhere else. This places added urgency to devise ways of effectively addressing these challenges. Already, several tools and approaches have been developed to address some of these challenges including innovative credit tools (e.g., warehouse receipt systems) and risk management tools (e.g., weather index insurance), which are examined in section IV.

Overview of current needs and sources

Agriculture Financing Needs

The transformation of African agriculture requires a broad set of measures ranging from support to small-scale farmers, to huge investment in infrastructure projects and R&D. Both "soft" and "hard" interventions are necessary for achieving the transition from subsistence-oriented systems to commercial agricultural production. In addressing the financial needs of the agricultural sector, it is useful to focus on the following category of needs; resources for farmers and agro-entrepreneurs, value chain financing, infrastructure finance etc.

Resources for farmers and agro-entrepreneurs: Given that agriculture employs most of the labor force in Africa, and smallholder farmers produce up to 80 percent of the food in SSA , real transformation in the sector will not happen without integrating farmers into markets. Improved linkages between smallholder farmers and buyers can ensure that farmers tailor their production to meet market demands, reducing wastage, promoting market access, making farmers more actively engaged in adding value to products, by improving quality, packaging and presentation. Famers, both large- and small-scale, as well as agricultural enterprises need financing to expand their production through mechanization, use of improved inputs and storage facilities and/or diversify their products and meet market requirements. They also need short-term financing to cover working capital needs for pre-production, and pre- and post-harvest activities; and long-term financing to invest in land improvement, warehousing and mechanization. Unfortunately, access to financial services, especially by smallholders, has been limited for a variety of reasons, some of which have been mentioned in the previous section.

Value chain financing: Value chain financing is an important mechanism to deliver financial services to rural households and SMEs. Channeling resources to support business transactions within value chains to reduce costs and risks and increase efficiency is, thus, important. In addition, developing strong linkages with importers and supermarkets provides scope for innovation by processors, wholesalers and

[2] http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf

[3] www.thisisafricaonline.com.

exporters. Even more important is participation in the high yielding global value chains (GVCs). Africa is still an insignificant player in global trade and value addition: in 2011 this statistic was only 2.2 percent, although up from 1.4 percent in 1995 . Yet, Africa is a little more integrated than this statistic suggests, as it participates in GVCs mainly at their lower stages, and its share of services may be higher than current data suggest.

African governments are under pressure to create and implement policies that facilitate agricultural development; including integrated regional value chain (RVC) development and moving African countries to the top of global agricultural value chains. The continent is, however, not using its full potential to join the GVCs. For instance, Cameroon, Côte d'Ivoire, Ghana and Nigeria are leading exporters of cocoa beans, but add very little value to the commodity. In contrast, Malaysia, Brazil and Mexico have achieved forward and backward integration in the cocoa sector, as a result of industrial policies and domestic capabilities. For instance, Brazil supported soya beans and cocoa production through input subsidies, a generous credit policy, and modernization of farming practices (UNECA, 2013).

Although they meet certain needs, financial services provided by non-specialized financial institutions along value chains have certain limitations: they tend to be expensive, lack flexibility, and are not diverse. However, an opportunity exists to improve this form of financing, as it becomes common and demand for it increases. The vast informational advantage on the value chain actors that non-specialized lenders hold can be used to slowly bring down the cost of financing. Partnerships between different types of financial institutions can reduce risks and the costs of services. This can increase financial access for all actors along the value chain but also, and most importantly, result in deeper financial inclusion, addressing the needs of more smallholder farmers (UNECA, 2013).

A promising approach for African countries would be to start developing and strengthening RVCs by developing regional clusters. Boosting intra-African trade, as outlined in the Malabo Declaration, in view of its more diversified composition, represents a promising avenue to support industrialization and foster the emergence of interconnected regional supply chains, notably in manufacturing. African countries should adopt a consistent trade and industrial policy framework, connecting RVCs and GVCs more closely (UNECA, 2015). Some 16 African countries are entirely land-locked and most African economies are small. Both features offer an opportunity for regional integration and trade, especially from product specialization and cross-border trade. Yet, the share of intra-African trade is extremely low relative to other major regions, hovering around 10–12 percent (UNECA, 2013). Similarly, the level of Africa's intra-trade in agriculture and food products is limited in comparison with its total trade volume (Rakotoarisoa, Lafrate, & Paschali, 2012).

Agricultural value chains offer upgrading opportunities in Africa. The recent rise of supermarkets across Africa and the associated increase in direct sales to these retail outlets has had a profound impact on agricultural value chain dynamics, with an increase in niche markets and buyer-driven chains. Quality and process standards can help African firms and farmers acquire skills and access large markets, but they can also exclude many due to the high costs of compliance. RVCs and emerging markets outside Africa offer an important alternative as standards are lower and growth rates higher (AfDB, UNECA, UNDP, & OECD, 2014). Yet, agricultural value-added in SSA, as a percent of GDP, stood at 13.98 in 2014, according to the World Bank .

[4] http://www.tradingeconomics.com/sub-saharan-africa/agriculture-value-added-percent-of-gdp-wb-data.html

Financing agricultural value chains to contribute to Africa's agricultural transformation will require massive resources. As part of its "Feed Africa" Strategy for African Agricultural Transformation, AfDB estimates that the transformation of selected key value chains will require approximately US$315–400 billion over the next decade (Table 7.1). This is the amount required to support critical needs such as infrastructure, expanded finance, and improving the general business environment, and to ensure inclusivity. Such an investment, to be made using public and private capital, but more so private capital, is likely to create annual revenue opportunities worth about US$85 billion per year by 2025 (AfDB, 2016).

Infrastructure finance: One of the major bottlenecks to agricultural production in Africa is inadequate infrastructure such as rural transport systems, irrigation systems, water supply, sanitation, electricity, storage, and telecommunication services. This constraint is

Table 7.1: Indicative investments to transform key value chains in Africa (US$ Billions)			
Value Chain	**Value Chain Development Estimates**		
	Production	**Value addition**	**Total**
Rice	~18–22	~3–4	~21–26
Cassava	~2–2	~2–3	~4–5
Wheat	~22–27	~16–20	~38–47
Cotton	~0.4–0.5	~1–1.2	~1–2
Horticulture	~5–6	~4–5	~9–11
Aquaculture	~1–1	~19–23	~20–24
Tree crops	~14–17	~9–11	~23–28
Sahel Region	~6–7	~9–11	~15–18
Guinea Savannah	~42–52	~26–32	~68–84
Total	~110–135	~90–110	~200–250

Source: *African Development Bank Strategy for African Agricultural Transformation (2016–2025)*

partly to blame for the continent's inability to feed itself, and to stimulate rural entrepreneurship. Rural infrastructure services play a critical role in poverty reduction, economic growth, and empowerment of Africa's rural poor (World Bank, 2001). However, it is not enough to meet the demand for services by simply constructing a road, installing a water pump, providing rural electricity, or planting trees for fuel wood. Countries and rural communities should not only provide physical infrastructure, but also ensure that services are continuously provided on a sustainable basis at appropriate levels of quality and affordability. For example, it is not only crucial to significantly scale up power availability, but also affordability and typology of power, especially in rural communities.

The infrastructure deficits in Africa are well known. Most African countries suffer from limited transport infrastructure, both in quantity and quality, to varying degrees by country. Poor rural accessibility restricts opportunities to trade in both local and international markets. It raises the costs of production and distribution, reduces profitability from the sale of produce, and constrains production yields. The economic impacts of improved rural accessibility are cumulative and far-reaching. Better access to markets makes it worthwhile for producers to modernize their farming methods through mechanization, increased use of fertilizers, and planting of higher-yielding varieties, or even different higher-value crops. These, in turn, increase demand for farming inputs, the provision of which creates more rural employment. A limited enabling environment discourages private sector engagement into bankable transport projects, in ports, aviation and railways. Institutional and technical capacity has also been another challenge for the transport sector in Africa. While notable progress has been achieved in certain sub-sectors in certain countries, the overall capacity is still limited.

Electricity has important applications in agriculture that are central to fostering investment in the sector and promoting performance and growth. The state of especially rural power in Africa has implications for the extent of farmland irrigated, value addition to farm produce in support of industrialization, and the shift to GVCs, post-harvest loss reduction, etc. Moreover, animal and tractor power are severely constrained in African agriculture, making the sector even more reliant on manual methods, which in turn, severely limits the amount of land that can be cultivated. This reduces the timeliness of farm operations and limits the efficacy of essential operations such as cultivation and weeding, thereby reducing crop yields and sector performance. Access to modern forms of energy is important for the rural poor, as it enables them to enhance their production and improve their household incomes, expenditure, educational outcomes, and standards of living.

Africa has about 9 percent of the world's fresh water resources and 11 percent of the world's population. Yet, SSA faces numerous water-related challenges that constrain economic growth and threaten peoples' livelihoods. African agriculture is mostly based on rainfed farming, and less than 10 percent of cultivated land is irrigated. There is substantial inter and intra-annual variability of all climate and water resources characteristics. The impact of climate change and variability is, thus, pronounced. The main source of electricity is hydropower, which contributes significantly to the current installed capacity for energy. Continuing investment in the last decade has increased the amount of power generated (UNWWAP, 2016). Solutions to the challenges of water for energy and food security are hindered by a big gap in water infrastructure and limited water development and management capacity to meet the demands of a rapidly growing population.

To give some idea of the investment needed to implement the Framework for Action, the joint AUC, AFDB, UNECA Africa Water Vision for 2025 (UNECA, 2000), focusing on "Equitable and Sustainable Use of Water for Socioeconomic Development", estimated that an investment of US$20 billion per year will be required until 2025 to attain the minimum condition of the desired water future. This is about 11 percent of the global estimate of US$180 billion per year for implementing the global Framework for Action in developing countries.

Access to technology plays a vital role in the agricultural sector in Africa, and the use of ICT on rural farms helps farmers access market prices, food production, weather information, and best practices information disseminated through their mobile phones. Table 7.2 illustrates the role of ICT in promoting agricultural value chains. The ICT infrastructure in Africa has seen substantial recent growth, thanks to the rapid expansion of mobile services and fiber connectivity, as a result of private sector investment and public broadband projects.

The continent's youth are an important category of players with great potential to play a considerable role in agriculture and agri-business. Indeed, young agripreneurs, riding on ICT, could benefit from investment in adequate infrastructure in this particular segment of the bigger picture because they already know the power of mobile technology (Juma, 2016). But what they might need most is access to broadband, which also helps link them to knowledge centers, given the absence of extension services. Today, the cost of broadband is prohibitive, although it is essential for dynamic business operations. Juma (2016) contends that one possible way to resolve such a divide could be to provide "broadband grants" in the same way the US government provided "land grants". In addition to that model that has proven its worth elsewhere, private enterprises operating on the continent could be encouraged to buy and donate broadband to selected agribusiness start-ups as part of their corporate social responsibility.

If the benefits of infrastructure are so obvious, why are so few infrastructure projects being successfully implemented in the continent, especially in rural areas? Limited infrastructure investment in Africa is not the result of lack of available financing—given the abundant resources in the form of wealth funds, pension funds, insurance and other forms of long-term liabilities. The challenge, it would appear, is one of matching the supply of finance from the private sector with investible projects globally and in rural areas in particular. This has a lot to do with how project contracts, especially rural projects, are designed in relation to how risks and returns are distributed in an incentive compatible manner (Ehlers, 2014). The private sector can only commit large sums of financing to projects if they are assured of their returns and can trust the legal and political environment. The lack of a pipeline of structured projects is, indeed, one of the reasons for the mismatch between the demand for infrastructure investment and supply of infrastructure.

Table 7.2: Role Of ICTs In Agricultural value chain

Regulatory and policy	ICTs assist with implementing regulatory policies, frameworks and ways to monitor progress.
Capacity building & empowerment	ICTs widen the reach of local communities, including women and youth, and provide newer opportunities, thereby enhancing livelihoods.
Financial inclusion, insurance & risk management	ICTs increase access to financial services for rural communities, helping to secure savings, find affordable insurance and tools to better manage risk.
Food safety & traceability	ICTs assist in delivery of efficient and reliable data to comply with international traceability standards.
Enhanced market access	ICTs facilitate market access for inputs as well as product marketing and trade in a variety of ways.
Disaster management & early warning system	ICTs provide actionable information to communities and governements on disaster prevention, in real-time, while also providing advice on risk-mitigation techniques.
Promote environmentally sustainable farming practices	ICTs provide access to climate-smart solutions as well as appropriate knowledge to use them.
Agricultural extension & advisory services	ICTs currenttly bridge the gap between agricultural researchers, extension agents and farmers thereby enhancing agricultural production.

Research and Development: Knowledge generation for agricultural development is central to any meaningful transformation of the sector. Investment in R&D is key to ensuring the generation of agricultural technologies and

technical knowledge about products. African countries continue to underinvest in agricultural R&D, despite efforts by governments and development partners in making long-term commitments through regional R&D initiatives and creating supportive policy environments for agricultural R&D . After a decade of stagnation in the 1990s, public agricultural R&D spending in SSA increased by more than 33 percent in real terms during 2000–2011, rising from US$1.2 billion to US$1.7 billion in 2005 constant PPP dollars, or from US$0.6 billion to US$0.8 billion in 2005 constant US dollars. Absolute spending varied considerably by country. The growth in public agricultural R&D spending in SSA was driven by a handful of countries including South Africa, Nigeria Uganda, Ghana, Kenya, and Tanzania. Investment levels in most countries are still well below those required to sustain agricultural R&D needs. In 2011 SSA invested US$0.51 in R&D for every US$100 of agricultural output on average, which is well below the NEPAD 1 percent national R&D investment target. Only 10 of the 39 countries for which agricultural R&D intensity ratios were available met the 1 percent target in 2011. In contrast, 18 countries recorded intensity ratios lower than 0.5 .

Given the substantial time lag between investing in research and reaping rewards, there is need for long-term commitment of sufficient levels of sustained funding. There is a clarion call for a minimum 5 percent annual growth in agricultural R&D spending in low- and middle-income countries over the next decade and allocation of at least 1 percent of agricultural GDP to public agricultural R&D. Given the SSA annual spending growth rate of 2.7 percent in 2000–2011 and its agricultural R&D intensity ratio of 0.51 percent in 2011, investments in agricultural R&D would need to double over the next decade if these ambitious targets are to be achieved .

Current Sources of Agriculture Finance

This section reviews some existing sources of agricultural finance in Africa. Currently, multiple sources of agricultural finance exist which respond to the needs of a variety of actors and their risk profiles. Some of the most common sources of agricultural finance in Africa are: (i) budgetary resources from governments and donors; (ii) financial institutions including commercial banks, microfinance institutions (MFIs) and development finance institutions; (iii) private investment and capital; and (iv) non-bank financial institutions such as savings and credit cooperative organizations (SACCOs) and financial cooperatives.

Budgetary sources: Governments remain an important source of finance for agriculture. Through budgetary allocations from own resources and donors, governments allocate funding to support the sector, sometimes targeting particular actors (such as smallholder farmers) or particular issues (such as climate smart agriculture). Traditionally, governments have been the primary source of investment in the sector, including supporting large-scale infrastructure, extension services, subsidies, agricultural credit, and R&D. Increasingly, however, government interventions in agricultural finance are being directed towards managing risks in the sector, through support to farmers in the form of payments to indemnities, creating credit guarantee funds to leverage private sector resources and providing information to the sector on potential risks.

African countries agreed in 2003 under CAADP to allocate at least 10 percent of public budgets to agriculture, to motivate spending from an extremely low base, to achieve 6 percent growth in the sector. More than a decade after the Maputo Declaration of 2003, ReSAKSS (2013) reported that Africa as a whole has not surpassed the CAADP target. In fact, the average agricultural expenditure share rose from 3.1 percent during the 1995–2003 period to 3.4 percent during the 2003–2013 period. For our period of interest, geographic distribution presents East Africa as the region with the highest average annual agriculture expenditure share in total public expenditure, at 5.8 percent, followed by West Africa, at 5.0 percent, and Central Africa, at 3.8 percent. Southern Africa had the lowest average annual agriculture expenditure share, at 2.5 percent. The 2013 review revealed that distribution along income group credited some countries with less favorable agricultural conditions as having the highest average annual agriculture expenditure share (at 10.2 percent); this was the only group to surpass the CAADP target during this period. Mineral-rich countries had the lowest average annual agriculture expenditure share, at 3.2 percent. The REC with the highest average annual agriculture expenditure share during

[6] http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128048/filename/128259.pdf
[7] http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128048/filename/128259.pdf
[8] http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128048/filename/128259.pdf

this period was IGAD, at 6.1 percent, followed by ECOWAS, at 5.0 percent. SADC had the lowest average annual agriculture expenditure share, at 2.6 percent.

Overall, most regions, income groups, and RECs experienced declines in the share of agricultural expenditures in total public expenditures during the 2003–2013 period. In most areas, the expenditure share was lower in the second half of the period (2008–2013), than in the first half (2003–2008). For the continent as a whole, the agricultural expenditure share dropped from 3.7 during 2003–2008 to 3.1 during 2008–2013. The region, income group and REC with the largest declines in percentage terms were IGAD (-58.7 percent), countries with less favorable agricultural conditions (-28.2 percent), and Northern Africa (-27.3 percent). The only areas to experience an increase in the agricultural expenditure share between the two periods were Central Africa (75.9 percent), ECCAS (39.6 percent), the group of mineral-rich countries (24.0 percent), and SADC (12.9 percent).

With regard to individual country performance, several reports exist and situate between 7 and 9 out of the 54, the number of AU member states that had met the budgetary target. Only a handful of the countries (including Burkina Faso, Ethiopia, Guinea, Malawi, Mali, Niger, and Senegal) have been consistent in meeting the target in most years.

African governments spent about US$12 billion on agriculture in 2014 (AfDB, 2016). Meeting the CAADP/Malabo commitments would imply raising this level of spending to around US$40 billion based on 2014 budgets, which would be a substantial investment for agricultural transformation in Africa. However, the feasibility of increasing public spending to this level, given the original Maputo Declaration was made in 2003 is low, in light of the significant budget constraints most governments and their partners currently face. Financing a business-led transformation agenda that relies heavily on government may, thus, not be feasible. The private sector offers an alternative which can leverage existing government funding, and more importantly contribute to increase funding of the agricultural sector.

During the 12th CAADP Partners Platform held in Accra, Ghana, in April 2016, AGRA, AUC, AfDB and the NEPAD Agency launched the "Seize the Moment" campaign that is expected to drive agricultural transformation in the continent by raising and maintaining the profile of Africa's agriculture. Through the campaign, these partners aim to prioritize African agriculture and secure the global, political and financial commitments needed to achieve the visions set out in commitments of the AU Heads of State outlined in national agricultural and food security investment plans (NAFSIPs), the Malabo Declaration, the AU Agenda 2063 and the sustainable development goals (SDGs). The campaign would be supported by the regional and international community, who would be requested to commit to support country champions by: i) providing technical support to these efforts; ii) rallying donors and partners to finance and operationalize country plans; and iii) championing country efforts to generate political will at the country, regional, and global levels.

On contributions from donors and foundations, one could say that overall, recent developments in the global and donor community further show that agriculture regained momentum, which led to some reversal in the previous downward trend of ODA dedicated to agriculture. Indeed, the financial crisis in North America and Europe, notwithstanding, Africa might continue to benefit from this contribution throughout the next decade. However, sustaining the CAADP Momentum (NEPAD, 2016) exercise warns that Africa must be realistic about future aid volumes, and must be wary of the implicit and explicit priorities of donors in respect of aid. Donors' use of particular instruments (especially food aid imported from outside the continent) can undermine long-run market development, and the costs to Africa of the policies that donors deploy with respect to their own agriculture (especially their subsidies of exports, and their policies that depress world market prices) can undermine Africa's own industry.

Financial institutions: Formal financial institutions including commercial banks and insurance companies have played an important role in agriculture in Africa, although there remains massive untapped capacity. Commercial bank lending to agriculture is about USD 660 million per year, out of a total of USD 14 billion per year, or 4.8 percent of annual lending (AfDB, 2016). As already indicated, these institutions have so far not been able to significantly reach smallholder farmers and small and medium agro-enterprises. Smallholder farmers in particular

[9] http://www.resakss.org/region/africa-wide/growth-options

continue to experience inadequate access to seasonal credit and practically no access to investment credit. Payment services, savings vehicles, and insurance are also unavailable to most farmers and agripreneurs. The result of this is a significantly unmet demand for credit in the agricultural sector, although such credit is crucial to addressing the growing demand for agricultural commodities and shifting preferences towards higher value food sources. Attempts to address this challenge are on record with banks downscaling and engaging in microfinance and agricultural finance. Examples of this include Equity Bank in Kenya, the Société Générale des Banques in Senegal, ZANACO in Zambia, DFCU Bank and Centenary Bank in Uganda, and BPR in Rwanda.

In the public sector domain, there has been a move to revamp or even establish new state-owned agricultural development banks which were common in the early 1980s and 1990s, providing subsidized services to farmers. Among the countries that have successfully reformed their agricultural development banks are Nigeria, Mali, South Africa and Tanzania. In Tanzania, besides the National Microfinance Bank which has a significant portfolio in agriculture, in 2015 the government established the Tanzania Agricultural Development Bank to address challenges related to access to finance, especially the high cost of credit. Similar initiatives include the support provided by the Government of Senegal to the Banque Nationale de Développement Economique (BNDE) and the Caisse Nationale du Crédit Agricole du Sénégal (CNCAS) which extend financial services to the agricultural sector.

Multilateral financial institutions, such as AfDB and the World Bank, as well as foundations have played an important role in agricultural financing. Multilateral and bilateral donors, plus foundations and NGOs spent about US$3.8 billion on agriculture in Africa in 2014 (AfDB, 2016). These institutions continue to represent an important source of finance, especially for infrastructural projects in low income countries. Increasingly, funds from these institutions are critical for leveraging other types of financing where the risks preclude other options.

Private Investments and private capital: There is growing consensus that the prime source of agricultural investment should be the private sector—both foreign and domestic. The sector will have to tap from the large and growing net assets of commercial banks, wealth funds, pension and insurance funds, and from direct foreign investments. In addition to sizable net banking assets, other institutions with net assets in Africa exist. For instance, oil-producing countries in SSA have recently created sovereign wealth funds (SWF) to manage oil proceeds. Compared to the size of their assets, the level of FDI by SWFs is still small at less than 2 percent of assets under management, and is limited to a few major SWFs. In 2013, FDI flows of SWFs were worth US$6.7 billion, with cumulative stock reaching US$130 billion (UNCTAD, 2014). Pension funds in 10 African countries (Botswana, Ghana, Kenya, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Zambia) already have US$379 billion in assets under management—85 percent or US$322 billion of it based in South Africa—and they continue to grow rapidly .

Renewed efforts at mobilizing resources from the private sector for agriculture are already under way in the continent. A case in point is the Grow Africa initiative. Launched in 2011, the Grow Africa partnership reported at its May 2016 Investment Forum in Kigali, Rwanda, that over US$500 million in new private sector investments were implemented in 2015, bringing the total to US$2.3 billion implemented, out of over US$10 billion committed by more than 200 African and global companies. In the past year, these investments reached around 10 million smallholder farmers and created 30,000 jobs, bringing the total number of jobs created to 88,000 since 2012. In the first quarter of 2016, almost US$500 million in additional investment commitments were made in rice and cassava production and processing in Nigeria and sorghum production and processing in Kenya (Grow Africa, 2016).

Regarding foreign private inflows, about 8 percent or US$11 billion of total agricultural FDI during 2003–2011 went to Africa (FAO, 2013b). In 2014 FDI into agriculture and agribusiness in Africa was worth US$10 billion. Investment from the continent's local private sector is also increasing rapidly. Creating the appropriate conditions for agribusiness growth, and aligning existing investment strategies of the private sector to the goals of transformation, should assist to increase the attractiveness and flows of FDI into the African agribusiness sector.

[10] http://www.africancapitalmarketsnews.com/2683/what-are-africas-pension-funds-investing-into/.

[11] http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_Feed_Africa_-En.pdf.

Non-financial institutions: Non-bank financial institutions such as cooperatives, SACCOs and self-help groups play an important role in agriculture in Africa. Because these institutions are normally not profit oriented, they tend to offer their members better and affordable access to financial services. Develtere, Pollet and Wanyama (2008) estimated that about 7 percent of Africa's population belong to cooperatives. While many of these institutions have served farmers, they suffer from governance related issues and management conflicts.

The contribution of the African Development Bank

AfDB is one of the main players in agricultural financing in the continent. Between 1967 and 2014, the African Development Bank Group approved loans and grants to its African member countries with commitments amounting to US$100.68 billion. Agriculture and rural development accounted for 12.4 percent (US$12.45 billion); infrastructure including transport, water and sanitation, energy, communications and industry took the bulk of the resources at 48.8 percent (US$49 billion), while the other sectors including environment, finance, social, urban development and multi-sector (covering more than one sector) received the balance.

The Bank's approach has been targeted to the diverse needs of each sub-region in the continent, addressing challenges that span boundaries and affect particular regions. These challenges include the serious situations of drought and food insecurity affecting the Horn of Africa and the Sahel, where AfDB has committed over US$500 million and leveraged a further US$2 billion. The Bank works hand in hand with both the public and the private sectors to improve markets and storage infrastructure, to add value to agro-processing, and to bring about social inclusion and job creation. Examples include the US$200 million investment in Uganda, supporting extensive market infrastructure development, which is expected to directly benefit close to 20,000 local vendors and contribute to developing markets and trade across the country. In Nigeria the agricultural transformation program is bringing transformative results, reaching over 45,000 economically active smallholders living in the targeted rural areas.

AfDB is also one of the supervising entities for GAFSP (see Box 7.1). With technical assistance from the Bank, 9 African countries have successfully secured a total of US$303.4 million in grants from GAFSP and have selected the Bank as their supervising entity. These countries are: Liberia (US$46.5 million); Malawi (US$39.6 million); Niger (US$33.0 million); Senegal (US$40.0 million); The Gambia (US$28.0 million); Mali (US$37.2 million); Zambia (US$31.1 million); Benin (US$24.0 million); and Kenya (US$24.0 million). These projects are expected to significantly contribute to enhanced food and nutrition securities, shared economic growth, and employment, especially for the vulnerable groups of women and youth in the beneficiary countries. The Bank has received about US$15.16 million as administrative fees for the supervision of approved GAFSP projects.

Moreover, the Bank has been working with its African member countries to mobilize additional resources for climate change, some of which have a focus on climate smart agriculture. These include the Climate Investment Fund (CIF), the Global Environmental Facility (GEF), the Green Climate Fund, and the Africa Climate Change Fund (ACCF). Support through these funds has been critical for leveraging financing from traditional sources to help mainstream environment, climate change and food security, and to build resilience and integrate fisheries and water resource management in the Bank's agriculture operations.

With CIF support, AfDB currently finances 39 investment plans in 26 countries and 1 region to transform their economies through renewables, sustainable transport, climate resilience and sustainable forest solutions. AfDB has approved 16 projects with commitments valued at US$2.1 billion (AfDB US$1.4 billion, CIF US$.7 billion). The AfDB-GEF portfolio has grown tenfold over the last five years. This portfolio currently funds 36 projects financed with US$286 million in GEF grant financing and US$1.8 billion co-financing in areas ranging from climate resilient agriculture to sustainable water management, and sustainable transportation, to renewable energy and energy efficiency.

ACCF is a €4.725 million German-funded trust fund to help African countries become resilient to climate change and transition to

[5] The High Fives, the African Development Bank's operational priorities, serve as a blueprint for African countries to embark on a course of sustainable transformation.

Box 7.1:
GAFSP: Country Examples

Rwanda: Increasing productivity; empowering co-operatives; strengthening entire value chain; both windows active and linking cooperatives connected to Africa Improved Foods Limited (AIFL), and DSM, a global sciences company and a world leader in the field of nutrition, through the Private Sector Window.

Cameroon: New private sector window investment that builds on IFAD and the World Bank's International Development Association (IDA) projects; pulling together public and private partners and resources to integrate farmers/cooperatives into the value chain.

Malawi: Linking farmers to market; engagement into agro-processing and ensuring systemic quality control; leveraging in private sector investment.

Togo: Government created matching grants scheme to leverage domestic financing that supports everything from cocoa plantations to entrepreneurs to agribusinesses.

low carbon growth. In 2015 five projects were approved: 1 multi-national and in 4 countries (Mali, Swaziland, Cape Verde, and Kenya) for a total amount of US$2.17 million. An additional 17 projects are in the ACCF pipeline, currently undergoing appraisal. Plans are underway to attract further funding and scale up the ACCF to a multi-donor trust fund by 2020.

Among the bold initiatives contained in the AfDB "High Fives"[5] vision and Feed Africa Strategy related to agricultural financing is the establishment of an African Agricultural Risk Sharing Facility. This was set up to motivate commercial banks and other financial institutions to lend at scale to agricultural value chains. Similar initiatives include:

- E-farmer registrations: development and establishment of digital ICT platforms for more efficient distribution of agro-inputs
- Blended finance structures
- Affirmative Finance Action for Women in Africa
- Deploying risk capital equity investments in dedicated funds
- Warehouse Receipt Financing and Agricultural Commodity Exchanges
- Development of inputs finance and agro-dealer networks
- Post-Harvest Loss Prevention Facility to provide long-term financing and a technical assistance facility to producers and retailers
- Deepening and broadening agricultural insurance markets.

Overview of recent approaches and initiatives

Clearly, Africa needs new ways of financing agriculture. These will help mobilize additional resources and address market and institutional failures that inhibit access to capital, especially by farmers and small- and medium-scale agro-enterprises. In the last few years several innovative agricultural financing approaches and instruments (sometimes experimental) have emerged, spanning four main categories: innovative credit tools, bonds and equities; risk management tools; results-based financing; and crowdfunding. In addition, there have been innovations specifically aimed at ensuring inclusivity by targeting groups such as women and the youth. These financing instruments and approaches are considered 'innovative' for different reasons and serve different functions in unlocking much needed capital to support the agricultural sector.

Innovative credits tools, bonds and equities

Established financial instruments such as microfinance, bonds and equities, which have been in existence for years, constitute a large proportion of the innovative financing market globally. Over the years, these tools have been refined and made "innovative" so as to mobilize additional resources and address market failures or institutional barriers. Some examples of recent developments in established financial products aimed at mobilizing additional resources for African agriculture are outlined in the following sub-sections.

Innovations in microfinance: MFIs remain a principal source of capital and savings, especially for the unbanked poor, who possess few assets that can be provided as capital. Africa has multiple types of MFIs, including banks that have downscaled to serve lower-income market segments and traditional savings-led member owned institutions and NGOs. To increase their reach, MFIs, working with national governments and sometimes donors and leveraging on technology, have developed innovative tools and products to provide individual loans to farmers. For example, in Kenya, Equity Bank in partnership with AGRA and the International Fund for Agricultural

Development (IFAD), has been implementing the Kilimo Biashara program, a risk-sharing innovation, to facilitate affordable financial services to farmers and agro-dealers to increase food security and household income. In Tanzania, the National Microfinance Bank has devised innovative knowledge-driven approaches to increase its lending to the agribusiness sector. The bank has combined credit with innovations, such as warehousing.

These institutions have largely been successful in serving farmers on account of their institutional commitment, including modifying products, adopting individual lending, hiring specialized loan officers and better tracking their clients. They have also invested heavily in enhancing their knowledge and understanding of Africa's agricultural sector. MFIs in Africa, however, still face several challenges in reaching their target populations. Although they have, in recent years, embraced ICT applications to reduce costs and risks, their operating costs remain high, well above global levels (Meyer, 2015). African MFIs are also still unable to fund larger and long-term loans that are necessary for effective agricultural value chain development. The interest rates they charge for their products remain unaffordable to farmers and to enterprises that they serve.

Additional innovations to enhance the operational effectiveness of formal financial institutions in agriculture are necessary. High transaction costs of banks have been cut dramatically thanks to mobile payments and mobile banking, as illustrated by the Kenya Commercial Bank (KCB M-Pesa), Commercial Bank of Africa (M-Shwari and M-Pawa) and Equity Bank (Equitel) initiatives in Kenya and Tanzania. These technologies have been adopted widely by other countries, including Uganda, Ghana, Rwanda, Niger, Nigeria, Malawi, Mozambique, and South Africa. Digital payment services allow non-bank financial institutions such as Mobile Network Operators and agripreneurs to bring payment and transfer services to previously unbanked populations in rural parts of these countries (Ondiege, 2010).

Digital financial services (DFS) facilitate access to financial services such as insurance, payments, savings and credit. They also generate a large amount of data which can be used to understand the smallholder farmers and rural economy space much better, which facilitates the improved offer and de-risking of financial services. Digital financial services have also enabled governments to make social payment transfers and to pay subsidies to the agricultural sector (e-fertilizer scheme in Nigeria). Digitizing these payments on a larger scale could bring millions of adults into the financial system and strengthen the digital financial infrastructure in emerging economies. Governments and agri-businesses in the developing world have already seen that digital transfers can drive progress in financial inclusion (Klapper et al., 2016). To improve information about borrowers' intentions and ability to repay their loans, psychometric technology is used in various countries like Malawi and Kenya, while biometric technology is a cost-effective way of applying "Know Your Customer" requirements when enrolling rural clients who often do not have identification documentation.

Warehouse receipt systems: Warehouse receipt systems (WRS) have, in the recent past, received considerable attention as a way of catalyzing agricultural lending by collateralizing stored commodities, thus eliminating the need for external collateral (Meyer, 2015). The system also provides secure places to aggregate and store commodities in the process of securing storage and marketing credit. Several African countries, including Ethiopia, Kenya, Tanzania, Zambia, Nigeria, Ghana, Niger, and Burkina Faso, have attempted some form of warehousing and have reported success, though limited, in reducing transactions costs and in strengthening the capacity of local and regional markets. As an innovative credit tool, WRS, among other benefits, reduce the pressure on the farmer to sell the commodity immediately after harvest when prices are normally low and reduce post-harvest losses.

Warehouse systems are usually complex to manage, especially the village level aggregation and transport to a certified warehouse and have, therefore, not been widely adopted in Africa (Meyer, 2015). Challenges include securing resources to manage the system, convincing farmers who typically sell after harvest to store their produce for a better price and the sustainability of the systems. There is also need for an enabling legal structure that enables bankers and insurers to accept stored produce as collateral covering credit extended to farmers. As part of efforts to promote agricultural market access in Africa, the AfDB, AGRA, UNECA, FAO and International Trade Centre (ITC) are currently collaborating in a continental study on agricultural market access, commodity exchanges and the warehouse receipt systems.

Bonds and equities: Bonds and equities are traditionally important sources for larger sums of money over longer periods of time. While these are not necessarily new instruments, they are attracting new participants and creating new opportunities in agriculture. As profitable businesses come into agricultural value chains, these kinds of financing are becoming increasingly important. Private equity to Africa in general and to the agricultural sector in particular has been trending strongly upwards in recent years. The number of equity funds established in the continent to support agriculture and related sectors has also been on the increase. According to the Emerging Markets

Private Equity Association, total private equity capital raised by fund managers in SSA in 2015 was US$3.6 billion, of which US$1 billion was invested (down from the US$4.3 billion raised and US$2.1 billion invested in 2014). AfDB is one of the largest private equity investors in Africa, with a well-diversified portfolio, knowledge of the markets and potential impact on improved governance in the targeted countries for investment. Since 2008, AfDB has invested in all vintages, covering the main sectors of services and industries, agribusiness, infrastructure, small and medium growth companies, and facilitating regional expansion.

A particular type of equity financing that is showing great potential in Africa is blended finance. Blended finance entails the strategic use of development finance and philanthropic funds to mobilize private capital flows to emerging and frontier markets. It is a capital structure that includes stakeholders from the public and private sectors, who engage in financial support based on their risk-return appetite. In addition, blended finance combines capacities and competencies from participating stakeholders. A good example of blended finance in Africa is the Africa Agriculture and Trade Investment Fund (AATIF) managed by Deutsche Bank. The US$146 million Fund, which invests in sustainable African agriculture, is structured to allow investments at three different levels through different share classes, each offering a unique risk/return profile with dividends being paid following a waterfall principle. The Fund invests between US$5 and 30 million in direct and indirect investments.

Another example of blended finance is the Lending for African Farming Company (LAFCo), founded by Germany's KfW Development Bank and agriculture impact investor Agricultural Development Company (AgDevCo), at the 2015 Grow Africa Investment Forum. LAFCo is a US$15 million facility that provides working capital loans to small and mid-sized businesses who supply and buy from Africa's smallholder farmers. It is managed by Root Capital. LAFCo aims to increase productivity and incomes of smallholder farmers through better integration in local and regional agricultural value chains, and improved access to formal markets.

Although promising, blended finance sponsors in Africa, like elsewhere in the world, face the difficulty of attracting and working with public funders. These funders need to be convinced that their funding is additional to private finance and that their funding is used to attract private capital, which would otherwise not be available (Convergence, 2015). These funds also tend to be technically complex, making it difficult to convince potential partners from the public sector and may not be flexible enough to meet the policy objectives of the various public funders.

The use of bonds to tap into non-traditional sources of finance for agriculture is also taking root in the continent. Examples include the Diaspora Investment in Agriculture (DIA) initiative and the Financing Facility for Remittances (FFR)—both multi-donor initiatives administered by IFAD. Launched in 2011, DIA aims to encourage the global diaspora to invest in sustainable agricultural projects, with real potential for impacting the lives of the poor in rural communities. The FFR was established in 2006 to increase the development impact of remittances. Africa's main beneficiaries of these initiatives are Angola, Burundi, Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Djibouti, Egypt, Liberia, Sierra Leone, Somalia, Sudan, and Tunisia. Remittances can be considered both as new and renewable sources of financing, and existing private capital that may be channeled to agriculture. FAO estimates remittances to agriculture in developing countries as being in the range of 5–7 percent. Attracting and nurturing remittances is, thus, a priority for the sector going forward.

Agricultural Investment Funds: Recent years have been characterized by an increase in the number of agricultural investment funds, reflecting in part the attractiveness of agricultural projects in light of the higher agricultural prices and the improved business environment in the continent. The funds, like the US$246 million Africa Agriculture Fund (nine investments made) and GAFSP have been inspired by public–private financing structures, which combine technical assistance facilities with investment funds to accommodate the different risk/return profiles. GAFSP has one public window and one private respectively managed by the World Bank and the International Finance Corporation (IFC). The Public Sector Window assists strategic country-led or regional programs that result from sector-wide country or regional consultations and planning exercises such as CAADP in Africa. The Private Sector Window is designed to provide long- and short-term loans, credit guarantees, and equity to support private sector activities for agricultural development and food security. It catalyzes private sector financing for agriculture in some of the most challenging business environments in the world (GAFSP, 2016).

GAFSP is regarded by its promoters as an effective and innovative financing tool because of its main features, namely:

- recipient-led with broad participation
- pooling of public/donor funds efficiently to generate scale in agricultural investment
- particular benefit to poor countries with limited alternate sources of finance
- grants can be catalytic in leveraging co-financing from other sources—public and private

- public resources invested through the Private Sector Window on average leverage 5.3 times additional (non-IFC) private investment
- supports countries mobilizing resources efficiently according to national priorities—reinforced by CAADP requirement
- financing is flexible—a range of complementary instruments and partnerships afforded under the two windows
- direct private sector "deals" and investments through the Private Sector Window
- attention to PPPs in Public Sector Window

Agricultural investment funds are important in that they help to pool the capital of different types of investors and channel capital to different agricultural stakeholders (FAO, 2010). By doing this, these funds help reduce risks by diversifying investments through pooled investments and having specialized fund management to support the individual investment. However, many of these funds remain small and would need considerable investment to scale to have any significant impact in the sector. So far no systematic assessment of the impact of these initiatives has been carried out, which would be a necessary step in scaling them up.

Risk management tools

Potential investors in African agriculture are exposed to several risks associated with the price of products, weather and disease related events, policies and other institutional and infrastructural deficiencies, as well as co-variant risk profiles. Due to real and even perceived risks in agriculture, banks and other financial institutions tend to limit their exposure. Several tools are being tried and used in Africa to reduce and manage risk for agricultural service providers and producers, with a view to catalyzing private sector funding for agriculture. These include weather-based tools, guarantees, and risk management tools.

Weather Index Insurance: Crop and livestock insurance can play an important role in reducing climate and disease related production risks. They can also reduce risks for financial service providers including banks and other financial institutions. Traditional crop and livestock insurance are uncommon in Africa, as they are costly to administer and are prone to moral hazards and adverse selection. Instead, countries, with the support of international institutions have explored index insurance for weather risks coupled with mobile registration and payments. The insurance compensates subscribers for production loss when a reference index, for instance, rainfall level, is not reached. Several African countries, namely Malawi, Ethiopia, Kenya, Rwanda and Tanzania have piloted weather index-based insurance schemes. In Malawi, the World Bank, in collaboration with Malawi's National Association of Smallholder Farmers (NASFAM), developed on a pilot basis, an index-based crop insurance to compensate farmers when rainfall during a crop growing cycle was insufficient. The insurance contract was bundled with loans to farmers that cover the cost of high quality seeds.

In Kenya, Rwanda and Tanzania, the Syngenta Foundation for Sustainable Agriculture launched the Agriculture and Climate Risk Enterprises (ACRE), a private commercial company, to take over its crop insurance operations, Kilimo Salama ("safe agriculture") initiated in Kenya. The company uses weather stations to collect rainfall data and implements short message service (SMS)-based mobile technologies to distribute and administer the payouts. Farmers can "try out insurance" by insuring as little as one bag of seed. Insuring one acre of maize against drought costs a farmer about US$37, or 10 percent of harvest value. In addition to insurance, the company facilitates agricultural lending and advisory services.

Experience from these and other countries indicates that weather index insurance offers a potential solution for managing risk in agriculture. It emboldens farmers to engage in riskier and more lucrative investments, and consequently, increases earnings. A 3-year study in Ghana found that farmers with rainfall-indexed insurance—in which insurance payouts are based on rainfall amounts—spent US$266 more on harvest expenditures, compared with uninsured farmers. Insured farmers also earned US$285 more in revenue, and their post-harvest assets were US$531 higher (Karlan et al., 2014). Index-based drought insurance products also showed positive effects in rural Kenya. Specifically, insured households are, on average, 36 percentage points less likely to anticipate

[12] hhttps://thegiin.org/knowledge/publication/annualsurvey2016

drawing down assets, and 25 percentage points less likely to anticipate reducing meals upon receipt of a payout (Janzen & Carter, 2013). Farmers who can obtain weather-based insurance have better access to other forms of financing as well (Ruete, 2015).

Weather insurance, however, is in no way a panacea and will only succeed if challenges related to production, marketing and sale of crops, etc., are addressed. Effective index-based weather insurance also requires reliable, timely and high quality weather data. More often than not, this is lacking in many African countries, as most countries do not have 10–20 years of historical rainfall data, while collecting, verifying and analyzing the data is time consuming. An enabling legal and regulatory environment is also key for the success of the insurance scheme. This is particularly important where the schemes in different countries, and differing insurance regulatory environments may pose a particular challenge.

Credit Guarantees: Credit guarantees are normally used to complement the security offered by the borrower in case the lender considers it insufficient. The approach is to provide a partial credit guarantee to financial institutions without necessarily relieving them of their credit responsibility. These schemes are designed such that on one side are financial institutions, including banks and microfinance institutions which extend credit to clients, and on the other is the guarantee provider. Typically a fund is set up by an international institution or a central bank which shares the default risk with the financial institutions. Credit guarantees thus improve access of farmers and small agribusinesses to finance, while compensating the lender for part of the risk, should the borrower default.

Although not widespread in Africa, credit guarantees are not new in the region. As early as 1977, Nigeria established, through a decree, the Agricultural Credit Guarantee Fund Scheme (ACGSF). The aim of the scheme was to encourage banks to lend money to all categories of farmers by providing guarantees on loans granted by commercial banks for the agricultural purposes defined by ACGSF. A revamped version of the ACGSF, the Nigeria Incentive-based Risk Sharing System for Agricultural Lending (NISRAL) was recently launched (see Box 7.2). NIRSAL, an initiative of AGRA and the Central Bank of Nigeria (CBN), the Bankers Committee and the Federal Ministry of Agriculture & Rural Development (FMARD), provides guarantee in the form of Credit Risk Guarantee (CRG) as comfort for banks to lend

Box 7.2:
The Nigeria Incentive-Based Risk Sharing System for Agricultural Lending

Objectives: NIRSAL aims to increase the productivity of the Nigerian agricultural sector by mobilizing financing for Nigerian agribusiness. The aim is to generate an additional US$3 billion in agricultural financing over 10 years by incentivizing banks to increase the availability of capital in the market. NIRSAL recognizes the need for a holistic approach. In addition to encouraging banks to lend, the system provides support to farmers and enterprises along the agricultural value chain through business and technical training.

Operations: NIRSAL was designed by AGRA on behalf of the Central Bank of Nigeria. It was capitalized at US$500 million and has five pillars: (i) a Risk Sharing Facility (US$300 million to leverage US$3 billion in loans to the agricultural sector); (ii) a technical Assistance Facility (US$60 million to support both borrowers and lenders); (iii) an Insurance Facility (US$30 million to develop innovative and affordable insurance products); (iv) a bank Incentive Mechanism (to further incentivize banks which demonstrate effective and significant lending to the agricultural sector; and (iv) Bank Rating Mechanisms (to rate banks and determine which ones should be further incentivized). NIRSAL provides Credit Risk Guarantee (CRG) as a comfort for banks to lend and also incentivize farmers through provision of Interest Drawback Program (IDP) to be paid quarterly based on the agricultural project. The guarantee ranges from about 30–75 percent, depending on the agricultural value chain involved. IDP also ranges from 20–40 percent depending on the category. A Technical Assistance Facility trains farmers and builds the capacity of banks and microfinance institutions to lend sustainably in agriculture.

Target: NIRSAL targets all actors in the agricultural value chain.

Outcomes: From inception in 2012 to date, 454 projects valued at ₦61 billion (US$273 million) have been guaranteed by NIRSAL and enabled 3 private insurance companies to expand their portfolios to include agricultural finance. Furthermore, ₦753.36 million (US$3.36 million) was paid out as interest rebate to borrowers who repaid promptly to encourage good repayment behavior, thereby minimizing default. In addition, by the end of 2014 NIRSAL had trained 27,142 farmers across the country.

and also incentivize farmers through provision of Interest Drawback Program (IDP) to be paid quarterly based on the agricultural project (Box 7.2). The guarantee ranges from about 30–75 percent depending on the agricultural value chain involved.

Another recent example of the use of guarantees is by the Standard Bank of South Africa. It established a US$100 million facility to provide financing to small-scale farmers and agricultural businesses in Africa. To mitigate the high risk that characterizes agriculture and increase commercial lending to the sector, loans are guaranteed by AGRA and the Millennium Challenge Account (MCA). One of the lessons learned is that banks should have a real interest and be incentivized to become involved in agricultural lending. Training bank staff in the specifics of agricultural lending is in most cases a prerequisite for successful schemes.

The flip side of credit guarantees in general is that they tend to diminish the incentive of lenders and borrowers to diligently monitor repayment. In addition, given that most experiences reflect dependence on government and donor subsidies, the sustainability of guarantee funds is questionable (FAO, 2013a).

The African Risk Capacity: The African Risk Capacity (ARC) is a recent initiative aimed at merging disaster relief with concepts of risk pooling and transfer for sustainable development in Africa. The ARC is a specialized agency of the AU designed to assist member states resist and recover from the havoc of natural disasters through a weather insurance mechanism. In this system countries purchase insurance against a crisis, say drought, and are compensated once it is determined that the country has experienced the risk. ARC Limited was established by the ARC Agency in 2013 to provide sovereign weather risk insurance coverage to African countries. It is a mutual insurance company owned by its members (participating governments and "returnable capital" contributors DfID and KfW, while their capital remains in the company). Up to 7 African countries have signed on to the schemes, with coverage of about US$178 million. So far, three countries, Mauritania, Niger and Senegal have received compensation from the scheme.

To play an even greater role in risk management in the continent, the ARC Agency needs capacity enhancement in modeling and data collection. So far, the agency is only able to handle risks associated with drought, yet Africa is also prone to other risks such as floods and cyclones. Extending the Agency's capacity to cover such risks is therefore critical. The capacity of the Agency capacity to support member states also needs enhancement. This is important considering that so far only seven African countries are participating in the risk program.

Result-based financing

As part of the agenda for development effectiveness, new efforts are being made to relate development finance more closely to outcomes achieved, rather than to inputs used. Given the importance of agriculture in socio-economic development in Africa, issues of result-based financing are becoming increasingly important in the sector. Four types of result-based mechanisms have been identified: prizes and award to incentivize research and development; development impact bonds for front-loading capital for social interventions; performance based contracts; and advanced market commitments to provide guarantees for future markets for a product. In the agricultural sector, this mechanism has been successfully applied in fertilizer subsidy schemes, whereby the governments are only receiving donor funds once the subsidy has reached the farmers on time.

A particular type of result-based financing that is taking root in the continent is impact investment: The aim of impact investment is to generate positive social and environmental impact alongside financial returns. Thus, the main distinction between this type of investment and other forms is the focus on positive social and environmental change. This type of financing is already attracting a wide variety of investors, both individual and institutional. Investments are typically through funds, with clear social and environmental goals. Although relatively new and initially focusing on investments in education, health, social housing and microfinance, the interest in this instrument for food and agricultural investments in Africa is growing, as shown by the Global Impact Investors Network (GIIN) 2016 Impact Investor Survey .

While a compelling case exists for results-based financing in Africa, significant untapped potential remains due to several bottlenecks in and out of the sector. These include the fact that results-based financing is often difficult to develop and implement, a lack of awareness of their existence, lack of adequate or appropriate financing sources, lack of appropriate corporate structures and lack of appropriate policy and institutional frameworks.

Financing to support women and the youth

Providing financing to agriculture is particularly challenging for both adult female and youth farmers. The challenges to women relate to their traditional role in the household that often restricts their control over assets and constrains their engagement in productive activities. Women often have limited control and ownership over land, and thus, the ability to access loans, which more often than not, requires land as collateral is not easy. Transforming African agriculture

requires: recognition of the critical role that women play; and investment in measures that target the needs of women farmers including but not limited to finance. Recent research and experience demonstrate that there is a business case to be made for closing the financing gap between men and women in African agriculture.

The youth similarly face several challenges that constrain their access to finance, and thereby limit their participation in agriculture. These include lack of innovation in the formal banking industry and inadequate financial capabilities by the youth themselves. Other constraints include the lack of assets and lack of knowledge and information about the general business environment. Like women, Africa's youth usually do not possess the collateral needed to make them eligible for loans from the formal banking sector or from informal sources. Youth typically do not possess formal land titles, they lack steady employment, and are not endowed with mobile assets, such as cars, motorcycles or furniture, that can be accepted by formal financial service providers as loan guarantees (Filmer & Fox, 2014).

Some good progress has been reported on financial inclusion in the continent, thanks to financial innovations and approaches, some of which have already been discussed. Financial institutions, riding on ICT technologies, are increasingly adopting tailor-made instruments for both the banked and unbanked women and youth in agriculture. Several efforts have supported women and youth in accessing agriculture value chain finance by addressing their specific needs. However, financial institutions alone cannot provide the solution. Indeed, governments and policy makers can influence the establishment of an investment climate favorable to rural women and youth. Adopting gender-responsive land reforms and increasing well-targeted public expenditure in agriculture are just two of the areas governments can be instrumental in improving the lot of women and youth in agriculture (Njobe, 2015). Private initiatives such as "Kiva" for mobilizing funds, especially for women and youth such as crowdfunding (Box 7.3) need to be nurtured and encouraged. To promote young agripreneurs, there is need to improve the financial literacy and the capability of institutions serving the youth for them to be able to assess agricultural sector opportunities.

International organizations and donors also have an important role to play, especially in mainstreaming issues of access to finance by women and youth and promoting women's legal, economic, political, social, and cultural rights. In supporting these special groups, international organizations and donors should also seek to promote forms of finance that do not require fixed collateral, such as contract farming, leasing and warehouse receipt schemes. These institutions can also play a more direct and affirmative role. For example, launched in 2016, AfDB spearheads the Affirmative Finance Action for Women in Africa (AFAWA) program, which is designed to provide available, accessible and affordable financial services to women in business through selected financial institutions. The approach is to de-risk the financial system to allow financial institutions to lend to women. AFAWA will also empower women in business with information, training and knowledge sharing.

Box 7.3: Crowdfunding for African farmers

A novel and fast growing financing model that can help women and the youth raise funding from multiple individuals and donations is crowdfunding. It essentially involves the use of the Internet to connect borrowers and lenders. This approach began as an online extension of traditional financing by friends and family and village saving clubs, which are common among women groups and the youth. This exciting phenomenon is spreading across the developed and developing world and into sectors such as agriculture and agribusiness. A good example in Africa is "Kiva" that is providing loans to the poor and the unbanked and underserved. Kiva extends loans of a minimum of US$25 which are operated by some 450 volunteers around the world. In Africa, Kiva has about 110 field partners, typically MFIs that operate the loans. Repayment rates for Kiva are as high as 98.7 percent.

[13] https://www.kiva.org/lend?gclid=CjwKEAjwIt C9BRDRvMfD2N66nIISJACq8591x3uwyU JL9dgVkiGKEBgNM6AvqaBHO0HWI9itBZdZAxoCx4jw_wcB

Conclusions and policy recommendations

Conclusion

Access to finance is critical for agricultural growth and transformation in Africa. The shift from subsistence-oriented agriculture to commercial agriculture will require resources at all levels of the agricultural value chain. Yet, Africa's agriculture sector today attracts less than five percent of the lending from formal financial institutions, leaving farmers and agricultural enterprises starved of the

capital they need to operate and grow their enterprises. Africa, especially SSA, lags behind other regions of the world in supplying financial services to the agricultural sector. This is despite the fact that the sector is a source of livelihood for many Africans, especially those based in rural areas.

This chapter has examined some of the new ways of financing agriculture in Africa. With the enormous financing needs in the sector, in recent years efforts have been made to explore and develop new ways of financing the sector. The objective is to mobilize additional resources and to address market and institutional failures that inhibit access to capital, especially by farmers and by small- and medium-scale agro-enterprises. The chapter has also reviewed current needs and sources of agriculture finance in Africa and the instruments available to address these needs. Moreover, it examined the role of different actors including government and the private sector.

Several innovations have been introduced in Africa aimed at channeling new resources for agriculture and catalyzing finance to the sector. By so doing, these innovations will complement the traditional sources such as government investment, ODA and FDI. Innovations, in terms of new products, delivery channels, and partnerships along with greater attention to savings, provide fresh optimism that the financing deficit in the agricultural sector can be bridged. Many of the innovative approaches have already become widespread, such as the value chain approach to agriculture, the use of insurance coupled with finance and the widespread incorporation of mobile applications for micro and small households. The tools that have been used range from innovative credit tools and derivatives, to risk management and impact financing. Some of these innovations such as the risk sharing system in Nigeria, NIRSAL and the weather based index insurance are potentially transformative. These will require careful expansion, fine-tuning and replication in the continent. More than ever before, greater attention is being paid to the need to manage and mitigate risks, including those associated with climate change.

Some of the innovative ideas are still in the early stages of design and implementation. Their potential impact and limitations are therefore not obvious at this stage. Also, some of the existing innovations have not been evaluated, or the evaluations lack the requisite rigor. There is thus need to evaluate the new ways of financing agriculture to draw critical lessons and experiences. More importantly, many of these innovative tools face the critical challenge of scale. For example, some of the funds such as AATIF and AgDevCo will need further investments at scale, if they are to have significant impact in the continent. A larger pool of private investors and more easily replicated instruments will be essential going forward. Furthermore, there is need to ensure that the interventions in the sector are well coordinated, given that these are coming from a large and growing number of institutions and agencies across the continent. In addition, there is clearly need for a “repository” of innovative ideas in financing African agriculture. On a more positive note, many of these tools such as impact investment and crowdfunding have attracted new investors to the agriculture sector in Africa. The challenge is to nurture and encourage them.

Generally, innovative ways of serving agriculture and rural areas, along with the promise of technology, have provided incentives to formal and informal financial institutions to increase their presence in rural areas, to serve the agricultural sector’s needs. Digital financial services (DFS) have the potential to address financial access and payment issues that farmers face today, especially those living in rural and remote areas. Although it is too early to draw conclusions from the positive effects of DFS, initial evidence from various parts of the world suggests that DFS present a real opportunity to address financial access challenges in agriculture. Efforts to complement existing DFS with new innovations that are designed to meet the needs of farmers, especially smallholders, and agricultural enterprises are necessary.

Innovative approaches to financing African agriculture should not be limited to financial institutions. Other actors, namely government, the private sector, donors and philanthropic organizations have important roles to play. The government can play a proactive role in developing policies and a regulatory environment conducive to growth of the private sector investments in the agriculture sector. Laws and regulations to ensure that existing and new instruments thrive are critical. For example, to attract remittances to the sector, governments need to ensure that appropriate rules and regulations are in place. Regulations need some elements of flexibility as well, so as not to stifle innovation. In addition, governments have an important role to ensure that the infrastructure gaps in the continent, some of which have been identified in this chapter, are addressed. The private sector will be instrumental in bringing new capital into the sector directly or through co-investment with the government through PPP arrangements, and to bring rigor in return on investment expectations and management of funds. Donors, including philanthropies, can help support new models of agricultural financing by taking the higher risk and lower return parts of the financing structures to leverage private sector investment in agriculture.

Policy Recommendations

This review on new ways of financing African agriculture suggests several policy implications:

- The need for African governments to engage directly with key stakeholders involved in scaling up financing by building synergies to achieve economies of scale. By directly engaging in instruments such as blended finance, governments can magnify the impact of their own resources and bring the innovations to scale.

- African governments to reflect on appropriate risk-sharing and financing mechanisms for the agricultural sector.

- Leveraging on partnerships with the private sector, development partners, philanthropies, NGOs, farmers and financial institutions. Partnerships between financial institutions and value chains actors as well as partnerships between different types of financial institutions should be encouraged. Supporting dialogue and partnership is critical.

- Governance and an appropriate legal framework to ensure transparency and responsibility in the financial market are critical to upscaling finance for African agriculture.

- Support measures and innovations to mainstream women, the youth and other minorities in agricultural finance through appropriate policies and guidelines.

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CHAPTER 8

Modernization of Agriculture through Digital Technology

AUTHORS

Hortense Mudenge
Milan Innovincy Consultant

Washington Otieno
CABI

KEY MESSAGES

ONE

The African continent has shown tremendous economic growth in the last decade based on the GDP per capita estimates with increasing investment in infrastructure, agriculture and trade. This has been largely influenced by the high level of political will and initiatives in these sectors and the increasing use of digital technology platforms in facilitating service delivery. Key challenges remain in sub-Saharan African countries however as regards scaling and sustaining this success.

TWO

Advances in digital technology are transforming the agricultural sector, quickly aggregating farmers and farm level data that is helping boost financial inclusion for smallholder farmers. Emerging technologies are also being integrated with mobile technology that is pervasive in SSA to scale and replicate success across the agricultural sector. This leads to networked value chains that have helped increase productivity at farm level, facilitated access to markets, and created cost efficiencies across value chains.

THREE

Smallholder farmers and farmer organizations are still facing challenges with information flow and management due to limited financial resources and technical knowhow for applying technologies needed to mitigate effects of climatic change. New technologies are also too complex and sophisticated for smallholder farmers to use, which has limited their adoption and impact.

FOUR

Governments and decision makers are intervening in the development and promotion of digital technology in the agricultural sector by fostering multi-stakeholder partnerships to promote the use of sustainable and climate smart ICT models so as to improve resilience to climate change and foster financial inclusion.

FIVE

Digital technology has the potential to catalyze all parts of the food system and is currently doing so in an inclusive and sustainable manner, targeting smallholders, women and youth. The high level political will and commitment to increased growth in the agricultural sector, observed through the enactment of regional policies is helping accelerate climate smart agriculture and financial inclusion,that has resulted in increased access to inputs and markets by smallholders and positive regional externalities.

Introduction

Traditional attempts to improve the incomes of smallholder farmers in SSA have focused on increased access to improved seeds, irrigation technology, fertilizers, pesticides, agronomic training and financial services. The increased penetration of mobile technology and the Internet have had an enormous impact on the lives of farmers, providing new ways of doing business, buying and selling produce and communicating outside one's village.

Digital technology is also beginning to offer new and improved ways of managing one's farm and connecting to other players throughout the value chain. Venture capitalists invested more than US$2 billion in agriculture technology startups in 2014 and again in 2015; the trend is expected to continue in 2016 and the coming years as the demand for innovative farm technology remains high (AyokaSystems, 2016). Advances in digital technology are bringing to the forefront potentially transformational technologies available to the typical smallholder farmer in SSA. These technologies are offering new ways to modernize agriculture, by quickly aggregating farmers, providing critical plot-level information, and delivering customized alerts.

This chapter looks at the trends and developments underpinning digital technology in agriculture in SSA to date. The chapter focuses on the models that have been successful in effectively addressing the challenges faced by smallholder farmers; the policies that are helping accelerate digitalization or the use of digitalization by smallholder farmers; and new interventions that are seeking to empower smallholder farmers, strengthen food systems, and advance rural development in SSA for the long haul.

Drawing on current successes and opportunities observed in the agricultural sector as regards digital technology, this chapter suggests a few policy recommendations and solutions for decision makers to enable the scaled and sustainable use of digital technology in the coming 10 to 15 years.

Changing economic landscape in Sub-Saharan Africa

Increasing competitiveness of SSA countries

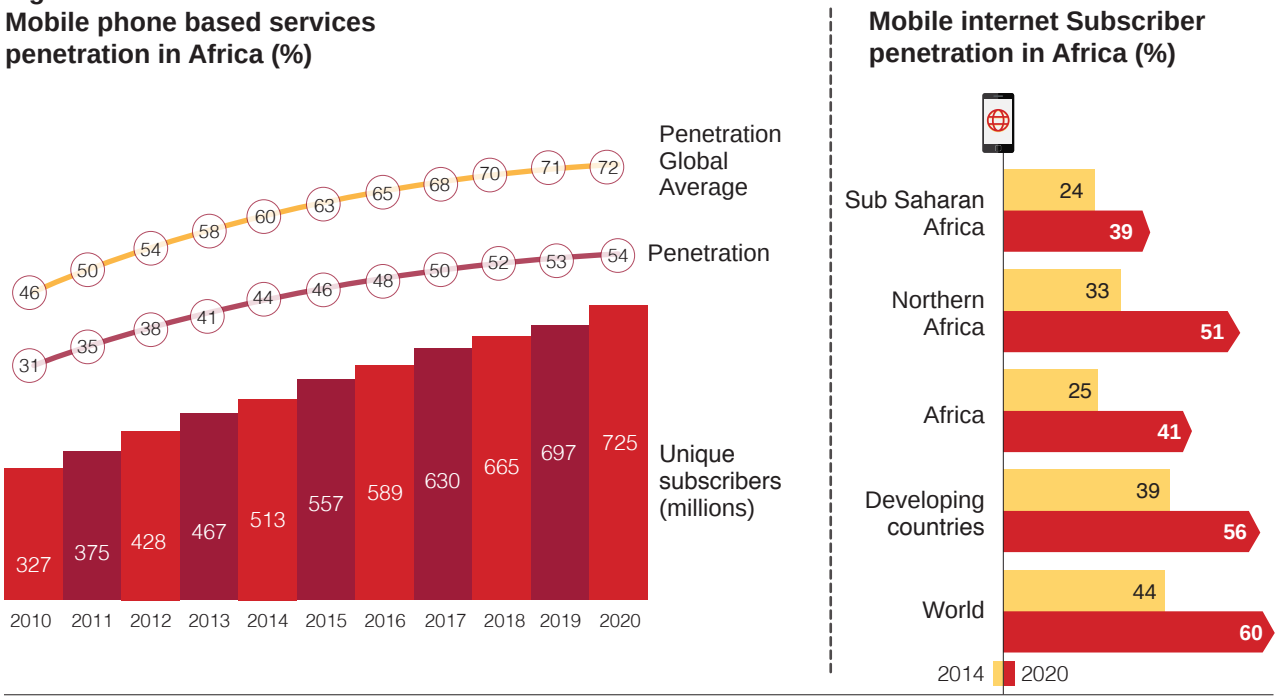
The International Monetary Fund (IMF) forecasts that Africa will be the second fastest growing region in the world between 2016 and 2020 with an annual growth of 4.3 percent, up from 3.5 percent in 2015 (Barton & Leke, 2016). Investment in infrastructure has doubled over the last decade and currently stands at 3.5 percent of GDP, mobile technologies and services generated 6.7 percent of GDP in 2015 (GSMA 2016) and in most countries GDP growth per capita registered at 4.2 percent in 2015 as a result of improved competitiveness and strong trade performance in continental and regional markets (Husman et al., 2015). Rapid technological change is also helping economies leapfrog the limitations of physical infrastructure, bringing about growth and change in key sectors (Barton & Leke, 2016). Africa's smartphone penetration is currently at 23 percent and is projected to reach 50 percent in leading sub-Saharan African countries in the next 5 years with the reduction in the cost of mobile phones (GSMA, 2016). Internet penetration stands at 24 percent, whereas mobile phone penetration is already above 75 percent in SSA, with penetration of mobile-based services increasing by 2–3 percent annually, as shown in Figure 8.1 (GSMA, 2016).

Productivity in cities is three times higher than in rural areas with increasing urbanization. Over the next decade, the United Nation estimates an additional 187 million Africans will live in cities; the African continent is expected to have the world's largest working-age population of 1.1 billion by 2034 (Barton & Leke, 2016).

Agriculture accounts for 32 percent of GDP in most countries in SSA, with 65 percent of the population employed by the sector (World Bank, 2015). Several countries have broken through the two-ton per hectare threshold for staple crops, meeting the benchmark for overall agricultural land productivity (Gertz & Kharas, 2016). This has been largely driven by the high level political commitment to agriculture that has resulted in investment in rural infrastructure; extension programs to increase farm level productivity; improved policies facilitating trade in local and regional markets; and new high yielding and resilient techniques and crops increasing farm level productivity (Makhtar, 2016). In a few countries in SSA, the agricultural sector is also slowly transforming from being subsistence-oriented into a more productive and commercialized sector (World Bank, 2016). With this shift, SSA is recording more medium- to large-scale farms which are beginning to supply the sector, largely as a result of improved infrastructure and land consolidation efforts by governments, arising from the need to capture economies of scale in production and marketing (WEF, 2015).

Despite this progress, small-scale agriculture is still prevalent in Africa with estimates showing about 60 percent of the farms in SSA to be smaller than 1 hectare (Ousmane, Makombe & Collins, 2016). The growth in the take-up of mobile services is also minimal with penetration expected to reach 54% in 2020 as a result of the high costs in mobile ownership, limited connectivity and high technical illiteracy rates (GSMA, 2016). In the next 15 years, food production in SSA will need to increase by 60 percent to

Figure 8.1:
Mobile phone based services penetration in Africa (%)



Source: *GSMA 2016 (The Mobile Economy Africa)*

feed a growing population (Makhtar, 2016). Policy makers therefore need to look at accelerating these economic and growth reforms, focusing mainly on expanding access to banking and financial services to smallholder farmers; increasing access to inputs and markets; increasing power supply and electricity; improving educational systems to develop the skills needed; promoting regional integration to unlock regional manufacturing and trade; and improving the physical and digital infrastructure (Barton & Leke, 2016).

The Changing Nature of Challenges in the Agriculture sector in SSA countries

Most countries in SSA are still plagued by several major infrastructural and natural challenges including: underinvestment in rural areas; inadequate access to infrastructure and markets; unfair market conditions; inadequate access to advanced technologies; and high production and transport costs to mention a few. These challenges continue to cripple agricultural value chains resulting in low productivity and limited cost efficiencies (Kelsey, 2013).

For under-performing value chains, the low capacity to comply with sanitary and phytosanitary (SPS) (WTO, 2014) measures and quality standards of agricultural products (OECD, 2009) restricts the share of African agricultural products in lucrative international markets. Overcoming these constraints requires policy and legal interventions that empower regulatory institutions to deliver on their mandates efficiently, rather than being bottlenecks to agricultural enterprises.

Limited access to; agricultural advisory services (AAS); technical knowledge; market information; training; quality inputs and capital; are among the chief obstacles to smallholder farmers in SSA improving their productivity, increasing their incomes and strengthening food security today (Elliott, 2015)), as shown in Figure 8.1 and discussed further in the following sections. Initiatives such as the CABI-led Plantwise Programme have shown that there is great potential to improve the quality of AAS for smallholder farmers. Through some of its products such as pest management decision guides (PMDGs), Plantwise is enabling stakeholders in plant health to target production practices in specific value chains to improve the adoption of good agricultural practices that are the prerequisites for competitiveness in markets for agricultural products. It is evident that a mixed model of giving both value chain specific and general advice to farmers presents the best opportunity for agricultural transformation when dealing with diverse small-scale farmers. These notwithstanding, access to and use of data on crops and factors that limit productivity across agro-ecozones and the information needed for crop management at production level is still limited. The Plantwise Programme has been able to initiate the data management systems across 12 countries in Africa (Burkina Faso, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Rwanda, Sierra Leone, Tanzania, Uganda and Zambia) since 2010. Under its knowledge bank countries and stakeholders in

agriculture are able to access data that they can use in endeavors to transform agricultural production. However, this requires proactive engagement among plant health stakeholders in public and private sector for maximum benefit to countries.

In Africa water is perhaps the most limiting factor to crop production. The FAO emphasis on intensification of agricultural production systems (FAO, 2011) should be embraced in all agriculture development programs. Agricultural investment in Africa must not ignore efficiency in water use through small-scale irrigation, for example, under plastic tunnel "green-houses" as offering an opportunity for intensification, especially with regard to high value cash crops such as vegetables. For intensification of small-scale agriculture to be realized, efforts must be made to improve water harvesting and storage in appropriate conservation infrastructure for later use during drought. Dependency on rainfed agriculture cannot guarantee realization of food security on the continent.

Limited access to finance: Large gaps remain in meeting the financial needs of smallholder farmers across SSA. According to the Global Financial Index, in 42 African countries in 2014; only 29 percent of adults in rural areas had a mobile money account or an account at a bank, compared to 34 percent at the national level with a significant gap between women (30 percent) and men (39 percent) (Okonjo-Iweala & Madan, 2016). Rural households were also excluded from formal sources of credit with only 6 percent borrowing from a formal institution and most relying on friends and family or informal lenders, such as traders or processors (Okonjo-Iweala & Madan, 2016). Smallholder farmers tend to be geographically dispersed, resource poor, and illiterate, all of which amplify costs and risks involved with lending. In addition, unpredictable weather patterns, long crop cycles, irregular market access, and high input costs make it even less appealing to financial institutions (Deloitte, 2012).

Disaggregation: Small-scale farming in SSA is often largely disaggregated with smallholder farmers owning small individual plots of land (Monitor, 2010). This strains logistics and access to supply for agribusinesses that have to invest much time and money in coordination efforts—traveling to and from individual farms to negotiate contracts, assess crops, and collect loans and payments with farmers trekking to company sites to collect payments and loans (Gustafson, 2016). The lack of primary information or data on farmers (such as profile, plot location, plot size, and productivity); markets (prices, locations, and buyers); and extension services (agents, locations, and channels), for example, in a few select countries, is still limiting the development of sustainable digital services that consolidate all data into one platform to bring new benefits to farmers and increase the reach of value chain actors (Balaji, 2009).

Poor information flow: In most African countries, farmer organizations lack the knowledge and tools to identify, assess and communicate agronomic knowledge and advisory services to their members. Extension service agents also face similar problems and often lack the means and tools, if they possess the knowledge, to disseminate information to these farmer organizations in a timely fashion (Accenture, 2015). In the case of financial management, smallholder farmers lack the knowledge and respective tools to enable this, resulting in poor or inaccurate records not consolidated effectively enough to allow for transparency, efficiency, proper governance and accountability (World Bank, 2011). This gap in information flow and tools limits and aggravates decision making in planting, monitoring, harvesting, marketing and general business management, resulting in major crop loss, low productivity, and subsequent low sales and incomes (Accenture, 2015). Many initiatives collect data useful for agriculture. However, if these initiatives remain disparate and are not conducted within the government systems, and if they are not accompanied with the corresponding adequate use of data to benefit farming, they cannot contribute to endeavors to make agricultural production systems efficient. Working with partners, CABI has built databases that countries have yet to use optimally. Putting, for instance, the data in the Plantwise Online Management System (POMS) into use is only possible if countries handle agricultural information and data as an input in integrated plant health systems in which extension, phytosanitary and pesticide regulators, agricultural research agencies, and private sector entities such as suppliers of agricultural inputs and farmer associations have common interests.

Poor farmer extension: Smallholder farmers continue to lack access to knowledge about current best practices and therefore end up misusing input resources at a hefty cost and great crop loss. The barriers to extension on a large scale continue to pose a great challenge: extension agents are too few; farmers grow too great a variety of crops and speak too many languages for service providers to develop and apply a standard approach or methodology; and transportation infrastructure is inadequate, making it difficult for extension agents to reach rural communities (Gandhi, 2016). Agro-input companies, on the other hand, have the input products needed, but face challenges in reaching smallholder farmers who live mainly in remote, hard to reach places. The core link between the two, agronomists and extension agents, also often lack a platform on which to record farm and crop data that could help other value chain actors. This can result in a vicious cycle of misinformation, misuse of resources, low productivity and crop loss despite

high input costs, and a disconnected and under-performing value chain system (Ousmane, Makombe & Collins, 2016). Across the 12 African countries where Plantwise has been piloted and even scaled up, the use of improved advice on plant health to farmers through government agricultural extension services has shown good potential to capture data that helps countries build their own databases such as the Plantwise Knowledge Bank. This also enables most problems to be traced back to the locations of their initial occurrence, enabling targeted control actions. Using paper-based data collection has worked relatively well in these countries. However, deploying tablet computers as an alternative (though so far piloted effectively only in Kenya & Rwanda) has made remarkable improvements in efficiency in data capture and flow and in delivery of advice to farmers even on complex pests. This program has targeted advisory services specific to plant health. Nevertheless, its potential to support National Plant Protection Organizations (NPPOs) in their functions (Article IV of IPPC), particularly surveillance and early warning needed to enable emergency action on newly detected pests or changes in pest situations, cannot be over-emphasized. However, the usefulness of these resources to countries requires multi-stakeholder engagements around important plant health issues.

The rise of digital technology and its relevance in Sub Saharan Africa

This section looks at ICT platforms that are currently being leveraged in the agricultural sector in SSA to create efficiencies across the value chain and support decision-making processes and the infinite potential of emerging digital innovations in the near future.

Defining Digitalization

Digitalization in agriculture includes activities such as the development, testing and deployment of ICTs for agricultural research, development and delivery. It includes software engineering, data analytics, precision agriculture, and farm systems management adapted to suit local and regional contexts in an effort to maximize production, and ensure cost effectiveness . Key elements of data capture and access to information that support extension officers in diagnosing problems with plant health and their access to information needed to advise farmers on effective and practical solutions to plant health problems have successfully contributed to improved efficiency and accuracy in solving plant health problems. These elements include the sharing of images taken in the field, use of various application networks such as Factsheet Library App and open access platforms like the Plantwise Knowledge Bank.

Much of the success of modern agricultural systems has depended on the use of various technologies. These include: machine power and technology to enhance soil fertility; improved genetics for crops and livestock to enhance yields, quality, reliability and resilience against pests and diseases ; access to efficient and effective irrigation systems to supplement rainfall in many climates; advanced harvesting, handling and storage equipment, software and techniques to prevent loss and to market commodities efficiently (Motes, 2010).

The benefits of these technologies have been largely only limited to large-scale industrial agricultural players in the past. However, recently the use of ICT has helped improve the farming experience across small-scale value chains as well. This has allowed smallholder farmers to selectively access market information, interact with value chain actors along the entire supply chain, and ensure traceability, compliance and sustainability of their produce and farms (Gustafson, 2016).Mobile-based technologies have helped facilitate digital payments and receipts by smallholder farmers, enabling them to get paid more quickly and reliably, and making it easier for them to access credit, insurance, and other financial instruments through well-documented financial histories (World Bank, 2016). Increased use of ICTs presents farmers and regulatory agencies with a wonderful opportunity to overcome the constraints to establishing effective traceability systems. With the need to organize smallholder producers under specific value chains into stable units, the technology enables value chain actors to establish structured and easy to regulate entities that comply with product safety and quality standards, as exemplified by those served under Farmforce, an initiative of Syngenta Foundation (Sygenta Foundation, 2013).

ICT tools thus empower those who give advice to farmers to do their work efficiently and farmers to improve how they manage their farming processes. Increasingly, young and educated people are getting into agribusiness. They will be the major drivers for the uptake of ICT tools and resources in agriculture. Published literature attesting to this is still scanty, as it comes largely from ongoing development work. Abstracts from various conferences, such as the Information Communications and Technology for Development (ICT4D) conference form the main references from where lessons can be learnt to target future interventions .

The Crux of Digital Technology

Digitalization has resulted in inclusion, efficiency, and innovation in Africa as a whole and particularly in the agricultural sector. This has enabled different value chain actors to trade and communicate easily and more

frequently across regions, make better use of their capital and labor, and exploit scale effects through online platforms and services (World Bank, 2016). Digital technology is also facilitating value chain actors in decision making on which strategic interventions to make to realize increased productivity, better quality produce and improved incomes, as shown in Figure 8.2 (Kearney, 2016).

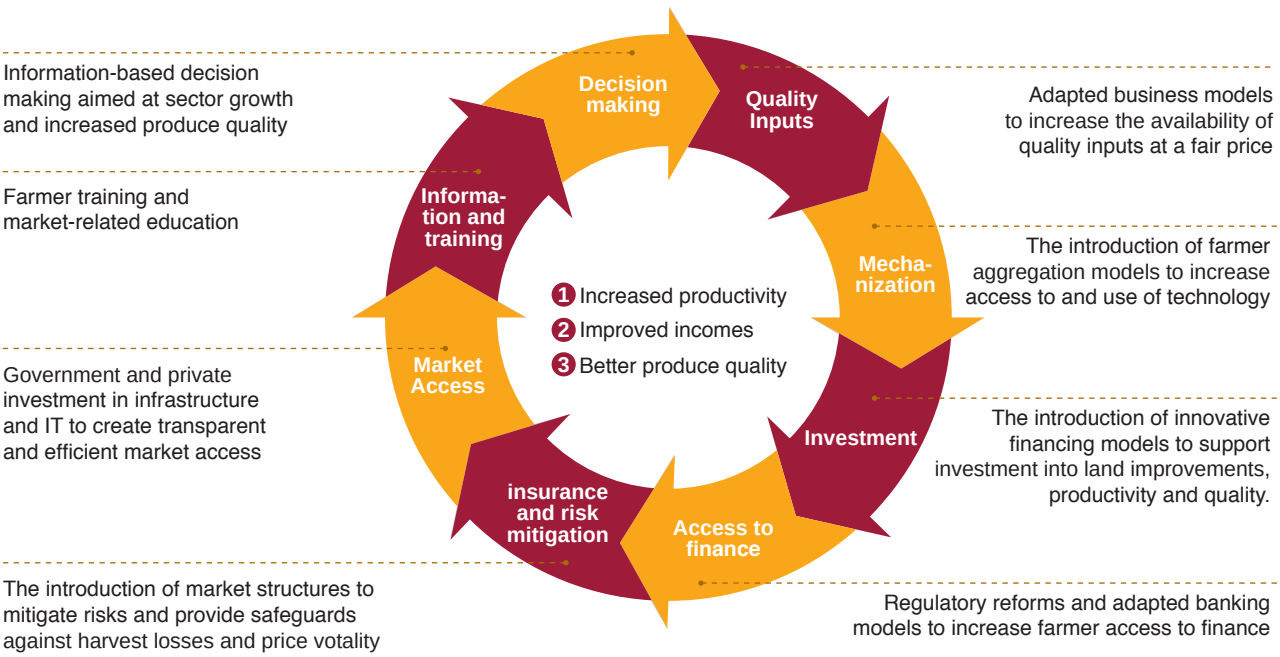
However, adoption of digital technologies has been low in SSA, especially among the poor, rendering viable and sustainable ICT delivery models somewhat useless in these situations. New agricultural technologies such as web-enabled sensors and data analytics are also alien to most of the smallholder farmers responsible for producing up to 70 percent of the world's food needs (Ousmane, Makombe & Collins, 2016). For these growers, services

Figure 8.2: Barriers Crippling Africa's Agricultural Sector

Underperforming Value Chains	Limited coordination of **research and development**	Insufficient utilization of **inputs and mechanization**	Limited reach of extension to boost **on-farm production**	Poorly organized post-harvest **aggregation and transport**	Inconsistent capacity for effective **value addition**	Poorly developed **market linkages** and trade corridors
Insufficient Infrastructure	Insufficient transport, energy, water, waste and other **hard infrastructure**, leading to uncompetitive cost structures			Undeveloped **soft infrastructure** including aging smallholder farmers and a lack of skills for commercial agriculture and agro-allied industries		
Limited access to agricultural finance	Real and perceived **risk** limiting private sector investment		High **service cost** due to small deal sizes, lack of credit data and low capacity in agricultural lending		Limited **market attractiveness** relative to perceived higher returns outside of the agricultural sector	
Adverse agri-business environment	Unfavourable **market access and incentives**, limiting trade and capacity to produce high-quality products		Ineffective **sector regulation** creating long lead times for new technologies and inconsistent trade policies		Unsupportive **business enabling environment** restricting land tenure and general ease of doing business	
Limited inclusivity, sustainability and nutrition	Insufficient **inclusivity** of women and youth in agricultural development		Limited incentives to ensure **sustainability** and climate resilient partners		Limited access and affordability of commodities with high **nutrition** levels	

Source: *Ojukwu, C, (2016). Feed Africa Annual Meeting*

Figure 8.3: Agricultural transformation across the value chain



Source: *A.T Kearney, Africa's Agricultural Transformation Opportunity, 2016*

available through less high-tech devices, like mobile phones, currently offer the most promise (World Bank, 2011).

Changing trends in digital technology in SSA countries

Current trends

Digital technologies are currently availing data on agricultural and market-based systems to farmers and other value chain actors much more quickly and effectively, giving all a strong foundation on which to make agronomic, logistical, financial and market-based decisions. This has slowly resulted in a connected value chain system supported by what are now called "digital farms" and "tech savvy farmers" (Bayer, 2016).

The rapid spread of mobile devices has allowed for instant interaction, information exchange and closer and broader collaboration to enhance performance (WEF, 2016). In the agricultural sector, mobile technology is enabling faster communication and response between value chain actors (CTA, 2015).

Digital Market Systems: Online and mobile-based content aggregation systems are overcoming the problem of disaggregation in agriculture in SSA, ensuring consistency in data collected, improving integrity of the data and addressing a wide variety of information needs (Deloitte, 2012).

- **Market intelligence services:** Digital platforms are currently enabling farmers to access price information, purchasing options, and other market intelligence. This increases farmers' power to negotiate with traders; to gain greater control over their product sales by finding new sources of demand; improving product quality to meet market conditions; and to cut out intermediaries by selling directly to large-scale buyers, traders and processors (World Bank, 2011), as has been the case with the success of Esoko. Work with Airtel Kilimo in Kenya from 2012–2014 that targeted 20 value chains (including maize, beans, cabbage, kale, passion fruit, mango, tomato, upland rice, poultry, cattle, fish, banana, coffee) delivered advice, covering the whole crop cycle from land preparation to post-harvest in seven major national markets. The initiative involved the Meteorological Department, incorporating weather data, which enabled production of information materials that support production processes and marketing relevant to prevailing country circumstances. The information resources were translated to Kiswahili to widen readership among Kenya's farming communities. Factsheets were produced for all the value chains and approved by experts from KALRO (GSMA, 2015). These factsheets have been added to the Direct to Farm (D2F) database where they can be accessed through an IP address. This example illustrates the potential mobile technology has to contribute to agricultural transformation in Africa.

CASE STUDY

Success of mobile and web enabled market intelligence platforms is yielding ripple effects across the region

Esoko, the popular SMS based platform that began as a small non-profit initiative in 2005 now has more than 350,000 farmers subscribed to it in over 10 countries in Sub-Saharan Africa, and access to over 170 markets and 150 field agents, collecting and sending over 9.5 million messages daily on input and commodity price information, that is helping farmers to realize sales margins of at least 11%.

Similarly, AGRO FIBA, a mobile and web based platform developed by M-Ahwi, a local Rwandan start-up, has managed to attract over 10,000 farmers in the maize and rice value chains in 1 year, through the access to agronomic, market and financial data via its platform and link to large-scale buyers like the Rwanda Grains and Cereals Corporation and East Africa Exchange, as well as financial institutions such as UOB (Urwego Opportunity Bank), that has facilitated a 60% increase in access to loans by member farmers.

Sources: *IFPRI Blog, 2016, Godan, 2016, and discussions with founder of M-Ahwi.*

- **Logistics Management:** Digital technology platforms are aggregating smallholder farmers in remote locations, making it easier for agribusinesses and processors to work with them, and subsequently ensuring reliability, quality and productivity of supply (GrowAfrica, 2015). With the use of mobile technologies to manage the business side of things—from establishing farmer contracts to making payments and sending receipts, agribusinesses are now able to cut down on both time and transportation costs which has made them more willing to work with remote farmers (Gustafson, 2016). The Zambia National Farmers Union (ZNFU), for example, launched an eTransport system known as Transzam. It is a web-based interactive information system which allows transport users to publicize availability of loads or cargo to a known destination and at preferred times of delivery to farmers and other transport users (Deloitte, 2012). Multiflower, a seed and cuttings exporter based in Arusha, Tanzania has also realized major savings in logistics from issuing mobile-based payments to its network of 3,500 out-grower farmers as show in Box 8.1.

- **Quality management:** Farmers can now make more informed decisions about which inputs are better or cheaper to buy and when and where to best obtain them to improve their capacity to raise yields. Service providers are also able to aggregate data on the origin of products for input providers enabling traceability and discouraging counterfeit goods (World Bank, 2011). As in the case of MPedigree in Kenya and Uganda, for example, developed by the International Fertilizer Development Center (IFDC) in partnership with CropLife Africa-Middle East, CropLife Uganda and Kenya, farmers subscribed to the platform are able to quickly authenticate the origin and assess the quality of input products via a USSD code. Likewise, data validation processes and their role in quality assurance on the advice given to farmers can help determine and correct cases where the advice has significant health and market access implications as exemplified by the recommendations to use red list pesticides or the wrong pesticide–crop–pest combinations. Lessons on these using Plantwise plant clinic data are best used by national regulatory authorities to monitor country situations with pest and pesticides; this is only feasible where the authorities are proactively engaging in sharing and using agriculture related data.

BOX 8.1:

Multiflower realizing savings in logistics from mobile payments

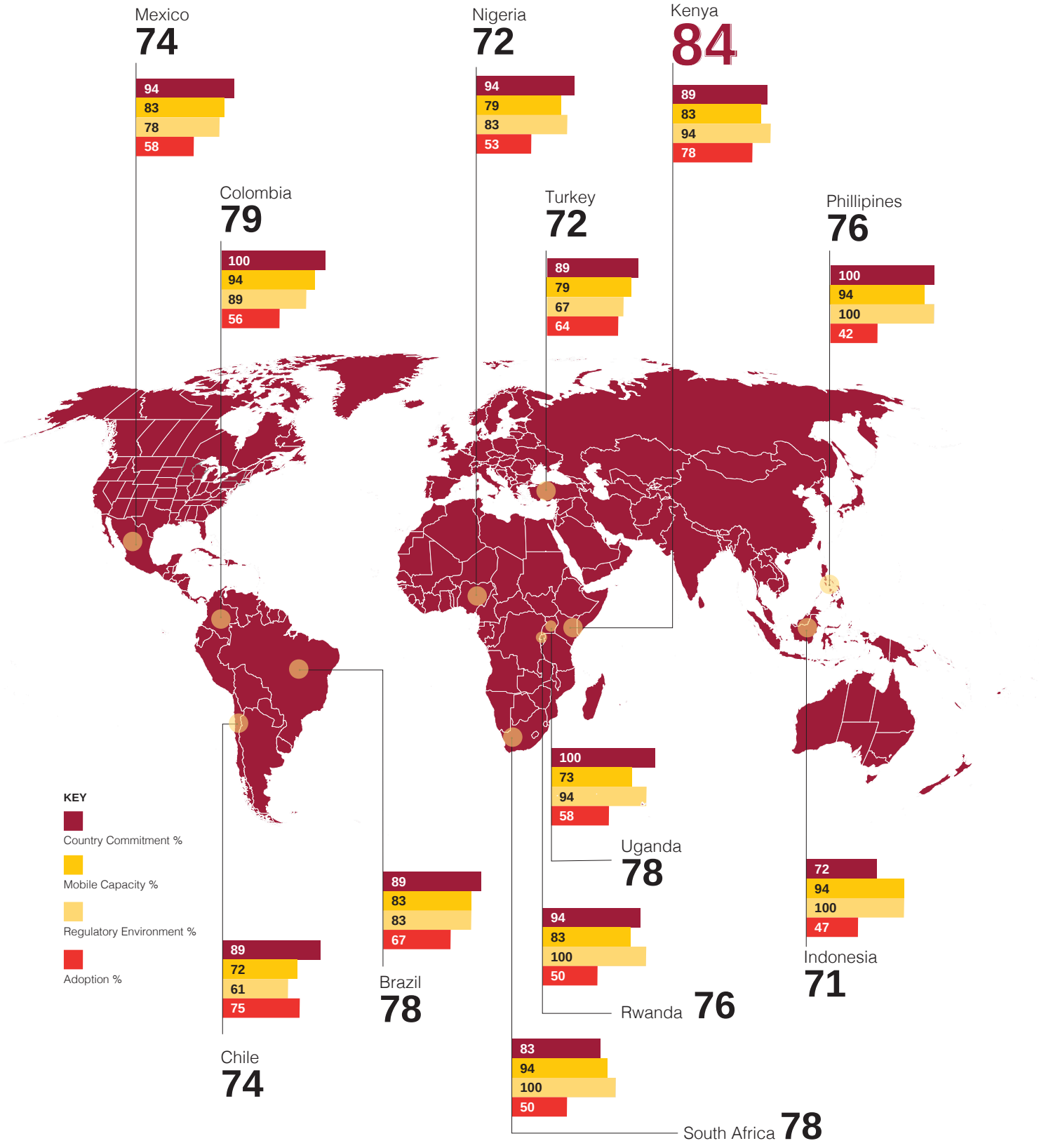
Multiflower, a seed and cuttings exporter based in Arusha, Tanzania, works with 3,500 out-growers and has close to US$1 million in annual revenue. The project embarked on a proof of concept pilot in 2013 where they issued loans totaling US$6,000 to 200 farmers and paid US$67,000 to 300 farmers via M-Pesa.

Apart from providing each farmer with an additional and simple method for accessing credit, the switch from cash to digital payment also resulted in an average saving of US$10.75 in transport costs and 8 hours per payment per farmer with participating farmers saving a total of approximately 6,000 hours over the duration of the pilot.

Source: *McKay C, Buruku, B, 2016*

Digital Agri-Based Financial Systems: The mobile phone has offered a powerful new channel to deliver affordable financial services to smallholder farmers, who have traditionally lacked access to training, finance, and market facilitation. SSA leads the way with over two-thirds of the world's 100 million active mobile money users, and mobile-based financial services diversifying into credit, savings, merchant payments, and insurance (Masiyiwa, 2016). The developing world now has five times more mobile money agents than commercial banks (Masiyiwa, 2016). The flexible, low-cost and ubiquitous models made possible by mobile technology and the evidence base to guide their design have created a major opportunity to deliver real value to the poor and more specifically to smallholder farmers (Masiyiwa, 2016). Kenya still ranks highest when it comes to the level of financial inclusion among the rural population with 8 in 10 adults using mobile money services (Figure 8.4). This has been due to the country's high-level commitment to financial inclusion with the Maya Declaration, Better Than Cash Alliance, and the Vision 2030 National Development Strategy, that has set out to reduce the population without access to finance from 85 percent to below 70 percent. (Villasenor, West, & Lewis, 2016).

Figure 8.4: Kenya leads the pack for increased access and use of affordable financial and digital technology services globally.



Source: *The 2016 Brookings Financial and Digital Inclusion Project* Report

- **Mobile-based payments:** Digitizing value-chain payments has: increased transparency and safety for businesses and farmers; decreased costs of sourcing; provided a great revenue stream for mobile network operators and financial institutions through transactions fees; and has integrated savings, credit, and insurance products, to drive financial inclusion for farmers (Elliott, 2015). A review of the expenses of several domestic cotton and coffee companies in rural Uganda by the mobile money issuer SmartMoney, revealed that businesses saved about 10 percent of their annual operating budget on alleviating losses from theft, fraud and expenses related to insuring, securing, and transporting cash (McKay & Buruku, 2016)

- **Mobile saving schemes:** Poor households are not well served by simple loans in isolation; they need a full suite of financial tools that work in concert to mitigate risk, fund investment, grow savings, and move money" (Kendall & Voorhies, 2014). Mobile applications are enabling this, permitting financial institutions to offer such services to huge numbers of customers in very short order. MyAgro, a mobile platform, is leveraging mobile technology to operate a saving scheme for farmers in Mali and Senegal. Rather than paying a lump sum to purchase seeds and fertilizer at the start of the planting season, smallholder farmers save small amounts throughout the year using MyAgro scratch cards from local stores and making deposits into their savings accounts—an initiative that has increased their harvests and raised their incomes by more than 70 percent compared to non-registered farmers (Okonjo-Iweala & Madan, 2016). In November 2012, the Commercial Bank of Africa and the telecommunications firm Safaricom launched a product called M-Shwari in Kenya. This product which enables M-Pesa (mobile money) users to open interest-accruing savings accounts and apply for short-term loans through their cell phones, eliminating the time and document constraints of loan applications. M-Shwari added roughly 1 million accounts in its first 3 months (Okonjo-Iweala & Madan, 2016).

- **Mobile-based Insurance:** Agricultural insurance is becoming increasingly important as extreme weather patterns generated by climate change increase volatility in food production and prices (World Bank, 2012). Although still extremely limited in SSA, agricultural insurance particularly for smallholder farmers is slowly increasing via mobile technology. One example of this is EcoFarmer in Zimbabwe (Box 8.2). The BIMA system also offers mobile-based crop insurance to small-scale farmers to protect against economic shocks and has managed to reach 18 million customers across 14 countries with insurance premiums between 1–3.5 percent for some crops (Goklany, 2016).

- **Digital accounting systems:** Accounting, record keeping and management systems have also become popular amongst smallholder farming organizations in SSA. These systems have helped increase efficiency, save time, and reduce mistakes, leading to better overall administration (World Bank, 2011). The AgriManager software, a warehouse receipt system (WRS), for example, is being used by collection centers to manage the process of buying agricultural produce from farmers with the software automatically recording all farmer transactions, enabling mobile-based payments and subsequently receipts. As the receipt also contains a record of the farmer's previous transactions, it can serve as a proxy for the farmer's creditworthiness, enabling access to finance (World Bank, 2011).

Advanced genomics: The cost of sequencing a genome has reduced more than tenfold in the past five years; the breeding cycle has shortened from five years to two

BOX 8.2:

EcoFarmer mobile insurance scheme tailored to suit smallholder needs

EcoFarmer in Zimbabwe developed insurance premium products that could cover the needs of smallholder farmers while remaining affordable by designing the input package. This was done basing the design around a 10-kilogram bag of maize (appropriate for the average size of a smallholder field), and creating a lower-tier insurance product so that farmers could opt for a premium of only 2 cents a day (as opposed to 8 cents) for the season, for a payout of $25 (covering the cost of the purchased seed).

This service has grown to include over 500,000 farmers.

Source: *Foreign Affairs report, 2016*

[14] http://www.cropscience.bayer.com/Magazine/Digital-Farming.aspx
[15] http://www.godan.info/blog-posts/esoko-provides-tech-solution-collect-and-share-market-prices-sms

years and higher quality seeds are being produced, allowing for better production and harvest planning (Gates, 2016). Biotechnology is a powerful and rapidly advancing technology that allows scientists to develop higher yielding, more nutritious and resilient crops, as observed in the maize and sorghum value chains with the introduction of pest and insect resistant seeds such as the Striga resistant hybrid seeds (see Box 8.3).

BOX 8.3: The rise of StrigAway Hybrid seed increasing productivity in maize value chains

Striga is a devastating parasitic weed that causes yield losses in cereal crops particularly sorghum, maize, and millet. It affects over 50 million hectares across Africa, leading to crop losses worth US$7 billion annually (ISSA, 2008).

The use of these Striga resistant maize seeds has led to an increase in yields of 38 to 82 percent higher than those currently obtained from traditional maize varieties, with the StrigAway hybrid seed now becoming commercially available to farmers particularly in East Africa.

The German-based chemical company, BASF, used tissue culture to develop a maize strain with a mutant gene known as IR. This gene conferred resistance to the weed and the herbicides that were being used to kill it, damaging the maize crop as a result. The International Maize and Wheat Improvement Centre (CIMMYT), in collaboration with the Weizmann Institute of Science, Israel, and the Kenya Agricultural Research Institute (KARI) incorporated the IR-gene into African maize varieties and adapted them for regions in Africa where Striga is endemic thus its success.

In the sorghum value chain, Scientists from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Kenya successfully determined the precise segments of the sorghum genome known to confer Striga resistance. The scientists then transferred the genes to farmer preferred varieties using marker-assisted selection and conventional breeding which led to a similar increase in sorghum crop yields (ISSA, 2008).

Source: *Juma, Tabo, Wilson and Conway (2013); ISAAA (2008)*

Data aggregation systems:

- **Are based on unique identifiers** are currently being used in a few countries in SSA to provide access to inputs and credit. Nigeria's mobile wallet program called e-Wallet has assigned identifiers to close to 15 million farmers to deliver seed and fertilizer subsidies (Annan & Dryden, 2016). The program is playing a critical role in connecting farmers to the formal banking system while helping eliminate middlemen, leveraging the 89 percent cellphone ownership in the country (Kalibata, 2016). By giving farmers a 50 percent subsidy through a voucher system, the government helped generate demand for seeds and fertilizer enabling; 1.7 million farmers to buy US$10 million worth of seeds and US$100 million worth of fertilizers, and helping to produce an additional 8.1 million metric tons of food in its first year alone (Kalibata, 2016). In addition, the number of seed companies operating in Nigeria has grown from just 11 to more than 100, with thousands of local mom-and-pop shops selling seeds from these companies directly to farmers (Kalibata, 2016).

- **Integrated:** In most developing countries, several different government ministries and agencies manage and track resources and information relevant to smallholder farms and productivity including climate, soil, crop, productivity data, etc. This makes it difficult for smallholder farmers and other value chain actors to access all these disparate, incomplete silos of information and make informed decisions in the face of uncertainty (Andelman, Seligman, & Bakarr, 2016). Vital Signs, a knowledge partnership led by Conservation International together with other international institutions, local partners, and governments in Tanzania, Ghana, Kenya, Rwanda and Uganda, is helping address this challenge. The partnership is using integrated data aggregation systems that provide evidence-based data at the scale at which government planners, donors, private sector investors and farmers in Tanzania evaluate trade-offs, manage risk, and inform decisions related to climate resilient farming practices. Vital Signs collects, integrates, and analyzes household data on health, nutrition, income and assets as well as farm level data, tracking, for example, which seeds and inputs go into the land and what yields they deliver and measuring the relationships between different types of agricultural management and intensification services, to produce a set of key indicators and decision support tools for governments and value chain actors (Andelman et al., 2016).

[16] http://ictupdate.cta.int/Regulars/Q-A/Sustainable-and-scalable-business-models/%2880%29/1439915106
[17] https://www.cgap.org/blog/digitizing-agriculture-value-chains-story-so-far
[18] http://sites.ndtv.com/cultivatinghope/project/can-the-new-crop-insurance-scheme-deliver/

CASE STUDY

Digital Green bringing about increased farm level productivity and literacy

The Digital Green project trains development agencies and agents in communities in which they work to produce and distribute locally relevant knowledge using videos which feature information about farming techniques and nutrition practices, screened by frontline workers among farmer groups, using battery-operated mobile projectors.

This models has spurred farmers to adopt new agricultural practices for about one-tenth of the cost of traditional extension systems and has enabled Digital Green to reach more than 800,000 smallholder farmers with more than 60% of them subsequently applying at least one practice and the adoption of these practices reducing input costs by an estimated 15% and increasing crop yield by a further 20%.

Digital Green's success has been as a result of; its network of partners and community members producing more than four thousand videos in twenty-eight different languages- 80% produced in the same district a farmer resides; targeting women and other marginalized farmers who tend to be more receptive to videos than men; using village-level frontline workers that help to build even deeper confidence among smallholder farmers as they vouch for the local applicability of the practices taught, ensure that viewers understand them, connect farmers with necessary inputs (such as seeds and fertilizers), and aggregate their produce for sale at market.

Source: *Foreign Affairs report, 2016*

Multi-channel farmer extension systems: Digital technology is helping amplify the effectiveness of current grassroots-level development efforts, leading to faster and easier adoption. It is enabling farmers to translate information into action, and ultimately income, agricultural buyers to trace the origin and quality of food, researchers to share information more efficiently and inform their studies based on farmer-level data, and curricula in agricultural universities, to be complemented with practical videos from actual farmers' fields (Gandhi, 2016).

Simple local fabrications: The use of simple storage technologies, including hermetic cocoons and bags, metal silos, and polypropylene storage bags are also helping smallholder farmers to dramatically reduce post-harvest losses. The Alliance for a Green Revolution in Africa (AGRA), for example, with support from The Rockefeller Foundation's agronomist expertise, trained 2,000 farmers—who had grown 1,425 metric tons of cereal—on different techniques focusing on simple storage technologies, including hermetic cocoons and bags, and polypropylene storage bags. After storing the maize for 6 months using these techniques, the farmers were able to alleviate the 30–40 percent loss they previously suffered using plastic containers, or custom-made baskets and other traditional methods (Biteye, 2016).

Emerging trends

New digital technologies are aiming to accelerate interventions that address three key constraints in the predominant smallholder agriculture in SSA—resilience, scale, and market incentives (Warshauer, 2016).

Precision Agriculture: Plot-specific information that allows producers to make management decisions about distinct areas of the field is called precision farming or precision agriculture (World Bank, 2011). The advent of new technologies such as drones, sensor networks, satellite to mention a few, is creating new opportunities in digital farming and precision agriculture. It is enabling farmers to: monitor the growth of their crops or animals much more efficiently; respond to disease and crop or animal anomalies in real time; predict yields and produce; and plan post-production activities more efficiently (Bayer, 2016). These tools are being used to answer questions pertaining to land preparation (including tillage depth and type, crop residue management and organic matter, soil types); seed (planting date and rotation, density and planting depth); fertilizers and other nutrients (types, application methods, seasonal conditions); harvest (dates, moisture content, crop quality); and as regards livestock or fisheries (pasture management, animal tracking, breed/school) (World Bank, 2011).

CASE STUDY

FieldLook South Sudan increasing farm management through satellite imagery

FieldLook South Sudan is a project using satellite imagery to improve water management and crop husbandry in the Gezira irrigation scheme, one of the largest irrigation projects in the world. Satellite images are used to provide information on crop growth, humidity, and nutrient needs of plants and based on this, specialists send SMS messages to farmers' phones, telling them the best time to irrigate their crops, when to apply fertilizer and in what quantities, including other best practices in crop husbandry. The advice takes into account the current state of the farm, the expected weather for the next five days, the date of the last irrigation and other agronomic factors.

Great interest was generated in the technology by both farmers and administrators working in the Gezira scheme. Farmers participating in the project irrigated their crops more often, but applied less water than non-participating farmers, and increased their yields by an average of 60%. The project has increased farmers' confidence in using information and communication technologies (ICTs) to receive extension advice to the point, where the Ministry of Agriculture and Irrigation in Sudan has expressed support for rolling out the system more widely in the Gezira scheme. There is also great interest in the approach from other irrigation schemes in the country.

Source: *FieldLook South Sudan, 2015*

Precision agriculture has been limited to large-scale farming due to the significant investment required and some of the new technologies have yet to realize their full potential in SSA as they are only just being implemented, but they are expected to bring about huge productivity and efficiency gains across agricultural value chains (Accenture, 2015).

- **Sensors:** Sensors like infrared or wireless sensor network technologies are being used to collect data on the status of crops during the growing season and upon harvest. In addition, sensors are used to collect data on the field's soil composition and topography, helping farmers and agronomists in plot level mapping, crop monitoring, and more importantly resource and cost management through the optimal application of inputs (Bayer, 2016). Although sensors have been scientifically viable since 2013, they have only recently become mainstream and financially viable (Zappa & Policy Horizons Canada, 2014). Soil and water sensors that are durable, unobtrusive and relatively inexpensive are allowing farmers to manage fertilizer application rates and irrigation to meet moisture and nitrogen levels in the soil thereby saving money, conserving resources and increasing yields (Zappa & Policy Horizons Canada, 2014). In the case of livestock farming, remote sensors such as radio frequency identification technology (RFID), are being used to monitor livestock, allowing farmers to better manage their herds and farmers, gain cost efficiencies, facilitate banks or insurers to locate animals, enabling traceability for products across the value chain (World Bank, 2012). As large data sources, they easily can form knowledge management systems, research databases, and response systems that can guide farmers and governments in agricultural development (Accenture, 2015).

- **Satellite:** Precision farming through satellite technology utilizes three technologies, namely global positioning systems (GPS; with tracking or positioning capacities in the field), geographic information systems (GIS; which can capture, manage, and analyze spatial data relating to crop productivity and field inputs), and vibration reduction technology (VRT; useful in determining plot specific input application rates). The three digital technologies combined are providing targeted information on input applications based on soil and crop conditions enabling optimal resource use and better planning during the planting and growing season by providing real time crop imagery (World Bank, 2011).

- **Drones:** Useful mapping technologies such as unmanned aerial vehicles (UAVs) are expected to provide significant help to farmers in developing countries in the next decade. They will replace the harder to access aerial imagery from manned aircrafts and satellites, as they become increasingly cheap and as open-source and lower cost processing software options are developed (CTA, 2016). UAVs equipped with special sensors can inexpensively collect multispectral Neutral Density Vegetation Index (NDVI) and infrared images. This will enable: farmers to monitor crop growth and anomalies; agricultural

CASE STUDY

Drones helping Nigerian policy makers to plan for irrigation models

Rice cultivation in Nigeria is mainly based on rainfall. Some areas lack of irrigation infrastructure, and in others the existing infrastructure is poorly designed. These challenges are a major obstacle to increasing rice production in the country, as rice fields need careful water management to control weed and nutrient distribution.

GrowMoreX Consultancy Company in the UK, which runs a drone-based farming application service, conducted a preliminary assessment for the development of a 3,000 hectare irrigated rice farm in New Bussa, Nigeria, in 2015. The assessment was done by surveying and mapping a total of 7,500 hectares in preparation for planning and building the irrigation infrastructure for the rice fields. The project site is located 700 kilometers away from the capital, Abuja, and has limited access to roads, electricity, clean water, and other amenities. The area is largely surrounded by smallholder farms which grow crops annually during the rainy season (including sorghum, rice and beans), and tomatoes are grown during the dry season using pump-fed irrigation. The team and Nigerian policy makers needed to test the viability and suitability of the drone technology to the local terrain.

A fixed-wing UAV was used for the first flight that gave the team time to sort out technical hiccups and figure out how to use its automatic mission planning function. The UAV was able to fly for roughly four hours a day, covering nearly 300 hectares in 55 minutes, helping the team to map about 1,000 hectares in a single day.

For the preliminary investigation, GMX researchers needed to create a map at a scale of 1:2,000 to be able to make informed decisions on the best layout of the paddy fields, the irrigation and drainage systems. With limited information from previous site visits, the team had estimated that they would have been able to lay out the rice fields as large, rectangular basins where large earth moving and farming machinery would have been needed to build and cultivate the basins. However, the drone survey proved the hypothesis wrong. Most of the terrain was an undulating landscape with a sloping terrain combined with a thin top soil layer. The researchers therefore changed the planned design from large rectangular basins to long, narrow fields that would follow the terrain. Thus a very different irrigation system design and machinery were necessary. The information collected using the UAV subsequently helped the team and the Government of Nigeria avoid unnecessary, large initial investments.

For the first time as well, the team could establish exactly how many households there were in the village. This enabled researchers to make a much better estimation of its population and plan better for recruitment of local labor to build and run the rice farm.

Source: *(CTA, 2016)*

planners, to conduct volume estimates, create irrigation and drainage models, and collect the data needed to generate high-definition, geographically accurate elevation models and maps in a timely manner (see the Nigeria case study); and crop insurers and insurance policy holders to benefit from readily-available and easily repeatable drone imagery allowing for more accurate and quickly calculated payouts (CTA, 2016).

Understanding farmers' needs, and the range of services and sources they rely on to meet those needs is critical. Translating this knowledge into tailored products is even more critical (Adesina, A., 2016). The uniquely tailored products and models highlighted above should be leveraged by policy makers in the near future to facilitate; increased scale of adoption of digital technology by smallholder farmers; and their integration with emerging technologies that are also slowly gaining visibility in Sub Saharan Africa, but are often complex and not customized to the end user's context and capacity. (World Bank, 2012).

Rationale behind the popularity and success of digital technology platforms in Sub-Saharan Africa

The surge in digital technologies has been the result of an increase in accessibility to and affordability of technological devices and infrastructure such as mobile phones. This has resulted in the radical transformation of the agricultural sector across the globe and in SSA primarily, helping improve the livelihood of smallholder farmers.

Rationale behind rapid adoption

- **Inclusion of the Private sector:** In Southern and Eastern Africa, the private sector is involved in data provision. Several pilot projects involving data services have produced promising results, as shown in previous sections. The benefits of digitizing transactions and operations either for farmers directly or via associations or cooperatives has also attracted large-scale private sector players in using and scaling the digital technology platforms creating a direct knock-on effect for farmers (CTA 2015). Having historic electronic data on farmers has also helped more progressive companies make better decisions on who to lend to, eventually leading to access to digital credit for smallholder farmers.

- **Decreasing infrastructure costs and increasing connectivity:** Making information supply and acquisition cheaper is key to enabling the fast adoption of digital technology in agriculture in SSA. New approaches to providing farmers with cheaper means of acquiring the information they need through mobile-based technology are promising (Kelsey, 2013). The increase in smartphone companies throughout the continent has also led to an explosion of cheap phones on the market; prices are expected to continue to drop. For example in 2015, Microsoft unveiled the world's cheapest smartphone, the Nokia 215 that retails at just US$29. With outlooks projecting 334 million African smartphone connections in 2017, a wealth of new ICT development services and business opportunities will open up, serving the needs of newly connected users (Gottlieb, 2015). Increasing regulation and tax reforms on mobile phone infrastructure has further reduced the cost of mobile phones and increased revenue and contribution to GDP, as shown in Table 8.1 (GSMA 2016). Many analysts expect this boost in mobile and Internet access will lead to further growth in Internet-related businesses, startups and services, and in turn economic growth. The World Bank noted that a 10 percent increase in connectivity corresponds with a 1.38 percent increase in GDP (Gottlieb, 2015).

- **Increasing access to finance:** The proliferation of connectivity and mobile technology across the continent is fostering great change, especially in the agricultural landscape in countries in SSA. The result is an extension of peer-to-peer mobile and online services, facilitating access to finance and financial inclusion for smallholder farmers that has subsequently led to investment in new digital technology platforms.

- **Increasing regional influences in ICT use:** The early adoption of the new technology by farmers in one area is slowly resulting in positive externalities or spillovers to other farmers in the form of information about the benefits and use of the technology often when the cost for adoption is low (Kelsey, 2013) as shown in the case of the Eastern Africa Farmer Federation.

Table 8.1: Impact of mobile tax reforms in a few SSA countries

	Democratic Republic of Congo	Ghana	Tanzania	Tunisia
				
	3.2 million connections (+5%)	**1.3** million connections (+3%)	**2** million connections (+5%)	**0.4** million connections (+2%)
	$**590** million in GDP (+2%)	$**598** million in GDP (-1%)	$**549** million in GDP (-1%)	$**314** million in GDP (+1%)
	$**28** million in tax revenue	$**0.67** million in tax revenue	$**11** million in tax revenue	$**22** million in tax revenue
Mobile Specific Tax Reform	Abolition of excise tax of 10% on mobile services	Reduction in service tax on voice services and abolition on data	Reduction in the excise tax on mobile services from 17% to 10%	Abolition of the 5% industry fee on mobile services

Source: *GSMA 2016 (The Mobile Economy Africa)*

Digital Green, for example, has expanded from India into Ethiopia and is exploring pilot programs in Ghana, Mozambique, and Tanzania successfully through ICT-enabled tools.

- **Increasing advocacy platforms:** These platforms have helped increase awareness and knowledge of digital technologies in agriculture and are increasing the influence of value chain actors in the decision-making process. The Pan-African Farmers' Organization (PAFO), for example, formally created in November 2010, emphasizes the need to organize farmers and agricultural producers, effectively engage members in advocacy, and promote their participation in the formulation and implementation of continental development policies that affect agriculture and rural development. Through e-discussions held on its website, the PAFO platform has helped build up and formulate policy ideas on several broad themes, such as land acquisition, climate change, financial inclusion that are eventually presented to policy makers during annual continental briefing meetings (CTA, 2016).

Rationale behind scale and sustainability

Business models that have been easily adopted by smallholder farmers and have achieved transformation at scale sustainably have been achieved as a result of several factors:

- **Simple designs tailored to the needs of smallholder farmers:** Simple systems and platforms that smallholder farmers can use with the most basic of phones and providing simple services initially with the addition of complementary products gradually has seen the most success in terms of scale and sustainability (Masiyiwa, S., 2016). The simplicity in the design and use of the mobile platforms has enabled EcoFarmer for example to build more attractive, relevant and sustainable products (EcoCash, EcoFarmer) for smallholder farmers at scale sustainably (Masiyiwa, S., 2016).

- **Rise of farmer organizations:** Currently, agricultural cooperatives make up 60 percent of all farming organizations in SSA with most being formed over the last two decades (Pollet, 2009). The easy and quick adoption of digital technology platforms thus has been the result of an increase in farmer engagement, connectivity and learning through community groups such as farmer organizations (see Figure 8.5). More prevalent farmer organizations such as cooperatives have helped introduce new technologies to smallholder farmers at scale, as they provide smallholder farmers with easy access to platforms through cost efficiencies obtained as a group. This pooling of resources has also created the opportunity to buy expensive equipment, such as food-processing and packaging machinery. Farmer organizations also invest in communications technology to find new markets, improve management processes, train, and deliver information services to their members (CTA 2012). With the rise in farmer organizations, donor-funded projects still looking to improve effectiveness and efficiency through sponsoring research, training, extension and technology driven programs are now more group focused as farmer organizations have paved the way for increasing financial inclusion and outreach to the previously "unbanked" in a sustainable manner, helping revolutionize agricultural value chain finance (World Bank, 2016).

- **Multi-stakeholder partnerships:** Business to business models are slowly becoming alternative revenue models—those that look at monetizing farmer data and integrating digital financial services as opposed to depending on farmers to pay for the service directly (Elliott, 2015). Involving the public, private and NGO sectors in ICT interventions has been key to ensuring their widespread uptake and commercial viability for the smallholder farmer (World Bank, 2011). Governments and development agencies

BOX 8.4:

Mobile banking - the most successful business model to date

Mobile banking has been so successful because it has been designed with the end user (people who are disconnected from formal institutions), in mind. Mobile banking in Africa began when Safaricom launched M-Pesa (mobile money) in 2008, a service that aimed to facilitate rural women repaying micro-loans. Its application as a tool for sending, receiving and saving money was far greater, and the M-Pesa model has now spread to Rwanda, South Africa, Tanzania and Uganda and mobile banking in general now exists in 33 African countries, with more people in Africa using their mobile phone to bank than in any other region in the world; 70% of the world's registered 81.8 million mobile money customers are in Sub- Saharan Africa.

Source: *Juma, Tabo, Wilson and Conway (2013)*

CASE STUDY

Eastern Africa Farmer Federation leveraging regional networks to influence adoption of mobile services

In partnership with a private investor, the Eastern Africa Farmer Federation, EAFF upon visiting the Indian Farmers Fertilizer Cooperative, IFFCO in India, developed a prototype of a mobile platform similar to IFFCO's for the purpose of linking farmers to both input and output markets and enabling their access to credit and insurance products.

To leverage technology for the benefit of farmer organizations, IFFCO launched ISKL in 2007, a joint venture in association with Star Global Resources and Bharti Airtel that involved using mobile phone technology to provide timely, up to date and pertinent agro-advisory services to farmers subscribed to ISKL's Green Card system. Through 1-minute voice messages in local languages, the platform shares timely and up to date agro-advisory services to farmer organizations subscribed to the mobile platform. In addition, farmers can call a helpline to request additional information about the data they have been provided or seek solutions for their specific problems.

EAFF is currently running a pilot in Kenya targeting the rice and maize value chains and plans to roll it out commercially with a target of more than 100,000 farmers in the first year in close collaboration with IFFCO Kisan Sanchar Ltd, IKSL.

Source: *Srinivassan and Muchiri (2015)*

are helping defray start-up costs and provide vital data to ensure proper program design while private sector actors are investing in R&D and contracting with processors and agribusinesses to help them reap the benefits of new technologies (CTA, 2015). A service like Connected Farmer provides an ideal sustainable multi-stakeholder solution; with Vodafone using its technology to help improve farmers' lives and business operations, while earning revenues for the company from license and payment transaction fees, and from the incremental addition of new customers (both farmers and agribusinesses). USAID funded the start-up costs; and supporting implementers like TechnoServe analyzed the problem, designed the system, and brought together different market players; the service has scaled the platform to over 50,000 farmers across East Africa.

- **Extensive field presence and trusted intermediaries:** Mass adoption has been realized with models such as Digital Green that have educated consumers on the value of the technology using "above-the-line" advertising such as radio, television, and print to raise initial awareness. In addition, direct "below-the-line" channels are also used through recruiting agents assigned to high-traffic areas, economic hubs, and rural trade centers, as well as respected peers in farming communities in promotional campaigns to champion the products and be at the frontline of customer interaction.
- Many agricultural extension officers have adopted the use of ICT tools to advise African farmers. Extension officers form a linkage between technology promoters and farmers, the key contribution of the promoters being improved efficiency and quality of advice as exemplified by e-plant clinics whose use is being scaled up under Plantwise in Kenya and Rwanda with piloting being scaled out to Uganda, Zambia, Malawi, and Ghana.
- **Enabling regulatory environment:** The case of Nigeria's eWallet program is a good example of how policy and regulation have led to wide-scale adoption and sustainability of the digital technology platforms. By leveraging mobile technology and partnerships to offer input subsidies and partial guarantees to farmers and financial institutions respectively, the Nigeria government enabled an increase in adoption of the eWallet program to date and subsequent increases in productivity and access to inputs and credit to farmers, as previously mentioned.
- **Data and service interoperability:** Financial services for smallholder farmers have moved beyond credit for agriculture to include complementary services, such as savings and insurance leading to the scaled and sustained adoption of technology platforms such as Safaricom's M-Pesa and M-Shwari as well as the suite of EcoFarmer services.

New interventions therefore must be built on simplicity and an understanding of smallholders' needs; complemented with extensive field presence and trusted intermediaries; and facilitated by regulatory support in order to be pervasive, inclusive and sustainable (Foreign Affairs, 2016).

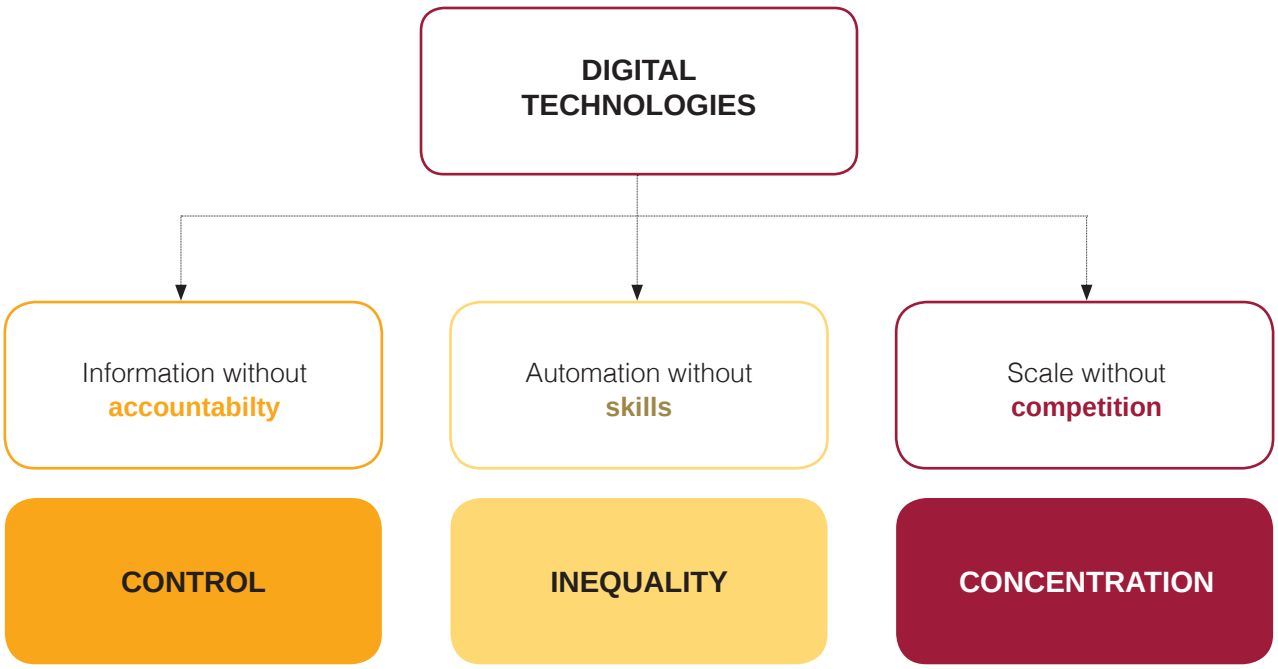
Limitations and constraints

Despite the major advances in digital technology with the increase in information flow across value chains, quick service delivery, and economies of scale, a few risks remain. These are limited skills, regulation and competition in the industry that hinder entry, and access and scaled adoption of the platforms (Figure 8.5). Smallholder farmers, for example, still face great challenges in translating data from digital technology platforms into operational insights that can help them understand which actions to take, when and where (Accenture, 2015) largely due to the limited skill and know how. This can be overcome by allowing AAS providers serve as a transitional inter-phase between digital technology and the farmers. Lessons from Plantwise show that farmers have confidence in agricultural extension officers who give effective and practical solutions quickly, without involving the farmers in the burdensome infrastructural (paper-based or digital) issues. Although the situation may change with a new generation farmers, in the interim, delivery of ICT-based information packages and uses should not ignore the existing providers of agricultural extension services

Digital illiteracy and limited technical sophistication: Many small-scale farmers remain illiterate and impoverished, with limited access to mainstream services. They operate in isolation, with little or no bargaining capacity. Improving access to funds alone has been insufficient. Smallholder farmers need to be relatively sophisticated to become involved in agricultural technology projects mainly because of the complexity of using technological platforms and of building productive partnerships with technology suppliers (CTA, 2015). In addition, smallholder farmers have difficulty managing money efficiently, challenging their ability to oversee the technology development projects successfully due to a lack of accountability and follow-through (WEF, 2015). Many smallholder farmers also admit they do not keep proper farm records, as they are unfamiliar with the use of technological platforms. This results in limited monitoring and evaluation of their agricultural activities and investments.

Restrictive Government actions: The largest barrier to wider adoption of drone technology in the agricultural sector in SSA is regulatory (CTA, 2016). Licensing and registration procedures for digital technologies in most countries in SSA are tedious and require extensive paperwork and skills before licenses are issued. In addition, without appropriate legislation and control mechanisms, some countries consider drones security hazards (World Bank, 2011). Although some nations, such as South Africa, have already introduced detailed regulatory regimes,

Figure 8.5: Potential risks and constraints with Digital Technologies



Source: *World Development Report, Digital Dividends, 2016*

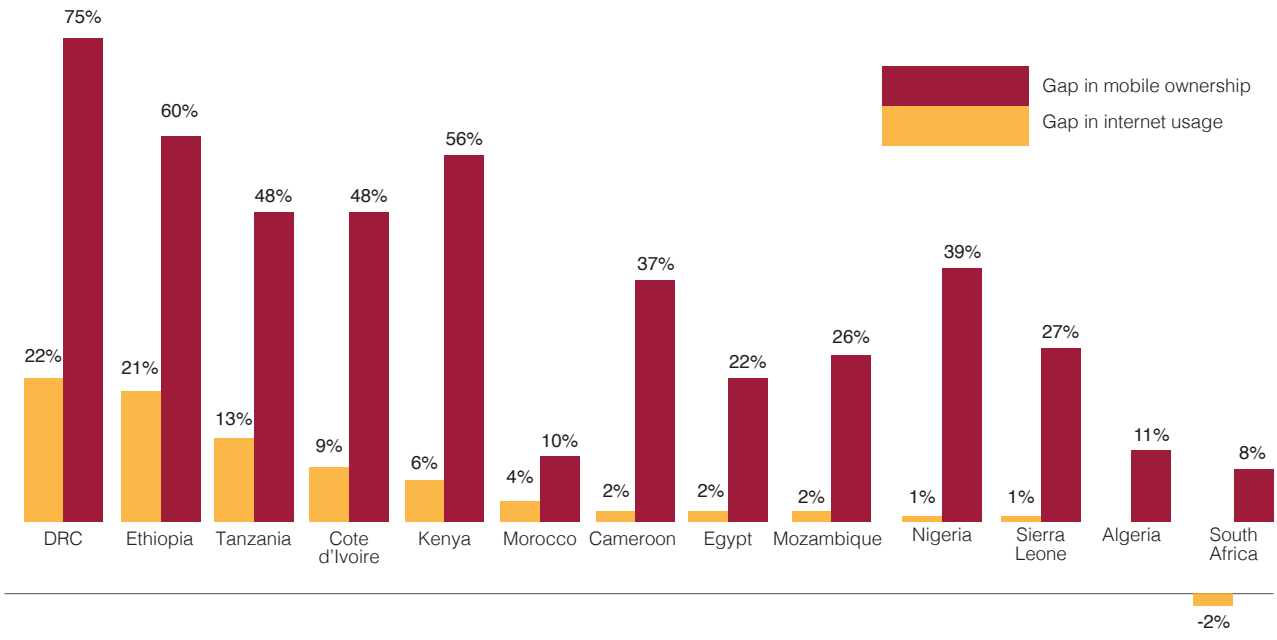
many others have none or have stringent rules such as in Kenya where the use of UAVs is banned without explicit permission from authorities, which entails a lengthy and bureaucratic process; or in Chad and Gabon that have yet to establish international norms on specifics such as certification, licensing and aircraft types to allow drone use (CTA, 2016). Coupled with high taxes and limited tax breaks, the start-up, development and operation of digital technologies become expensive, hampering operation in SSA.

Cost inefficiencies: It is expensive to implement new digital technology solutions largely targeted towards large-scale farms and farming organizations such as remote sensing platforms. Farmers have limited assets that they can invest on their own and lack access to financial services that can allow them to invest in digital technology, leaving government agencies, donors and NGOs to subsidize famers' investment in the technology (Williams et al, 2015). Although farmer organizations with relatively homogenous membership and with close links to the market are generally better able to be involved in technology, they need to be strengthened and supported financially to work effectively with the technology system (World Bank, 2011). In addition, technology adoption is difficult due to the lack of knowledge of expected returns to a new technology as most emerging platforms are still being piloted in SSA (Bandiera, Burgess, Deserrano, Rasul, & Sulaiman 2016).

Poor Infrastructure and Connectivity: Significant access gaps remain and need to be addressed to ensure inclusive growth. The use of computers and the Internet is still limited in remote areas of SSA, limiting access to timely and relevant information (World Bank, 2011). Only 38 percent of the population in Africa has access to Internet (GSMA, 2015). Aside from the issue of connectivity, another key factor restricting the use of digital technologies is the lack of access to a reliable electricity supply. The electrification rate in SSA was no higher than 32 percent and less in rural areas (Torero, 2014). Although digital technologies allow different market agents to communicate with each other more efficiently thereby enhancing information flows, inadequate infrastructure tends to make ICT tools irrelevant and markets less integrated.

Limited inclusion: Lowering monitoring costs, improving information flows, and developing self-enforcing contracts all have the potential to help local labor markets function more smoothly and increase individual incentives to adopt new technologies (World Bank, 2011). Women produce the bulk of food in Africa, and yet they are largely locked out of land ownership, access to credit, productive farm inputs such as fertilizers, pesticides, and farming tools and are bypassed by extension services, due to the gaps in mobile phone ownership and Internet usage, as shown in Figure 8.6, limiting their productivity (Byanyima, 2016). A recent study by the GSMA Connected Women program shows that women in low- and middle-income markets are 14 percent less likely to own a mobile phone than men, which translates to approximately 200 million women, with regions SSA having a 13 percent gender gap in mobile phone ownership overall; this figure is higher in a few countries

Figure 8.6: The gender gap is larger in Internet usage than ownership



Source: *GSMA 2016*

such as Niger and the Democratic Republic of Congo that have gender gaps in mobile phone ownership of 45 percent and 33 percent respectively (GSMA, 2015). Those that own mobile phones tend to use mobile services less frequently or less intensively than men. Women have the most to gain in terms of financial inclusion via mobile services and closing the gender gap in terms of mobile ownership and usage in low- and middle-income countries could unlock an estimated US$170 billion market opportunity for the mobile industry in the next five years (GSMA, 2015).

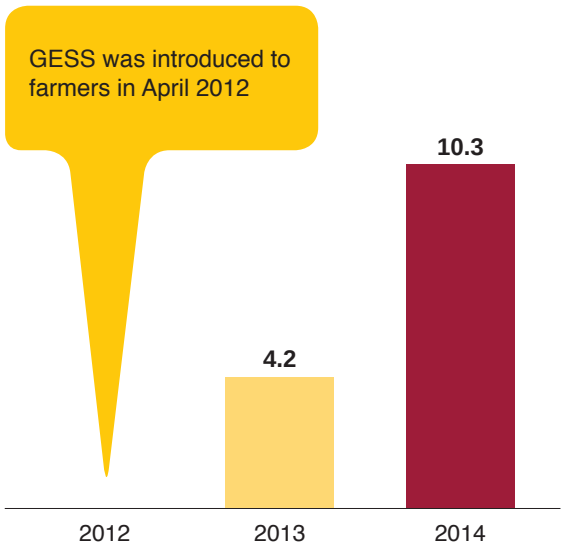
Limited dependability: Risk and uncertainty are unfortunately increasing. Climate change, energy costs, availability of skilled labor and market volatility all constrain decision making for farmers and policy makers. Severe and unexpected weather patterns are shrinking already limited yields, as farmers face major crop failures (Accenture, 2015) and long-term climatic and landscape level data are lacking in most countries. SSA has no capacity and analytical tools to downscale the results of global models to regional or national levels and watershed scales are not readily available as well. Thus the lack of information, research-based evidence and limited human and institutional capacity inhibit decision-makers' to target implementation and subsequent financing plans of CSA (Williams, et al., 2015). While new digital technologies such as computing and sensor technologies have been used in the developed world for the last two decades, adoption in developing countries has been uneven as the full potential is just being realized (World Bank, 2011). Currently, many technologically driven projects targeting smallholder farmers are largely donor-funded with farmers operating from the position of a junior partner, as they lack the capacity, technical skills or inclination to engage with technology providers over a prolonged period; this has further limited scale and sustainability of these projects (Elliott, 2015).

Promising policies and programs on the horizon

Feed Africa and the Comprehensive African Agricultural Development Programs, CAADP: The implementation of the Feed Africa and CAADP initiatives have led to an increase in growth and productivity in the agricultural sector of several countries in SSA. The CAADP initiative for example, resulted in Nigeria amending its public procurement system and the rise of the highly successful eWallet program that has transformed the agricultural sector and digitized the input subsidy and credit systems; 25 percent of the total subscribers are women (Okonjo-Iweala & Madan, 2016). The Ministry of Agriculture in Nigeria facilitated an increase in agricultural lending to smallholder farmers by offering partial guarantees for loans attached to farmers in the eWallet program that led to banks quadrupling their lending to the agricultural sector from roughly 10 billion naira annually to in excess of 40 billion naira currently. (Okonjo-Iweala & Madan, 2016).

Figure 8.7: Nigeria leveraging mobile technology to drive new public procurement policies and agricultural transformation

NIGERIA
Improving Yields Through Modernized Input Distribution



- Strong political will and government support to transform the inpput supply system.
- Use of public funds to leverage private sector investment (i.e. agro-dealers networks)
- Leverage mobile technology to achieve scale and provide nationwide access

Source: *Ojukwu, C. (2016). Feed Africa Annual Meeting*

Tech-Based Sector Regulatory Incentives: The success of mobile money applications in Kenya and the Philippines was found dependent on favorable legislation and regulation on taxes, licensing, liberalization, and competition policies that removed taxes on communication services, import duties on information technology equipment, value-added tax on ICT related goods and services, and excise taxes on communication services, that subsequently reduced product prices and encouraged use, especially for low income consumers (Husmann et al., 2015).

ICT for Agriculture Initiatives: These initiatives, also known as ICT4Ag, set out detailed plans by countries for

the strategic adoption of ICT with the aim of modernizing agriculture and promoting agro-business (Kirsten, Mapila, & Okello, 2013). To optimally exploit synergies across value chains and build upon existing ICT models and approaches, key decision makers in several SSA countries are leveraging the ICT4Ag initiatives based on the CTA Building Viable Delivery Models (BVDM). The aim is to build policy that facilitates an increase in the development of digital technology platforms, accelerates the process of adoption, uptake and scale up of ICTs for agriculture, benefitting rural communities (CTA 2014). In Ethiopia, the government created the Agriculture Transformation Agency (ATA) to serve as this agent of change. The Ministry of Agriculture and Animal Resources in Rwanda is finalizing a national ICT strategy for Rwandan Agriculture that is closely aligned with the Smart Rwanda Master Plan 2016–2020 to coordinate financial, human and institutional resources. The aim is to address challenges in the agricultural sector through targeting different initiatives like competition, capacity building schemes, the introduction of new technologies and incubation support to drive the development and implementation of the strategy innovations (Nkurunziza, 2016). Fostering the Internet of things (IOT) projects, introduction of drones in agriculture, strengthening the capacity of ICT development hubs such as the KLab and FabLab, academic research institutions and other innovation centres to develop such technologies, and offering online courses in agro-technology in both English and Kinyarwanda, are some of the key potential sub-projects planned (Nkurunziza, 2016).

Integrated and Collaborative R&D networks: While research is mostly carried out in national research institutes, formal education is done in universities with limited research activities. One way policy makers are helping to bring agricultural research closer to farmers is by building a new generation of agricultural universities that combine research, teaching, extension and direct farmer engagement that has resulted in increased efficiency and productivity at the farmer level (Juma et al., 2013). Ethiopia's national agricultural research system (NARS), for example, includes 67 research centers and 7 research agencies run by higher learning institutions that collaborated in the development of rust-resistant bread wheat varieties that averted near-complete loss of bread wheat production in half of the wheat cultivated in the country. Over the last decade as well, the NARS in Ethiopia have also contributed to increased farm-level productivity of chick peas from 0.8 to 1.7 metric tons per hectare; lentils from 0.6 to 1.2 metric tons per hectare; and teff from 0.8 to 1.2 metric tons per hectare as a result of this collaboration (Meridian Institute, 2015). Similarly, in Ghana, DNA-based molecular diagnostic methods help researchers from the CABI Africa, Centre for Agriculture and Biosciences International and the Cocoa Research Institute assess the variation between and within isolates of Phytophthora species found on cocoa pods, as part of a project to develop environmentally friendly control measures. The Scottish Crop Research Institute (SCRI) and CABI have even gone further to develop a website that provides detailed protocols and access to a database containing the digest profiles of 46 Phytophthora species that researchers anywhere in the world can access, enabling unknown isolates to be identified in a matter of hours rather than in several days (Cooke, 2005).

Climate Smart Agriculture Policies: Initiatives such as the Economics and Policy Innovations for Climate Smart Agriculture (EPIC) program in Malawi and Zambia, for example, are helping to build the evidence base to identify country-specific climate smart agricultural practices that will subsequently help increase policy and research capacity to integrate climate change issues into agricultural and food security planning, and develop investment proposals for scaling up CSA activities linked to climate financing sources and to traditional agricultural investment finance sources (FAO, 2009). Regional climate risk management and financing schemes are also being developed to tackle the issue of climate change at a larger scale, such as the African Risk Capacity Agency's Extreme Climate Facility, shown in Box 8.5.

Public sector engagement in precision agriculture: Farmers can only participate in new technology development if there is political support to prove to farmers that these systems give them something they actually want (Dryden, 2016). This already happens in a few countries in SSA with new transformational technologies, such as remote sensing, where governments are involved in development and promotion of the technologies. The University of Maryland in the US, for example, supports the collection of national agricultural statistics to inform food security policy-making in Tanzania under the Spurring a Transformation for Agriculture through Remote Sensing (STARS) program. The program uses two fixed-wing drones to map maize-based agricultural systems with results scaled up to the national level, using satellite data and crowd-sourced information from the ground. Officials at the Tanzania Ministry of Agriculture can then use these maps to help local agricultural experts more accurately forecast yields at a national level, and to make informed decisions about the state of food security (CTA, 2016).

Cluster-specific initiatives: Better supply, from farmers who have learned about and invested in improving their yields and product quality, helps build a stronger market, increase product availability and production competence (Kearney, 2016). The New Zealand Dairy Board created a platform in the form of a cooperative called Fonterra in 2001 for best-practice sharing among its members leveraging ICT tools to improve productivity, product quality

and create export markets for excess products. Fonterra is currently one of the leading global milk processors and dairy exporters, with roughly 22 billion liters of milk produced annually, and more than 2 million tons of dairy ingredients, specialty ingredients, and consumer products annually, 95 percent of which are exported (Kearney, 2016). The Kenya Maize Development Program (KMDP), implemented by the Agricultural Cooperative Development International and Volunteers in Overseas Cooperative Assistance (ACDI/VOCA), worked closely with the Cereal Growers Association of Kenya, Farm Input Promotions Africa Ltd and the Kenya Agricultural Commodity Exchange in collaboration with the Ministry of Agriculture to help quadruple smallholder farmer maize yields from 720 kilograms to 2,880 kilograms per 0.4 hectares from 2002 to 2011, resulting in increased earnings of US$208 million for 370,000 smallholder farmers, a third of them women (Juma et al., 2013). This was achieved through establishing a network of 160,000 private sector-sponsored demonstration plots, agricultural fairs and partnerships with mobile phone companies that enabled KMDP to disseminate market price information, weather alerts and extension messages via SMS to farmers for the price of a local call (Juma et al., 2013).

Public private partnership extension programs: Public–private partnerships in extension programs have helped yield great results in farm level productivity, and literacy amongst farmers. CocoaLink, a public–private partnership between the Ghana Cocoa Board, Hershey and the world Cocoa Foundation is an outreach program. It allows farmers to send agricultural queries direct to experts via SMS, receive free, practical and timely information and advice in return. This service is supported by agricultural and social content from the Cocoa Research Institute. This partnership also allows field officers to access content to train farmers on mobile phone usage and agronomy and to collect useful data via a CocoaLink registration application pre-loaded on to smartphones. Since its launch, over 4,000 cocoa farmers in 15 villages have registered with the service. Almost 40 percent of registered farmers have attended community education sessions and yields of CocoaLink-trained farmers are estimated at 15–40 percent higher than those of non-trained farmers. (ONE, 2015). The program has now reached more than 8,000 Ghanaian cocoa farmers in 10 communities in the Western region.

A look ahead

"The new African food system should be built around valuing and empowering the smallholder farmer by supplying them with appropriate seeds and fertilizer, providing education and training, and ensuring easy access to markets and larger economic networks" (Kofi Annan; Annan & Dryden, 2016).

BOX 8.5:

Regional integration in Climate Smart Agriculture policies yielding results

The African Risk Capacity Agency (ARC) and its financial affiliate, a mutual insurer—ARC Insurance Company Limited (ARC Ltd) was established in 2012. The aim was to transfer some of the burden of climate risk away from governments and farmers to the international financial markets, by building the capacity of participating governments to model their own risk, respond early to disasters and select appropriate coverage for their level of risk. With a premium payment, countries can then leverage additional coverage from the reinsurance industry. ARC is thus able to leverage limited public resources to attract private capital that provides incentives for investment in risk reduction and response capacities, and by putting African countries in charge, ARC cuts duplication and delays, leading to faster and better results.

In its first year of operation, Senegal, Mauritania, and Niger paid a combined premium of US$8 million and received payouts of over US$26 million, triggered by drought in the Sahel. These countries used the insurance payouts to purchase livestock fodder and staples primarily from local producers, reaching over half a million livestock and 1.3 million people. More countries are also joining the initiative with the pool increasing further in 2015 to include an additional 9 countries, (35 in total) which paid a total premium of US$25 million for US$180 million in drought coverage.

By 2020, ARC aims to reach as many as 30 countries with nearly US$1.5 billion of coverage against drought, food, and cyclones in line with the G-7 global target of reaching 400 million people insured by that time. To achieve this, ARC plans to offer up to US$500 million in climate adaptation financing in 2017, through the Extreme Climate Facility (XCF) to protect the investments of member states investments in, by providing direct funds to those countries experiencing significant detrimental shifts in their weather patterns.

Source: *(Wilcox 2016)*

To address constraints to improving the performance of agriculture sector, efforts must target how to address policies that enable access to inputs at the right place, right time and right price. These should be developed and implemented equitably. In some countries such policies are in place with implementing laws and regulations already developed. However, these remain largely non-functional in creating an environment that is facilitative of the work of the responsible staff, the input suppliers (largely private sector) and farmers.

By increasing the scale at which knowledge and new technologies can be applied, and by reducing transaction costs, technology service providers can create sustainable business models, based on private sector inclusion (World Bank, 2012). However, agricultural data from new digital technological innovations in SSA are often inaccurate, incomplete and unrelated to the smallholder context, as most technologies are still being piloted and this is done mainly on large consolidated farms (Dryden, 2016). African governments are thus trying to design policies to feed their people and fuel economic development without a clear understanding of the farmers who produce 80 percent of their food while international crop breeders are trying to develop new varieties with anecdotal evidence about which traits smallholder farmers value (Gates, 2016).

To facilitate increased adoption of digital technology by smallholder farmers and the subsequent scale and sustainability of the digital technology models, policy makers need to establish an enabling environment including legal and business environments backed by informed and knowledgeable decision makers and reliable technological innovations meeting the specific needs of smallholder farmers (FAO, 2012). To achieve this, policy makers will need to consider the key policies behind the success and scale of current business models and identify ways to build on them to suit their local contexts. Such policies should recognize to the potential of digital technologies to enhance adoption of good agricultural practices rather than adoption of the digital technologies just for the sake of it. This way, the focus should be on agricultural transformation partially through better and more efficient advisory services to farmers.

Build upon climate smart agriculture policies: The Intergovernmental Panel on Climate Change 2007 report estimates that Africa will be the most vulnerable to climate change globally, due to the multiple stresses of poor infrastructure, poverty and governance (FAO, 2009). Projections on yield reduction show a drop of up to 50 percent, with crop revenues falling by as much as 90 percent by 2100 (Williams et al., 2015). World Bank forecasts also show that SSA will become the most food insecure region with 40–50 percent of undernourished people globally inhabiting the region in 2080, as levels of arable land for production are predicted to decline by 9–20 percent ((Williams et al., 2015). Policy makers therefore need to strengthen their initiatives in CSA so they can alleviate this misfortune. The World Bank unveiled a bold new plan at the UNFCCC COP21 meeting in Paris that calls for US$16 billion in funding to help Africa adapt to climate change and enhance the continent's resilience to climate shocks, focusing on CSA and accelerating agricultural transformation (Makhtar, 2016).

Foster data aggregation systems and interoperability: To transform food systems in the next decade, decision makers will need to look at developing policies that foster data aggregation systems using unique identifiers (Dryden, 2016) and spatial data infrastructure to collect and analyze data effectively. This is being done in developed countries where service providers are able to provide proactive and personalized services (Dryden, 2016). Unique identifiers, along with satellite imaging technology, allow service providers to collect data about farmers (location, plot size, crops cultivated, inputs used, farm productivity, sales, etc.), and enable policy makers to prioritize investments and make trade-off decisions easily based on adequate information (Dryden, 2016). To achieve data inter-operability, public agencies will need to invest further in farmer registration programs that can help service providers anticipate the next wave of digital solutions targeting smallholders and facilitate information sharing, widening opportunities for value chain actors (Gates, 2016).

Foster inclusion in building digital technology: More farmers should benefit from training in the use and application of ICTs, especially women farmers (World Bank, 2012). Women are involved in agricultural production, but require access to financial resources and training to adopt and use digital tools respectively. The inclusion of the private sector in ICT development has led to widespread adoption of digital technologies. Regional collaboration has resulted in positive externalities and spillovers to farmers and farmer organizations in the adoption and use of the technology, as is the case with EAFF. The private and public sectors can play a crucial role in increasing financial inclusion by shifting payments into accounts, as opposed to making cash payments. In developing economies overall, 23 percent of unbanked adults—440 million people—receive payments in cash for the sale of agricultural products and 36 percent of unbanked adults (125 million) receive such payments in cash in SSA. Shifting these agricultural payments from cash into accounts will lead to an increase in the number of mobile account holders able to access other financial services (Demirgu-Kunt, Klapper, Singer, & Van Oudheusden, 2014).

Increase investment in infrastructure and software: There is plenty of information that can help farmers make decisions; the problem is in helping farmers access and apply it. Access to input and output markets and information require improvements in road, electricity and network infrastructure. While mobile phones have become the most ubiquitous telecommunication technology in SSA, playing a major role in the development of the agricultural sector, many people still suffer from limited network coverage (World Bank, 2016). Investment should also be made in developing network infrastructure and software that systematizes information and enables value chain actors to make informed decisions (Feijoo, 2014)

Establish regulation for emerging technologies: In 2015, Grand View Research estimated the global commercial drone market size to be US$552 million in 2014; this was projected to grow to US$2.07 billion by 2022, with agriculture dominating other drone sectors (CTA, 2016). Decision makers should make user-friendly and forward-looking policies that foster capacity building in the use of emerging technologies. They should also modernize the bureaus of statistics with UAV technologies, focusing on open access solutions, to guarantee sustainability. Before this, however, policy makers need to understand the technology and how it works so they can facilitate its market entry and adoption. Networking or dialogue platforms should be established between policy makers, customers and technology companies to enable policy makers to: (i) assess the changes happening with digital technology products and services around the world; (ii) connect with their counterparts in other countries to demonstrate and understand the transformative benefits and security of the platforms; and (iii) be involved in the development and implementation of digital technologies to ensure they are in line with government plans and regulations for the agricultural sector as a way to improve inclusion (Dryden, 2016)

Foster institutional networks: A review of the RAIP and NAIPs of 15 member states ECOWAS, revealed that only 1 country, Burkina Faso, explicitly linked climate change adaptation to its NAIP; the remaining 14 countries failed to mainstream climate change adaptation into their NAIPs (Williams et al., 2015). This was largely the result of the lack of entities in those countries providing technical support and developing the evidence necessary to catalyze climate resilience strategies. Strong institutional support therefore, agencies such as Ethiopia's ATA need to be built to facilitate evidence-based data collection and analysis that will enable policy makers to: make informed decisions; promote inclusivity in decision making; improve the dissemination of information; provide financial support and access to markets; provide insurance to cope with risks associated with climate shocks and the adoption of new practices; and support farmers' collaborative actions (Williams et al., 2015).

Conclusion

As more farmers seek to gain access to markets, and as markets develop to allow for transparent pricing, the farmer receives a fair price, can become self-sufficient and the process in the end creates an ecosystem with enough resources to invest back into improved agricultural processes, which in turn improves yields and lowers losses (WEF, 2016). Beyond pricing, there is also the need for greater transparency about non-tariff measures (NTMs) to mitigate the risks of denying small-scale farmers opportunities to embed codes of good agricultural practice in their farm operations and hence getting their produce to lucrative markets.

As highlighted in the 2016 World Economic Forum, the ultimate success of any innovation depends not so much on a "blue sky" approach where one size fits all. The success also depends on developing solutions that: meet the day-to-day needs of farmers; are in line with what farmer organizations actually care most about; and meet the needs of other market actors in the agricultural system to incentivize them to invest in the digital technology, thereby facilitating the easy and sustainable adoption by smallholder farmers (Warshauer, 2016).

The success and use of pro-technology strategies and regulatory frameworks have achieved this in the financial service sector, helping cut the cost of financial services in rural communities by as much as 50 percent and giving farmers both access to credit and the means to mobilize it (Kalibata, 2016). Besides financial services and ICTs, regulatory frameworks for agri-input suppliers and traders in agricultural produce deserve attention. These should be embedded in national laws and must not be overly restrictive of private enterprise. However, they should also be effective enough to ensure fair practices in the supply of farm inputs, farm produce quality and safety and the associated processes of certification and marketing. Global frameworks for some of these such as for seeds and plant-based agricultural products are already created under OECD, UPOV, ISTA, IPPC, etc., but have not been fully translated into effective national regulations in many countries.

Advances in digital technology enhance efficiency and enable stakeholders to effect traceability systems along value chains, a requisite for facilitative market structuring and regulation. They have also shown that smallholder farming can become profitable businesses and that the private sector is becoming increasingly interested in serving them as conditions improve and largely as a result of the impact of mobile technology (Adesina, 2016). However, foreign direct investment targets countries showing actual progress in sustainable agricultural productivity driven by related innovations on the ground (Husmann et al., 2015).

The question remains as to what regulatory reforms can foster inclusion, avert future shocks and replicate sustainable business models at scale in the next decade (WEF, 2016).

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CHAPTER 9

The Roles of Agricultural Research Systems, Advisory Services and Capacity Development and Knowledge Transfer

Nelson Ojijo
Forum for Agricultural Research in Africa

Steven Franzel
World Agroforestry Centre

Franklin Simtowe
International maize and Wheat Improvement Centre

Rufaro Madakadze
Alliance for a Green Revolution in Africa

Apollo Nkwake
African Women in Agricultural Research and Development

Lerato Moleko
Lesotho Millennium Development Agency

KEY MESSAGES

ONE

A guided evolution or reform of agricultural research systems from a technology- to system-oriented configuration for AR4D is called for, and this process can benefit from advocacy and intermediation actions by supranational agricultural research organizations.

TWO

The lack of sustained funding and misalignment of research priorities hinder long-term effectiveness and efficiency of AR4D and compromise transformative growth of the agricultural sector in SSA. Innovative ways to develop sustainable home-grown funding of AR4D in countries in the region exist, but the policy domain must be appropriate for agricultural research systems to leverage such funding avenues.

THREE

Since agriculture is increasingly knowledge intensive and involves many different actors, advisory systems and staff need to play convening, brokering and coordinating roles and not just the role of passing on information.

FOUR

More evaluations of advisory system approaches (such as ICTs and farmer-to-farmer extension) are needed to assess what types of approaches work well for particular types of agricultural technologies, for particular target groups (e.g., women), at what cost, and how approaches may be combined and improved.

FIVE

Several capacity development frameworks have been proposed and many organizations working in SSA have embraced various approaches for agricultural capacity development, depending on their programmatic focus

SIX

Undertaking and documenting capacity development impact assessments will help highlight the key role of capacity development in AR4D, and evidence-based advocacy for capacity development by multiple organizations.

Introduction

The success registered in South and East Asian economies has been directly attributed to the Green Revolution, starting in the 1960s, which heralded agricultural productivity gains and rural poverty alleviation on a mass scale (Dietz, et al., 2014). About 63 percent of the population in SSA live in the rural areas where their livelihoods depend predominantly on agriculture. Thus, it would seem appropriate to benchmark development strategies in SSA to the Asian experiences. According to the agriculture-based development paradigm, growth in agriculture as a primary sector is imperative for rural development, positive structural transformation, and broad-based economic growth (Bellu, 2011). Indeed, CAADP, as a transformative framework and blueprint for Africa's agro-renaissance, is predicated on this precept.

Amidst other factors, technical change was at the heart of the Green Revolution (Dietz, Foeken, Soeters, & Klaver, 2014) and it underscores the central role of research and research systems in spurring agricultural growth. With mounting pressure to produce more food to feed an explosive world population against inexorable challenges, research can only be expected to play a greater role in global agricultural development efforts. In the African case, the path to attaining the needed agricultural productivity growth can only be illuminated by sustained, broad-based, integrated, systematic and home-grown research and innovation, recognizing the overriding premise that long-term food and nutrition security necessarily hinges on food self-sufficiency (Akinbamijo & Ojijo, 2016). To this end, national and regional research systems in SSA have experienced pockets of reforms and realignments aimed at increasing their performance.

Innovation generates new and improved technologies that are appropriate and well-targeted, leading to improved productivity. Effective innovation that is systemically transformative requires efficient and effective agricultural research and advisory systems with appropriate research capacity and infrastructure (Beintema & Stads, 2008). The global agricultural R&D spending in the public and private sectors grew steadily by 22 percent during the 2000–2008 period, indicating the increasing recognition of the vitality of agricultural research (Beintema & Stads, 2008). However, investments within SSA continue to be patchy. For example, total public agricultural R&D spending in the region decreased at an annual average rate of 0.2 percent during the 1990s. This has dire consequences for agricultural productivity and food security.

Agricultural advisory services (AAS), also called extension services or rural advisory services, are the activities that provide the information and services needed and demanded by farmers and other actors in rural settings to assist them in developing their own technical, organizational and managerial skills and practices so as to improve their well-being (Christoplos, 2010; GFRAS, 2011). The low adoption of agricultural technologies is widely recognized as a main contributor to low agricultural productivity in SSA. This may be due to several causes such as discrepancy between available technologies and farmers' needs, lack of credit, marketing constraints and poor policies; but farmers' knowledge and access to these technologies are critical (Jack 2013). Inadequate and ineffective knowledge-sharing approaches on the supply side and lack of understanding of farmers' needs and information pathways they currently use on the demand side contribute to a mismatch of information and skills necessary for successful adoption of technologies and access to inputs and markets. Equally important is assessing attitudes and other trade-offs farmers make in choosing whether to adopt a technology. Insights from these will help identify strategies that can be used to improve technology adoption.

Capacity, in all its dimensions, is key to effective knowledge generation, dissemination and use for agricultural transformation. Emerging from the CAADP 10-year review and subsequent forward planning, Africa's capacity to generate knowledge, foster learning, and enable skills development among its workforce is recognized as a game changer in the context of reshaping agriculture and empowering smallholder farmers. However, agricultural research actors are not configured to collectively deliver innovative solutions to agricultural challenges. Moreover, public agricultural research institutions in Africa are producing only a trickle of new technologies that can be used by farmers (Eicher, 2006), although significant progress has

> "No country has ever been able to sustain agricultural growth without consistent research and development"
>
> **Calestous Juma,** Harvard University Professor

been registered over the last decade. Skills in agricultural and agribusiness development remain a fundamental factor for increasing productivity, profitability and competitiveness of Africa's agriculture (Sarfo et al., 2015).

Section 1 of this chapter presents the current status of agricultural research systems in SSA at national and regional levels against a backdrop of key policy changes and progressive elaboration of agricultural knowledge frameworks registered in the last decade or so. The section argues for endogenous mechanisms to encourage sustainable funding of agricultural research in the region. Section 2 discusses key trends and some innovative approaches that are helping bridge the supply and demand mismatch in AAS. Section 3 discusses progress in the practice and delivery of agricultural capacity development in SSA, emphasizing key actions that have been taken to decrease the gender gap in agricultural research and extension. The last section of the chapter includes pertinent conclusions and recommendations to ground possible policy action.

Agricultural Research Systems

For nearly two decades, reforms in African agricultural research systems have received deserving attention from many quarters due to the overall desire to improve delivery and impact of agricultural research. A good country perspective to the reform agenda was offered by Idachaba (1997) in his treatise on the instability of the Nigerian agricultural research system. According to Chema, Gilbert and Roseboom (2003), the main reform themes have involved: redefinition of the role of government, decentralization, stakeholder participation, new financing mechanisms, and system linkages. A review by Roseboom (2004) further considered these principal reform areas, but also highlighted the underlying organizing principles that guided the reform agenda.

Subsequently, FARA commissioned an assessment of the requirements for efficient, effective and productive agricultural research systems in African countries. The assessment report (FARA, 2006) gave concrete recommendations for actions by a variety of stakeholders in the areas of governance and management, financial status and management, scientific capacity and management, and collaboration and linkages. These recommendations largely provided the basis for the 1st FARA Strategic Plan and Mid-Term Operational Plan and also yielded a major regional capacity development initiative that strengthenedagricultural research management systems, managerial competencies,and ability to conduct quality research in national agricultural research institutes (NARIs) and universities of 10 countries in SSA.

Rather than a diagnostic account of the obtaining reform dynamics, our aim in this section is merely to present the status of agricultural research systems in SSA to identify lessons and characteristics that could be leveraged to inspire transformative agricultural research for development (AR4D) in the region. We adopt the European Commission (2008) definition of AR4D as multi-dimensional research that addresses agricultural challenges and provides technological, economic and institutional knowledge and innovations contributing to sustainable development. Whereas we do not presume any specific analytical framework, the section has been tacitly guided by how changes in the exogenous circumstances (e.g., regional agricultural policy environment) and the progressive elaboration of agricultural knowledge frameworks have influenced institutional developments and funding at national and regional levels.

Evolution and Configuration of Agricultural Research Systems in SSA

The evolution of agricultural research systems in the SSA region has had a chequered history. Taylor (1991) and Beye (2002) give good accounts of developments in African agricultural research systems from the post-independent formative years, through the turbulent era of structural adjustment programs, and to the form that largely persists in many countries to date. By the 1990s, agricultural research in many SSA countries was executed by designated departments or divisions of the ministries of agriculture. These had little autonomy and functional linkages locally (with tertiary agricultural education institutes, extension services, policy makers, and technology recipients) and abroad.

A few countries (Ethiopia, Ghana, Kenya, Nigeria, and Sudan) had, however, managed to confer semi-autonomous status to the agricultural research function through legally constituted research councils or institutes with clear distinctions in regard to mandate, governance structure, operational domain, planning, and funding. Currently, most SSA countries have adopted the semi-autonomous model with a NARI or national agricultural research organization (NARO) as the main executor of public agricultural research. Beintema and Stads (2014) classify the SSA NARIs into four categories: 1) as a research department within a ministry of agriculture or equivalent (e.g., in Botswana); 2) as a semi-autonomous government institute with the flexibility to determine key internal policies (e.g., in Kenya); 3) as multiple agencies focusing on specific agricultural subsectors (e.g., in Sudan); and 4) as numerous institutes organized under a council (e.g., in Ghana).

Agricultural research is, however, not an enterprise for

exclusive pursuit by technical departments of ministries or semi-autonomous entities with the sole mandate of conducting research. Faculties of agriculture in tertiary agricultural institutes, the private sector, and NGOs can equally indulge in fruitful research. This variety of possible agricultural research executors inspired the now defunct ISNAR[1] to come up with the concept of the national agricultural research system (NARS). According to FAO, NARS refers to "all institutions in a country, public or private, devoting full or partial time of their activities to agricultural research and are committed to a national research agenda" (Beye, 2002, p. 13). Inferred in this definition are discrete components with no particular insinuation as to any degree of their functional integration. As an organizing principle, NARS is perceived to focus on technology generation, and technologies thus generated are then extended to end-users for uptake. This linear mode of technology transfer, in which the NARI/NARO is the main originator and epicenter of agricultural research (Roseboom, 2012), persists in many countries (Ojijo et al., 2013b) and has contributed in part to the low adoption rates of agricultural technologies and the ailing state of Africa's agriculture.

Lack of capacity for demand articulation by end users and inexistent policies to encourage co-innovation, are possible reasons for the persistence of the "technology push" mode. Kenya is one of the very few countries to have elaborated a NARS Policy in 2012, as a regulatory framework to improve the synergies and complementarities among the various players operating along the research–development continuum. However, the Policy focuses on coordination and duplication of efforts and is heavy on the supply side of things. Thus, it seemed a lost opportunity not to have addressed the confounding issues of fragmentation and stakeholder integration in any systematic way, borrowing from the market principles inherent in the prevailing agricultural knowledge frameworks.

With the introduction of the World Bank-funded agricultural productivity programs—starting with the West African Agricultural Productivity Program (WAAPP) in 2007, the East Africa Agricultural Productivity Program (EAAPP) in 2009, and the Agricultural Productivity Program for Southern Africa (APPSA) in 2013—the Agricultural Knowledge and Information Systems (AKIS) paradigm came into play (World Bank, 2007). The AKIS advocated for special information channels for technology dissemination beyond technology generation and brought the end user of agricultural technologies into perspective, albeit still passively. The key actors under AKIS are largely public agencies comprising NARIs, universities and extension departments. To some extent, the AKIS paradigm is akin to the national agricultural and extension system (NARES) that has also been used in the literature to incorporate the concept of delivery.

Contemporary and expected future challenges to agricultural development defy conventional approaches to finding solutions. This has stimulated the elaboration of the agricultural innovations systems (AIS) perspective. In 2012 the World Bank published an authoritative guide to this concept titled: "Agricultural Innovation Systems: An Investment Sourcebook". The AIS adds value to the AKIS paradigm by embracing the application of new knowledge and technologies (potentially emanating from a multiplicity of actors) in addition to technology generation and dissemination (Roseboom, 2012). The concept also gives prominence to the role of markets and market actors, for example, in defining the research agenda and also recognizes the progressive evolution of agricultural sector institutions each potentially bringing to bear unique knowledge capabilities and combinations to spur transformative innovations.

A comparative account of the value added by each sequential agricultural system concept or knowledge framework (NARS, AKIS and AIS) has been given by Rajalahti (2012). Suffice to mention here that the AIS perspective currently supersedes the NARS and AKIS for configuring research systems. As a theoretical construct, the AIS is applicable at various scales (namely: national, regional and continental) and is useful for: i) rallying and integrating stakeholders(from various knowledge nodes) to jointly address agricultural challenges; ii) programmatic design; iii) evaluation of gains to investments in AR4D;and iv) capacity development. According to a survey conducted by FARA in Botswana, Ghana, Kenya and Zambia, there were indications of a gradual shift in paradigm from the NARS concept toward the AIS model at the policy level in some of these countries, but gaps still existed in the downstream domain where each stakeholder group seemed to be operating in isolation of the other key actors in subsector value chains (Ugbe, 2013).

The little progress in shifting from the NARS to

[1] The International Service for National Agricultural Research (ISNAR) was founded in 1979 as a member of the CGIAR to strengthen national agricultural research in developing countries and bring about sustained improvements in the performance of their national agricultural research systems (NARS) and organizations. It ceased to exist on March 31, 2004.

the AIS paradigm at policy and programmatic levels within countries is perhaps due to paucity of concrete evidence on the transformative advantages of one paradigm over the other. Moreover, reconfiguration of agricultural research systems has been sporadic and exogenously instigated, often lacking a sense of ownership, continuity and systematic contagion across countries. The whole process is not aided by the seeming lack of catalytic action—akin to the role that ISNAR played—by external agencies with a supranational mandate. As discussed in the next section, this is where FARA, sub-regional organizations(SROs), and RECs could play a value-adding role.

Development of Institutions for AR4D

The Asian Green Revolution relied heavily on technical support from the CGIAR (an international public good organization exemplified by the International Rice Research Institute (IRRI) based in Asia) to produce enhanced crop germplasm. As an interesting contrast, Brazil was inspired by international partners, but developed the local agricultural research system capacity for technical innovations that helped shape the agricultural transformation agenda (see Box 9.1). Within two decades, Brazilians used home-grown science and sheer will to dramatically transform traditional agriculture into a modern and strongly competitive enterprise (Akinbamijo & Ojijo, 2014). Due to the striking agro-ecological similarities between the South American Cerrado and the African Savanna, SSA countries need to bring home the Brazilian lessons in terms of strategic institutional development of research systems coupled with targeted investments in AR4D to promote food and nutrition security. In so doing, there would be need to adapt successful experiences, as the farming systems in Brazil and SSA may not be roundly comparable.

In its role as the lead institution for Pillar 4—focusing on technology generation, dissemination, and adoption—in the first CAADP decade, FARA elaborated the Framework for Africa's Agricultural Productivity (FAAP) to help advocate for: i) evolution and reform of agricultural institutions and services; ii) increasing the scale of Africa's agricultural productivity investments; and iii) aligned and coordinated financial support (FARA, 2006). FAAP outlined guiding principles for the evolution of Africa's agricultural productivity

Box 9.1: Embrapa - A Success Story

The success of Brazilian agriculture hinges on the pull effects arising from a government-led industrialization process starting in the 1960s, giving rise to rapid urbanization, improvement in income of urban dwellers and higher demand for food. At the same time, lack of land for expansion (Brazil made a green choice not to encroach into the Amazonian forestlands, but rather reclaim the Cerrado), constrained production increase and the only recourse was science-based production intensification. Thus, there was imminent demand for agricultural research and consequent pressure at the macro level to reform public agricultural research agencies.

These circumstances conspired to "midwife" the Brazilian Agricultural Research Corporation (Embrapa) in 1973, the singular agency at the center of the Brazilian agricultural modernization. As a successful institutional innovation, Embrapa has the following main characteristics: a semi-autonomous national corporation with spatially decentralized centers, specialized research units, strong human capital base, and unwavering vision of agriculture based on science and technology and results orientation.

The main factors that contributed to the success of Embrapa include: prioritized budget support by the federal government as a result of sustained policy dialogue between Embrapa staff and budget decision makers; huge initial investments (over US$6 billion) in the training of human resources and development of research infrastructure; strong human capital base derived from a comprehensive human resources policy; short-term research goals, dissemination of existing results, and good public image (based on good relationship with the media); induced innovation based on farmer–researcher interactions (farmer–researcher interactions were promoted based on decentralization of Embrapa units to sub-national territories); transparency and public accountability (good media management and corporate communication); semi-autonomous status allowing for flexibility to administer resources and personnel, plan, assess performance, implement the budget, disseminate results and be transparent; non-political interference in the operations of Embrapa; and a policy of openness to national stakeholders and to the world.

This encouraged strategic partnerships at home and abroad (with foreign universities, CGIAR, NARS) and creation of technology transfer (e.g., Embrapa-Ghana) and co-innovation units (Labex USA, Labex Europe and Labex Asia) in foreign countries.

Adapted from Alves (2012).

programs and called for scaling up investment in regionally coordinated agricultural research, extension, and education programs.

At continental level, the FAAP principles have guided support to the evolution and strengthening of key continental agricultural institutions for AR4D, namely: research—Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) and North African Sub-regional Organization (NASRO); tertiary agricultural education—RUFORUM and ANAFE; extension services—African Forum for Agricultural Advisory Services (AFAAS); agribusiness and private sector—Pan African Agribusiness and Agro-Industry Consortium (PanAAC); farmers—Pan African Farmers Organization (PAFO); and civil society and NGOs—Pan African NGOs Consortium on Agricultural Research (PANGOC). These organizations were either aligned or alignable to CAADP Pillar 4, with the common agenda of promoting AR4D in their respective domains based on complementarity and subsidiarity.

Thus, as it stands now, Africa has perhaps the most definitive configuration of what could safely be called a continental or regional AIS. Such a configuration is well poised to support emergence of respective national chapters or constituents, strengthening of national agricultural innovation systems (NAIS), and facilitating innovations in areas that can benefit from transboundary or supranational collaborations (Roseboom, 2012). As the apex organization, FARA has exercised its convening role, notably through the triennial Africa Agriculture Science Week, to foster a common vision and collective action for AR4D amongst the Pillar 4 institutions and allied stakeholders. Like in any innovation system, the role of an intermediary is key to foster functional connectedness of the AIS components at various scales (Howells, 2006). Intermediation in innovation systems is like grease in tribology. Supranational agencies are well poised to perform this role at regional level as are sector-coordinating or oversight agencies at national level and innovation champions at sub-national level.

Within countries, FAAP has similarly helped advocate for inclusion of various actors in AR4D towards a progressive evolution of NARS into functional NAIS. Introduction of the concept of integrated agricultural research for development (IAR4D) by FARA, and popularized under the Sub-Saharan Africa Challenge Program (SSA CP), has aided this process. Basically, IAR4D provides a grounded context for co-innovation; it brings together multiple actors around a common theme (i.e.,a commodity value chain, natural resource, or organizational and research management) to jointly address challenges and identify opportunities to generate innovations (Adekunle et al., 2012). One way of implementing the IAR4D concept is through innovation platforms (IPs)—a transitory social space, often loosely-organized and informal, whose membership is based on free entry and free exit self-interested persons or stakeholder groups. IPs provide space for horizontal or vertical networking with a problem-solving objective (Ugbe, 2013), and are supposed to inspire a change from technology- to system-oriented configuration for AR4D. Impact studies conducted at the SSA CP pilot learning sites indicate that IAR4D is effective in reducing food insecurity and improving the quality of food dietary diversity and smallholders' coping strategies when compared with control sites (Mango, Nyikahadzoi, Makate, Dunjana, & Siziba, 2015; Nkonya,Kato, Oduol, Pali, & Farrow, 2013).

Further, independent assessment by stakeholders indicate that IPs have been successfully used in poverty-alleviating agrotechnology dissemination and adoption ventures across Africa, including orange-fleshed sweet potatoes in Kenya, Rwanda, Uganda and Tanzania; climbing beans in Rwanda; and quality protein maize in Democratic Republic of Congo (DRC), Rwanda, Uganda and Tanzania (Kimenye & McEwan, 2014). According to Schut et al. (2015, p. 20), the extent to which IPs have "institutionalised demand-driven AR4D to support systemic capacity to innovate" is still unclear. However, in countries where IPs have been piloted, success is evident at sub-national scales,as demonstrated by the case of Rwanda (Box 9.2). Moreover, most CGIAR centers continue to promote IPs in their technology outreach efforts, most recently under the emerging "Technologies for African Agricultural Transformation (TAAT)" initiative. TAAT is a FARA-CGIAR partnership supported by AfDB for accelerated transformation of rural economies of African countries by bringing to scale proven technologies pegged to about 23 prioritized agricultural commodity value chains. About US$700 million is earmarked for the initiative to be implemented over a 5-year period.

Re-organizing for a More Effective Role of Science in SSA Agriculture

The "Sustaining the CAADP Momentum" drive was crafted at the end of the 1st CAADP decade to bridge the transition into the next phase of implementation, building on past experiences and lessons. It served as the basis for a new Results Framework for CAADP and specified the need to develop a Science Agenda for Agriculture in Africa (S3A), as a component knowledge support system for renewed CAADP implementation. The development of S3A has been successfully led by FARA working with the other regional stakeholders, and the S3A document was ratified during the Heads of State Summit in 2014 in Malabo, Equatorial Guinea.

The S3A outlines the guiding principles to help Africa take

Box 9.2: Rwanda - A Phoenix Rising from the Remains of Murambi[2]

"Rwanda's experiences provide meaningful lessons on how a well-performing agriculture and food sector can make a sizeable dent in poverty,"

Severin Kodderitzsch, Manager in the World Bank Agriculture Global Practice.

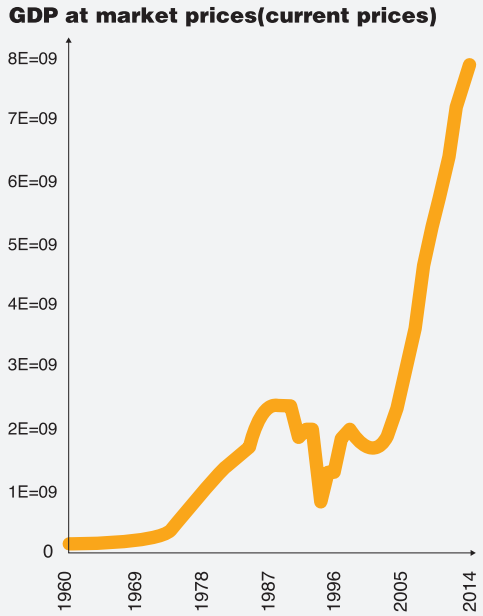
The infamous massacre of 1994 caused a major dip in Rwandan growth trajectories. Nevertheless, in the aftermath of this dark episode, the country has been rising and statistics attest to this celebrated resilience. Within a decade, the GDP has quadrupled, agricultural gross production value has doubled, and funding allocation to AR4D increased by almost 6 percent.

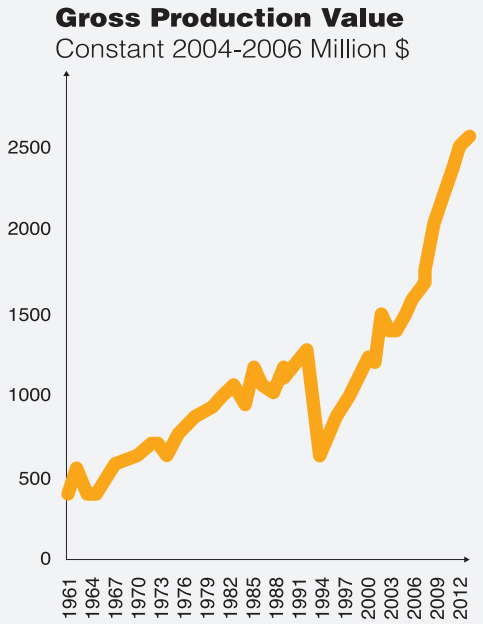
Previously, agricultural research in Rwanda was conducted by the Institut des Sciences Agronomiques du Rwanda (ISAR). However, the weak link between research and extension systems necessitated the merger of ISAR, the Rwanda Agricultural Development Authority (responsible for crop production and management) and the Rwanda Animal Resources Development Authority (responsible for animal production) into the current Rwanda Agricultural Board (RAB), a process which started in 2008 and was finalized in 2011. This institutional reform was inspired by FAAP principles and innovation systems thinking (which was nascent at the time) to bring research scientists and extension agents together under a single entity for more effective and efficient delivery of AR4D. A corresponding institutional change was the amalgamation of all public universities to form the University of Rwanda in 2013.

Rwanda was the first country to sign the CAADP Compact in 2007. The findings of an Integrated Household Living Conditions Survey showed a 14 percent reduction in poverty between 2007 and 2011 with a million children, men and women lifted out of poverty in Rwanda. Almost half the reduction in poverty was attributed to developments in agriculture, specifically an increase in agricultural production and rural income from sale of surplus produce in the local markets (Bizimana, 2014). In addition to institutional reforms, Rwanda's agro-renaissance was made possible by proactive and pro-poor policies (e.g., land use consolidation and agri-livestock integration), good research management, strategic partnerships, agro-ecological AR4D focus, capacity development, a strong extension program using farmer field schools and farmer promoters (MINAGRI, 2016), and accountability for results.

Notable AR4D features have been on the development of improved varieties against biotic and abiotic stresses for different

Figure A





crops including beans, rice, wheat, maize, cassava, bananas, Irish potatoes, and sweet potatoes. Specific successful technological interventions include breeding for animal genetic improvement, crop disease resistance, biotechnological diagnostics for livestock diseases, development of forage germplasm and straw feeding technology, integrated soil fertility management techniques and GIS application in land use. Between 2008 and 2013, substantial yield increases were achieved for key crops (Figure B) due to concerted research efforts (Mbonigaba, 2014). On nutrition-sensitive agriculture, specific CGIAR centers have supported the development of various nutrient-rich crop varieties, which have been widely adopted via IPs to combat malnutrition. Examples are vitamin A rich cassava (International Institute of Tropical Agriculture—IITA), high quality protein maize (International Maize and Wheat Improvement Center—CIMMYT), biofortified beans (International Center for Tropical Agriculture—CIAT), orange-fleshed sweet potatoes (International Potato Center—CIP) and indigenous vegetables (RAB, 2015).

[2] Murambi is a school where some of the grisly massacres occurred during the Rwanda genocide. It is currently maintained as one of the major memorial sites.

Figure A

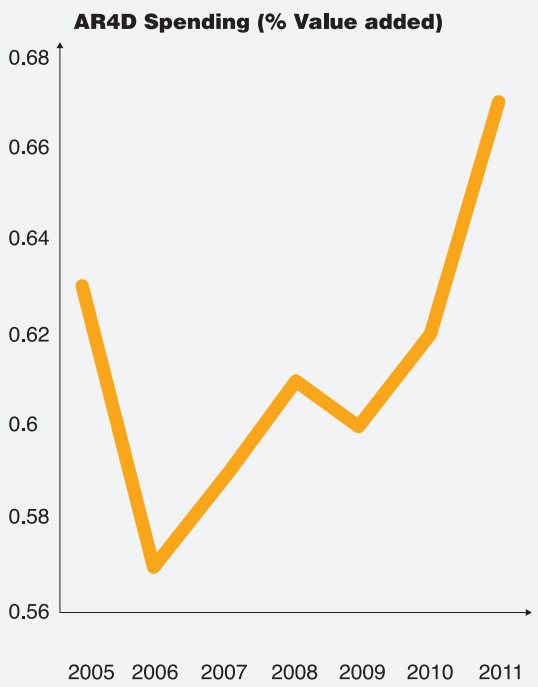
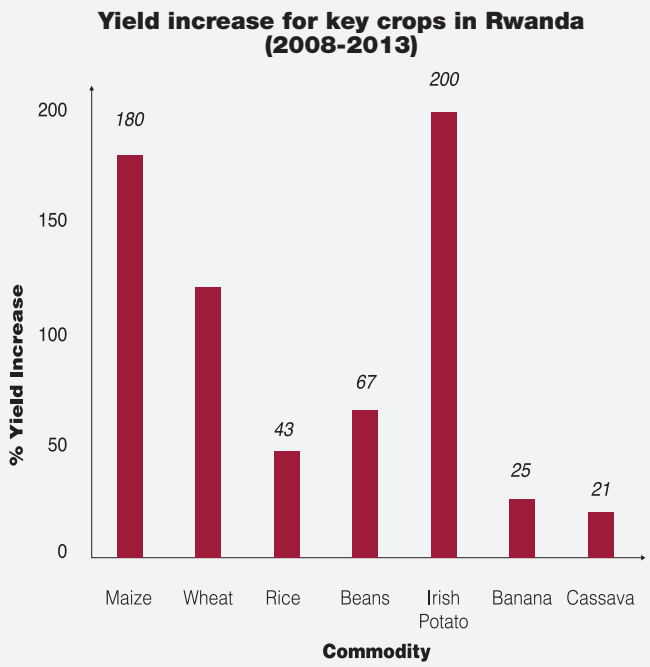


Figure B



charge of the science to develop its agriculture and how science can play a more prominent role in Africa's agricultural transformation. Like FAAP, the S3A advocates for institutional shared vision based on the fact that "science for agriculture in Africa is too important to be outsourced to external actors", and a doubling by 2030 of public and private sector investment into AR4D. The S3A specifies four thematic areas of focus: i) sustainable productivity in major farming systems; ii) food systems and value chains; iii) agricultural biodiversity and natural resource management; and iv) responses to megatrends and challenges for agriculture in Africa. These thematic areas are underpinned by cross-cutting issues on sustainable intensification, modern genetics and genomics, and foresight capabilities (FARA, 2014).

Currently, regional actors in agricultural research are reorganizing themselves into a new institutional configuration in response to the readjustments in the continental agricultural policy environment triggered by the Malabo Declaration of 2014. The new AR4D partnership known as the Science for Agriculture Consortium (S4AC), comprises the core actors (FARA, SROs[3], and AFAAS) and

[3] Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), CCARDESA and West and Central African Council for Agricultural Research and Development (CORAF/WECARD).
[4] ANAFE and RUFORUM.

other supportive partners (tertiary agricultural education networks[4], PAFO, NPCA, CGIAR centers, and the Global Forum on Agricultural Research (GFAR)). The S4AC seeks to better support the S3A implementation at country level and give impetus to the "Accelerated Africa Agricultural Growth and Transformation" drive based on the post-Malabo CAADP Roadmap and Strategy. Its priority work streams are: i) supporting implementation of the CAADP national agricultural investment plans at country level; ii) engaging the policy agenda on fertilizer, seed, agribusiness, value chains and food markets; iii) strengthening institutional systems for knowledge management, innovation systems and platforms at national, regional and continental levels; and iv) developing foresight capabilities for megatrends for R&D (FARA, 2015).

Already the core partners have embraced new engagement principles to enrich subsidiarity and minimize transaction costs through joint programmatic planning, resource mobilization and sharing of staff compliments. Thus, whereas agricultural research, technology generation and dissemination may not be a programmatic pillar in the current CAADP dispensation, institutional reconfiguration around the S3A will facilitate similar reforms at national level and knowledge-driven agricultural progress in the second decade of the CAADP. The evolving Consortium will act as an important bridge to help cascade regional policy frameworks (e.g., the S3A) to national level so as to promote conscious investments in and application of science in agriculture.

Indeed, the S3A will help orient the direction for agricultural scientific inquiries in Africa, especially if the Consortium is successful in mobilizing home-grown funding. Currently, agricultural research in Africa is to a large extent supply driven and predominantly reflects the areas favored by donors. This is despite the major principles (e.g., alignment with recipient priorities) agreed upon at High Level International Fora on Aid Effectiveness namely: the Paris Declaration on Aid Effectiveness (2005), the Accra Agenda for Action (2008), the L'Aquila Joint Statement on Global Food Security (2009), and the Busan Partnership Agreement (2011). Yet again, far-reaching commitments on the table, little compliance in practice.

Funding for AR4D in SSA

Between 2010 and 2014, some 40 African countries were engaging in the CAADP process. About 30 countries had signed the CAADP compacts; 24 countries had finalized their investment plans; and 17 countries had leveraged US$611.5 million from GAFSP to support implementation of the CAADP national agricultural investment plans (NAIPs). It is unclear what proportion of these funds was allocated to AR4D. However, based on an analysis commissioned by the European Initiative for Agricultural Research for Development (EIARD), donor funding allocations to AR4D in SSA in 2010 are given in Table 9.1.

Table 9.1: Donor funding for AR4D

Category	Funding (US$, million)
CAADP Pillar 4 (FARA + SROs)	46
NEPAD + other CAADP Pillars 1 - 3	19
Non-CAADP Pillar 4 aligned	46
Non-CAADP Pillar 4 alignable	37
IARCs & CB/PPs	16
AGRA Funding for NARS	90
CGIAR	304
TOTAL	**558**

Funding around CAADP Pillar 4, mainly through multi-donor trust funds managed by the World Bank, amounted to nearly 32 percent of the total donor investment in agricultural research and development (ARD) in SSA. As is traditional, the largest share of investment allocation was in favor of the CGIAR (65 percent), a significant proportion of which was forwarded to national research institutes on sub-contracts. The share of agricultural ODA for Africa grew by an average of 6.3 percent in the first decade of CAADP, between 2003 and 2012 (Bahiigwa, Collins, Makombe, Jemaneh, & Tefera, 2014). Correspondingly, these authors also report that the African agricultural production index grew at an annual average rate of 3.2 percent between 2003 and 2012. According to ASTI, public (i.e., national government) agricultural research spending in SSA increased by more than one-third in real terms, from US$1.2 billion in 2000 to US$1.7 billion in 2011, measured in constant 2005 purchasing power parity (PPP) dollars (Beintema & Stads, 2014). However, nearly half of this value was due to investments made

in only three countries: Kenya, Nigeria, and South Africa.

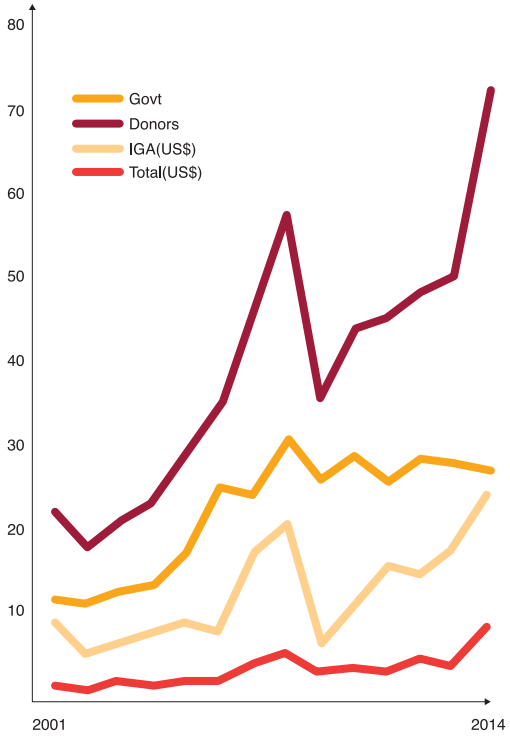
Figure 9.1 shows the research funds in real dollar value availed to the Kenya Agricultural Research Institute (now Kenya Agricultural and Livestock Research Institute—KALRO) over the last 15 years. An increase in research fund allocation from the Kenya Government was indeed apparent from 2004, but this has since tapered off to a plateau of around US$27 million per year. Correspondingly, the food production index also registered a marked increase from around 2004 perhaps due to a KARI/KALRO mediated adaptation and adoption of new technologies (e.g., developed by the CGIAR) by farmers.

The Africa agricultural productivity programs (i.e. WAAPP, EAAPP, and APPSA) have provided another funding avenue for AR4D in Africa. Administered through the World Bank's Adaptable Program Loan (APL), the productivity programs—whose design is based on the FAAP principles and the AKIS paradigm—have directly facilitated implementation of agricultural policies of RECs (ECOWAS, COMESA, and SADC) and, more specifically, the NAIPs of participating countries. Based on World Bank reports, nearly 20 countries in SSA have benefited from a total of US$441 million to date in support of AR4D through the WAAPP, EAAPP and APPSA (World Bank, 2012) as shown in Table 9.2.

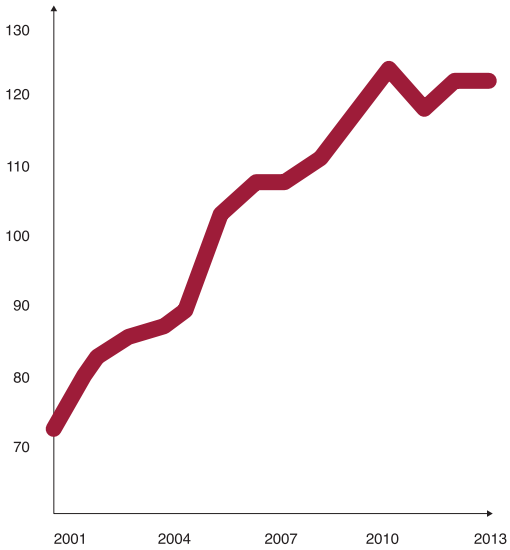
Notwithstanding the apparent growth in AR4D spending over the last decade, the SSA AR4D intensity ratio (measure of total public AR4D spending as a percentage of agricultural GDP) has steadily declined from 0.59 percent in 2006 to 0.51 percent in 2011, far below the 1 percent recommended by the AU (Beintema & Stads, 2014). A common feature in many SSA countries is that the bulk of funds allocated to agriculture goes into recurrent expenditure (e.g., staff salaries) rather than research execution. Thus, the share allocation to AR4D has not been commensurate with agricultural output. In Ethiopia, for example, agriculture contributed nearly 45 percent of the national GDP in 2011, yet the government allocated a paltry 0.19 percent of its agricultural GDP to research, the lowest amongst 10 comparing countries. In contrast, Swaziland, where agriculture contributes only 8 percent of GDP, allocated 1.43 percent of agricultural GDP to research (Figure 9.2). Obviously, there are idiosyncratic circumstances that dictate budgetary allocation in various countries and funding of agricultural research is least determined by reciprocal sector contribution to the economy.

Agricultural research can be a protracted enterprise (e.g., breeding programs can take decades for any returns to investments to be demonstrated) and therefore requires sustained funding and some patience. However, AR4D funding in many SSA countries has exhibited high volatility over the last decade chiefly due to high dependence on external donors (Stads, 2012) and vacillating government priorities. African partners, unable to fund their own AR4D, often sacrifice their strategic interests at the altar of donor aid. Indeed, the multi-donor trust funds managed by the World

Figure 9.1. Research funding (US$ billions)



Food production index in Kenya



Source: *Personal Communications, Director General, KALRO*

Table 9.2: SSA AR4D funding through agricultural productivity programs

No.	Adaptable Program Loan (APL)	Amount (US$, million)	Year	Countries	Commodity focus
1	APPSA	90 (51.87)	2013–2020	Malawi Mozambique Zambia	Maize Rice Food legumes
2	EAAPP	90	2010-2015	Ethiopia Kenya Tanzania	Wheat Smallholder dairy farming Rice
3	WAAPP – 1A	45	2008-2012	Ghana Mali Senegal	Roots & tubers Rice Cereals
4	WAAPP – 1B	90 (11)	2010–2016	Burkina Faso Côte d'Ivoire Nigeria	Fruit & vegetables Bananas & plantains Aquaculture
5	WAAPP – 1C	120.7 (11.8)	2012–2016	Benin, The Gambia, Niger, Sierra Leone, Togo, Guinea, Liberia	Livestock, maize, and mangrove rice
6	WAAPP - 2A	180 (101)	2013-2018	Ghana Mali Senegal	Roots & tubers Rice Cereals
	TOTAL	**615.7(175.67)**		**20**	

Source: *Adapted from figures available on the World Bank website and PAD reports (Amounts still to be disbursed as at December 2015 according to the WAAPP PAD)*

Bank, whilst addressing the issues of donor harmonization and long-term funding horizons, have equally been veritable instruments for micro-managing the programs and activities implemented by regional agencies like AUC, NEPAD, FARA, SROs and AFAAS.

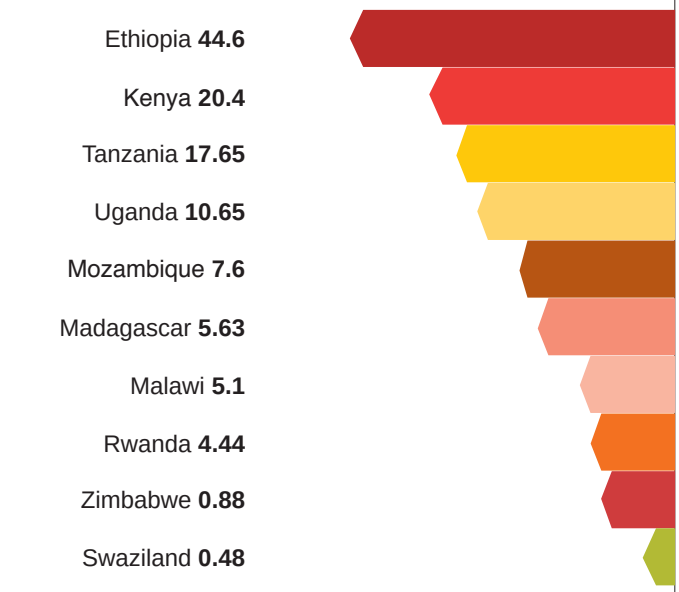
The lack of sustained funding and misalignment of research priorities hinders long-term effectiveness and efficiency of AR4D and compromises transformative growth of the agricultural sector. Furthermore, governmental instability, resource constraints, and lack of recognition of the importance of investing in AR4D contribute to systemic underfunding of AR4D in SSA countries. Some innovative ways for sustainable home-grown funding of AR4D in SSA countries include:

- **Leveraging philanthropic funding nationally and abroad.** Philanthropic funding agencies are unique in that they can invest in riskier ventures than the private or public sector. In the last decade, the Bill and Melinda Gates Foundation (BMGF) has invested huge sums in AR4D the world over and is currently one of the largest contributors to AR4D in SSA. Growing African economies are also generating billionaires. Some of them (e.g., Aliko Dangote of Nigeria) have indicated a sense of philanthropic disposition and could be persuaded to support AR4D in SSA.

- **Business orientation in NARIs and universities.** NARIs and universities in the region must increasingly embrace a business orientation in their mandate to generate revenue from their knowledge products. This is already happening in some countries (e.g., CSIR in Ghana) where the research institutes have been conditioned to explore ventures for revenue generation over and above government capitation (Beintema & Stads, 2014). Such ventures could include setting up incubation centers and other client uptake streams for own-generated technologies. Stanford University is accredited with many of Silicon Valley's most successful start-ups because every one of its departments has a business incubation unit.

- **Private sector funding.** This will only be possible where

Figure 9.2
Agricultural Contribution to GDP (%)



National investment in agricultural research

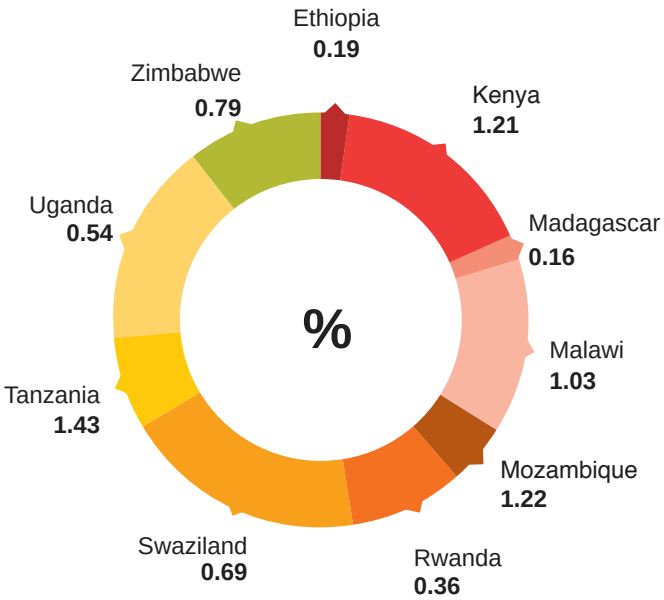


Figure 2: *Agricultural GDP and contribution to research (ASTI, 2014)*

there is sufficient incentive for profit. For example, a seed company could fund breeding research by a NARI or university if they will retain exclusivity to commercialize the developed germplasm. Similarly, cutting edge research in areas like biotechnology has attracted private sector funding (e.g., Syngenta and Monsanto) due to the inherent proprietary potential of the research outputs. Unfortunately, the intellectual property regimes in many SSA countries are for most part not supportive of such ventures.

- **Commodity (ad valorem) levies.** The NARI in Kenya has undergone structural changes in the recent past by amalgamating the former Kenya Agricultural Research Institute (KARI) with previously quasi-private research agencies (e.g., the Coffee Research Foundation and the Tea Research Foundation) managed by farmer-based organizations (FBOs). This creates opportunity for appropriating pooled levies from high-value commodity proceeds to fund research. As indicated in Figure 9.1, the surge in total funding of KALRO between 2013 and 2014 was due to the appropriation of coffee, sugarcane and tea levies.

- **Public–private partnerships in agricultural research.** This is exemplified by the case of Golden Valley Agricultural Research Trust (GART) of Zambia, a self-sustaining and autonomous public–private partnership between the Zambia Government and Zambia Farmers Federation. GART is self-sustaining due to proceeds from commercial farming and contract research.

- **Competitive grant funding (CGF).** The Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) has successfully used this instrument to fund supranational agricultural research in the member countries (Tizikara, 2005). The same applies to the West and Central African Council for Agricultural Research and Development (CORAF/WECARD), especially under the World Bank funded agricultural productivity program, WAAPP. National science, technology and innovation (STI) coordinating agencies (e.g., Kenya's National Council for Science Technology and Innovation) have used the Consultative Group for International Agricultural Research (CGIAR) to varying degrees to fund research themes that address national development priorities.

By its nature and design, the CGF can help countries move away from the NARS concept towards functional NAIS by fostering strategic linkages of various actors

(e.g., NARIs, universities, NGOs, FBOs, and private sector players) to execute strategic, high quality, and demand-driven AR4D. Indeed, the idea of competition has been proposed even in public funding of AR4D. Currently, SSA countries allocate block funding to national research institutes based on annual budgets. In the European Union, it has been suggested that allocation of research funds even to public AR4D agencies should be pegged to competition, peer review and institutional assessment (Georghiou, 2013). This will promote excellence and targeted competition for resources against a set of predefined priorities. Through competition, the little funds availed by national governments to AR4D can be more efficiently and effectively used to bring about transformative agricultural innovations.

Agricultural Advisory Services

Economic returns to investment in AAS are infrequently measured but studies show such returns to be very high. Reviewing 57 studies across the world, Evenson (1997) reported rates of returns were greater than 50 percent for most cases, but also found that returns varied widely. Alston, Wyatt, Pardey, Marra, & Chan-Kang (2000) reviewed 18 studies and found mean returns of 80 percent. Assessments of the impact and effectiveness of AAS in Africa, either as a whole or for particular methods and approaches, are even rarer. A recent meta-analysis by the Initiative for Smallholder Finance (2015) found robust evidence from the tropics that agricultural extension improves crop yields and quality, and thereby smallholder livelihoods. AGRA (2014) reported, based on analyses in four African countries, that access to extension services also reduces production risks. However, little has been written on the economic returns to extension in Africa, perhaps because of the huge measurement challenges, declining interest in rates of returns studies or other factors (Davis, Franzel, & Spielman 2016)).

Moreover, given the diversity of AAS providers (government, NGOs, private sector) and variations in the skills and competencies of field staff and management systems across countries, it is difficult to come up with broad generalizations about the economic contribution of AAS (Evenson, 1997). There is also little information on the returns to particular AAS approaches and many gaps persist in our understanding of the effectiveness and impact for both existing AAS approaches (e.g., demonstration plots) as well as new ones (e.g., call centers and other ICT-based approaches). While a few approaches, such as farmer field schools have been analyzed in depth (see Waddington et al., 2014) most others, particularly the newer ICT-based ones, have hardly been assessed at all. Davis, Franzel & Spielman (2016) note that whereas many evaluations ask whether an AAS approach works the more important questions are what types of AAS approaches work well for particular types of agricultural technologies, particular target groups (e.g., women), at what cost and how these approaches may be improved.

Nonetheless a review by Evenson (1997) on impact studies of AAS in about 50 countries showed that many extension programs have been highly effective in aiding farmers to achieve higher productivity, although some had no effect due to poor design and management discipline. Overall, AAS appear to be most effective when researchers are effective in generating innovations that are demand driven and in economies where farmers have access to schooling, new technology, and extension.

Key Trends

As mentioned in the previous section, conventional models of technology transfer, popular in the last century but still in wide use, involve technology and information passing from research to extension to farmers. The innovation systems model, also discussed in the previous section, features many more actors and knowledge-generating processes and thus has important implications for advisory services. A major implication is that extension staff need to play convening, brokering and coordinating roles and not just one of passing on information (GFRAS, 2012).

Several key trends in recent years affect the supply and demand for AAS and the types of services and approaches that would be most relevant to meet Africa's agricultural development challenges. First, on the supply side, agricultural technologies and recommendations to farmers are becoming more and more knowledge intensive. For example, instead of recommending that farmers apply blanket fertilizer recommendations, advisory staff recommend integrated soil fertility management, involving advice and new skills for applying manure, compost, and micro-doses of fertilizer. While the need for AAS to share information and train farmers is increasing, the numbers of publicly funded extension staff have been decreasing in most countries. Nor are other service providers, such as private sector extension or farmer organizations able to meet the demand, leaving farmers in remote and marginal areas under-served. Proportions of farmers interacting with extension staff are typically under 20 percent and significantly lower for female farmers (Meinzen-Dick et al., 2011.

On the demand side, there is increasing evidence of the importance of urban-based farmers; the proportion of urban households owning agricultural land across 6 countries ranged from 24 percent in Ghana to 49 percent in

Rwanda (Jayne et al., 2015). Moreover, many other urban dwellers provide advice and inputs to relatives and friends who farm. This implies that providing urban dwellers with advice on agriculture is an important means of influencing agricultural practices. A further development is that there are considerably more ways for farmers to access information than there were five years ago. The spread of mobile phones and other forms of ICT, such as television, radio and mobile and web applications (Bell, 2015), present new avenues for reaching and receiving feedback from farmers. It is estimated that mobile phone penetration (the number of mobile subscribers as a proportion of the population) has reached 74 percent in Kenya, 62 percent in Tanzania and 60 percent in Ghana (The Africa Report 2015; The East African, 2016). In Tanzania, 41 percent of the population watches television weekly (Murthey, 2011).

Further, several issues affecting AAS have become increasingly important over the last several years. First, assisting farmers to access markets and improve the quality of their produce to satisfy consumer demand has become a more common AAS function. Targeting women and youth and assisting farmers to adapt to climate change have also become increasingly important. An important and positive development was the emergence of strong global, continental and regional organizations to support AAS, promote exchanges of experience and advocate for greater investment among nations and donor agencies. These organizations include GFRAS (The Global Forum for Rural Advisory Services), AFAAS and RESCAR-AOC (Réseau des Services de Conseil Agricole et Rural des Pays d'Afrique de l'Ouest et du Centre). Whereas research in Africa has long had strong bodies to support it (e.g., FARA and CORAF), AAS have been relatively neglected. Strong national bodies supporting AAS have also become active in several countries, such as Uganda, where the national forum assists members to exchange experiences on extension approaches and lobbies the government on national agricultural extension policy (UFAAS, 2016)

Advisory Services on the Ground: Organization and Focus

Extension systems are provided by an array of different organizations, including government, NGO, farmer organizations, universities, and private sector (Ojijo et al., 2013b). Governments and sometimes NGOs are the principal organizations serving farmers. There is considerable and growing investment in AAS by farmer organizations (GFRAS, 2015) and by the private sector (Root Capital, 2015; Zhou & Babu, 2015), including a range of actors such as agro-vet shops selling inputs and multi-national corporations buying produce. However, the advisory services of these organizations only reach a small proportion of farmers and tend to specialize in cash crops and to operate in areas with favorable market access.

Most countries lack national policies on AAS. Two exceptions are Rwanda and Kenya, which developed national agricultural extension strategies in 2009 and 2012 respectively (Government of Kenya, 2012; Government of Rwanda, 2009). Both have decentralized AAS to improve efficiency and responsiveness to local needs (Ojijo et al., 2013b). Having a national policy on extension has the potential to improve the profile of extension in development strategies and improve coordination of field-level AAS.

Ratios of numbers of AAS staff to farm households are available in some countries. The ratio across SSA is estimated to be 1 agent to 1,500 to 3,000 farmers, far more than a single agent can visit, even when working with groups of farmers rather than individuals (CTA, 2012). Ratios vary considerably among African countries and are not generally more favorable than those prevailing in Asian countries (Table 9.3). In Kenya the ratio is 1:950 whereas the government's desired ratio is 1:300 (Government of Kenya, 2012). Ethiopia has the lowest ratio of farmers per agent shown in Table 9.2 and, perhaps not coincidentally, has one of the highest agricultural growth rates in Africa. However, these ratios typically only include government AAS. Data on the AAS of NGOs, producer organizations and the private sector are generally unavailable. The extent of these other types of AAS is indicated in an inventory of AAS conducted by Tsafack et al. (2015) in Cameroon. The authors identified 151 AAS operating in the country's seven southern-most regions, an area with a rural population of about five million. Over two-thirds were managed by NGOs, particularly local and international NGOs (Table 3). Government services accounted for 17 percent of the AAS and the private sector, only 1 percent.

A survey of 80 AAS across Cameroon, Kenya and Malawi found that 65 to 76 percent targeted all farmers in the areas they were working whereas 24 to 35 percent targeted specific types of farmers, such as those who were members of a cooperative, were growing a particular crop or were members of a particular strata, such as those affected by HIV/AIDS (Franzel, Sinja, Simpson, 2014; Kundhlande, Franzel, Simpson, & Gausi, 2014; Tsafack, Degrande, Franzel, Simpson, 2014). Main extension methods used across the three countries included demonstrations (28 to 72 percent), exchange visits (23 to 36 percent) and field days (12 to 53 percent). Farmer field schools were used by 44 percent of the AAS in Malawi, but by less than 10 percent in Cameroon and Kenya. Farmer-trainers or lead farmers were used by 31 percent of AAS in Cameroon and by 78 percent in Malawi (Masangano & Mthinda, 2012).

Table 9.3: Number of extension agents and farmers per agent

Country	Number of agents ('000)	Farmers per agent
Africa		
Democratic Republic of Congo	11	540
Ethiopia	60	480
Kenya	6	950
Malawi	2	1,800–2,514
Nigeria	5	3,330
Tanzania	7	2,500
Asia		
China	800	620
India	60	5,000
Indonesia	30	1,670

Source: *Adapted from Ragasa, Mazunda and Kadzamira (2015)*

Table 9.4: Types of extension services operating in seven regions in Cameroon

Type of service	Number	Percent
Local NGO	50	33
International NGO	35	23
Government*	26	17
Producer organizations	20	13
National NGO	18	12
Private sector	2	1
Total	151	100

Note: The seven are the southern-most regions and thus exclude North, Far North, and Adamawa.

*includes several different ministries involved in AAS and projects that are managed as separate entities.

Source: *Tsafack et al. (2014); Sygnola Tsafack (personal communication)*

Ojijo et al. (2013b), in a review of extension services in Africa, noted several weaknesses in public systems. The policy framework was unclear in many countries and even where strategies did exist, they did not sufficiently provide for involvement of the private sector, universities and other tertiary agricultural education institutes. Other weaknesses included lack of staff and resources, lack of clear dissemination approaches and inability to exploit the opportunities offered by ICT in extension. Ragasa et al. (2015) note three other areas where performance needs to be strengthened in Malawi and elsewhere: ensuring that priorities are demand-driven, strengthening the role of the national AAS system in coordinating AAS interventions among a wide range of actors, and in being accountable to stakeholders and in particular farmers.

Novel AAS Approaches

The following are examples of three novel and cost-effective AAS approaches that show promise for helping farmers learn new skills and information for improving their farm productivity and profitability.

Shamba Shape-Up

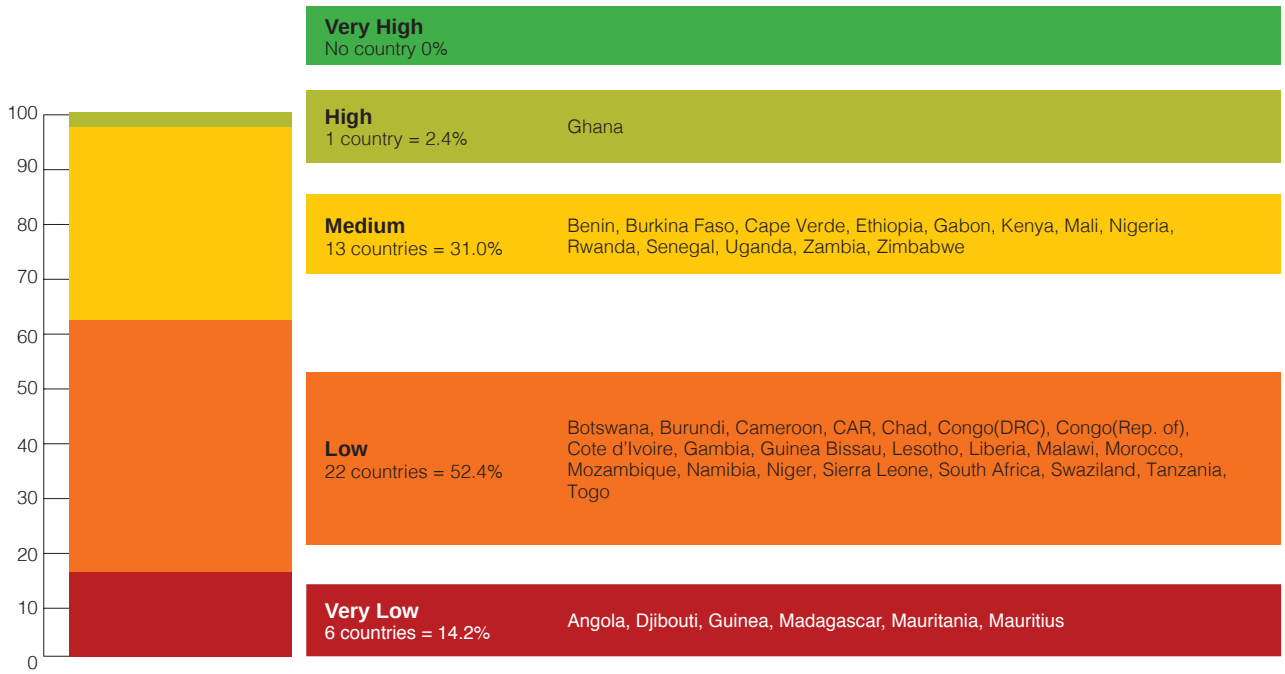
The Shamba Shape-Up (SSU) weekly television program in Kenya, Tanzania, Uganda and Rwanda educates farmers on basic and innovative farming practices. Broadcast in both English and Kiswahili, a particularly innovative aspect of the program is its combination of education and entertainment, dubbed "edu-tainment". SSU's novel approach is to have TV celebrities visit farmers experiencing problems on their farms and discuss potential solutions and opportunities with experts and other skilled farmers. The audience can phone the SSU call center to ask questions or send SMSs to ask for information leaflets. The audience per show in Kenya is about 3,500,000 households (Kiptot, Franzel, Nora, & Steyn, 2016).

Costs of producing a show are relatively high, in terms of absolute cost—filming five six-minute segments costs US$50,000—but are low in terms of the cost per household reached: US$0.014 (Kiptot et al., 2016). The University of Reading (2014) found that in the 25 counties in Kenya that the show targets, 13 percent of rural households viewed SSU and most reported specific examples of the show increasing productivity and profitability on their farm. SSU was found to increase net benefits accruing to 428,000 farmers in the 25 counties by US$25.7 million. These figures do not include benefits accruing to urban households who farm which, as mentioned above, are high. Nor do they consider that farmers often use more than one information source when making a decision on use of a new technology. The importance of TV as an agricultural advisory service is likely to continue to increase in response to two trends noted above: the rapid increase in TV coverage in rural areas and the growth of urban-based emergent investor farmers. Shows are also broadcast over the radio and are available for viewing on the SSU webpage. The show also has an active Facebook page, helping involve youth more in agriculture; the page has 44,500 fans.

Farmer-to-Farmer Extension

Farmer-to-Farmer Extension (F2FE), the provision of training by farmers to farmers is used by many AAS. In Malawi, for example, a survey of 37 extension services found that 78 percent used some form of F2FE (Masangano & Mthinda, 2012 Several national extension services, such as Malawi and Rwanda have over 10,000 farmer-trainers.

Figure 9.3: Capacity indicators for agricultural transformation (ACBF, 2012)



Source: *Computed from ACI Database 2012*

Surprisingly, as pervasive as these programs are, little has been done to assess their effectiveness or distill lessons on successful implementation. Simpson, Franzel, Degrande, Kundhlande, and Tsafack (2015) summarized the results of a survey of 80 organizations (government, NGO, farmer organizations and private companies) implementing the approach across three countries: Cameroon, Kenya and Malawi. Nearly all reported that the approach was effective, with farmer-trainers typically volunteering their services and training between 17 and 37 farmers over the previous year, depending on the country. Nevertheless, the authors found several opportunities for improving the effectiveness of the approach.

By involving the community (e.g., local administrators or leaders of producer organizations) in selecting, monitoring and evaluating farmer-trainers, organizations backstopping farmer-trainers can make their programs more sustainable. Concerning gender, some organizations were able to recruit many more women as farmer trainers than they were able to recruit female frontline extension staff. For example, whereas only 5–10 percent of field staff working with the East Africa Dairy Development (EADD) Project in Kenya and Uganda were women, over 30 percent of the volunteer farmer trainers were women. Since women train more women than men, farmer-to-farmer extension in EADD serves both to empower women as trainers and to improve their access to AAS (Franzel et al., 2015b).

These findings show that AAS can make their volunteer farmer-trainer programs more effective and sustainable through understanding what motivates volunteer trainers and providing low-cost incentives for keeping them motivated. For trainers interested in altruism and social benefits, means of recognition (certificates, T-shirts and public recognition from local leaders) are important. Training, literature and visits with researchers and innovative farmers are important for those interested in early access to information. For those interested in earning income from associated services, for example, selling seed from their demonstration plots, helping link farmer trainers to clients interested in buying their services is important (Franzel et al., 2015a).

Management Advice for Family Farms

Management Advice for Family Farms (MAFF) is an advisory approach based on learning and decision-making processes aimed at strengthening farm families' entrepreneurial skills and capacity to manage resources. Participatory methods are used to enable participants to conduct self-analysis of their enterprises, keep records or analyze their technical and economic results and use decision-support tools to plan, implement and evaluate their performance. Typically, farmers receive both technical training (e.g., fertilization of maize and cotton pest control) and management training (e.g., cash flow planning and gross margin analysis) (Faure et al., 2015). MAFF differs from the farmer field school approach in that it deals with

the whole farm whereas the field schools typically focuses on a single enterprise.

Advisors typically work with farmer groups and group members share results and learn from each other. As a result, producers gain a new understanding of their farming systems and are able to improve their practices and develop new projects that improve their well-being. In Benin, for example, a dozen organizations, including NGOs and the Ministry of Agriculture, employ MAFF advisers that work with 7 to 9 farmer groups each, thus reaching over 20,000 farmers throughout the country.

Literacy is not required to participate. In fact, MAFF specialists have created management tools specifically targeted for illiterate farmers. Advisory costs are high, about US$20–80 per year per farmer. But some MAFF programs have successfully used farmer facilitators to take on some of the tasks of advisers, reducing advisory costs to between US$2 and US$20 per year per farmer. About 100,000 farmers have been reached by MAFF, in Mali, Benin, Burkina Faso, Côte d'Ivoire, Cameroon and Malawi.

Capacity Development

The African Capacity Indicator Initiative

Agricultural information if fuelled by knowledge that comes from all levels of capacity building. Unblocking capacity gaps across the value chain is therefore critical to effect not only knowledge generation but also dissemination and scaling out. Despite substantial donor support over a long period, capacity remains a binding constraint to agricultural development in SSA Africa. Indeed, all the High Level Fora on Aid Effectiveness have successively pegged aid effectiveness to developed capacity of recipients. This led African governments and their development partners to set up the African Capacity Building Foundation (ACBF), chiefly to help build sustainable multi-sectoral human and institutional capacity for development management. In 2011, ACBF launched its first Africa Capacity Indicators Report (ACIR) that measures and empirically assesses capacity in relation to the development agenda in African countries. The ACIR classifies progress made by African countries based on the Africa Capacity Index (ACI), a thematic composite index computed from four sub-indices: i) policy environment; ii) processes for implementation; iii) development results at country level; and iv) capacity development outcomes.

The thematic focus for the ACIR for 2012 was "Capacity Development for Agricultural Transformation and Food Security", realizing that agriculture is key to economic transformation in Africa. In computing the capacity indicators for agricultural transformation, the report used the above four sub-indices and the three core capacity dimensions (enabling environment, organizational level, and individual level) to generate a set of sub-indices and a composite index of capacity that allows linkage to strategies and actions aimed at improving capacity. Using cluster analysis, four clusters of agricultural capacity were identified in the ACIR for 2012: (i) the ability to have a good strategy for the agricultural sector; (ii) the investment in dynamic capacity, including the skills, knowledge and innovation needed to get results in the agricultural sector; (iii) the explicit role of the private sector in the agricultural value chain and the capacity of this sector to contribute to the process of transformation; and (iv) the information system that supports farmers, buyers and sellers and other stakeholders in the value chain, including making research relevant for farmers. The ACI for agricultural transformation was then calculated from the harmonic mean of scores based on these four clusters (ACBF, 2012).

Progress under Cluster 1 on strategy development has been inspired in many SSA countries over the last decade mainly by the CAADP Country Roundtable Process. Recently—and in tandem with Cluster 2 of ACIR 2012—the elaboration of the Science, Technology & Innovation Strategy for Africa (STISA-2024) and its consequent adoption by African Heads of State and Government in 2014 heralded an overarching policy framework for developing STI capacity in the continent. The STISA-2024 identifies six priority areas with Priority I being dedicated to "Eradication of Hunger and Achieving Food Security". S3A has been adopted as the implementation framework for Priority I of the STISA-2024. Information systems support to farmers and stakeholders has been aided by continental institutional developments (i.e., AFAAS), which have had an impact on the national fronts through the country forums. In sum, the idea of an ACI index for ranking countries on their preparedness to transform the agricultural sector is likely to inspire a competitive spirit that will favor the ongoing reforms in the national research systems. It suffices to mention here, that S3A also provides for the development of a "science-readiness" index that the S4AC will use to support countries in identified areas of need.

A Plethora of Frameworks on Capacity Development

Perhaps due to the inherent ambiguity in meaning of capacity and the intractability of capacity development in practice, several agencies and practitioners—in an effort to forge some common point of reference—have crafted their own frameworks for capacity development. Most of the time, such agencies and practitioners are convinced of the need for existent or local capacity for development effectiveness,

yet baffled by the arbitrary and sheer lack of agreement on how to conduct capacity development in practice. This stems partly from the implicit divergence in initially having to contend with the answers (which can be as diverse and the intervention domain) to the twin questions: capacity for what and for whom? On the whole, frameworks serve to define the bounds and scope of practice in capacity development; but their specific purposes differ depending on the agency or practitioner. A few examples will be illustrated.

The UNDP framework is process based and identifies five key stages for capacity development, viz: engage stakeholders; assess capacity assets and needs; formulate capacity development program; implement capacity development response; and evaluate capacity development. A Framework for Capacity Development by the Centre for Development Innovation, The Netherlands, is also process based and identifies six stages: capacity assessment and analysis; crafting a vision for capacity development; elaboration of a capacity development strategy and action plan; implementing the plan; evaluating capacity development results; and facilitation, reflective monitoring and adaptation.

The NEPAD Capacity Development Strategic Framework outlines a set of principles and cornerstones for successful capacity development and identifies six cornerstones for effective capacity development: 1) leadership transformation; 2) citizenship transformation; 3) knowledge and evidence-based innovation; 4) utilizing African potential, skills and resources; 5) developing capacity of capacity developers; and 6) integrated planning and implementation for results. It offers little on process.

The FAO Capacity Development Framework outlines the specific areas of focus in capacity development including the three dimensions—human, organizational and enabling environment—as well as technical and functional capacities. The CGIAR Capacity Development Framework (CDF) intends to foster dialogue that enables the CGIAR Centers and CRPs to incorporate capacity development into their planning. Based on a systems approach to capacity development, the CGIAR CDF is a mix model identifying both the process and the specific areas of focus on capacity development.

Finally, the World Bank's Capacity Development Results Framework promotes a common and systematic approach to the identification, design, and M&E of learning for capacity development. It has four main elements: a clearly specified development goal or set of goals that motivates the capacity development effort; three capacity factors that determine the extent of local ownership of the effort to achieve the stated development goal(s)—conduciveness of the sociopolitical environment, efficiency of policy instruments, and effectiveness of the organizationa-l arrangements; a change process that leads to improvements in the targeted capacity factors at the hands of agents of change empowered through learning; and activities and instruments designed to achieve the necessary learning outcomes for the agents of change.

As such, there is considerable variability in the existing capacity development frameworks and we are nowhere near a unified framework for capacity development. Agencies like the Learning Network on Capacity Development (Len CD) have been promoting change for better capacity development practices on all levels, with little progress in forging a unified approach. As discussed below, the FAO, under the Tropical Agriculture Initiative (TAP), has recently advanced a framework that proposes a practical approach to capacity development for agricultural innovation aimed at harmonizing the diversity of existing strategies through an AIS perspective.

Organizations Involved in Capacity Development

As demonstrated by the success of the Green Revolution in South and East Asian countries and by the Brazilian agricultural renaissance, high quality human capital, appropriate institutions and supportive policies and infrastructure are central to agricultural transformation. Further, a key lesson that underpinned the Results Framework for the post-Malabo CAADP Roadmap and Strategy was that lack of systemic capacity hampered country progress with CAADP during its 1st decade of implementation (NEPAD, 2013). It is therefore instructive that capacity development should be a key investment priority in Africa's agricultural transformation agenda.

Agricultural capacity development in SSA, like in many other regions of the world, has been equated with training of personnel without due consideration to the other dimensions of capacity. Moreover, experiences with farming systems research and innovation systems perspectives are gradually changing this limited view. Practitioners and development agencies are progressively of the view that capacity refers to the ability to deliver, that is, to realize intended development results. From an AIS perspective, whilst the capacity of individual actors is crucial, what matters is the aggregate functionality of the system to deliver on the agricultural transformation agenda.

Baser and Morgan (2008) have identified three approaches to capacity development: planned, incremental and emergent. In the planned approach, the change in capacity of an organization or system from one state to the other is a linear, planned and directed process. In the incremental

approach, organizational or system change is effected through small experimental steps (trial and error), especially in unstable contexts where the choice of an overarching strategy is difficult to clarify. The emergence approach lends itself well to complex adaptive systems, which characterize most of the real world situations. In this approach, the driving forces for change are not control, centralized direction or adaptiveness; but rather relationships, interactions and system energy. Capacity then emerges and forms out of the multiple interdependencies and the multiple causal connections that are operating and being encouraged within the system (Baser & Morgan, 2008).

Thus, just like the progressive elaboration of agricultural knowledge frameworks (or system concepts) for organizing agricultural research, capacity development for agricultural transformation has correspondingly mirrored the shift in approach from linear to an innovation systems perspective. This change has reflected to varying degrees in the agricultural capacity development interventions in SSA by several regional (AGRA, African Institute for Capacity Development (AICAD), ANAFE, AWARD, FARA, and RUFORUM) and international (e.g., CTA, FAO and CGIAR,) agencies over the last decade. A few examples are discussed in the following subsections.

The Impact of Capacity Development

Few studies have estimated the economic impact and cost-effectiveness of capacity development interventions. This lack of evidence on economic impact is a weak point in capacity development evaluation. As reported by Posthumus, Martin and Chancellor (2012), the reasons for the limited number of evaluations on the impact on agricultural development include: methodological difficulties in assessing impact at this level (e.g., lack of counterfactuals and attribution gaps); the long time horizon over which capacity development generally translates into observed outcomes and impact; the short timescales over which capacity development interventions sometimes operate; and the limited attention given to and resources provided for M&E and impact assessment.

CASE STUDY

Alliance for a Green Revolution in Africa

Transforming smallholder agriculture into a highly productive, efficient, competitive and sustainable system that assures food security and lifts millions out of poverty requires a cadre of scientists, technicians, agribusiness personnel and farmers with various capacities to ensure success. The AGRA capacity development initiatives aim to address the capacity gaps for increasing productivity and incomes of smallholder farmers and develop the skills sets and capabilities required to promote a value-chain driven transformation. The emphasis is on postgraduate training (MSc and PhD), and short-term courses for scientists, technicians and other key stakeholders (including agro-dealers, seed company personnel, field and laboratory technicians and farmers).

To date, over 750 postgraduate students specialized in various disciplines such as seed systems, soils and applied agricultural economics have benefitted from AGRA scholarships. A special feature is that research for a PhD thesis is done in the student's home institution and includes an initial participatory rural appraisal for research problem co-identification with farmers. In addition, vocational training has been conducted for over 20,000 personnel from the seed industry (over 800), grain aggregators, research support staff (field and laboratory technicians 300), extension workers (over 3,000), fertilizer inspectors, agro-dealers (over 16,000) and farmer organizations.

The capacity development activities also focus on facilitating linkages between research, private sector and universities as well as building infrastructure in universities and rural areas. Due to lack of adequate academic staff (in terms of both numbers and qualifications) in universities, arrangements for co-supervision of postgraduate students' research work has been fostered with the other public national research agencies and the CGIAR. In addition, all training grants for universities include 40 percent funding for infrastructure development, for example, cold rooms, computers, laboratory equipment, irrigation facilities, transport and seed processing plants. In rural areas, AGRA has funded the construction of warehouses for storing produce and market stalls.

Theses capacity development initiatives have had significant impacts in farmers' fields and agri-businesses, and on academia. For example, trained researchers have released over 130 improved varieties of maize, rice, beans, cassava, groundnuts, finger millet, sorghum, and cowpea that are already widely adopted by farmers in 13 countries. A significant contribution to the global knowledge pool has been made through over 300 scientific publications on priority African crops. Businesses and farmers have also benefitted from over 120,000 tons of seeds produced.

CASE STUDY

Forum for Agricultural Research in Africa

Between 2008 and 2010, FARA, SROs (ASARECA, CORAF/WECARD, and the then SADC/Food Agriculture Natural Resources and national partners jointly implemented the "Strengthening Capacity for Agricultural Research and Development in Africa" (SCARDA) program in 12 research and tertiary agricultural education institutes located in 10 SSA countries. The program was based on the findings of a capacity needs assessment of the NARS in SSA conducted in 2005 and had three salient design features: (i) the combination of training with organizational development and change management; (ii) mentoring and the use of team-based approaches to solving problems; (iii) structured lesson learning—mediated through specific learning platforms—that provided "space" for reflection thereby promoting a more open and frequent communication amongst the project implementing partners.

Due to these unique features, the SCARDA design was ground-breaking in the region and was necessarily informed by innovation systems thinking. The training aspect of the program was also holistic in that it targeted the simultaneous strengthening of the knowledge-generating tripod of the focal institutes, namely: senior researchers (managerial and technical courses), junior researchers (MSc studies) and technicians (refresher courses). The MSc component intended in its design to instill both technical (training in selected professional disciplines) and soft skills (through mentoring, coaching and exposure) competencies in the graduates. This was a significant departure from prevailing postgraduate training programs in the region. Other than serving to fill existing capacity deficits, the reintegrated MSc graduates would necessarily be the implicit change champions in their respective institutes, working with senior mentors and leveraging on their (youthful) enthusiasm and learning outcomes to drive the change process toward more effective research delivery. Reviews conducted by FARA have since indicated key changes in regard to management, quality and conduct of agricultural research attributable to SCARDA implementation in the targeted research and tertiary educational institutes (Ojijo, et al., 2013a)

FARA launched a ground-breaking agribusiness capacity development initiative in 2010: "Universities, Business and Research for Agricultural Innovation (UniBRAIN)" program in 2010. The intended impacts of UniBRAIN are jobs created and incomes increased through sustainable agribusiness development. The program development objective was to create mutually beneficial partnerships between universities, research organizations and the private sector for profitable agribusinesses and improvement in tertiary agribusiness education. So far, UniBRAIN has created thriving agribusiness incubators in specific value chains in Ghana (animal products value chains), Kenya (sorghum value chain), Uganda (banana and coffee value chains), Mali (non-timber forest products value chain), and Zambia (horticultural value chains). The program has also developed agribusiness curricula that have been adopted by several universities in many countries; commercialized near-market technologies; mentored incubatees and interns; and created jobs. A collaborative venture between Agri-Business Incubation-International Crops Research Institute for the Semi-Arid Tropics (ABI-ICRISAT) and the six UniBRAIN incubators has produced a compendium of near-market agribusiness technologies (Ariho, Karuppanchetty, & Kumar, 2014). This will facilitate access to scalable technologies by budding entrepreneurs through the UniBRAIN agribusiness incubators. The success of the UniBRAIN model has endeared it to several stakeholder agencies and development partners including the AU, AfDB, AGRA, and Africa-India Fund, which have expressed interest in up-scaling the model in their respective areas of interventions in Africa and Asia.

Currently, FARA is undertaking a comprehensive review of human and institutional capacity endowment to implement CAADP and S3A in over 20 countries across Africa. The results will outline, inter alia, the existing proportion of staff in different disciplines (e.g., plant breeding, agronomy, soil science, social science, and post-harvest technology) across value chains. This level of aggregation by discipline is not currently reported on by ASTI/IFPRI data. Furthermore, the FARA review will also provide the anticipated future demand for human capital in key competencies identified by the labor market.

CASE STUDY

Regional Universities Forum for Capacity Building in Africa

The Forum on Agricultural Resource Husbandry (FORUM) was initially a Makerere University project funded by the Rockefeller Foundation to strengthen MSc training in agriculture in Kenya, Malawi, Mozambique, Uganda and Zimbabwe. In 2004, it became a corporate entity adopting the name RUFORUM and has since demonstrated phenomenal institutional growth with an increasingly continental outlook. Between 2009 and 2010, RUFORUM served as an implementing partner responsible for placing MSc students and ensuring quality control of the MSc studies under the FARA SCARDA program in the ASARECA sub-region. This role helped RUFORUM garner critical social capital and visibility amongst key stakeholders and partners that it has leveraged to: (i) increase the number and regional span of member universities to over 60 in 25 countries; (ii) evolve in operational scope; and (iii) redefine its business orientation.

The main thrusts of the RUFORUM business are threefold: regional postgraduate training in agriculture (MSc and PhD); collaborative research administered through CGSs; and fostering collaboration in research and training facilities to achieve economies of scale and scope. To date, the RUFORUM regional programs have trained over 381 PhD and 1,373 MSc students in various agricultural disciplines. Of special note is that, RUFORUM alumni have demonstrated a remarkable retention rate of 94 percent in their countries of origin. Other key achievements from RUFORUM interventions include: focused faculties produce more relevant and user-oriented research as well as proactive and skilled graduates; alumni are proactive and dynamic change-makers in the agricultural sector; and member universities have increased collaboration and also institutionalized enabling policies, principles and practices.

Conclusions and Policy Recommendations

Growth in agriculture as a primary sector is imperative for rural development, positive structural transformation, and broad-based macro-economic economic growth. The path to attaining the needed agricultural productivity growth can only be illuminated by sustained and systematic homegrown research and innovation. Positive developments have occurred in regard to the evolution, configuration, and funding of agricultural research systems in SSA over the last decade or so. Focus must be on consolidating and sustaining the gains whilst addressing new and persistent challenges. AAS have also undergone considerable changes in terms of actor array, modes of delivery and roles in the innovation system. Capacity, in all its dimensions, is a core imperative for agricultural transformation in Africa. Regional initiatives, notably the ACBF Capacity Indicators, are serving to buttress this key point and thereby justify increased investments in capacity development for agricultural innovation. Like the progressive elaboration of systems concepts in agricultural research, approaches to capacity development have similarly tended to embrace a systems perspective.

The following are some pertinent conclusions and recommendations:

1. Agricultural research systems have evolved in SSA countries to varying degrees. Currently, semi-autonomous agencies, especially NARI/NARO, are the main executors of public agricultural research in most countries and the linear mode of technology generation and transfer still persists. There is opportunity for other potential actors (i.e., universities, private sector, farmers and NGOs) to play increasing and integrated roles in national agricultural research, for example, around the concept of AIS. Initiatives like IAR4D based on innovation platforms have served to promote the AIS concept at sub-national national scales. The IPs have been successful in delivering poverty-alleviating technology along specific value chains in many SSA countries. The CF on CDAIS elaborated under the TAP initiative is also expected to further assist in developing the national AIS capacity.

2. At continental level, institutional developments instigated by regional agencies like FARA have mirrored the AIS perspective. Ultimately, the continental institutional array needs to map onto and strengthen corresponding actors at the national level where agricultural transformation must take place. Agricultural research, technology generation and dissemination may not be a programmatic pillar in the current CAADP dispensation, but ongoing institutional reconfiguration around the S3A will ensure that agricultural progress in the

second decade of the CAADP is knowledge-driven by conscious investments in and application of science. The need to strengthen NARS is underscored by success stories in emerging economies exemplified by Brazil. Evident progress registered over the last decade in countries like Rwanda is showing that such transformative experiences can and are already taking root in the SSA region

3. The appetite for funding AR4D by African countries is still as depressed as ever. The outlook for supranational agencies, at least from the donor perspective, is also not very good although there are prospects of some significant funding from AfDB under the TAAT initiative. As such, funding remains a critical issue in SSA AR4D and innovative funding mechanisms away from the traditional donor-dependence are called for. National governments need to prioritize and fund AR4D if the livelihoods of smallholder farmers and their families are to be improved. Some suggested avenues for sustainable home-grown funding of AR4D in SSA countries include: leveraging philanthropic funding nationally and abroad; encouraging business orientation in NARIs and universities; creating suitable regimes (e.g., IP regimes) for proprietary partnerships with private sector players; appropriating pooled levies from high-value commodity proceeds; setting up of research trusts; and competitive grant funds.

4. Extension approaches can only be effective if the AAS that use them: (1) have information and recommendations that are relevant, appropriate for and useful to farmers; (2) have the needed attitude and skills to train farmers: (3) have operational budgets to implement programs: and (4) have systems to elicit feedback from farmers and use it to modify programs. In fact, many extension systems have critical deficiencies in one or more of these areas. A starting point in assisting AAS to improve their effectiveness is to conduct simple diagnostic assessments at a national or province/district level to identify key constraints limiting AAS performance (for examples of such assessments see MEAS, 2016).

5. Possible innovations to improve effectiveness of AAS could include coordinating mechanisms, policy changes, policy implementation measures, capacity strengthening, increasing operational budgets and measures to enhance private sector and civil society participation in extension initiatives. More evaluations of AAS approaches are also needed to assess what types of advisory system approaches work well for particular types of agricultural technologies, for particular target groups (e.g., women) at what cost and how these approaches may be improved.

6. A unified framework for capacity development does not exist, but recent initiatives like TAP have suggested some schema for harmonizing the diversity of practices in capacity development for agricultural innovations.

7. Several institutions are contributing to capacity development of AR4D capacity on the continent. Equally, there is need for strong partnerships among these actors to leverage on each other's strengths and ensure effective capacity development for agricultural innovations. An in depth situational analysis on capacity development interventions by various actors, for example, AGRA, FARA, RUFORUM and others is necessary and lessons from these programs could inform policies and shape a way for more involvement of donors, private sector and government in capacity development. Some work has been documented on formal training, but very few studies have analyzed the capacity gaps at lower levels and along the value chain.

8. Failure to demonstrate tangible impacts of capacity development interventions partly contributes to low investments in this area. There is need for a defined and evidence-based advocacy for capacity development by multiple organizations, especially based on rigorous studies to demonstrate the long term results of capacity development.

CASE STUDY

African Network for Agriculture, Agroforestry and Natural Resources Education

As a network of around 134 African colleges and universities, ANAFE focuses on review and reform of curricula; improving context relevance of learning materials through content development and enhanced delivery; improvement of institutional governance and leadership; and creation of enabling policy and institutional environment through networking. Other areas include improving agribusiness programs, enhancing the interest of women and youth in taking up agricultural careers, and developing capacity to tackle management of risks and uncertainties.

In the recent past, ANAFE has clearly distinguished itself as a unique facilitator of curricula development for uptake by member universities, especially on "agribusiness" under the UniBRAIN program. Further, the ANAFE emphasis on agroforestry has tended to focus on "neglected and underutilized plant species" in collaboration with Bioversity International. The Network has also administered research grants to students, convened thematic knowledge management symposia, facilitated tracer studies of agricultural graduates, and promoted linkages of member universities with the private sector to foster job creation and income generation.

CASE STUDY

Development Alternatives Inc.

DAI is a private company that works on the frontlines of international development transforming ideas into action—action into impact. One of the projects of DAI, "Africa Leadership Training and Capacity Building Program" (Africa Lead), focusses on training African leaders. Africa Lead is operated in partnership with the U.S. Government's Feed the Future (FTF) initiative and targets the capacity development of Africa's emerging food security leaders to devise and manage their country's CAADP investment plans. Africa Lead contributes to institutional strengthening and leadership development, two key challenging areas with few interventions across Africa.

The Africa Lead approach involves assessment of capacity needs to understand the roles that people and training institutions play in meeting FTF goals; tie those roles to the capacity development activities; train African food security leaders on the skills and knowledge needed to scale-up activities in agriculture and food security; and create an interactive, easily-updated training database that serves as a matchmaking tool for institutions that seek to develop appropriate training materials for their own use. To date, the program has trained more than 1,600 CAADP champions from 29 countries in leadership, change management, and strategic planning. It has also facilitated the participation of about 553 members of NGOs and the private sector to CAADP workshops and created a database featuring 650 short-course offerings relevant to African agricultural professionals.

CASE STUDY

African Women in Agricultural Research and Development

The dearth of women in AR4D, has necessitated the emphasis of women participation in most capacity development interventions in SSA. Many programs currently have intentional targets to admit women in their programs. For example the SCARDA program exacted a 30 percent target for women participation in the agricultural research management and MSc training. Further, AGRA programs require 40 percent female student's admissions into the funded programs. ANAFE has reported 42 percent female participants in funded students in one of its programs.

However, nothing has epitomized women empowerment in African AR4D more than the AWARD program. AWARD invests in supporting African women scientists and institutions to deliver innovative gender-responsive ARD solutions to tackle the biggest challenges facing African smallholder farmers. Since 2008, the tailored career-development fellowships offered by AWARD have equipped top women agricultural scientists across SSA to accelerate agricultural gains through the strengthening of their science and leadership skills. More than 1,000 scientists (465 fellows, 397 mentors and 366 mentees) from 16 countries—Ethiopia, Ghana, Kenya, Liberia, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda, Zambia, Cameroon, Cote d'Ivoire, Mali, Senegal, and Burkina Faso—have participated in the program since its inception.

AWARD empowers women scientists or fellows through three cornerstone interventions (mentoring, science and leadership) to help them gain skills and access resources and networks to ensure gender-responsiveness, innovations and visibility within the agricultural sector. Furthermore, the AWARD approach believes that if these changes in fellows take place, their academic research, entrepreneurial activities or scientific work will be increasingly reputable, visible, well-resourced and relevant to development in Africa. As a result of these changes, it is expected that the AWARD fellows will display commitment to organizational and societal change; exploit career and leadership opportunities, and attain better career and leadership achievements.

AWARD has created several components of leadership that aim to assist fellows navigate organizational gender issues, leverage team talents, manage conflicts and use influence appropriately. The leadership courses include the AWARD Leadership Skills Course, AWARD Women's Leadership and Management Course and AWARD Enhancing Negotiation Skills for Women Course. As a way of applying their newly gained leadership skills, AWARD requests fellows to practice their new leadership skills by organizing a role modeling event which is used to inspire students to consider careers in agricultural science. The role modeling experience also offers the AWARD Fellow an opportunity to show case their newly acquired skills to colleagues within their respective institutions.

Mentoring is a proven and powerful driver for career development and particularly, for retaining women in science. AWARD pairs each fellow with a mentor—a respected female or male senior science professional—who is chosen to match the fellow's area of expertise and career goals, but also her personality and style. Every fellow is mentored for the first year of her fellowship and in the second year, "shares forward" by taking a female junior scientist who she herself mentors. Building science skills, one of the pillars of the fellowship, offers each fellow a range of courses designed to improve her ability to share her knowledge, through science and proposal writing courses and to improve her presentation skills through AWARD sponsored travel to scientific conferences and memberships in scientific organizations. This allows fellows to connect with latest debates, methods and findings relevant to their research, and fellows do report that this access increases their professional networks, visibility and job opportunities.

The AWARD African Women in Science Empowerment Model (AWSEM) which examines expansion in agency (power within, to do, over, with, and to empower), is used to measure program success. Data for 249 fellows in the first four rounds (2008–2011) were recently analyzed and indicate: i) increased self-knowledge, confidence, motivation, vision and direction (power from within) in over 70 percent of the fellows; ii) increased scientific skills, leadership capabilities and access to opportunities (power to do) in over 90 percent of the fellows; iii) increased professional achievements and recognition (power over) in over 85 percent of the fellows; iv) increased professional collaboration (power with) in over 65 percent of the fellows; and v) increased ability to influence and inspire others into gender responsive agricultural research (power to empower).

CASE STUDY

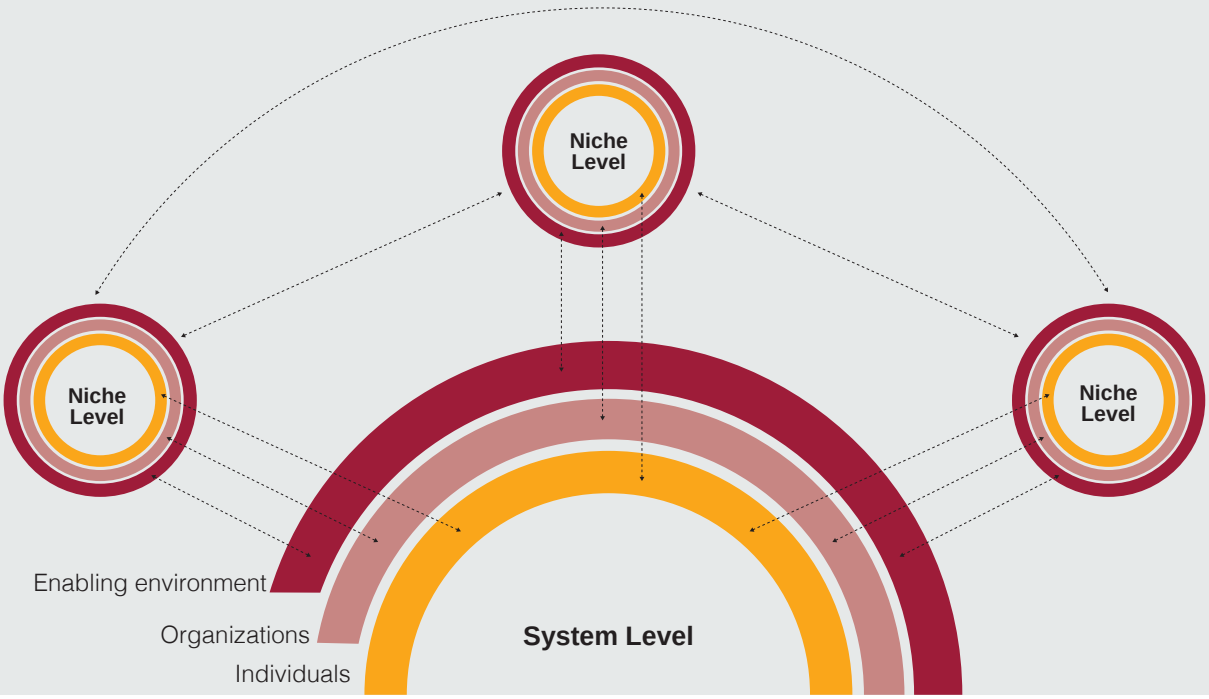
FAO—Tropical Agriculture Platform

Traditional capacity development is a directed process focusing on an organizational entity (e.g., a research institute) and seeks to impart technical skills to individuals within the organization, improve infrastructural endowments of the organization, and influence the enabling environment. Based on the AIS concept, capacity development not only focuses on an entity, but more importantly the functional inter-connectedness between the component entities of a system. Furthermore, the AIS concept views capacity as an emergent and dynamic property of the system, subject to constant renewal as the various interests and motives of system actors change with time.

TAP, a G20 initiative managed by FAO recently came up with the Common Framework on Capacity Development for Agricultural Innovation Systems (CF on CDAIS). The Framework provides concepts, principles, methodologies and tools to better understand the architecture of AIS; assess capacity development needs; and plan, implement, monitor and evaluate capacity development interventions so as to lead to more sustainable and efficient AIS. Further, it emphasizes the crucial role of facilitation (or intermediation), documentation and knowledge management issues as well as that of reflection and learning for enabling agricultural innovation (FAO, 2016).

The Common Framework proposes a dual pathway for capacity development for agricultural innovation, namely: the innovation niche and system levels (Figure 4). The innovation niches are akin to the IAR4D innovation platforms—the spaces in which small groups of actors become part of a learning process where alternative socio-technical practices can be experimented with and developed in such a way that they subsequently inform and influence mainstream issues. The niche is a part of a wider system consisting of multiple and diverse actors within the boundaries of a defined AIS. An enabling environment for AIS emerges from interactive co-learning within and between niches. Capacity development is aimed at enhancing capacities of individuals and organizations (actors in the innovation niche) on the one hand, and capacities of other social, institutional and political actors for improving enabling environment on the other hand (Nichterlein et al., 2016). As shown in Figure 9.4, the CD of individuals and organizations will be linked to their involvement within niches or at system level. In Africa, the Common Framework on CDAIS is being piloted in Angola, Burkina Faso, Ethiopia, and Rwanda.

Figure 9.4: Dual pathway for capacity development proposed by the CF on CDAIS



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CHAPTER 10

Achieving Food Security and Nutrition

AUTHORS

Tshilidzi Madzivhandila
Simbarashe Sibanda
Farai Alice Gwelo
Food, Agriculture and Natural Resources Policy Analysis Network

Augustin Wambo Yamdjeu
Kefilwe Moalosi
New Partnership For Africa's Development

KEY MESSAGES

ONE

The poverty rate and prevalence of undernourishment declined in sub-Saharan Africa (SSA) between 1990–1992 and 2014–2016. However, the total number of undernourished people continues to increase with an estimated 217.8 million in 2014–2016 compared to 175.7 million in 1990–1992.

TWO

To realize CAADP goals and objectives and the Malabo Declaration targets, high level leadership and good governance are required, besides political commitment, to translate government policies and strategies into concrete actions.

THREE

There is a need to adopt an integrated approach—which comprises sustained implementation of a mix of complementary and comprehensive food security and nutrition policies and programs—to effectively impact hunger, food insecurity, and malnutrition in SSA.

FOUR

Lessons for improving nutrition through agriculture include: efficient and effective production of diversified, highly nutritious and (bio)fortified foods; enhancing value chains to improve nutritional quality and food safety; effective participation of all stakeholders; involvement of the private sector in strengthening linkages within agricultural supply chains; setting up effective accountability systems; and better policies and investments.

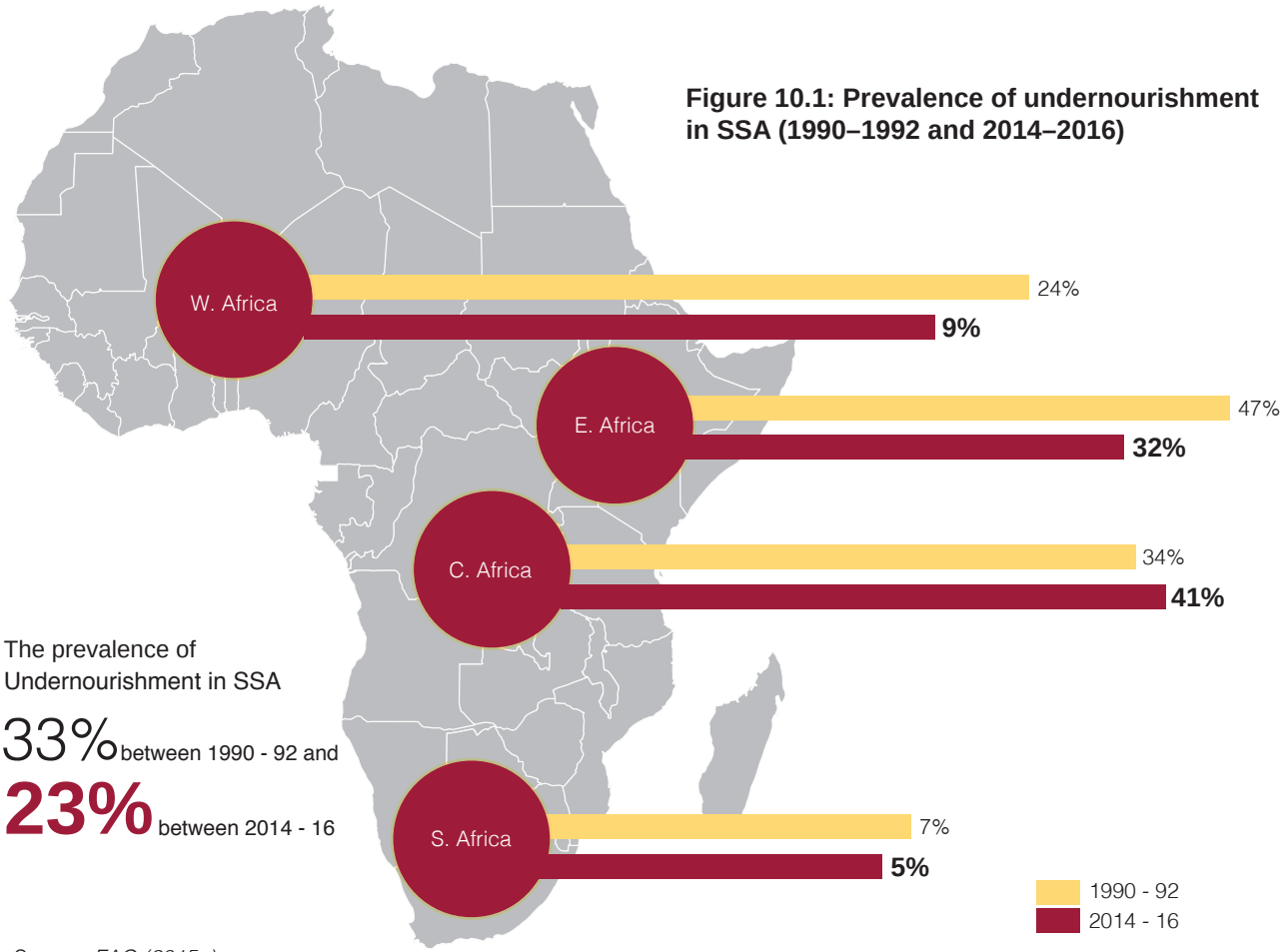
Introduction

The year 2015 marks the transition from the Millennium Development Goals (MDGs), launched by world leaders in 2000 to fight poverty in its multiple dimensions, to the 2030 Sustainable Development Goals (SDGs) with their sharper focus on food and nutrition security. Sub-Saharan Africa (SSA) made significant progress towards halving the proportion of its population suffering from hunger (FAO, 2015a, 2015b). The prevalence of hunger in the region declined by 31 percent between the base period (1990–1992) and 2015 (see also FAO, 2015c). The recent period of high global food prices and recurring droughts in the region are among the key factors accounting for only partial achievement of the MDG nutrition targets. According to the Global Alliance for Improved Nutrition (GAIN, 2015), climate change and conflicts exacerbate these challenges, for example, pushing up food prices, worsening food security, and hindering the production and movement of food. Moreover, rising urbanization puts pressure on urban food systems, which are failing to keep up with the rapid growth of cities. Despite these impediments, impressive progress has been recorded across all of the sub-regions of SSA over the past 15 years, except in Central Africa (Figure 10.1).

Because of rapid population growth, even while the percentage of undernourished people has declined, the absolute numbers of undernourished in SSA has risen. About 42 million people were added to the total number of undernourished people in the region, with an estimated 217.8 million in 2014–2016 compared to 176 million in 1990–1992 (Table 10.1). The current share per sub-region is presented in Figure 10.2.

[1] African Development Bank. Poverty Reduction is lagging behind economic Growth. http://www.afdb.org/en/topics-and-sectors/topics/millennium-development-goals-mdgs/goal-1-eradicate-extreme-poverty-and-hunger/

Figure 10.1: Prevalence of undernourishment in SSA (1990–1992 and 2014–2016)



The prevalence of Undernourishment in SSA

33% between 1990 - 92 and

23% between 2014 - 16

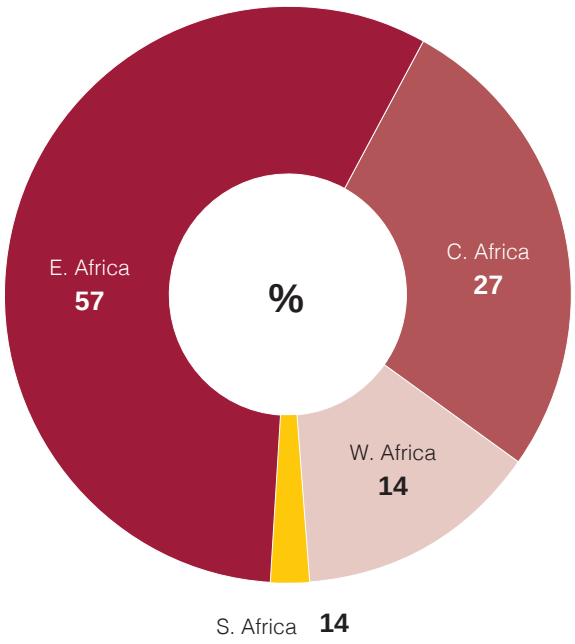
Source: *FAO (2015a)*

Table 10.1: Number of undernourished people (millions), 1990–1992 and 2014–2016

Sub-region	Number of undernourished (millions)		Change so far (%)
	1990–1992	2014–2016	
Eastern Africa	103.9	124.2	19.6
Central Africa	24.2	58.9	147.7
Western Africa	44.6	31.8	-29.4
Southern Africa	3.1	3.2	2.3
SSA	175.7	217.8	23.9

Source: *FAO (2015a)*

Figure 10.2: Current share of undernourished people by sub-region (2014–2016)



Source: *FAO (2015a) and IFPRI (2014)*

According to FAO (2015c), 40 countries were assessed in terms of their state of food insecurity in 2015. The report indicated that the number of countries that achieved the MDG target has almost doubled in SSA; and the results of the 2014–2016 assessment are shown in Figure 10.3 and the accompanying map. The region is showing some commitment to improve food security and nutrition. However, it is unclear which of the four dimensions of food security—availability, access, stability, and utilization—has accounted for most of the improved food security and nutrition situation over this period.

Figure 10.4 shows that the proportion of poor people (living on less than US$1.25 per day) in SSA declined from 61 percent in 1993 to 47 percent in 2011. The high levels of poverty are compounded by the complex nature of inequality in Africa. Also, the level of decline is much slower than the world's trends. In all the sub-regions of SSA, trends in the prevalence of underweight children have been decreasing (Figure 10.5). However, in most countries in SSA an estimated 3 out of 10 children under 5 years of age are still stunted (Figure 10.6; FAO, 2015a).

Undernutrition puts children at greater risk of dying from common infections, increases the frequency and severity of such infections, and contributes to delayed recovery. Undernutrition also has long-term effects that include mental illness (Victora et al., 2008), hypertension and diabetes, and impaired working capacity, leading to poor productivity causing negative consequences on individual health and standard of living of the affected individuals throughout their life (Martins et al., 2011). Although significant progress has been made in reducing undernutrition (Figure 10.7), more effort is needed, especially in West and Central Africa. Rethinking our food systems is one way that can significantly contribute to the reduction of undernutrition in all its forms.

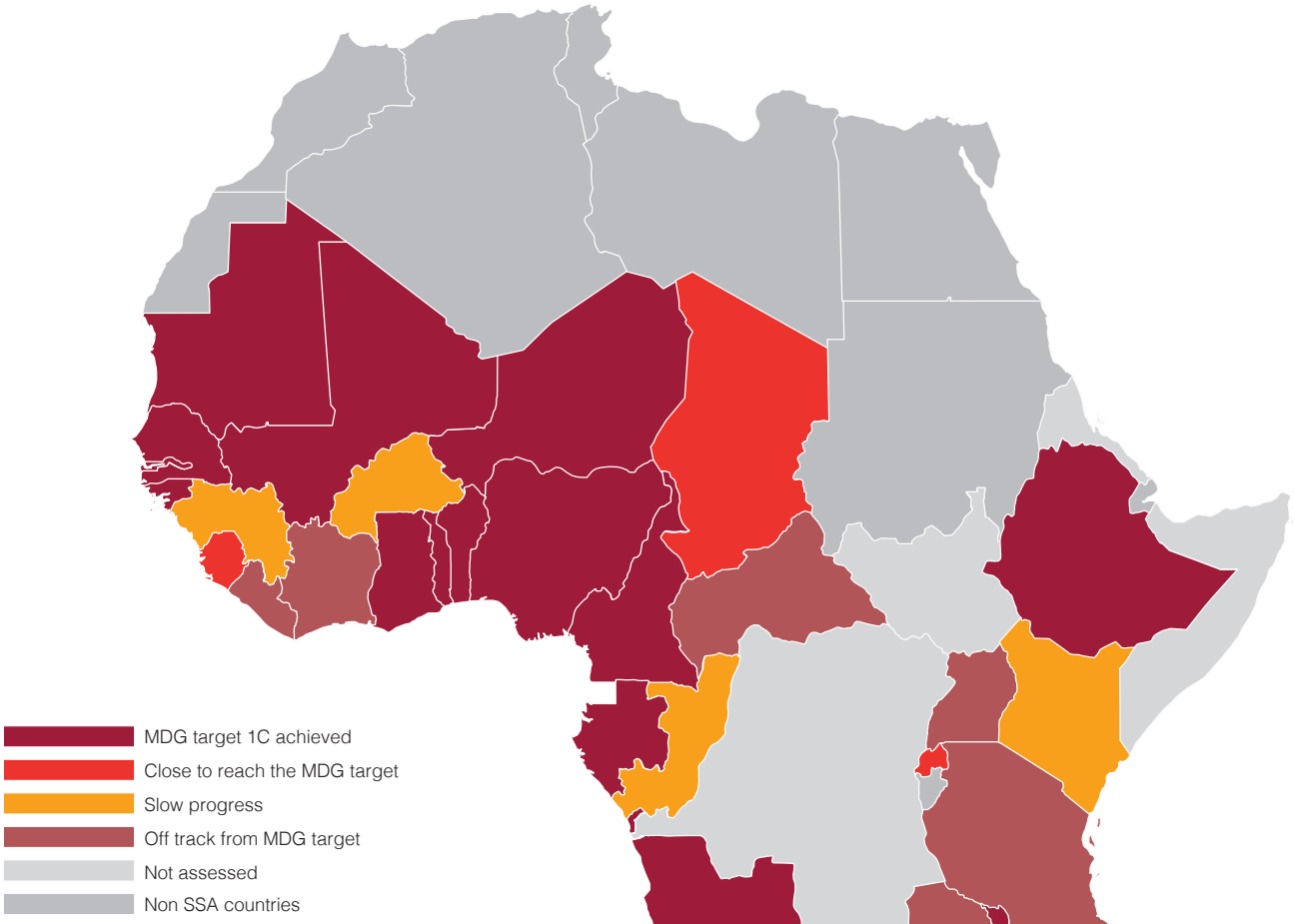
Defining the Concepts

Food security: a four-dimension concept

This chapter adopts the 1996 World Food Summit definition of food security. It states that food security exists: "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Pinstrup-Andersen, 2009, 5). This definition has evolved over the years to encompass these four dimensions: food availability; access to food; utilization; and stability. For SSA to be food secure, all four dimensions of food security should be addressed (Capone, Bilali, Debs, Cardone, & Driouech, 2014; FAO, 2006).

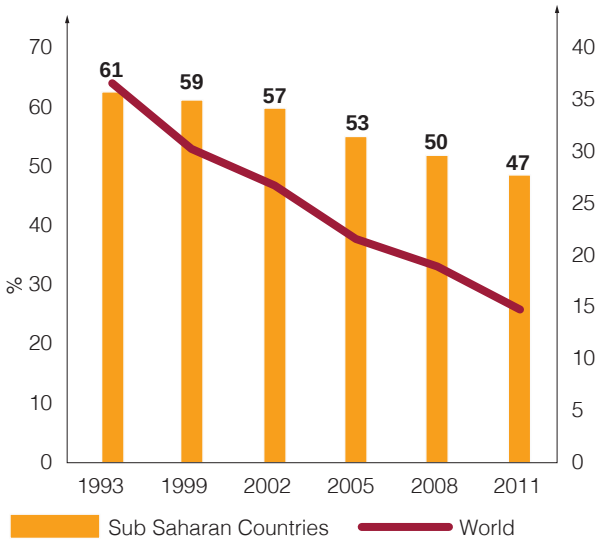
Food availability, defined as the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid) (Carletto, Zezza, & Banerjee, 2013), can be improved through post-harvest technologies that increase the shelf-life of perishable fresh foods such as fruits, vegetables, milk and some animal products. Drying and canning or processing technologies allow food to last longer without spoiling, while preserving the nutrient content of the food and reducing food loss, thereby increasing food availability.

Figure 10.3: Status of the number of countries towards achieving the MDGs

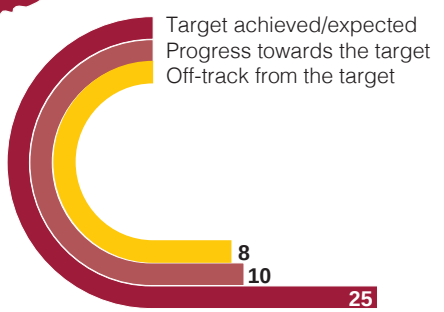


Source: *IFPRI (2014)*

Figure 10.4: Trend in the prevalence of poverty (US$1.25/day) (%)



Source: *FAO (2015a)*



Source: *FAO (2015a)*

Figure 10.6: Stunting in children under five years in sub-Saharan Africa

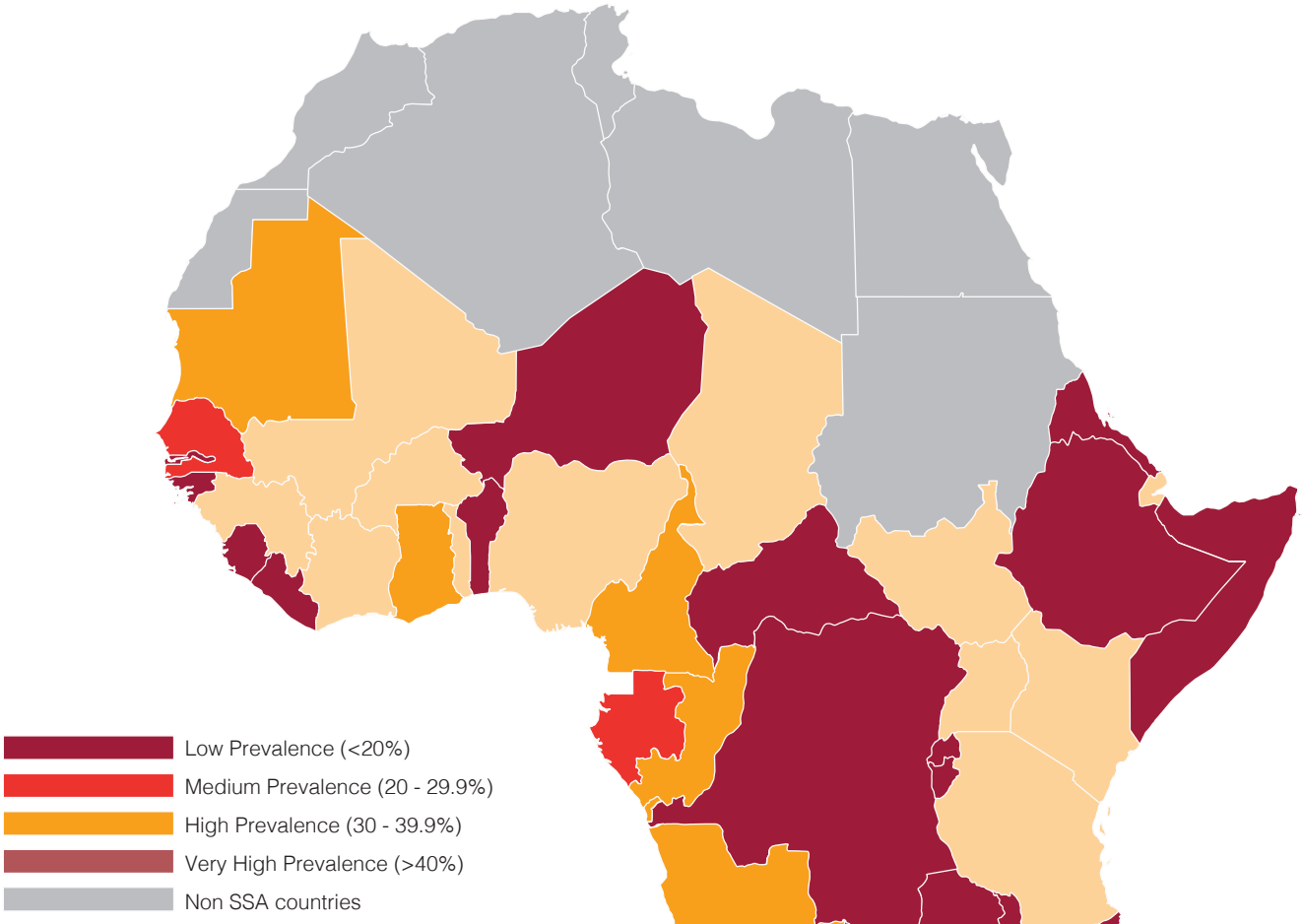
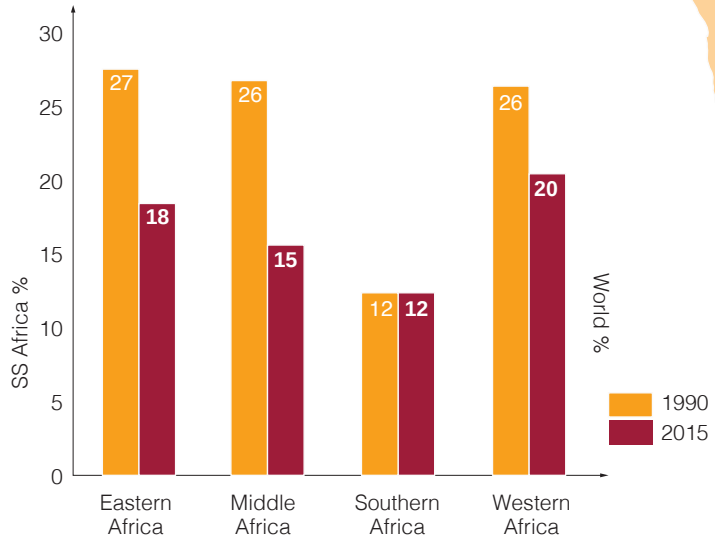
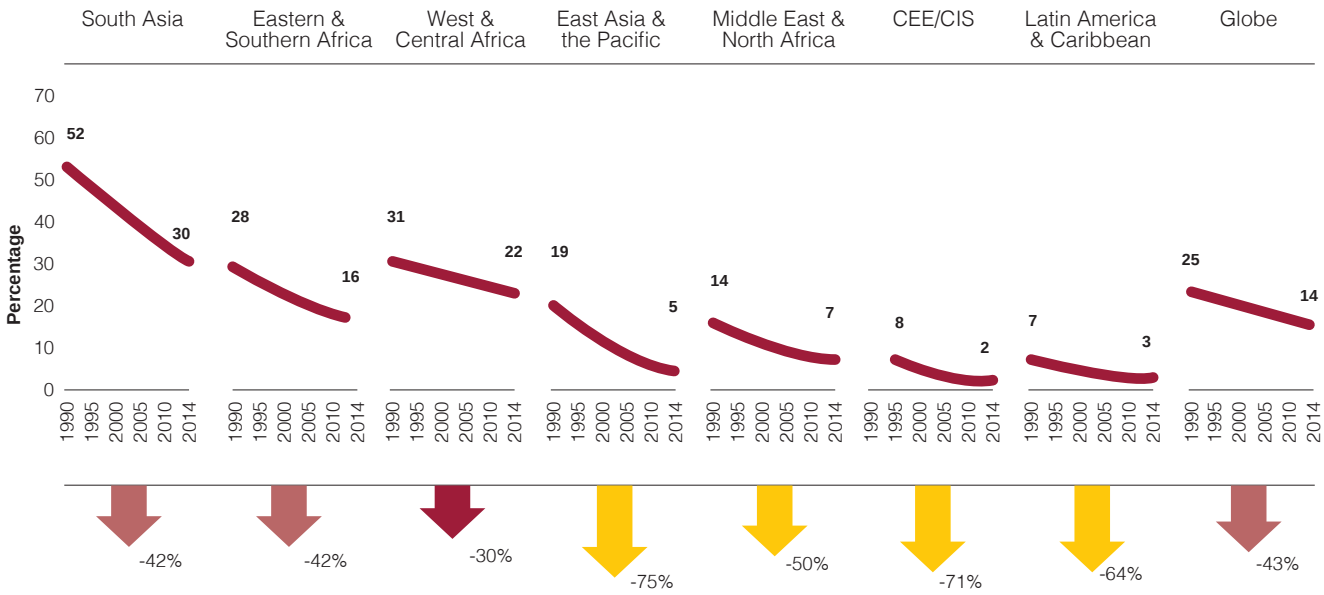


Figure 10.5: Trend in the prevalence of underweight children in SSA



Source: *FAO (2015a) and IFPRI (2014)*

Figure 10.7: Percentage of stunted and overweight of children under five years, 1990–2014



Source: *UNICEF/WHO/World Bank (2015)*

Although nutritious food may be available, individuals within the population need to be able to access the food resources adequately (entitlements) to ensure they acquire appropriate foods for a nutritious diet. Poverty is the single largest impediment to food access. The lack of resources to purchase or otherwise procure food, and other socio-economic and political problems can greatly reduce access to food, increasing vulnerability among the affected households.

The utilization of the available diet by individuals or households is also important. An adequate diet, clean water, sanitation and health care all work together to help the individual achieve a state of nutritional well-being where all physiological needs are met. Therefore, to achieve food security there is need to look beyond just food inputs to non-food inputs that can help achieve this status.

Stability in the access to nutritious food is crucial. Food stability is a state where the household is not at risk of losing access to food as a consequence of sudden shocks such as economic or climatic crises.

Related to food security and nutrition is food safety. Food safety is an umbrella term that encompasses many facets of handling, preparation and storage of food to prevent foodborne illnesses to humans, resulting from eating such food (Schmidt and Rodrick, 2003). Included under the umbrella are chemical, physical and microbiological aspects of food safety (Hanning, O'Bryan, Crandall, & Ricke, 2012). Food-borne illnesses contribute to decreased worker productivity, disability, and even early death, thus lowering incomes and access to food. Adequate nutrition during the first 1,000 days of life is critical. The time from conception until a child is two years old is the most important time to pay attention to a child's nutrition. Good nutrition during this critical window can change their lives, leading to improved cognitive capacity and general bodily growth UNICEF/WHO/World Bank (2015).

[2] Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic, and social arrangements of the community in which they live (including traditional rights such as access to common resources).

Why single out nutrition matters?

Although the definition of food security includes aspects of nutrition security, in most cases, the application of the term food security does not include nutrition security. We adopt the nutrition security definition of the World Bank: "the ongoing access to the basic elements of good nutrition, i.e. a balanced diet, safe environment, clean water, and adequate health care (preventive and curative) for all people, and the knowledge needed to care for and ensure a healthy and active life for all household members" (McDermott, Aït-Aïssa, Morel, & Rapando, 2013, 667). Nutrition security goes beyond the traditional food security by considering access to essential nutrients, not just calories. When most governments in SSA refer to food security, they largely concentrate on provision of calories, mainly through staples.

Malnutrition in all its forms—undernutrition, micronutrient deficiencies, and overweight and obesity—imposes high economic and social costs on countries at all income levels (FAO, 2013). The impact of malnutrition on the global economy is estimated to be as high as US$3.5 trillion per year or US$500 per individual (Global Panel, 2016). This economic loss results from reduced adult productivity in individuals who were malnourished (stunted) as children, resulting in premature adult mortality, loss in human capital investment, and increased health-care costs for malnutrition related non-communicable diseases. Malnutrition can affect up to the third generation and when nutrition status improves, it helps break the intergenerational cycle of poverty, generates broad-based economic growth, and leads to a host of positive consequences for individuals, families, communities, and countries.

The food system approach to nutrition

Because nutrition security is dependent on a wide array of factors, there is need for a multi-sectorial approach. Re-thinking our food systems—from agricultural inputs and production through processing, marketing and retailing, to consumption—can promote more nutritious and sustainable diets for everyone. This is because a food system operates within and is influenced by social, political, economic and environmental contexts, thereby providing that multi-sectorial approach to achieve nutrition security. Food systems, if appropriately strengthened, have the potential to deliver adequate availability, access, utilization, and supply stability of both macro-and micronutrients that contribute to food and nutrition security (Garret, Luthringer, & Mkambula, 2016).

Food systems include all processes and infrastructure involved in feeding a population: growing, harvesting, processing, packaging, transporting, marketing, consumption, and disposal of food and food-related items. The term also includes the inputs needed and outputs generated at each of these steps. Food systems need to be more nutrition sensitive such that from agricultural inputs, right through all the processes to consumption, nutrition outcomes are factored in. If this approach is taken, then nutrition-sensitive food systems cannot be separated from nutrition–sensitive agriculture. Nutrition-sensitive agriculture contributes to nutrition-sensitive food systems by ensuring that agricultural initiatives from design, through implementation to output, consider nutritional outcomes. When agricultural interventions are designed to deliver specific nutrition outcomes, from input to consumption, this can help address the different forms of malnutrition. Nutrition-sensitive agriculture is not so much a new concept as an emphasis on a central rationale for agricultural development. It refers to agriculture which has a nutrition objective and addresses one or more of the underlying causes of malnutrition, including nutrient content of different foods, food safety, inadequate food access, care and feeding practices, and health and sanitation environments.

Context and Point of Departure

As far back as 2012, the African Union Commission (AUC) and the New Partnership for Africa's Development (NEPAD) Agency decided to examine the main drivers that had a direct bearing on the implementation of the Comprehensive Africa Agriculture Development Programme (CAADP) and its capacity to deliver results and impact on the ground. This gave rise to the "Sustaining the CAADP Momentum" (SCM) exercise whose ultimate goal was to develop a renewed agenda that would build on the achievements and lessons learned to upscale and enhance performance to deliver predictable and substantial results. The exercise was conducted in line with the CAADP principles of local ownership, collective responsibility and mutual accountability.

In July 2013, as the main outcome of the High Level Meeting of African and International Leaders that reflected on an African renaissance, a "Renewed Partnership for a Unified Approach to End Hunger in Africa by 2025 under the Framework of the Comprehensive Africa Agricultural Development Programme" was concluded. The meeting was jointly convened by the African Union (AU), the Food and Agriculture Organization of the United Nations (FAO) and the Lula Institute (African Union, 2013).

Figure 10.8: CAADP Results Framework

Impact to which agriculture contributes	**Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development**				
	1.1 Wealth creation	**1.2** Food & Nutrition Security	**1.3** Economic opportunities, poverty alleviation and shared prosperity	**1.4** Resilience and sustainability	
Changes in African agriculture resulting from CAADP implementation support	**Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth**				
	2.1 Increased Agriculture production and productivity	**2.2** Increased intra-African regional trade and better functioning of national & regional markets	**2.3** Expanded local agro-industry and value chain development inclusive of women and youth	**2.4** Increased resilience of livelihoods and improved management of risks in the agriculture sector	**2.5** Improved management of natural resources for sustainable agriculture
Added value of CAADP support to institutional transformation and systemic capacities	**Level 3—Strengthening Systemic Capacity to Deliver Results**				
	3.1 Effective and inclusive policy design and implementation processes	**3.2** Effective and accountable institutions including assessing implantation of policies and commitments	**3.3** Strengthened capacity for evidence based planning implementation & review	**3.4** Improved multi-sectoral coordination, partnerships and mutual accountability in sectors related to agriculture	**3.5** Increased public and private investments in agriculture	**3.6** Increased capacity to generate, analyze and use data, information, knowledge and innovations

Source: *AU (2015)*

The main output of the SCM exercise was the "Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods" adopted by the African Ministers of Agriculture and later Heads' of States and Governments in June 2014. The Declaration was adopted as a set of concrete objectives for the transformation of agriculture through the second decade of CAADP (2015–2025). The implementation of this Declaration would deliver the vision of a prosperous Africa fueled by a transformed agricultural system that should lead to the end of hunger by 2025, Commitment #3 of the Malabo Declaration that was largely informed by the collaborative work between AU, FAO and the Lula Institute. During the same summit, the Declaration on Nutrition Security for Inclusive Economic Growth and Sustainable Development in Africa was also made.

For Africa to achieve agricultural transformation through the Malabo Declaration goals and targets, the identified stakeholders in the implementation process need to scale up their efforts. One of the key outputs to facilitate the operationalization of the Malabo Declaration was the Implementation Strategy and Roadmap (IS&R). The IS&R was endorsed by the African Union January Summit of 2015 (AU, 2015) and has four "Strategic Action Areas" (SAAs). To ensure transformation, the four SAAs at impact level, the five IS&R implementation support drivers, six relevant institutional transformations, and systemic capacities are suggested, as presented in the CAADP Results Framework (Figure 10.7).

To effect changes in African agriculture resulting from CAADP implementation support, Governments play a decisive role in influencing the extent to which smallholder farmers, large-scale farmers, and other actors invest in the agricultural value chains in ways that promote SDG 2 (i.e., end hunger, achieve food security and improved nutrition, and promote sustainable agriculture food security goals). Public sector policy choices and the composition of public expenditures to agriculture influence the enabling environment, either positively or negatively, influencing whether and how the private sector invests in food value chains. Hence, private sector investment patterns

[3] http://www.nepad-caadp.net/sites/default/files/Core-Meetings/malabo_synthesis_english_0.pdf.

BOX 10.1:
The 7 Malabo Declaration Commitments

1. Re-commitment to the Principles and Values of the CAADP Process
2. Enhancing Investment Finance in Agriculture
3. Ending Hunger in Africa by 2025
4. Enhancing Agriculture's Contribution to Economic Growth and Significant Poverty Reduction (by at least half)
5. Boosting Intra-African Trade in Agricultural commodities and services
6. Enhancing Resilience of Livelihoods and Production Systems to Climate Variability and other related risks
7. Mutual Accountability to Actions and Results

in agriculture and food production and markets are largely outcomes of public sector behavior—its policy choices, integrity of its institutions, and the ways it spends its funds through the treasury.

In SSA, there are efforts to strengthen the contribution of the agriculture sector in reducing poverty and malnutrition. One example is through the development of the CAADP National Agriculture and Food Security Investment Plans (NAFSIPs), which provide the much needed impetus for linking agriculture and food systems to counter hunger and malnutrition in Africa. However, most initiatives lack the concrete actions necessary to ensure food and nutrition security. This gap is being addressed by the NEPAD CAADP Nutrition Initiative which is designed to strengthen capacity for mainstreaming nutrition in the NAFSIPs and agricultural strategies and policies in 49 African countries.

The Disconnect between Agriculture and Nutrition

Evidence shows that the Green Revolution in agriculture which swept large parts of the developing world, especially Asia, during the 1960s and 1970s dramatically increased agricultural productivity and reduced poverty. South Asia for example, enjoyed a surplus of production over food consumption of 60 million tons in 2010, up from around 10 million tons in 1970. Rice and wheat, the main food crops, account for 60 percent of the surplus (Pingali, 2015). The achievements of the Green Revolution came with environmental consequences, leaving soils degraded and groundwater resources depleted. This undermined the very resource base that made the revolution possible (Hazell, 2003; IFAD, 2013). Most of these hungry families live in rural areas where they mainly depend on agriculture to survive. Smallholder farmers, as major producers of food for the continent, and paradoxically the biggest investors, have often been neglected in debates on the future of agriculture, and have been left out of policy making at numerous levels (Vorley et al., 2012; Wiggins, Farrington, Henley, Grist, & Locke, 2013). Many poverty-stricken families depend on their land and livestock for both food and income, leaving them vulnerable to natural disasters that can quickly strip them of their livelihoods. Drought—which is linked to climate change and increasingly unpredictable rainfall—has become one of the most common causes of food shortages in the world. This means that the daily ratio of calories in these families is well below the minimum necessary for survival and is largely made up of cereals. Yet, most countries still interpret food security as self-sufficiency in staple grains. This has hampered the achievement of positive nutritional outcomes. Such a picture could be a clear illustration of a permanent disconnect that has existed between agricultural development and promotion of nutrition for the African people.

Addressing policy-making challenges

Food shortages in sub-Saharan African countries have led governments to put in place policies and programs to improve food production, but mainly of cereal crops. For example, the Government of Malawi responded to the 2004/2005 food shortages by introducing the farm input subsidy program which mainly promoted maize production. Zambia, one of the biggest maize producers in SSA, owes its high volume of maize production to government policies such as the farm input support program and the Food Reserves Agency that buys maize from farmers at above market prices (Africa Research Institute, 2013). Although such policies greatly improve cereal production, for example, Zambia produces a surplus of more than a million metric tons of maize after a good season, leaving an imbalance in the nutrient content of the diet, with more than 50 percent of the dietary calories obtained from

BOX 10.2:
Creating a bond between Agriculture and Nutrition: An Example

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), through its "Agriculture to Nutrition (ATONU): Improving Nutrition Outcomes Through Optimized Agricultural Investments" Project, is making an effort to change this state of affairs. ATONU is a six-year (2014–2020) regional initiative focusing on understanding how agriculture can deliver positive nutrition outcomes to smallholder farm families through the generation of research-based evidence.

To do this, the ATONU project is using cluster randomization trials (CRTs) to evaluate the impact of the considered nutrition-sensitive interventions. The nutrition-sensitive interventions are: (i) distribution of high-producing chicks to households through the distribution of chicken with superior genetics; (ii) Social Behavior Communication Change Communication (SBCC) intervention on poultry-specific aspects of nutrition, water, sanitation and hygiene), women's empowerment, and use of income; and (iii) vegetable production and home gardens intervention.

CRTs are defined as clusters of people, or intact social units, rather than individuals who are randomized to intervention and control groups and outcomes are measured on individuals within those clusters. For ATONU, the cluster is a village and a unit of analysis is a household which is randomly allocated an NSI. Collection of data is through three repeated measures in longitudinal analysis or multiple measures done on the same household over 18 months: at baseline, strategic mid-line, and end-line. The primary beneficiaries are smallholder farm families, with particular emphasis on child bearing women and children in their first 1,000 days. The three pilot countries are Ethiopia, Nigeria and Tanzania. The results of these trials are expected in early 2018.

[4] The CAADP Nutrition Initiative was endorsed in 2011 after a study that revealed that nutrition was invisible in the NAFSIPs. Sub-Regional CAADP Nutrition Capacity Development workshops were conducted and 49 countries in Africa participated.

cereals. This is such an unbalanced ratio of calorie intake that can only be addressed by an improved, and more importantly, a visionary policy making that integrates the need to ensure that food production reflects the optimal response to the nutrition needs of the populations.

Creating incentives towards nutritious foods

Most African farmers are left with little or no incentive to produce foods that provide other dietary components such as minerals, vitamins and protein (vegetables, legumes, nuts and fruits among others). In the particular context of rural communities, indigenous foods are known for their high nutritious value which is unparalleled by that of some of the conventional and fashionable foods forming the bulk of their daily diet. Since fewer farmers produce such crops beyond subsistence, the cost of these foods, referred to as "orphan crops", is often so high that poor urban and rural households may not consistently afford to buy them, despite their proven nutritional value.

Yet, ensuring adequate supplies of high-quality food is a necessary condition for countries to achieve their nutritional targets, but it is certainly not a sufficient condition. Perhaps ironically, households involved in food production are among the most vulnerable to malnutrition. The link between agricultural investments and nutritional outcomes has not been robustly demonstrated (Gillespie et al., 2012; IFPRI, 2012; Masset, Haddad, Cornelius, & Isaza-Castro, 2011; Webb, 2013). There are limited effective coordination mechanisms and partnerships for simultaneously reducing hunger and multiple forms of malnutrition. The 2015 Global Nutrition Report (IFPRI, 2015) reconfirmed earlier statements that nutrition cannot be addressed in isolation, but requires multi-disciplinary and multi-sectoral approaches across all levels. Stronger multi-sectoral coordination is critical to achieving the nutrition commitments that result in action and entice investments across sectors such as agriculture and health to deliver positive nutrition and health outcomes. Lack of investment further contributes to insufficient capacity to design and evaluate effective agriculture–nutrition interventions, including advocacy for agriculture–nutrition related topics. Relative to other sectors, dedicated investment in efforts to improve nutrition outcomes through agricultural projects has been low.

Reducing post-harvest losses

FAO estimates from 2011 suggest that as much as 37 percent of food produced in SSA is lost between production and consumption. Estimates for cereals are 20.5 percent. For post-harvest handling and storage loss only, the FAO estimate is 8 percent, and the African Post-harvest Losses Information System (APHLIS) estimate is 10–12 percent (World Bank, 2015). The challenge of having reliable statistics in Africa is well known. Whether more credit should be given to the FAO estimates or to those of APHLIS should not shift attention from the core issue that remains: even from rapid empirical observations a considerable amount of the food produced perishes before it reaches the consumers' tables. The onus is therefore on policy makers to work towards reducing post-harvest losses. Nutrient dense foods could benefit from deliberate efforts to reduce post-harvest losses, especially as it stills looks feasible for Africa as a whole, to meet the food and nutrition security target. Among other transformative measures, some deliberate efforts need to be set in motion to expand the infrastructure capacity to preserve highly perishable foods such as fruits and vegetables. More research is needed to develop low cost food preservation technologies that small-scale rural farmers can use on farm to reduce food loss due to spoilage and to improve the shelf-life of their produce.

Investing resources to make it happen

Achieving food security and nutrition for SSA will only materialize if a set of measures are put in place. These include matching the level of required investments in research, with the need to prolong the shelf-life of such foods, as a contribution towards addressing the disconnect between what gets produced, what is consumed, and the nutritious value it ensures. Indeed, when agricultural investments seek to integrate nutrition-sensitive interventions, appropriate approaches and impact pathways are often unknown or results are often not measured robustly enough. For example, household income is crucial in determining access to sufficient quantities of a diverse range of food for adequate nutrition. However, initiatives to develop food value chain should seriously question whether increasing income will be sufficient to address food and nutrition security challenges or whether other interventions will also be required. Research indicates that while increased household income does tend to improve caloric intake, it does not necessarily improve nutrition (Fan & Brzeska, 2011). The agricultural income pathway is not linear and is affected by the characteristics of food markets (e.g., the availability and affordability); the extent to which women and men are differentially empowered to make decisions about household food purchases; and knowledge and social norms that reinforce the use of income on goods and health investments that benefit nutrition. Income generation can have a positive, negative, or neutral effect on nutrition within agricultural projects . Agricultural food systems and nutrition are fragmented, thereby affecting choices for nutrient dense foods and compounding the undernutrition challenge. A transformed and diversified agricultural production system is necessary to influence the delivery of optimum diets to rural and urban populations. This is an area where more research efforts and findings will help inform the structural changes required at all levels in the chains of transformative actions.

Key Messages: Transformation Enablers and Drivers

To end hunger, achieve food security and improved nutrition and promote sustainable agriculture, urgent actions are required to sustain some of the gains shown here to truly drive the agricultural transformation needed for Africa's development and to ensure a better life for all its people as laid out in the Malabo Declaration and the SDGs. The following are the key messages:

- **Value Chain Approach:** Food value chains have recently been identified as a potential route through which agriculture can benefit nutrition (Ruel & Alderman, 2013). Value chain and marketing strategies which usually target farmers, producers and retailers with sufficient assets for them to invest, produce at scale and be more competitive, can contribute to nutrition-sensitive agriculture and yield nutritional benefits both for food suppliers—primary producers, processors and retailers—and consumers.

- **Multi-sectoral Approach:** There is indeed a noted divide resulting in single sector approaches which militate against achievement of food and nutrition security goals. Malnutrition is better addressed through a multi-sectoral approach involving agriculture, nutrition, gender, health, water and sanitation, and education.

- **Monitoring and Evaluation of Impact:** The link between agricultural investments and nutritional outcomes has not been robustly demonstrated. As part of much required agricultural transformation, (i) the evidence base of agriculture investments which have had positive nutritional or health impact should be strong; (ii) systematic impact assessment of investments should be sizable; and (iii) impact assessment studies should be designed and implemented as scalable pilots, and should take into account the impact pathways and the barriers inherent in them.

BOX 10.3:

Women empowerment does change the status quo

Strong evidence exists in literature of improved infant nutritional status and health and reduced infant mortality through women empowerment through decision-making power related to income, time, labor, assets, and knowledge or preferences of female community members (Agha, 2000; Alemayehu, Theall, Lemma, Hajito, & Tushune, 2015; Kamal, 2012; Pamuk, Fuchs, & Lutz, 2011). This improved nutritional status comes through women's ability to make decisions on what to produce and food choices with social and behavior change when these are integrated into agriculture development activities.

Over 80 percent of the food produced in SSA passes through the hands of women, yet they often have limited decision-making authority about what to grow, what to sell, and how to spend household income. Research has shown that when women are empowered to make such decisions, children's education, health and nutrition improve. Some studies have found that women's discretionary income has greater impact on child nutrition and food security than men's (Smith et al., 2003).

Among agricultural interventions that have resulted in improved nutrition, women's active involvement has been a consistent element (Ruel & Alderman, 2013). Research has also shown that a child's chances of survival increase by 20 percent when the mother controls the household budget (Gorrepati, 2016). If women had the same access to productive resources as men, they could increase yields on their farms by up to 30 percent, which could reduce the number of hungry people worldwide by up to 17 percent (FAO, 2011).

- **Inclusivity and Women Empowerment:** The translation of increased income into better child nutrition, in turn, depends on a series of intra-household factors and processes (Hawkes et al., 2013). Women's empowerment interventions should include: nutrition knowledge, and social inclusion and behavior change on advancement of women's status, health-related practices, decision-making power, income, and access to and use of health and sanitation services (see Box 10.3). Nutrition education encourages people to adopt healthy diets, and is also a way to increase demand for local agricultural produce and encourage local suppliers, such as producers, processors and retailers, to supply nutrient rich foods.

- **Extension and Advisory Services:** Most of the approaches have focused on improving the nutritional quality of food production, as well as on nutrition education and on awareness messages regarding better utilization of foods. The capacities that extension agents need to effectively integrate nutrition into agriculture include: technical knowledge of nutrition; communication, facilitation, and management skills; and gender-sensitive nutrition awareness.

- **Conducive Policy Environment:** Policies should create an enabling environment for producers (smallholder farmers) processors and retailers, to help them sell their products and generate income which can be invested in better health, care and food consumption; and for consumers, to improve availability and affordability of nutrient-dense foods. Also, policy level pathways such as the control of food pricing can help farmers better deal with decision making regarding the trade-off between production for own consumption and income-oriented production. Government should provide policies, institutions and regulations that result in a conducive environment for small enterprises to make a substantial contribution to food and nutrition security. They should also use in-depth case studies and evidence from countries which have been most and least successful in mobilizing investment for nutrition-sensitive agriculture.

BOX 10.4:

Growing trend towards a multi-sectoral approach towards improving nutrition

The Scaling Up Nutrition (SUN) Movement is a good example of an inclusive, multi-stakeholder, multi-sectoral movement open to all countries committed to achieving nutrition justice and an end to malnutrition in all its forms.

A recent example is **Guinea Bissau** which in 2011 revised its national nutrition policy which placed emphasis on food security and direct nutrition interventions to adopt a multi-sectoral holistic approach to addressing malnutrition. In 2014 the new policy was adopted in conjunction with various ministries (up to 13 sectors) and technical and financial partners with support from UNICEF. The main objective was to create synergies between direct interventions and those who contribute to nutrition so as to reduce chronic malnutrition by 40 percent and acute malnutrition to less than 5 percent among children under-5 by 2025. The country is now in the process of drawing up the multi-sectoral nutrition strategic plan which will specify the priority interventions to be carried out and the conditions of their implementation. The results and impact of this approach will reveal whether this is a good approach to addressing malnutrition.

Ethiopia has taken a step in the same direction by transitioning the successful Productive Safety Net Programme from an independent program to one that is integrated with nutrition, social protection, disaster risk management, and climate resilient green economy policies (Ethiopia, Ministry of Agriculture, 2014). The Government of Ethiopia and other stakeholders have thus redesigned the program to mainstream nutrition across its components and feature nutrition-sensitive programming.

Burkina Faso established a National Council for Dialogue on Nutrition in 2008; it is the designated multi-sectoral platform. The Council reports to the Ministry of Health and includes the ministries responsible for agriculture and food security, water and sanitation, social action and national solidarity and the economy and finances, education, trade, empowerment of women, scientific research and secondary and higher education. This also includes civil society and academic institutions, while the private sector is also represented. The multi-sectoral common results framework was finalized in 2015 (SUN Movement, 2015).

Recommendations for Improved Food and Nutrition Security

A set of recommendations is offered that ties in well with several ongoing global and continental partnerships, such as the AU-Lula-FAO initiative, and the Scaling Up Nutrition (SUN) Movement (see Box 10.4).

1. Incorporate explicit nutrition objectives and indicators into the design of agriculture program, and track and mitigate potential harms, while seeking synergies with economic, social and environmental objectives.

2. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock (e.g., horticultural products, legumes, livestock and fish at a small scale, underutilized crops, and biofortified crops). Diversified production systems are important for vulnerable producers to enable resilience to climate and price shocks, more diverse food consumption, reduction of seasonal food and income fluctuations, and greater and more gender-equitable income.

3. To achieve a holistic approach, improve processing, storage and preservation to retain nutritional value, shelf-life, and food safety, to reduce seasonality of food insecurity and post-harvest losses, and to make healthy foods convenient to prepare.

4. Promote nutrition education around food and sustainable food systems that builds on existing local knowledge, attitudes and practices. Nutrition knowledge can enhance the impact of production and income in rural households, especially important for women and young children, and can increase demand for nutritious foods in the general population.

5. Empower women by ensuring access to productive resources, income opportunities, extension services and information, credit, labor and time-saving technologies (including energy and water services), and support their voice in household and farming decisions. Equitable opportunities to earn and learn should be compatible with safe pregnancy and young child feeding.

6. Collaborate and coordinate with other sectors (health, environment, social protection, labor, water and sanitation, education, and energy) and program, through joint strategies with common goals, to address concurrently the multiple underlying causes of malnutrition.

7. Promote the creation of an enabling environment; that is, there should be increased investment in generating evidence in the agriculture–nutrition–health nexus and capacity building to understand and leverage on this linkage.

Conclusion

In sum, looking back over the years since the implementation of the MDGs, real progress on hunger reduction in SSA has been made. However, only limited progress has been achieved in improving the quality of people's diets, in terms of reducing malnutrition including micronutrient deficiencies. This chapter: (i) highlighted major trends in SSA agriculture, food security and nutrition; (ii) identified the drivers of those trends, and the emerging challenges that Africa's agriculture and food systems are facing in the 21st century; (iii) identified key lessons that will enable better targeting of investment resources to increase agricultural productivity and to alleviate undernutrition; (iv) explored how—as recommendations—agricultural transformation can contribute to solving the reality of rural poverty, low productivity, food insecurity, malnutrition, unemployment, and lower income among the population in SSA countries. Overall this is, a transformative agriculture approach being proposed and that should include the use of seeds that are more resistant to disease, drought and flooding control and mitigation to enhance productivity; information from trusted local sources about more productive farming techniques and technologies; greater access to markets; ensure inclusivity and women empowerment; consider a multi-sectoral approach; and government policies that serve the interests of farming families.

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CHAPTER 11

Progress towards Agricultural Transformation in Africa

Putting it all together

AUTHORS

David S. Ameyaw Thomas S. Jayne
Alliance for a Green Revolution in Africa

Thomas S. Jayne
Michigan State University

“Africa is simply tired of being in the dark. It is time to take decisive action and turn around this narrative: to light up and power Africa and accelerate the pace of economic transformation, unlock the potential of businesses, and drive much needed industrialization to create jobs”.

Akinwumi Adesina,
AfDB President.

“The time has come for making Africa Agriculture and agribusiness a catalyst for ending poverty, we cannot overstate the importance of agriculture to Africa’s determination to maintain and boast its growth rates, create jobs, significantly reduce poverty, and grow enough cheap, nutritious food to feed its families, export its surplus crops, while safeguarding the continent’s environment”

Makhtar Diop,
World Bank Vice President for Africa Region.

“The new African food system should be built around valuing and empowering the smallholder farmer by supplying them with appropriate seeds and fertilizer, providing education and training, and ensuring easy access to markets and larger economic networks”,

Kofi Annan.

Taking Stock of What's Happened Since 2000

The 2016 AASR provides compelling evidence that Africa is now on the move.

- Since 2000, the share of the labor force primarily engaged in small-scale farming is declining surprisingly rapidly. Today, farming accounts for 40 to 65% of the primary employment in Africa's working-age population, down from 60 to 80% only 10 years ago (Jayne and Ameyaw, Chapter 1).

- The share of the work force engaged in farming has declined most rapidly among countries enjoying the highest rates of agricultural productivity growth. This pattern is consistent with historical structural transformation processes in Asia and elsewhere, where agricultural productivity growth was the primary driver of economic transformation and associated employment shifts to non-farm sectors among countries in their early stages of development (Ulimwengu et al., Chapter 3).

- A decade of intense domestic attention to farmers and food production under the CAADP framework has generated "the most successful development effort" in African history, with countries that made the biggest investments rewarded with sizeable jumps in both farm productivity and overall economic performance (Badiane et al., Chapter 2).

- The poverty rate and prevalence of undernourishment declined in sub-Saharan Africa (SSA) between 1990–1992 and 2014–2016 (Madzivhandila et al., Chapter 10). Most of the region's poverty reduction has been associated with significant reallocation of the work force from semi-subsistence farming to off-farm jobs.

- For the first time since 1990, African economies are again experiencing rising per capita GDP. The economic growth has been observed across all sectors including agriculture. Agriculture value addition has increased by 5.2 percent in 2000 to 2014. Per capita GDP has increased by an average of 2.3 percent as compared to 2.5 percent in the world, and as the world per capita GDP declined by 1.4 percent in 2009, Africa's economy demonstrated resilience by maintaining a growth of 0.8 percent and 3.0 percent respectively in 2009 and 2010 (see Chapter 4). GDP per capita increased in Africa from an annual average of US$987 in 1995–2003, to $1,154 in 2003–2008, and even higher to $1,289 in 2008–2014. As a result, the incidence of poverty has been declining. The depth of poverty as measured by the poverty gap index has also declined from 15.5 percent in 1995–2003 to 12.5 percent in 2008–2014.

- Private companies have been investing heavily in Africa's agriculture value chains in recent years, paving the way for more efficient and dynamic agri-food systems that multiply the options for farmers in terms of the seeds they plant, the fertilizers they use, the markets they can now tap into, and the information services now available to help them manage their farming activities. Agricultural growth in Africa has also expanded livelihood opportunities for millions of people now engaged in the growing off-farm stages of the agri-food system.

- Farm size distribution patterns in Sub-Saharan Africa are changing rapidly. While farms under five hectares still account for 90% of all farms in the region, an increasing portion of agricultural land is controlled by medium-scale and large-scale farms owned by African investor farmers. While most survey datasets are unable to provide accurate estimates, medium-scale farms between 5 and 100 hectares were found to control between 30 and 50 percent of total farmland in Ghana, Kenya, Zambia and Malawi (Jayne and Ameyaw, Chapter 1).

African countries are taking ownership and leadership in their agricultural agenda. These signals taken together create optimism that significant agricultural transformation (and broader economic transformation) is underway in much of Africa. More detailed evidence behind these developments are outlined in the various chapters of this report.

Agricultural transformation has been defined in this report as the process in which agriculture transforms over time from being subsistence-oriented and farm-centered into one that is more commercialized, productive, and off-farm centered. The progress being seen in Africa's agricultural transformation has its origins in the ratification of the Comprehensive African Agricultural Development Programme (CAADP) in 2003 in Maputo. CAADP for the first time signaled strong political resolve of African leaders to revitalize agriculture as a driver of economic growth, poverty reduction, and food and nutrition security. In practice, there has been great variations in the extent to which CAADP resolutions were adhered to across Africa. Badiane et al (Chapter 2) show that African governments implementing their CAADP agenda experienced higher agricultural productivity growth and poverty reduction than countries that implemented CAADP principles later or not at all. In 2014 the CAADP agenda was significantly expanded through the 2014 Malabo Declaration. While reaffirming the principles, values and targets set at Maputo, the Malabo Declaration added ambitious commitments on ending hunger, reducing child malnutrition, and halving poverty by

2025, tripling intra-African trade, enhancing resilience in livelihoods and production systems to climate variability and other shocks, and mutual accountability to actions and results (AU, 2014).

While more could have been done by some governments, it is important to acknowledge that progress has been made since Maputo. The volume of public agriculture expenditure by African countries has increased tremendously over the last 20 years. The country average in Africa increased from US$128.55 million in 1995–2003 to US$186.4 million in 2003–2008, and to US$219.62 million in 2008–2014. African governments' expenditures on agriculture as a share of total agricultural GDP rose faster during the post-CAADP period, from 5.1 percent in 1995–2003 to 6.1 in 2003–2008, before declining slightly to 5.8 percent during 2008–2014.

The agricultural transformation paradigm refines our understanding of how to promote economic development because it clarifies the roles of different types of farmers in contributing to economic transformation and growth. African farmers are not all the same, and there are even major differences among African "smallholder farmers". A relatively small percentage of smallholder farmers – those who are commercially oriented, productive, and possess the skills to navigate the increasingly complex world of farm production and market management operations will drive agricultural growth and produce the multiplier effects from agricultural growth that expand job opportunities for others in the growing non-farm economy. An important finding from recent analyses is that the greatest source of rural poverty reduction in most African countries has been through the creation of non-farm jobs that pull semi-subsistence farmers into more lucrative off-farm jobs. Significantly less poverty reduction has occurred over the past 15 years through smallholder farmers gaining more income from farming, although in many cases this may have more to do more with insufficient government support to smallholder farmers than an inherent inability for smallholder farming to thrive under supportive conditions. The important contribution of viewing Africa's development through an Agricultural Transformation lens is to understand the importance of generating agricultural growth among the segment of farmers where growth can be achieved most easily and effectively in order to generate the multiplier effects that expand employment opportunities in the off-farm segments of the economy and hence reduce poverty as the labor force progressively shifts from farming to more lucrative off-farm jobs. Promoting livelihood options through removing barriers to labor mobility may be particularly important to young people under 30, who now constitute roughly 50% of the entire workforce in Sub-Saharan Africa. The implications of viewing economic development through an agricultural transformation lens is the need for a two-pronged approach, one that focuses policy actions generating growth among commercially oriented smallholder farmers as well as medium- and large-scale farms, while also recognizing the different set of policy actions to raise the productivity and incomes of small-scale farmers, which also includes income diversification and labour mobility as important processes of economic transformation and poverty reduction.

Key Findings and Recommendations

Progress towards African agricultural transformation during the last decades has been remarkable, but still faces many challenges. To sustain and maintain African agricultural transfor=mation and growth, the potential for sustainable intensification strategies to enhance the resilience of agricultural systems in the context of new economic, demographic, and agro-ecological challenges and opportunities has been explored extensively in this report. The policy actions driving yield growth and adoption of improved technologies for African smallholders include

- greater funding of and sustained commitment to national agricultural adaptive research systems that generate more productive new seed varieties, planting materials, and improved farm management practices for the full range of diverse micro-climates and market access conditions in which African smallholders operate.

- more effective and sustainable agricultural extension programs providing smallholder farmers with the skills to be productive, address soil fertility constraints, and navigate the range of increasingly complex farm production and market management operations required in the 21st century. Especially in light of increasing climate variability, African farmers will truly need effective extension systems to help them adopt locally appropriate climate-smart farm management practices as identified by national adaptive agricultural research systems. Digital technologies will be increasingly important in providing bi-directional learning between African farmers and information service providers.

- improved market access conditions, which will largely come through a policy and enabling environment that promotes private investment and competition in agricultural value chains and input distribution systems.

- public investments in improved road, rail and port infrastructure, which will reduce the cost of yield-enhancing inputs and contribute to wider adoption of improved technologies.

- policies that acknowledge the pace at which farm size distribution patterns are changing in many African countries and contribute to agricultural commercialization, which will attract new agribusiness investments that will benefit smallholder farms as well as larger ones.

The factors driving agricultural transformation include policy actions that contribute to farm productivity but go well beyond what happens on the farm. Downstream market access conditions are increasingly important. But governments don't need to do everything themselves. If they can create a favourable enabling environment, the private sector will invest in agricultural value chains and input distribution systems, which will in turn benefit smallholder farmers and promote agricultural transformation. By private sector, we mean both the large national and multinational agribusiness firms and just as importantly the hundreds of thousands of small-scale African entrepreneurs operating in many countries who contribute to a diversified and competitive agri-food system. Private sector jobs within the broad agri-food systems of Africa are growing rapidly and with proper policy support will provide livelihoods for many young people entering the labor force in Africa. More jobs and more competitive food systems are a win-win for Africa.

In summing up the overall findings and recommendations of this report, the following observation have been made..

1. Governance, Political Leadership and Commitment

Africa Heads of State and Government ratified the CAADP framework in 2003 in Maputo, as part of AU-NEPAD. This action signalled a strong political resolve for Africa's leaders to revitalize agriculture as the driver of economic growth, poverty reduction, and food and nutrition security. The 2014 Malabo Declaration expanded the CAADP agenda in terms of coverage and mutual accountability requirements to incorporate issues dealing with reducing child under-nutrition, post-harvest losses, and vulnerabilities of livelihoods, and reaffirmed their commitment to mutual accountability by calling for a continental agricultural biennial review to assess progress on commitments. If the 2014 commitment is to make any difference, there is the need to have a firm commitment, African ownership and political leadership, and a firm mutual accountability that goes beyond a declaration and continental reviews.

The review of the progress and achievement of the CAADP agenda demonstrates that none of the two key CAADP targets during the first decades were achieved. On the 6 percent agricultural growth rate, only 15 countries surpassed the target during the 2008–2014 period. On the 10 percent agriculture expenditure target, the average amount spent as a share of the total public expenditure has been less than 4 percent per year for Africa as a whole. Progress towards African agricultural transformation is possible under the Malabo Declaration and Africa can achieve food and nutrition security and inclusive growth, but it will require total commitment, good governance, and quality institutions along with human capital development for it to happen by 2030.

2. Promotion of broad-based agricultural growth policies

Broad-based agricultural growth is the foundation of structural economic growth. This report notes: "Virtually no country in the world has ever successfully transformed its economy from an agrarian to a modern economy with low poverty rates without sustained agricultural productivity growth" (see Chapter 2). Agricultural growth has the highest impact on non-farm income and employment and a one percent increase in agriculture per capita GDP reduces the poverty gap five times more than a one percent increase in GDP per capita of other sectors (Christiaensen, Demery, & Kuhl, 2011).

To promote broad-based agricultural growth policies, Africa government, institutions, and private sector should invest in agricultural productivity research and development; distribution and availability of improved certified seeds; efficient distribution and timely delivery of blended fertilizers and other organic and soil fertility restoration technology; agricultural extension services that enhance uptake of technology; and development of domestic and regional markets for African food and agricultural products. This will ensure that millions of farmers can and will be able to participate and contribute to progress towards Africa's agricultural transformation.

3. Increased Funding and Investment in Agriculture

This report notes that access to finance and investment is critical for agricultural transformation, wealth creation and long-term prosperity in Africa. For the continent to sustain and maintain its momentum in the progress

towards agricultural transformation, agriculture investment is needed. This investment encompasses support to small-scale farmers, value chain finance, finance for agribusiness and agro-entrepreneurs, rural road access and infrastructure, market infrastructure development, and research and development. IFPRI estimates that the 10 percent threshold agreed upon under the Maputo Declaration was in line with the average level of investment required to attain the MDGs. This does not include the spending needed to improve rural infrastructure. ODA earmarked for agriculture, which had been declining in the previous 30 years from 16 percent of total ODA in 1980 to 3 percent in 2006, has increased slightly since 2008. New ways of financing agriculture are emerging but: "with enormous financial needs of the agricultural sector today, there is clearly need to explore and develop new and innovative ways to finance the sector" (see Chapter 7).

Agricultural investment and finance need to be mobilized to sustain and maintain agricultural transformation in Africa. The investment and finance from national governments, public and private financial institutions, private investment and private capital, and non-financial institutions need to be sourced to finance agriculture. Other innovative credit tools and initiatives such as MFIs, WRS, bonds and equities, and other agricultural investment funds need to be nurtured and tapped into by smallholder farmer and agro-entrepreneurs to finance agriculture value chains. There are other risk management and mitigation tools that can also be mobilized and used to support agricultural investment such as weather index insurance, credit guarantees and the African Risk Capacity initiatives that aimed at merging disaster relief with the concept of risk pooling and transfers for sustainable development in Africa.

4. Promotion of sustainable intensification for resilience and productivity

Africa's agricultural transformation depends on increased productivity of small family farms and smallholder farmers. Family farms make up most agricultural producers in SSA, where there are approximately 33 million smallholders farms. Eighty percent of all farmers are smallholder farms. Family farming produces 98 percent of the food crops in SSA. For this type of farming system to continue and for transformation to take place, there is a need to build resilience intensification in the production system. Sustainable intensification has been defined as "increasing production, income and other benefits, from the same land or less with prudent use of inputs such as water, fertilizers and pesticides while reducing the negative environmental impacts associated with clearing forests, water extraction, and soil usage, and at the same time enhancing the flow of environmental services" (Chapter 4).

With the changing dynamism in farmland ownership and farm size distribution patterns, the population pressure on arable land and the emergence of medium-size farming, holistic sustainable intensification approaches that can be delivered to build resilience of the agricultural system in Africa are needed. "Agriculture is a type of socio-ecological system or an ecosystem managed with the intention of producing, distributing, processing and consuming food, fuel, and fiber—consequently, agricultural resilience must be built on and beyond the farm" (see Chapter 4). Building resilience in agriculture on and beyond the farms on three dimensions—economic, social, and environmental—requires an approach that integrates technological, institutional, and policy options. An integrated approach will have direct positive effects on reducing sources of risk (e.g., production and market) and vulnerability and thereby increasing livelihood resilience (see Chapter 4).

5. Increased market access, agribusiness and intra-regional trade

One of the hallmarks of agricultural transformation is the ability to transform subsistence-oriented and farm-centered agriculture into one that is more commercialized, enabling producers to make more money. They would in turn spend the money earned from their rising surplus production to stimulate demand for goods, services and jobs in the various off-farm sectors of the economy. The ability to receive equitable prices for farm produce and to be able to market surplus production that meets quality standards needed by the growing urban population and consumers is a challenge being faced by many smallholder farmers in Africa. These farmers face challenges such as high transport and trade costs, limited access to lucrative segments in agricultural value chain, unstable output prices, high cost of production inputs, high post-harvest losses, and counter-productive government policies. Overcoming such constraints and challenges can open opportunities for Africa's farmers and agribusinesses to the projected one trillion food Africa market by 2030. "Agriculture food systems currently valued at US$313 billion a year can triple if governments and business leaders radically rethink their policies and support agriculture, farmers and agribusinesses, which together account for nearly 50 percent of Africa economic activity".

Unlocking the potential of market access at domestic, intra-region and international levels to spur the progress towards African agricultural transformation requires addressing policy and institutional bottlenecks, and removing and reducing infrastructure constraints. These will include the adoption of improved technology both on and off farm, increased investment in physical infrastructure, development of storage and processing facilities, and providing appropriate financing for smallholder farmers

and marketing support for institutions. Competitive market access and trade can be achieved if national government and policy makers can fulfill certain conditions: support the promotion of private investment in agricultural value chains by maintaining a predictable policy environment which does not impose sudden bans on cross-border or inter-district trade; promote competition in agricultural markets and avoid offering certain types of market action advantages through preferential access to subsidies or incentives; encourage platforms for periodic private sector–government consultations about the conditions in grain markets, needed actions and ways to improve the functioning of these markets; and last but not the least if they can increase public investments in agricultural adaptive research and extension to raise farm productivity and surplus production. These actions will encourage value chains to promote local production as a way to feed the growing cities rather than relying on imports.

6. Introduction and adoption of modern digital technology

The success of agricultural transformation in other parts of the world has been dependent on some form of machine power and technological advancement. Technology has been used to improve soil fertility, develop certified seed varieties, control pest and diseases, control irrigation to supplement rainfall, advance harvesting, handling and storage equipment, and reduce post-harvest losses and enhance market efficiency (see Chapter 8 page INSERT PAGE NUMBER). For decades such facilities have been limited in Africa's agricultural landscape. Only a few and to some extent large-scale industrial agricultural players have had access to this equipment and technology. The limited access has somewhat affected the level of agricultural productivity in SSA. "Adoption of digital technologies in a few select countries has not been pervasive, however, and has remained particularly low among the poor with viable and sustainable information and communication technology delivery models achieving transient success. New agricultural technologies such as web-enabled sensors and data analytics are also alien to most of the smallholder farmers responsible for producing up to 70% of world's food needs".

In the past five years, with the emergence and the explosive usage of ICT, opportunities now abound for African smallholder farmers and agribusinesses to improve farming and farming activities along and across small-scale value chains. This will allow smallholder farmers to selectively access market information, interact with value chain actors along the entire supply chain, and ensure traceability, compliance and sustainability of their produce and farms. Mobile-based technologies have helped facilitate digital payments and receipts by smallholder farmers, enabling them to get paid faster and more reliably, making it easier for them to access credit, insurance, and other financial instruments through well-documented financial histories (World Bank, 2016). Africa's agricultural transformation can be accelerated if smallholder farmers and agribusinesses receive support to adopt modern technology in the production, post-harvest, marketing, and distribution process. With the proliferation of mobile devices along the agricultural landscape in SSA, smallholder farmers can embrace digital technologies to access data on agricultural and market and other value chain processes.

Progress towards agricultural transformation cannot be sustained and maintained without digital technology. Therefore its adoption and utilization by smallholder farmers in SSA should be facilitated. This facilitation includes strengthening of the establishment of an enabling environment including legal and business environments backed by informed and knowledgeable decision makers, and reliable technological innovations which meet the specific needs of smallholder farmers, fostering data aggregation systems and interoperability, fostering inclusion in building digital technology, increasing investment in infrastructure and software development, establishing regulation for emerging technologies, and fostering institutional networks.

7. Agricultural Research, Advisory Services and Capacity Development

Africa's agricultural transformation cannot happen without efficient, effective and productive agricultural research systems. Research and research systems with appropriate research capacity and infrastructure spur agricultural growth. AR4D is defined as multi-dimensional research that addresses agricultural challenges and provides technological, economic and institutional knowledge and innovations, contributing to sustainable development. An efficient and effective agricultural research system should have the capacity to generate, analyze and use data, information, knowledge and innovations to support agricultural productivity at national and regional levels of SSA. This system requires both public and private investment and funding. Available data show that multi-donor trust funds managed by the World Bank, amounted to nearly 32 percent of the total donor investment in ARD in SSA. According to ASTI, public (i.e., national government) agricultural research spending in SSA increased by more than one-third in real terms, from US$1.2 billion in 2000 to US$1.7 billion in 2011, measured in constant 2005 purchasing power parity (PPP) dollars. However, nearly half of this value was due to investments made in only three countries: Kenya, Nigeria, and South Africa.

While agricultural research generates, analyzes, and uses data, information, knowledge and innovation to support agriculture productivity, this knowledge and innovation should be translated and interpreted for use by smallholder farmers in Africa. Studies show that economic returns to investment in AAS range from 50 to 80 percent. There is also robust evidence from the other areas to show that agricultural extension improves crop yields and quality, improving smallholder livelihoods and reducing production risks. The current situation in SSA is that smallholder farmers have limited access to AAS. Public support and private extension services are being evolved into innovative approaches and are helping bridge the supply and demand mismatch in AAS.

Progress towards Africa's agricultural transformation requires an efficient and effective agricultural research system and robust agricultural advisory or extension services. Many organizations and institutions are currently engaged in capacity building initiatives to support such systems and services, but the continent needs a unified framework that works in our context and culture. Agricultural research systems, AAS and capacity development initiatives that will address the needs and aspirations of smallholder farmers and African agribusinesses should: be able to deliver poverty-alleviating technology along specific value chains in many SSA countries; be knowledge-driven by conscious investments in and application of science; come up with innovative funding mechanisms away from the traditional donor-dependence; and use an effective innovative approaches.

The Road Ahead and Next Steps

Even under the most optimistic projections, non-farm wage jobs in SSA will be able to absorb only half of the additional 350 million workers estimated to enter the labor force before 2035. This means that, for at least the next several decades, agriculture will be called upon to provide gainful employment for at least a third of young Africans entering the labor force. However, agriculture will be unattractive to young people unless it can earn a decent livelihood. To achieve this, farming must become more productive and innovative, benefiting from science and research, as in most of the rest of the world. Moreover, profitable farming requires access to more land. In some parts of Africa, land scarcity is becoming a major problem, exacerbated in some cases by government policies toward the transfer of land to domestic and foreign investors.

Countries such as Japan and South Korea, which now rely on manufacturing and technology-driven service economies, were predominantly smallholder farming societies 60 years ago. Through good policies and public investments in infrastructure, agricultural research breakthroughs, and extension services to help farmers benefit from new technologies, smallholder farmers in these countries increased their productivity and incomes, thereby supporting the demand for non-farm businesses and the growth of employment opportunities off the farm. Over time, most smallholder farmers eventually moved into these non-farm jobs.

Africa's transformation from a primarily semi-subsistence, small-scale agrarian economy to a more diversified and productive economy will still require unwavering support to African smallholder farmers so that they are able to participate in and contribute fully to the region's economic transition. While migration from farm to non-farm sectors, and from rural to urban areas will provide the brightest prospects for the transformation and modernization of Africa's economies, it will happen only as fast as educational advances and growth in the non-farm job opportunities allow. The rate of growth of non-farm jobs in turn depends on the rate of income growth among the millions of families still engaged in smallholder agriculture. Thus, there is a symbiotic relationship between inclusive agricultural growth, non-farm growth, and poverty reduction.

Inclusive agricultural growth is needed to facilitate broader economic transformation and poverty reduction objectives. Therefore continuous investment in areas that contribute to inclusive agricultural growth such as agricultural R&D, innovative ways of disseminating improved farm management practices to smallholders (e.g., using ICTs, smart phones, and other innovative forms of information dissemination to rural people, and rehabilitation of public agricultural extension programs where feasible), programs to restore soil fertility and promote resilience in the face of increasing climate variability, strategies to reduce transport costs and improve farmers' access to markets and services, holistic approaches to nutritional improvements, and perhaps most importantly helping young Africans to obtain quality education and skill training are imperative

Government policies and public investment policies must be decisive, as these will determine the incentives and scope for investment by the private sector. These policies will largely determine whether the region's economic transformation is a relatively smooth, robust, and peaceful process, ohr a painful and protracted one.

Currently, SSA is making progress towards agricultural transformation. The progress is uniquely African and it is putting smallholder farmers first while protecting biodiversity, promoting sustainability and advancing equity. The progress is towards a food secure and prosperous Africa. The core of the transformation is a system that is

highly productive, efficient, competitive, and sustainable and that assures food security and lifts millions out of poverty

African agricultural transformation (as stated in the AGRA strategy document published in 2009), is a strategy that transforms today's rural poverty into tomorrow's prosperity, through sustainably and significantly increasing the productivity of smallholder farmers. It starts from the understanding that African agriculture can be a powerful and transformative engine for sustainable economic growth. It is grounded in Africa's very diverse and largely rain-fed agriculture; wise use of science and technology; and in learning from previous green revolutions.

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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

Sources of data as follows:

Rural Population (% of total population)

Source: Source: World Development Indicators, World Bank

GDP per capita Growth (Annual %)

Source: World Development Indicators, World Bank

Agriculture Value Added Per Worker (Constant 2010 US$)

Source: World Development Indicators, World Bank

Cereal yield (kg per hectare)

Source: World Development Indicators, World Bank

Crop Production Index (2004-2006 = 100)

Source: World Development Indicators, World Bank

Fertilizer Consumption (kg per hectare of arable land)

Source: World Development Indicators, World Bank

Total Factor Productivity

Source: Economic Research, Washington D.C.

Aid (ODA) Disbursements to Countries and Regions

Source: OECD Statistics data

Internet Users (per 100 people)

Source: World Development Indicators, World Bank

Cell Phone Subscriptions (per 100 People)

Source: World Development Indicators, World Bank

Net ODA received per capita (current US$)

Source: World Development Indicators, World Bank

Spending, Total (As a Share of Agriculture GDP, %)

Source: ASTI (Agricultural Science and Technology Indicators) http://www.asti.cgiar.org/

Government Agriculture Expenditure (% Share of Total Expenditure)

Source: Regional Strategic Analysis and Knowledge Support System (ReSAKSS)

Rural Population (% of Rural Population)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Angola	66.8	66.1	65.4	64.6	63.8	63.1	62.3	61.5	60.7	59.9	59.1	58.3	57.5	56.7	56.0
Benin	61.4	61.0	60.7	60.4	60.0	59.7	59.3	58.9	58.5	58.1	57.7	57.3	56.9	56.5	56.1
Botswana	45.9	45.6	45.4	45.2	44.9	44.7	44.5	44.2	44.0	43.8	43.5	43.3	43.1	42.8	42.6
Burkina Faso	81.5	80.7	80.0	79.2	78.5	77.7	76.8	76.0	75.2	74.3	73.5	72.7	71.8	71.0	70.1
Burundi	91.5	91.3	91.1	90.9	90.6	90.4	90.1	89.9	89.6	89.4	89.1	88.8	88.5	88.2	87.9
Cabo Verde	45.7	44.9	44.0	43.2	42.3	41.5	40.6	39.8	39.0	38.2	37.4	36.6	35.9	35.2	34.5
Cameroon	53.9	53.3	52.7	52.1	51.5	50.9	50.3	49.7	49.1	48.5	47.9	47.3	46.8	46.2	45.6
Central African Republic	62.3	62.2	62.1	62.0	61.9	61.8	61.7	61.5	61.4	61.2	61.0	60.7	60.5	60.2	60.0
Chad	78.3	78.3	78.3	78.2	78.2	78.2	78.1	78.1	78.1	78.0	78.0	77.9	77.8	77.7	77.5
Comoros	72.0	72.0	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.1	72.0	72.0	71.9	71.8	71.7
Congo, Dem. Rep.	64.4	63.9	63.5	63.0	62.5	62.0	61.6	61.1	60.6	60.1	59.6	59.1	58.5	58.0	57.5
Congo, Rep.	40.8	40.4	39.9	39.5	39.0	38.6	38.1	37.7	37.2	36.8	36.3	35.9	35.5	35.0	34.6
Cote d'Ivoire	55.8	55.1	54.5	53.8	53.2	52.5	51.7	51.0	50.2	49.4	48.7	48.0	47.2	46.5	45.8
Equatorial Guinea	61.2	61.2	61.2	61.2	61.1	61.1	61.0	61.0	60.9	60.8	60.7	60.5	60.4	60.2	60.1
Eritrea	82.2	82.0	81.7	81.4	81.1	80.8	80.5	80.1	79.8	79.4	79.0	..	..	..	..
Ethiopia	85.1	84.9	84.7	84.5	84.3	84.1	83.9	83.5	83.1	82.7	82.3	81.8	81.4	81.0	80.5
Gabon	19.2	18.4	17.8	17.2	16.6	16.0	15.6	15.1	14.7	14.3	14.0	13.6	13.3	13.1	12.8
Gambia, The	51.2	50.3	49.4	48.5	47.7	46.8	46.0	45.2	44.4	43.7	43.0	42.3	41.6	41.0	40.4
Ghana	55.4	54.7	54.0	53.4	52.7	52.0	51.3	50.6	50.0	49.3	48.6	47.9	47.3	46.6	46.0
Guinea	68.6	68.3	67.9	67.6	67.2	66.8	66.4	66.0	65.6	65.1	64.7	64.3	63.8	63.3	62.8
Guinea-Bissau	62.5	61.7	60.8	60.0	59.1	58.3	57.4	56.5	55.7	54.8	53.9	53.1	52.3	51.5	50.7
Kenya	79.8	79.4	79.1	78.7	78.3	78.0	77.6	77.2	76.8	76.4	76.0	75.6	75.2	74.8	74.4
Lesotho	79.9	79.4	78.9	78.3	77.8	77.2	76.7	76.2	75.7	75.2	74.7	74.2	73.7	73.2	72.7
Liberia	55.3	55.0	54.6	54.3	53.9	53.6	53.3	52.9	52.6	52.2	51.8	51.5	51.1	50.7	50.3

Madagascar	72.6	72.3	72.1	71.8	71.2	70.6	70.0	69.3	68.7	68.1	67.4	66.8	66.2	65.5	64.9
Malawi	85.3	85.2	85.1	85.0	84.9	84.9	84.8	84.7	84.6	84.5	84.3	84.2	84.1	83.9	83.7
Mali	70.9	70.2	69.5	68.7	67.9	67.2	66.4	65.6	64.8	64.0	63.2	62.4	61.6	60.9	60.1
Mauritania	50.0	49.2	48.4	47.6	46.9	46.1	45.4	44.7	44.0	43.3	42.7	42.0	41.4	40.7	40.1
Mauritius	57.5	57.8	58.0	58.2	58.4	58.6	58.8	59.0	59.2	59.4	59.6	59.8	60.0	60.2	60.3
Mozambique	70.7	70.5	70.4	70.2	70.0	69.8	69.6	69.5	69.3	69.0	68.8	68.6	68.3	68.1	67.8
Namibia	67.1	66.2	65.3	64.3	63.4	62.4	61.4	60.4	59.4	58.4	57.4	56.3	55.3	54.3	53.3
Niger	83.7	83.6	83.5	83.4	83.3	83.1	83.0	82.8	82.6	82.4	82.2	82.0	81.8	81.5	81.3
Nigeria	64.3	63.5	62.6	61.8	60.9	60.1	59.2	58.3	57.4	56.5	55.6	54.8	53.9	53.1	52.2
Rwanda	84.2	83.2	82.4	81.6	80.7	79.8	78.9	78.0	77.0	76.0	75.1	74.1	73.1	72.2	71.2
Sao Tome and Principe	45.6	44.7	43.8	42.9	42.0	41.2	40.3	39.6	38.8	38.1	37.4	36.7	36.1	35.5	34.9
Senegal	59.5	59.4	59.2	59.1	58.9	58.7	58.5	58.3	58.0	57.8	57.5	57.2	56.9	56.6	56.3
Seychelles	49.7	49.5	49.4	49.2	48.9	48.7	48.5	48.2	48.0	47.7	47.4	47.1	46.8	46.4	46.1
Sierra Leone	64.1	63.9	63.6	63.4	63.2	62.9	62.6	62.4	62.1	61.8	61.4	61.1	60.8	60.4	60.1
Somalia	66.4	66.0	65.6	65.2	64.8	64.4	64.0	63.6	63.2	62.7	62.3	61.8	61.4	60.9	60.4
South Africa	42.6	42.1	41.6	41.0	40.5	39.9	39.4	38.8	38.3	37.8	37.3	36.7	36.2	35.7	35.2
South Sudan	83.4	83.2	83.1	83.0	82.8	82.7	82.6	82.4	82.3	82.1	82.0	81.8	81.6	81.4	81.2
Sudan	67.5	67.4	67.3	67.3	67.2	67.2	67.1	67.1	67.0	66.9	66.8	66.7	66.5	66.4	66.2
Swaziland	77.4	77.6	77.7	77.8	78.0	78.1	78.2	78.3	78.4	78.5	78.6	78.6	78.7	78.7	78.7
Tanzania	77.3	77.0	76.4	75.8	75.2	74.5	73.9	73.2	72.6	71.9	71.2	70.5	69.8	69.1	68.4
Togo	66.6	66.2	65.7	65.3	64.8	64.4	63.9	63.4	62.9	62.5	62.0	61.5	61.0	60.5	60.0
Uganda	87.8	87.7	87.5	87.2	87.0	86.7	86.4	86.1	85.8	85.5	85.2	84.9	84.6	84.2	83.9
Zambia	65.0	64.6	64.2	63.8	63.4	63.0	62.5	62.1	61.7	61.3	60.8	60.4	60.0	59.5	59.1
Zimbabwe	65.8	65.4	65.5	65.7	65.9	66.1	66.3	66.4	66.6	66.8	67.0	67.2	67.3	67.5	67.6

Source: World Bank Development Indicators

GDP per Capita Growth (Annual %)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Angola	0.84	-10.10	1.58	7.01	14.19	16.64	18.49	10.04	-0.97	-0.00	0.50	1.71	3.34	1.43	-0.27
Benin	2.02	1.26	0.06	1.04	-1.51	0.73	2.77	1.79	-0.64	-0.77	0.12	1.83	4.06	3.76	2.52
Botswana	-1.23	4.64	3.25	1.29	2.97	6.55	6.33	4.22	-9.46	6.41	3.92	2.34	7.66	1.19	-2.13
Burkina Faso	3.62	1.40	4.73	1.46	5.47	3.09	2.47	4.05	-0.14	5.21	3.38	3.35	0.65	1.06	1.01
Burundi	-0.58	1.34	-4.44	1.27	-2.57	1.74	1.14	1.39	-0.11	0.24	0.69	0.58	1.18	1.27	-5.69
Cabo Verde	0.26	3.39	2.54	8.71	5.73	7.07	14.45	6.09	-1.85	0.70	2.97	-0.07	-0.23	1.47	1.22
Cameroon	1.82	1.34	1.38	1.07	-0.30	0.61	0.65	0.30	-0.63	0.68	1.53	1.98	2.94	3.31	3.64
Central African Republic	2.58	1.87	-6.93	4.28	-0.78	1.84	2.74	0.19	-0.18	1.11	1.34	0.93	-38.23	-3.18	3.42
Chad	7.53	4.41	10.41	28.72	13.17	-2.79	-0.14	-0.28	0.86	9.87	-3.19	5.31	2.24	3.43	-1.47
Comoros	-0.19	-0.15	-0.33	-0.51	0.38	0.19	-1.62	-2.02	-0.51	-0.26	0.12	0.52	1.02	-0.36	..
Congo, Dem. Rep.	-4.87	-0.13	2.30	3.37	2.78	1.98	2.87	2.83	-0.42	3.68	3.49	3.80	5.12	5.59	3.61
Congo, Rep.	1.37	2.24	-1.45	1.02	4.97	3.24	-4.52	2.35	4.26	5.67	0.66	1.17	0.89	4.16	0.08
Cote d'Ivoire	-1.94	-3.50	-3.09	-0.54	-0.13	-0.43	-0.26	0.42	1.03	-0.25	-6.58	8.09	6.59	5.93	5.84
Equatorial Guinea	57.99	15.54	10.24	33.58	13.08	4.39	8.87	6.64	-7.36	-6.67	-1.04	2.63	-9.25	-3.18	-14.71
Eritrea	5.19	-0.62	-6.12	-1.96	-0.52	-3.57	-0.92	-11.67	1.78	0.10	6.41	..	..	..	..
Ethiopia	5.21	-1.37	-4.92	10.41	8.75	7.84	8.49	7.87	5.97	9.65	8.34	5.90	7.81	7.55	6.93
Gabon	-0.21	-2.47	0.01	-1.51	1.62	-5.76	3.31	-5.46	-2.11	4.69	4.69	2.89	3.28	2.01	1.59
Gambia, The	2.61	-6.25	3.49	3.64	-4.09	-2.08	0.35	2.38	3.06	3.12	-7.40	2.46	1.43	-2.33	..
Ghana	1.47	1.89	2.52	2.89	3.18	3.67	1.68	6.37	2.21	5.22	11.25	6.66	4.77	1.57	1.52
Guinea	1.85	3.34	-0.58	0.36	0.82	0.12	-0.79	2.17	-2.96	-0.81	1.12	1.15	-0.44	-2.27	-2.54
Guinea-Bissau	0.04	-3.06	-1.54	0.60	2.06	0.13	0.99	0.96	1.02	2.04	6.77	-4.15	-1.62	0.07	2.31
Kenya	1.18	-2.00	0.30	2.40	3.18	3.72	4.08	-2.37	0.61	5.56	3.31	1.79	2.91	2.58	2.93
Lesotho	3.38	-0.21	3.96	1.58	1.97	3.53	3.91	4.85	2.41	6.81	2.90	3.75	3.17	2.35	..
Liberia	-0.75	1.33	-31.34	0.67	2.54	4.37	5.26	2.76	1.20	2.44	4.98	5.14	6.08	-1.65	-2.08

Madagascar	2.81	-15.28	6.54	2.19	1.59	2.03	3.25	4.14	-6.68	-2.51	-1.35	0.19	-0.55	0.29	0.20
Malawi	-7.44	-0.86	3.07	2.73	0.51	1.79	6.47	4.49	5.12	3.68	1.71	-1.19	2.02	2.50	-0.16
Mali	11.34	4.74	9.53	-9.06	6.89	8.89	4.77	5.97	8.16	7.41	4.50	7.95	3.92	4.67	4.47
Mauritania	-1.09	-2.41	2.77	2.64	5.89	15.65	0.14	-1.47	-3.51	2.16	2.09	3.17	3.47	1.66	..
Mauritius	1.77	1.41	2.91	5.08	0.64	3.46	5.41	5.13	2.78	3.85	3.72	2.94	2.96	3.44	3.36
Mozambique	9.55	5.67	3.40	4.69	5.61	6.76	4.44	3.92	3.41	3.73	4.14	4.22	4.17	4.48	3.37
Namibia	-0.55	3.36	3.04	11.02	1.30	5.67	5.12	1.07	-1.41	4.04	2.91	2.70	3.18	3.84	3.26
Niger	3.26	-0.70	1.51	-3.51	0.71	1.94	-0.63	5.54	-4.43	4.25	-1.64	7.44	1.12	2.82	-0.48
Nigeria	1.81	1.19	7.58	30.34	0.79	5.41	4.04	3.48	4.12	4.99	2.10	1.51	2.60	3.52	-0.01
Rwanda	4.66	10.72	-0.27	5.22	4.78	6.60	4.77	8.09	3.36	4.51	5.17	6.16	2.22	4.52	4.44
Sao Tome and Principe	1.10	0.17	4.19	1.49	4.71	6.72	1.01	5.85	1.78	2.23	2.57	2.34	1.96	2.26	..
Senegal	1.92	-1.97	3.85	3.04	2.79	-0.28	2.13	0.86	-0.44	1.16	-1.29	1.21	0.28	1.10	3.27
Seychelles	-2.36	-1.81	-4.86	-2.50	8.48	7.21	9.86	-4.31	-1.49	3.04	10.76	5.57	4.17	1.62	1.83
Sierra Leone	-10.65	20.50	4.07	1.55	0.20	2.07	5.09	2.90	2.33	3.02	3.88	12.49	17.84	2.33	-22.00
Somalia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
South Africa	0.62	2.47	1.64	3.19	3.88	4.15	3.90	1.73	-2.96	1.52	1.65	0.65	0.61	-0.08	-0.37
South Sudan	..	..	..	..	..	..	..	..	0.52	0.95	-8.76	-48.39	8.46	-0.60	-9.60
Sudan	3.52	3.45	4.71	0.96	4.46	6.96	8.37	4.78	0.39	0.67	7.33	9.35	1.15	0.91	1.17
Swaziland	0.12	1.08	1.70	2.27	1.55	2.05	1.99	0.70	-0.46	0.01	-0.29	1.42	1.39	0.96	0.25
Tanzania	3.25	4.31	3.96	4.79	5.05	1.56	5.18	2.31	2.11	3.04	4.53	1.86	3.92	3.65	3.68
Togo	-4.21	-3.55	2.16	-0.61	-1.53	1.26	-0.46	-0.52	0.73	1.21	2.08	2.03	1.22	3.16	2.74
Uganda	1.85	5.21	2.97	3.27	2.81	7.12	4.83	5.12	3.73	1.74	6.12	1.05	-0.04	1.46	1.68
Zambia	2.64	1.89	4.27	4.30	4.40	4.96	5.31	4.68	6.04	7.05	3.18	3.53	3.50	2.41	-1.42
Zimbabwe	0.60	-9.52	-17.53	-6.49	-6.56	-4.52	-4.88	-18.87	4.24	9.36	9.69	8.21	2.15	1.48	-1.24

Source: World Bank Development Indicators

Agriculture Value Added Per Worker (Constant 2010 US$)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Angola	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Benin	827.7	854.8	859.9	918.8	902.7	946.8	978.4	985.4	1020.3	989.9	1000.4	1024.1	1069.9	1115.9	1150.8
Botswana	856.2	671.0	794.5	787.0	754.0	840.0	923.9	923.7	963.6	1003.6	989.7	894.2	895.1	881.3	876.2
Burkina Faso	388.9	398.4	413.9	387.0	413.8	416.7	385.9	446.8	392.2	422.9	395.8	412.5	412.5	406.6	388.7
Burundi	287.9	291.3	271.5	261.4	235.7	234.9	206.8	196.4	197.0	200.3	205.6	214.1	214.0	219.2	231.4
Cabo Verde	2658.7	2571.2	2699.3	2863.1	2754.6	2762.4	3747.1	3782.8	4311.8	4155.5	4337.5	4906.4	4847.0	4721.0	..
Cameroon	1012.9	1045.3	1078.3	1121.9	1148.8	1180.5	1258.4	1320.4	1355.2	1434.1	1477.3	1516.1	1571.5	1646.1	1786.8
Central African Republic	589.4	592.8	604.9	592.4	615.5	667.6	687.4	765.2	775.9	796.4	853.0	864.4	474.6	447.2	458.4
Chad	..	..	..	..	..	..	1814.9	1702.1	1629.2	1869.1	1706.1	1885.3	1825.9	1922.7	2096.6
Comoros	975.5	979.7	981.0	980.9	984.5	984.9	983.0	1039.4	978.8	945.7	958.5	972.2	986.8	982.0	..
Congo, Dem. Rep.	328.4	310.2	305.4	303.0	297.7	308.1	312.1	315.1	318.2	322.2	326.3	330.5	335.3	340.2	349.9
Congo, Rep.	601.4	650.4	691.2	723.0	750.4	786.2	822.3	863.2	830.8	877.8	947.8	998.6	1074.3	1158.8	1217.2
Cote d'Ivoire	..	..	..	..	..	..	..	2320.2	2257.5	2169.2	2326.0	2265.0	2420.6	2696.8	2795.9
Ethiopia	293.8	279.5	242.8	275.7	304.2	330.5	351.3	368.0	381.9	391.9	417.4	428.2	448.7	463.4	483.4
Gabon	2795.7	2707.8	2766.3	2779.6	2948.3	3319.8	3562.2	3373.0	3187.7	3071.4	3123.4	3252.4	3363.5	3669.7	3949.1
Gambia, The	434.8	346.6	402.5	418.6	398.2	331.4	316.0	387.8	421.5	455.5	335.8	346.6	331.2	298.6	..
Ghana	..	..	..	..	..	1385.9	1322.6	1384.8	1447.3	1485.0	1459.6	1455.6	1499.8	1530.8	1529.8
Guinea	214.5	220.9	225.8	230.1	230.0	235.7	238.9	243.5	247.1	250.2	256.5	261.9	274.9	274.2	269.5
Guinea-Bissau	774.6	766.4	790.0	764.9	847.3	825.7	838.2	850.3	862.5	850.5	908.3	891.4	879.4	893.3	..
Kenya	767.8	723.8	724.5	720.9	754.4	751.9	776.8	725.1	695.7	751.3	753.7	760.0	784.4	794.2	820.7
Lesotho	595.0	417.8	430.9	424.5	429.3	383.9	381.5	442.0	417.3	457.3	495.4	423.5	475.2	493.9	..
Liberia	975.4	945.6	660.0	699.4	724.6	567.5	586.5	622.5	631.6	634.3	643.5	644.0	650.3	637.0	593.5

Madagascar	351.1	337.2	332.9	323.7	316.0	314.6	317.4	316.0	331.7	310.0	302.2	297.1	267.3	263.2	253.8
Malawi	427.5	444.7	451.3	458.9	407.6	380.2	397.4	400.4	404.8	419.9	424.8	411.2	424.5	435.1	411.3
Mali	671.0	671.4	851.3	637.0	717.7	839.0	816.9	982.4	1045.4	1156.4	1143.4	1505.9	1497.1	1633.2	1731.3
Mauritania	1124.0	1060.7	1073.8	1009.8	1062.9	1034.4	1108.2	1166.9	1152.3	1181.6	1128.8	1184.1	1144.2	1174.5	..
Mauritius	5335.1	4393.7	4609.7	5426.8	5225.2	5352.0	5183.2	5549.8	6178.8	6387.2	6788.4	7078.7	7438.8	7912.9	8025.9
Mozambique	205.1	223.9	231.1	237.7	248.9	269.9	287.0	301.2	310.6	320.1	326.5	326.0	324.9	327.4	339.5
Namibia	3587.5	3907.9	4082.8	4108.6	4298.8	4233.4	3585.5	2992.6	3482.9	3624.6	3549.8	3592.9	3171.5	3321.9	3063.5
Niger	..	..	..	..	..	492.6	499.7	562.4	492.5	552.0	518.4	576.3	554.7	584.8	584.3
Nigeria	2700.5	4199.5	4501.8	4794.8	5143.1	5534.2	5939.4	6316.7	6689.7	7077.5	7278.0	7755.8	7969.9	8292.1	8578.8
Rwanda	348.5	394.3	374.1	373.9	388.0	387.1	386.9	399.8	417.8	425.6	432.9	447.8	449.9	460.7	470.7
Sao Tome and Principe	1226.5	1226.7	1213.8	1259.3	1236.6	1309.7	1301.6	1413.4	1422.7	1404.4	1376.0	1335.3	1348.3	1332.4	..
Senegal	519.9	394.3	452.6	451.4	488.4	436.1	399.3	464.2	510.2	524.8	434.8	460.1	455.3	453.0	520.2
Seychelles	1004.8	1017.0	924.1	897.8	966.9	915.1	891.9	933.3	779.4	731.0	756.6	749.2	917.0	865.6	..
Sierra Leone	552.1	703.6	741.4	778.8	808.2	837.3	932.6	980.3	1007.3	1029.3	1066.0	1093.2	1128.8	1124.0	1144.1
Somalia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
South Africa	4861.3	5267.6	5397.7	5574.7	5876.7	5704.5	5965.8	7305.7	7361.2	7542.9	7866.8	8146.8	8514.1	9260.1	8739.0
South Sudan	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sudan	2194.2	2236.3	2207.6	2130.2	2152.3	2308.6	2231.2	2268.5	2165.6	2147.6	2264.4	2288.2	2389.5	2420.7	2464.5
Swaziland	1308.3	1387.4	1475.3	1453.4	1542.4	1526.5	1566.7	1565.6	1562.0	1613.6	1667.2	1701.4	1784.4	1760.4	1904.0
Tanzania	452.7	466.2	471.7	489.4	516.2	516.8	516.5	542.2	555.9	556.5	560.9	563.6	565.6	568.1	570.0
Togo	926.3	913.0	884.3	900.9	977.4	912.3	919.5	1053.6	764.4	764.5	791.0	858.3	845.4	952.5	961.2
Uganda	499.7	521.6	518.8	513.1	509.7	498.4	484.7	477.8	478.3	480.2	481.0	473.5	469.5	471.3	473.0
Zambia	826.0	786.2	797.5	798.2	758.1	734.9	691.6	658.6	647.3	622.6	655.5	681.9	614.0	635.9	..
Zimbabwe	894.9	682.6	584.6	536.4	514.1	497.9	467.5	285.2	348.0	371.1	371.9	394.3	376.5	453.8	422.2

Source: World Bank Development Indicators

Cereal Yield (kg per hectare)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Angola	585	627	646	492	583	446	464	653	571	629	662	552	815	889
Benin	1,069	945	1,149	1,147	1,136	1,125	1,014	1,248	1,271	1,201	1,518	1,373	1,399	1,460
Botswana	554	359	1,214	274	443	372	639	361	359	374	452	367	218	398
Burkina Faso	968	943	996	941	1,127	1,204	936	1,040	1,002	1,063	995	1,203	1,157	1,226
Burundi	1,284	1,309	1,262	1,328	1,344	1,277	1,345	1,281	1,296	1,299	1,309	1,102	1,176	1,330
Cabo Verde	637	149	379	385	243	141	110	337	231	220	178	196	182	36
Cameroon	1,709	1,683	1,620	1,563	1,727	1,811	1,676	1,678	1,765	1,669	1,681	1,597	1,652	1,623
Central African Republic	1,011	1,048	1,019	991	962	860	951	947	948	1,447	1,522	1,684	1,716	1,649
Chad	635	671	791	671	762	750	763	812	830	843	772	856	1,008	941
Comoros	1,279	1,169	1,197	1,255	1,285	1,322	1,380	1,291	1,403	1,418	1,411	1,390	1,443	1,447
Congo, Dem. Rep.	787	772	772	772	772	772	772	772	772	772	744	770	767	763
Congo, Rep.	777	778	814	822	752	778	766	771	791	780	814	848	889	910
Cote d'Ivoire	1,720	1,751	1,827	1,854	1,836	1,918	1,569	1,735	1,712	2,270	1,882	2,766	3,125	3,254
Eritrea	637	158	261	275	758	799	939	252	500	536	578	608	602	626
Ethiopia	1,198	1,354	1,123	1,163	1,361	1,563	1,439	1,450	1,683	1,833	1,962	2,047	2,193	2,325
Gabon	1,538	1,442	1,588	1,604	1,600	1,584	1,666	1,603	1,658	1,687	1,698	1,685	1,691	1,688
Gambia, The	1,283	960	1,198	1,171	1,040	1,026	800	977	1,049	1,127	869	910	959	745
Ghana	1,186	1,349	1,396	1,373	1,432	1,335	1,317	1,598	1,660	1,814	1,594	1,768	1,689	1,703
Guinea	1,483	1,487	1,485	1,491	1,496	1,502	1,514	1,464	1,469	1,459	1,532	1,513	1,508	1,543
Guinea-Bissau	1,005	1,067	1,099	1,275	1,534	1,675	1,346	1,487	1,627	1,618	1,367	1,481	1,330	1,262
Kenya	1,640	1,489	1,594	1,806	1,646	1,647	1,773	1,418	1,243	1,710	1,515	1,745	1,662	1,628
Lesotho	995	737	611	597	690	523	436	390	421	909	664	240	811	755
Liberia	1,115	917	833	917	1,290	1,262	1,449	1,553	1,184	1,179	1,183	1,164	1,174	1,077

Madagascar	2,020	1,967	2,202	2,354	2,516	2,565	2,620	2,810	2,717	2,698	2,674	2,700	2,522	2,437
Malawi	1,176	1,046	1,209	1,021	778	1,445	2,467	1,599	2,124	1,907	2,094	2,087	2,069	2,188
Mali	986	792	979	864	1,090	1,125	1,101	1,398	1,675	1,716	996	1,527	1,567	1,551
Mauritania	638	1,012	805	631	844	665	709	769	717	946	1,395	1,841	1,183	1,206
Mauritius	7,204	7,763	6,556	6,474	7,540	7,793	9,454	7,541	8,000	6,833	3,902	3,390	3,219	3,765
Mozambique	880	697	818	774	529	782	885	763	884	1,028	1,041	630	670	703
Namibia	387	413	328	418	466	609	481	496	365	435	389	551	315	421
Niger	401	412	442	347	437	451	426	488	380	490	378	514	403	436
Nigeria	1,234	1,255	1,309	1,373	1,422	1,508	1,400	1,598	1,531	1,528	1,338	1,401	1,236	1,594
Rwanda	914	1,027	944	959	1,184	1,138	1,014	1,278	1,748	1,930	2,106	2,170	2,172	1,920
Sao Tome and Principe	2,174	2,107	2,131	2,146	2,385	2,455	2,308	2,154	1,539	1,333	834	706	575	471
Senegal	887	651	1,090	973	1,200	879	722	1,172	1,134	1,196	966	1,229	1,123	1,110
Seychelles	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sierra Leone	998	996	1,012	1,011	1,118	1,348	1,290	1,350	1,658	1,771	1,702	1,553	1,802	1,721
Somalia	813	770	688	580	560	506	606	465	416	575	457	1,190	964	730
South Africa	2,424	2,772	2,537	2,783	3,315	3,159	2,793	4,062	4,413	4,143	4,024	3,689	3,725	4,320
South Sudan	..	..	..	..	..	..	..	..	..	..	..	..	..	1,254
Sudan	626	487	644	657	504	645	730	567	587	452	564	..	..	683
Swaziland	1,412	986	1,013	1,237	1,307	1,414	556	989	1,077	1,196	1,335	1,330	1,365	938
Tanzania	2,047	1,903	860	1,371	1,102	1,327	1,427	1,334	1,110	1,648	1,390	1,315	1,418	1,660
Togo	1,150	1,131	1,155	1,095	1,133	1,131	1,122	1,144	1,243	1,187	1,226	1,112	866	1,146
Uganda	1,641	1,639	1,678	1,468	1,574	1,523	1,526	2,056	2,038	1,978	2,078	2,029	1,998	2,019
Zambia	1,402	1,419	1,702	1,814	1,899	1,816	2,253	2,180	2,066	2,534	2,731	2,689	2,532	2,755
Zimbabwe	1,160	547	803	1,075	588	851	653	309	424	743	794	806	724	789

Source: World Bank Development Indicators, World Bank Database

Crop Production Index (2004-2006 = 100)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Angola	62.8	74.2	81.4	93.1	101.5	105.4	120.1	132.9	178.7	189.2	209.8	166.4	236.4
Benin	89.0	98.5	102.1	106.8	101.8	91.4	95.6	114.1	112.1	116.2	127.6	133.6	149.1
Botswana	98.3	102.8	104.7	109.2	99.3	91.5	74.9	82.6	79.9	89.9	105.4	98.8	96.2
Burkina Faso	84.2	87.8	98.0	87.3	104.5	108.2	77.5	119.5	99.4	120.7	102.3	128.1	141.6
Burundi	93.8	106.0	94.9	107.4	91.1	101.5	93.1	101.1	98.7	107.4	100.5	92.1	129.4
Cabo Verde	105.7	97.8	106.3	103.9	96.7	99.4	99.2	105.2	100.3	98.3	100.5	104.6	99.8
Cameroon	78.3	80.3	83.0	85.6	103.5	110.9	116.7	120.6	131.3	144.6	148.3	156.5	161.2
Central African Republic	104.2	100.9	94.9	98.6	99.7	101.7	106.9	109.6	115.3	111.6	117.4	118.9	122.1
Chad	91.5	89.5	93.9	92.8	106.1	101.1	91.0	98.7	99.6	100.8	88.9	123.7	116.0
Comoros	96.9	96.5	98.8	102.6	95.2	102.2	101.8	98.7	107.1	113.1	108.8	111.7	113.1
Congo, Dem. Rep.	100.1	98.1	98.7	99.5	100.1	100.4	101.4	102.3	103.1	105.1	109.2	115.0	116.4
Congo, Rep.	87.8	89.4	90.9	95.7	100.2	104.2	106.9	112.1	114.8	112.9	114.5	122.5	127.2
Cote d'Ivoire	93.8	95.1	94.0	95.7	100.0	104.3	99.4	105.8	99.2	106.5	110.2	120.4	123.6
Equatorial Guinea	93.6	91.2	95.0	96.4	100.4	103.2	112.4	109.2	114.3	111.1	112.6	116.1	116.7
Eritrea	90.2	54.8	69.3	69.2	115.0	115.8	128.3	57.5	87.1	88.6	92.3	96.0	93.6
Ethiopia	80.5	78.5	82.0	89.1	105.6	105.4	108.0	113.4	126.4	137.0	145.6	157.7	156.8
Gabon	95.2	96.7	97.2	97.8	99.9	102.3	104.8	109.6	113.5	117.9	119.4	122.1	123.3
Gambia, The	111.2	64.3	84.7	109.5	92.1	98.5	64.5	100.6	123.2	140.8	84.2	108.1	96.8
Ghana	80.7	90.3	93.0	97.3	99.9	102.8	100.1	112.0	122.1	124.7	131.9	139.6	144.3
Guinea	84.3	89.1	93.4	98.2	100.8	101.0	104.6	109.2	108.5	111.1	115.2	121.0	121.4
Guinea-Bissau	89.5	90.2	88.6	97.2	99.1	103.7	103.4	119.3	122.8	121.6	128.1	139.0	142.7
Kenya	87.0	87.2	87.9	86.6	104.7	108.7	109.2	109.0	112.3	125.7	115.2	126.1	127.0
Lesotho	146.1	108.0	95.2	101.1	98.4	100.6	90.7	90.9	82.9	126.2	106.8	85.1	113.0
Liberia	97.9	97.5	96.1	100.9	104.9	94.3	109.0	103.5	93.0	96.0	99.3	99.4	95.5

Madagascar	86.0	84.2	87.3	91.8	103.0	105.2	107.6	110.3	121.3	125.6	125.9	131.9	116.9
Malawi	106.6	82.4	95.1	98.8	83.7	117.5	134.2	134.9	158.0	155.8	163.8	171.5	182.1
Mali	91.0	84.2	108.1	95.9	104.3	99.9	102.7	113.6	134.0	137.8	132.1	147.5	138.6
Mauritania	87.5	94.1	106.3	90.4	105.9	103.7	112.0	114.7	103.3	151.8	134.9	175.4	165.5
Mauritius	115.6	96.8	103.7	105.6	98.8	95.6	86.3	90.6	95.1	90.2	88.0	84.2	81.7
Mozambique	84.5	89.7	96.7	100.1	93.3	106.6	110.9	110.2	122.1	157.8	168.4	158.1	163.7
Namibia	79.4	78.5	83.6	96.7	94.7	108.6	103.2	102.4	99.8	108.8	108.5	116.3	107.4
Niger	82.3	94.8	103.5	82.1	103.4	114.6	121.8	161.2	118.9	180.5	153.3	172.7	160.0
Nigeria	78.8	82.8	88.1	94.9	99.7	105.4	96.2	103.1	88.4	102.8	94.1	105.0	108.7
Rwanda	81.1	101.3	94.2	93.4	100.9	105.7	105.2	115.4	138.6	146.8	159.9	171.3	175.4
Sao Tome and Principe	101.5	104.1	102.9	97.5	100.3	102.3	103.3	101.8	103.9	102.0	99.5	101.2	110.9
Senegal	103.3	61.4	95.1	94.7	113.8	91.6	80.1	135.5	148.1	163.3	102.6	130.8	125.3
Seychelles	112.2	109.5	105.8	107.4	94.8	97.9	94.6	90.5	87.5	84.3	89.6	95.6	98.7
Sierra Leone	49.2	58.4	84.4	93.0	92.2	114.8	98.2	104.3	129.0	147.9	154.4	160.4	169.5
Somalia	92.7	99.1	96.2	99.8	103.0	97.2	92.0	90.8	101.7	114.7	96.8	121.7	124.4
South Africa	94.0	102.6	99.0	100.7	105.5	93.8	93.1	113.3	109.0	107.7	107.5	112.1	114.7
South Sudan	..	..	..	..	..	..	..	..	..	..	..	..	..
Sudan	85.6	83.7	97.7	93.9	101.2	104.9	102.9	99.8	105.9	92.8	109.7	97.5	122.9
Swaziland	88.1	95.0	93.4	98.5	103.1	98.5	96.2	99.4	99.6	101.7	103.6	109.8	110.8
Tanzania	72.3	94.9	80.1	96.6	96.8	106.6	109.5	108.9	111.2	130.9	141.5	150.7	156.6
Togo	99.6	100.6	102.0	105.1	95.2	99.7	102.5	110.4	119.1	121.1	135.4	132.4	116.9
Uganda	98.9	102.4	102.8	102.0	99.9	98.1	101.0	105.3	106.4	109.4	111.3	107.4	107.9
Zambia	69.9	69.8	86.9	93.8	98.7	107.6	109.1	106.4	135.8	154.2	168.4	172.9	158.4
Zimbabwe	141.0	107.4	107.2	115.5	88.3	96.2	94.3	88.3	82.5	99.6	105.7	106.5	108.2

Source: World Bank Development Indicators

Fertilizer Consumption (Kilograms per Hectare of Arable Land)

Country Name	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Angola	1.7	1.8	4.5	2.3	3.7	3.3	8.3	5.5	8.4	8.2	10.1	8.8
Benin	16.4	0.8	0.1	0.5	0.0	0.2	0.3	6.7	9.0	5.4	19.4	5.5
Botswana	..	..	..	..	..	..	..	48.6	83.1	29.5	54.2	82.7
Burkina Faso	0.4	10.4	12.5	15.2	13.4	10.1	9.5	9.5	9.4	10.7	11.0	14.3
Burundi	1.3	0.3	1.1	3.5	3.3	2.0	2.2	1.9	3.6	5.6	5.7	7.4
Cameroon	9.8	8.2	11.1	8.0	9.0	8.6	6.6	7.0	9.2	11.1	10.1	6.7
Congo, Dem. Rep.	..	0.3	0.2	0.1	0.5	0.6	0.9	0.8	1.1	1.6	0.9	1.3
Congo, Rep.	..	..	2.7	0.1	0.1	0.4	0.7	4.6	0.5	0.4	1.2	2.3
Cote d'Ivoire	31.0	29.3	27.2	17.8	22.8	24.0	18.2	15.3	32.1	19.4	25.4	36.1
Eritrea	6.2	1.6	0.0	2.3	0.0	3.5	..	2.8	0.4	0.8	1.3	0.8
Ethiopia	17.0	5.7	10.3	10.9	11.1	16.0	17.2	17.7	21.8	20.8	23.8	19.2
Gabon	5.6	3.6	5.1	8.3	8.5	9.1	10.5	12.0	3.2	10.0	4.8	6.1
Gambia, The	..	9.4	8.1	9.8	10.8	9.0	4.3	6.3	7.3	10.3	6.5	0.5
Ghana	3.7	6.8	13.2	6.0	20.1	17.8	14.5	19.0	18.7	13.2	34.8	35.8
Guinea	1.0	0.8	1.0	0.9	0.9	1.2	1.3	0.6	0.9	3.6	2.3	1.6
Kenya	27.3	33.1	27.7	34.3	33.2	36.4	33.3	31.9	30.3	43.6	42.1	52.5
Madagascar	2.1	2.1	2.2	5.5	2.5	3.2	4.1	2.3	2.4	3.2	2.5	3.9
Malawi	29.7	31.1	34.4	30.5	36.8	41.7	34.9	30.8	35.4	29.5	39.9	43.2

Mali	..	..	52.0	15.7	17.5	31.1	22.5	6.1	19.6	22.0	26.0	27.9
Mauritius	318.4	299.5	307.7	352.2	257.9	282.2	228.8	228.0	163.2	243.2	224.2	192.0
Mozambique	6.0	0.7	2.3	1.4	4.6	2.7	11.4	4.0	8.2	7.4	6.0	9.3
Namibia	3.9	1.4	3.2	1.9	2.8	2.5	0.3	1.6	4.4	6.6	6.1	3.8
Niger	0.6	0.3	0.2	0.4	0.5	0.4	0.2	0.4	0.5	0.5	1.3	0.7
Nigeria	4.5	6.1	4.5	7.2	10.0	4.2	5.9	5.3	12.2	6.6	11.4	17.8
Rwanda	..	2.2	1.8	3.1	3.5	7.9	9.6	1.3	0.1	0.1	4.1	9.3
Senegal	11.8	10.9	12.7	9.9	2.3	2.1	2.3	6.3	8.1	7.7	8.0	11.0
Seychelles	..	24.0	11.0	34.0	11.0	30.0	34.0	52.0	32.2	562.5	1450.0	1750.0
South Africa	61.2	55.2	60.3	47.3	62.3	61.0	56.3	60.2	53.8	60.3	59.5	57.7
South Sudan	..	..	..	..	..	..	..	..	..	..	..	..
Sudan	3.5	3.5	4.6	2.7	2.6	3.6	3.8	8.4	10.8	9.4	10.6	12.8
Tanzania	3.7	4.5	5.3	5.8	5.4	5.1	4.7	7.5	8.8	8.6	7.7	4.7
Togo	5.2	7.5	3.4	9.7	5.5	6.3	0.0	6.2	9.0	10.2	5.0	11.7
Uganda	1.3	1.6	1.5	1.0	1.3	1.2	2.9	2.1	1.7	1.8	1.8	2.2
Zambia	26.1	26.2	29.9	28.0	25.7	32.3	38.7	25.8	29.2	46.1	33.9	42.1
Zimbabwe	35.7	40.0	22.7	21.8	32.4	27.0	22.0	28.8	34.1	29.5	29.1	36.8

Source: World Bank Development Indicators

Total Factor Productivity (Average Annual)

	1961-70	1971-80	1981-90	1991-00	2001-10	2001-12	2003-12	1971-1990	1991-2010	1971-2010	1961-2010	1961-2012
Angola	-0.0193	-0.0472	-0.0036	0.0337	0.0434	0.0436	0.0462	-0.0258	0.0353	0.0099	-0.0011	0.0015
Benin	-0.0136	0.0174	0.0222	0.0160	0.0073	0.0012	-0.0205	0.0101	0.0214	0.0166	0.0126	0.0127
Botswana	0.0200	-0.0185	0.0011	-0.0451	0.0098	0.0128	0.0116	-0.0002	-0.0098	-0.0025	-0.0024	-0.0019
Burkina Faso	-0.0075	-0.0086	0.0169	0.0114	-0.0198	-0.0132	0.0006	0.0056	0.0069	0.0097	0.0044	0.0045
Burundi	-0.0157	-0.0153	0.0024	-0.0024	-0.0240	-0.0278	-0.0373	-0.0009	-0.0018	-0.0009	-0.0046	-0.0048
Cameroon	-0.0002	-0.0148	0.0087	0.0086	0.0446	0.0404	0.0428	-0.0025	0.0212	0.0099	0.0071	0.0081
Cape Verde	0.0000	-0.0096	-0.0024	0.0481	0.0040	0.0061	0.0020	0.0049	0.0323	0.0141	0.0098	0.0098
Central African Republic	-0.0141	-0.0015	0.0166	0.0160	0.0051	0.0080	0.0101	0.0028	0.0066	0.0087	0.0052	0.0054
Chad	-0.0184	0.0082	0.0077	0.0013	-0.0060	-0.0035	-0.0037	0.0081	-0.0023	0.0024	-0.0008	-0.0005
Comoros	0.0002	-0.0023	0.0128	-0.0201	0.0041	0.0047	0.0033	0.0019	-0.0064	0.0014	0.0014	0.0014
Congo	-0.0092	0.0139	0.0007	0.0105	0.0093	-0.0008	-0.0112	0.0015	0.0156	0.0067	0.0031	0.0035
Congo, DR	-0.0127	-0.0050	0.0058	-0.0025	-0.0067	-0.0047	-0.0066	0.0036	-0.0039	0.0002	-0.0019	-0.0021
Côte d'Ivoire	0.0009	-0.0020	0.0054	0.0199	-0.0026	0.0023	0.0061	0.0030	0.0089	0.0074	0.0061	0.0059
Djibouti	0.0175	-0.0541	0.0286	-0.0210	0.0456	0.0334	0.0290	0.0295	0.0189	0.0116	0.0107	0.0103
Equatorial Guinea	-0.0200	-0.0406	0.0058	0.0000	0.0206	0.0202	0.0208	-0.0099	0.0111	0.0032	-0.0083	-0.0069
Ethiopia	-0.0125	0.0110	-0.0120	-0.0037	0.0212	0.0201	0.0167	0.0025	0.0134	0.0018	-0.0005	0.0007
Gabon	-0.0065	-0.0237	-0.0061	0.0148	0.0059	0.0065	0.0119	-0.0124	0.0022	0.0003	-0.0046	-0.0044
Gambia	-0.0056	-0.0400	-0.0206	0.0066	-0.0177	-0.0098	-0.0011	-0.0255	-0.0031	-0.0152	-0.0180	-0.0172
Ghana	-0.0091	-0.0348	0.0374	0.0185	0.0107	0.0133	0.0170	-0.0020	0.0097	0.0147	0.0065	0.0074
Guinea	0.0009	0.0065	0.0093	-0.0172	-0.0028	-0.0060	-0.0080	0.0094	-0.0017	-0.0004	0.0016	0.0015
Guinea-Bissau	-0.0261	-0.0051	0.0333	0.0014	0.0202	0.0197	0.0186	0.0087	0.0074	0.0098	0.0049	0.0055
Kenya	-0.0024	0.0162	0.0062	0.0049	0.0093	0.0036	-0.0030	0.0119	0.0130	0.0104	0.0100	0.0098
Lesotho	-0.0007	0.0061	-0.0116	0.0035	0.0084	0.0156	0.0166	-0.0028	-0.0032	-0.0007	-0.0008	-0.0006
Liberia	-0.0106	-0.0109	-0.0053	0.0109	-0.0219	-0.0233	-0.0266	-0.0033	0.0029	-0.0074	-0.0076	-0.0078

Madagascar	-0.0053	-0.0075	0.0073	-0.0011	0.0116	0.0111	0.0114	-0.0022	0.0085	0.0029	0.0028	0.0032
Malawi	0.0011	0.0078	-0.0040	0.0476	0.0212	0.0207	0.0266	-0.0014	0.0274	0.0132	0.0101	0.0111
Mali	-0.0138	0.0182	0.0130	0.0144	0.0266	0.0170	0.0189	0.0119	0.0124	0.0096	0.0073	0.0076
Mauritania	-0.0050	0.0032	-0.0107	0.0026	0.0058	0.0116	0.0146	0.0036	0.0042	0.0002	-0.0012	-0.0007
Mauritius	0.0102	-0.0019	-0.0046	-0.0058	-0.0014	-0.0007	-0.0028	-0.0077	0.0002	-0.0052	-0.0025	-0.0027
Mozambique	0.0027	-0.0303	0.0095	0.0304	0.0082	0.0148	0.0164	-0.0147	0.0153	0.0023	-0.0016	-0.0001
Namibia	0.0235	-0.0216	-0.0076	-0.0209	0.0047	-0.0048	-0.0112	-0.0159	-0.0060	-0.0101	-0.0061	-0.0063
Niger	-0.0201	-0.0025	0.0038	0.0207	0.0188	0.0115	0.0038	-0.0078	0.0211	0.0073	-0.0004	0.0004
Nigeria	-0.0101	-0.0269	0.0167	0.0260	-0.0010	-0.0041	-0.0084	-0.0049	0.0140	0.0141	0.0062	0.0062
Réunion (France)	-0.0013	0.0129	0.0293	0.0245	0.0086	0.0126	0.0169	0.0138	0.0147	0.0182	0.0147	0.0148
Rwanda	0.0083	0.0223	-0.0052	0.0085	0.0177	0.0276	0.0433	0.0053	0.0027	0.0008	0.0022	0.0035
Sao Tome and Principe	0.0063	-0.0453	-0.0122	0.0553	-0.0051	-0.0053	-0.0046	-0.0299	0.0160	0.0013	-0.0039	-0.0032
Senegal	-0.0319	-0.0036	0.0104	-0.0044	0.0156	0.0147	0.0143	0.0017	0.0046	-0.0007	-0.0036	-0.0029
Seychelles	-0.0135	-0.0123	0.0117	0.0136	0.0054	0.0102	0.0191	-0.0028	0.0036	0.0034	-0.0041	-0.0037
Sierra Leone	-0.0066	-0.0049	0.0002	0.0121	0.0325	0.0345	0.0402	-0.0014	0.0248	0.0029	0.0007	0.0025
Somalia	0.0011	0.0124	-0.0015	0.0169	0.0100	0.0171	0.0214	-0.0018	0.0097	0.0051	0.0044	0.0047
South Africa	-0.0112	0.0095	0.0297	0.0301	0.0280	0.0262	0.0249	0.0125	0.0326	0.0225	0.0166	0.0170
Sudan	-0.0105	0.0100	0.0032	0.0281	0.0061	0.0049	0.0007	-0.0011	0.0214	0.0095	0.0057	0.0057
Swaziland	0.0283	0.0230	0.0019	-0.0065	0.0116	0.0090	0.0089	0.0222	0.0093	0.0108	0.0159	0.0153
Tanzania	-0.0054	0.0042	0.0060	0.0014	0.0132	0.0138	0.0199	0.0078	0.0045	0.0049	0.0037	0.0043
Togo	-0.0081	-0.0175	-0.0246	0.0066	0.0194	0.0060	0.0045	-0.0179	0.0066	0.0004	-0.0027	-0.0025
Uganda	0.0231	0.0020	0.0161	-0.0019	-0.0219	-0.0217	-0.0250	0.0026	-0.0091	-0.0035	0.0012	0.0007
Zambia	0.0065	0.0118	0.0091	0.0105	0.0428	0.0416	0.0426	0.0049	0.0272	0.0127	0.0104	0.0119
Zimbabwe	0.0075	0.0093	0.0087	0.0097	-0.0119	-0.0066	-0.0053	0.0016	-0.0009	0.0017	0.0034	0.0029

Source: Economic Research Service, Washington DC

Aid (ODA) Disbursements to Countries and Regions

Country Name	2006	2007	2008	2009	2010	2011	2012	2013	2014
Angola	48.0	105.0	218.6	141.1	151.6	118.1	133.0	143.7	92.4
Benin	228.6	238.2	305.1	325.7	340.4	423.9	259.8	254.0	252.5
Botswana	36.3	63.6	682.8	223.4	103.4	88.4	62.4	90.1	62.4
Burkina Faso	385.9	412.4	475.3	453.0	440.8	450.8	522.2	526.0	562.5
Burundi	222.7	202.1	255.2	264.0	282.1	268.8	224.7	248.6	216.0
Cabo Verde	98.7	114.2	162.7	161.9	247.6	220.0	218.4	217.5	179.9
Cameroon	1505.7	1697.3	298.7	267.9	267.1	326.4	257.5	361.7	446.5
Central African Republic	65.3	118.0	128.5	98.6	112.8	108.4	73.3	112.4	281.1
Chad	152.5	227.4	277.5	355.5	289.7	245.6	245.6	218.7	158.3
Comoros	19.9	19.6	20.8	28.1	22.4	28.3	31.6	38.6	30.6
Congo	169.4	48.8	382.6	226.3	1219.0	176.2	48.9	77.9	48.8
Côte d'Ivoire	199.9	112.4	200.2	1721.1	437.3	721.6	2101.7	723.3	245.0
Democratic Republic of the Congo	1501.0	789.9	986.6	1100.1	2383.7	4240.1	1654.5	1189.7	1166.4
Djibouti	90.0	76.0	66.1	97.7	97.6	88.2	85.7	76.3	82.6
Equatorial Guinea	18.9	25.8	18.5	25.1	78.7	21.6	13.4	5.7	5.1
Eritrea	63.2	46.9	52.5	43.4	36.2	33.5	15.4	14.1	15.1
Ethiopia	1027.0	1245.6	1845.1	1818.2	1856.7	1929.6	1798.5	1913.5	1914.8
Gabon	31.9	33.6	37.6	52.5	83.8	62.3	60.9	74.9	99.5
Gambia	25.2	33.2	27.9	21.9	33.1	36.0	30.5	33.5	22.0
Ghana	595.1	710.0	726.0	820.9	897.6	898.1	844.2	733.5	605.8
Guinea	103.1	124.6	210.1	171.3	91.9	81.7	146.5	249.0	186.6
Guinea-Bissau	39.4	43.7	53.2	51.6	54.3	52.3	37.2	41.5	26.9
Kenya	776.5	827.1	954.7	1224.8	1156.7	1563.6	1668.7	2019.4	1602.2
Lesotho	38.5	62.3	66.0	70.7	93.8	143.3	152.0	185.7	49.1
Liberia	187.7	229.6	845.2	341.6	699.0	518.7	334.0	318.2	421.0
Madagascar	261.1	386.7	274.5	241.7	216.6	225.6	184.6	225.6	191.0

Malawi	401.9	405.1	437.2	438.9	511.8	447.6	639.6	646.2	509.3
Mali	398.8	558.0	532.1	575.1	685.0	777.2	732.4	722.9	678.4
Mauritania	93.8	133.4	139.1	122.2	101.7	129.3	165.8	125.3	91.4
Mauritius	8.5	43.6	16.1	63.6	58.2	113.5	86.3	64.5	75.1
Mayotte	337.5	406.9	474.7	543.1	602.9	..	..	..	..
Mozambique	941.2	1077.0	1345.0	1289.3	1349.0	1691.8	1465.6	1641.8	1424.9
Namibia	108.3	146.0	153.7	249.1	213.5	235.5	190.9	199.9	180.0
Niger	235.3	232.8	269.1	255.4	375.2	297.6	413.4	335.9	315.3
Nigeria	10820.4	1385.4	637.8	688.3	845.8	852.2	894.7	1138.3	1062.1
Rwanda	321.5	375.3	452.4	520.3	547.1	589.7	424.5	567.1	474.3
Saint Helena	23.1	40.6	56.0	33.3	53.7	79.3	168.2	131.0	124.7
Sao Tome and Principe	18.3	31.1	26.4	19.7	33.0	37.9	28.5	22.4	18.0
Senegal	510.2	453.5	555.0	514.6	535.0	590.3	705.7	634.6	800.0
Seychelles	7.2	1.5	5.0	11.8	29.3	6.6	6.0	7.3	3.4
Sierra Leone	179.6	380.9	175.1	196.4	190.9	173.2	188.1	207.7	524.4
Somalia	263.3	256.8	565.9	499.8	316.7	758.5	659.4	716.7	763.6
South Africa	560.8	594.3	881.9	861.7	817.8	1026.4	683.3	1015.4	735.1
South Sudan	..	..	..	..	..	390.4	1039.3	1136.5	1629.3
Sudan	1533.3	1684.5	1823.1	1911.7	1508.7	1314.9	862.1	1073.4	533.0
Swaziland	12.3	12.5	17.8	18.5	30.8	65.9	54.7	45.5	50.7
Tanzania	995.9	1839.8	1373.3	1409.4	1654.0	1659.6	1763.6	1952.3	1454.9
Togo	54.9	65.2	176.1	362.0	252.7	327.4	114.5	82.6	79.8
Uganda	941.0	1005.4	1009.0	1016.8	1000.9	989.8	923.1	964.1	1030.0
Zambia	1116.3	714.2	705.2	702.3	597.2	701.3	651.4	729.0	774.7
Zimbabwe	200.0	371.9	532.7	620.7	505.4	547.0	671.3	541.5	538.2
South of Sahara, regional	1342.2	1340.2	2072.7	1602.8	1983.0	1917.2	2309.0	2015.8	2843.6

Source: OECD. Statistics data
Aid (ODA) disbursements to countries and regions [DAC2a]

Internet users (per 100 people)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Angola	0.1	0.3	0.4	0.5	1.1	1.9	3.2	4.6	6.0	10.0	14.8	16.9	19.1	21.3
Benin	0.4	0.7	1.0	1.2	1.3	1.5	1.8	1.9	2.2	3.1	4.1	4.5	4.9	5.3
Botswana	3.4	3.4	3.3	3.3	3.3	4.3	5.3	6.3	6.2	6.0	8.0	11.5	15.0	18.5
Burkina Faso	0.2	0.2	0.4	0.4	0.5	0.6	0.8	0.9	1.1	2.4	3.0	3.7	9.1	9.4
Burundi	0.1	0.1	0.2	0.3	0.5	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
Cabo Verde	2.7	3.5	4.3	5.3	6.1	6.8	8.3	14.0	21.0	30.0	32.0	34.7	37.5	40.3
Cameroon	0.3	0.4	0.6	1.0	1.4	2.0	2.9	3.4	3.8	4.3	5.0	5.7	6.4	11.0
Central African Republic	0.1	0.1	0.2	0.2	0.3	0.3	0.4	1.0	1.8	2.0	2.2	3.0	3.5	4.0
Chad	0.0	0.2	0.3	0.4	0.4	0.6	0.8	1.2	1.5	1.7	1.9	2.1	2.3	2.5
Comoros	0.4	0.6	0.8	1.3	2.0	2.2	2.5	3.0	3.5	5.1	5.5	6.0	6.5	7.0
Congo, Dem. Rep.	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.6	0.7	1.2	1.7	2.2	3.0
Congo, Rep.	0.0	0.2	0.5	1.1	1.5	2.0	2.8	4.3	4.5	5.0	5.6	6.1	6.6	7.1
Cote d'Ivoire	0.4	0.5	0.8	0.8	1.0	1.5	1.8	1.9	2.0	2.7	2.9	5.0	8.4	14.6
Equatorial Guinea	0.2	0.3	0.5	0.8	1.1	1.3	1.6	1.8	2.1	6.0	11.5	13.9	16.4	18.9
Eritrea	0.2	0.2	..	..	..	..	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0
Ethiopia	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.8	1.1	1.5	1.9	2.9
Gabon	1.3	1.9	2.7	3.0	4.9	5.5	5.8	6.2	6.7	7.2	8.0	8.6	9.2	9.8
Gambia, The	1.3	1.8	2.4	3.3	3.8	5.2	6.2	6.9	7.6	9.2	10.9	12.4	14.0	15.6
Ghana	0.2	0.8	1.2	1.7	1.8	2.7	3.9	4.3	5.4	7.8	9.0	10.6	12.3	18.9
Guinea	0.2	0.4	0.5	0.5	0.5	0.6	0.8	0.9	0.9	1.0	1.3	1.5	1.6	1.7
Guinea-Bissau	0.3	1.0	1.4	1.8	1.9	2.1	2.2	2.4	2.3	2.5	2.7	2.9	3.1	3.3
Kenya	0.6	1.2	2.9	3.0	3.1	7.5	8.0	8.7	10.0	14.0	28.0	32.1	39.0	43.4
Lesotho	0.3	1.1	1.5	2.2	2.6	3.0	3.4	3.6	3.7	3.9	4.2	4.6	5.0	11.0
Liberia	0.0	0.0	0.0	0.0	..	..	0.6	0.5	2.0	2.3	2.5	2.6	3.2	5.4

Madagascar	0.2	0.3	0.4	0.5	0.6	0.6	0.7	1.7	1.6	1.7	1.9	2.3	3.0	3.7
Malawi	0.2	0.2	0.3	0.3	0.4	0.4	1.0	0.7	1.1	2.3	3.3	4.4	5.1	5.8
Mali	0.2	0.2	0.3	0.4	0.5	0.7	0.8	1.6	1.8	2.0	2.2	2.8	3.5	7.0
Mauritania	0.3	0.4	0.4	0.5	0.7	1.0	1.4	1.9	2.3	4.0	4.5	5.0	6.2	10.7
Mauritius	8.8	10.3	12.2	13.7	15.2	16.7	20.2	21.8	22.5	28.3	35.0	35.4	39.0	41.4
Mozambique	0.2	0.3	0.4	0.7	0.9	0.8	0.9	1.6	2.7	4.2	4.3	4.8	5.4	5.9
Namibia	2.4	2.6	3.4	3.8	4.0	4.4	4.8	5.3	6.5	11.6	12.0	12.9	13.9	14.8
Niger	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.7	0.8	0.8	1.3	1.4	1.7	2.0
Nigeria	0.1	0.3	0.6	1.3	3.5	5.5	6.8	15.9	20.0	24.0	28.4	32.8	38.0	42.7
Rwanda	0.2	0.3	0.4	0.4	0.6	..	2.1	4.5	7.7	8.0	7.0	8.0	9.0	10.6
Sao Tome and Principe	6.3	7.6	10.2	13.3	13.8	14.2	14.6	15.5	16.4	18.8	20.2	21.6	23.0	24.4
Senegal	1.0	1.0	2.1	4.4	4.8	5.6	6.9	7.1	7.5	8.0	9.8	10.8	13.1	17.7
Seychelles	11.0	14.3	14.6	24.3	25.4	35.0	38.4	40.4	..	41.0	43.2	47.1	50.4	54.3
Sierra Leone	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.6	0.9	1.3	1.7	2.1
Somalia	0.1	0.1	0.4	1.1	1.1	1.1	1.1	1.1	1.2	..	1.3	1.4	1.5	1.6
South Africa	6.3	6.7	7.0	8.4	7.5	7.6	8.1	8.4	10.0	24.0	34.0	41.0	46.5	49.0
South Sudan	..	..	..	..	..	..	..	..	..	7.0	..	..	14.1	15.9
Sudan	0.1	0.4	0.5	0.8	1.3	..	8.7	..	..	16.7	17.3	21.0	22.7	24.6
Swaziland	1.3	1.8	2.4	3.2	3.7	3.7	4.1	6.9	8.9	11.0	18.1	20.8	24.7	27.1
Tanzania	0.2	0.2	0.7	0.9	1.1	1.3	1.6	1.9	2.4	2.9	3.2	4.0	4.4	4.9
Togo	0.9	1.0	1.2	1.5	1.8	2.0	2.2	2.4	2.6	3.0	3.5	4.0	4.5	5.7
Uganda	0.2	0.4	0.5	0.7	1.7	2.5	3.7	7.9	9.8	12.5	13.0	14.7	16.2	17.7
Zambia	0.2	0.5	1.0	2.0	2.9	4.2	4.9	5.6	6.3	10.0	11.5	13.5	15.4	17.3
Zimbabwe	0.8	4.0	6.4	6.6	8.0	9.8	10.9	11.4	11.4	11.5	15.7	17.1	18.5	19.9

Source: World Bank Development Indicators

Cell Phone Subscriptions (per 100 People)

Country Name	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Angola	0.5	0.9	2.3	4.6	9.7	17.8	28.0	37.0	42.8	48.1	59.8	61.4	61.9	63.5
Benin	1.7	3.0	3.1	5.8	7.3	12.5	23.6	40.4	54.5	74.4	79.4	83.7	93.3	99.7
Botswana	18.6	18.4	24.3	28.2	30.1	43.4	60.1	76.8	96.0	120.0	146.0	153.8	160.6	167.3
Burkina Faso	0.6	0.9	1.9	3.0	4.7	7.4	13.1	20.6	25.3	36.7	48.0	60.6	66.4	71.7
Burundi	0.5	0.7	0.9	1.3	2.0	2.5	3.2	5.6	10.3	18.2	20.1	22.8	25.0	30.5
Cabo Verde	7.0	9.4	11.4	13.9	17.1	22.6	31.5	57.3	59.8	76.3	80.8	86.0	100.1	121.8
Cameroon	2.6	4.2	6.3	8.7	12.4	16.8	23.8	31.4	39.8	41.9	49.6	60.4	70.4	75.7
Central African Republic	0.3	0.3	1.0	1.5	2.5	2.7	8.3	13.6	20.2	22.5	22.4	25.3	29.5	24.5
Chad	0.3	0.4	0.7	1.3	2.1	4.5	8.6	14.5	20.1	24.5	30.3	35.4	35.6	39.8
Comoros	0.0	0.0	0.4	1.4	2.6	6.0	9.8	14.1	18.4	24.2	30.9	39.5	47.3	50.9
Congo, Dem. Rep.	0.3	1.1	2.4	3.8	5.1	7.9	11.5	16.9	15.6	19.0	24.5	30.6	41.8	53.5
Congo, Rep.	4.7	6.8	9.8	11.1	15.8	25.2	34.3	46.6	73.8	90.4	91.9	98.8	104.8	108.1
Cote d'Ivoire	4.4	6.2	7.6	9.8	13.5	23.0	41.6	57.2	70.9	82.2	89.4	91.2	95.4	106.2
Equatorial Guinea	2.8	5.8	7.3	10.6	16.1	19.3	23.5	27.4	29.5	57.4	66.9	68.1	67.5	66.4
Eritrea	0.0	0.0	0.0	0.4	0.8	1.2	1.6	2.0	2.5	3.2	4.1	5.0	5.6	6.4
Ethiopia	0.0	0.1	0.1	0.2	0.5	1.1	1.5	2.4	4.8	7.9	15.8	22.4	27.3	31.6
Gabon	11.9	21.7	22.8	36.3	53.4	63.6	80.8	87.7	95.4	103.5	148.7	179.5	214.8	171.4
Gambia, The	4.3	7.7	11.1	12.6	17.2	27.3	52.3	73.9	80.6	88.0	80.8	85.2	100.0	119.6
Ghana	1.3	2.0	3.9	8.1	13.4	23.7	33.8	50.1	63.8	71.9	85.3	101.0	108.2	114.8
Guinea	0.6	1.0	1.2	1.7	2.0	..	19.9	26.7	32.9	36.8	43.5	48.8	63.3	72.1
Guinea-Bissau	0.0	0.0	0.1	2.8	7.0	10.8	20.0	33.0	36.1	42.7	45.1	63.1	55.2	63.5
Kenya	1.9	3.6	4.7	7.3	12.9	20.0	30.1	42.0	48.6	61.0	66.8	71.2	71.8	73.8
Lesotho	3.0	7.3	6.6	10.3	13.0	18.4	24.7	30.1	33.2	49.2	60.7	75.3	86.3	85.0
Liberia	0.1	0.2	1.5	3.0	4.9	8.3	16.0	23.3	28.4	39.7	49.5	56.8	59.4	73.4

Madagascar	0.9	1.0	1.6	1.9	2.8	5.6	11.4	24.3	30.7	36.6	40.0	39.4	36.9	41.2
Malawi	0.5	0.7	1.1	1.8	3.3	4.7	7.7	10.7	17.1	20.8	25.6	29.2	32.3	33.5
Mali	0.2	0.4	2.2	3.5	6.4	12.3	19.9	26.2	32.9	53.2	75.1	98.4	129.1	149.1
Mauritania	4.0	8.6	11.8	17.1	23.7	32.7	42.5	61.1	62.1	76.9	89.5	106.0	102.5	94.2
Mauritius	22.8	29.0	38.4	45.3	54.2	63.5	76.1	84.5	88.6	96.8	104.8	119.9	123.2	132.2
Mozambique	0.8	1.3	2.2	3.5	7.2	10.8	13.9	19.4	25.6	30.1	32.0	34.9	48.0	69.8
Namibia	5.5	7.7	11.3	14.3	22.1	29.7	38.5	49.8	76.1	89.5	99.0	95.0	118.4	113.8
Niger	0.0	0.5	0.7	1.4	2.5	3.5	6.3	12.9	17.0	23.1	28.7	31.4	39.3	44.4
Nigeria	0.2	1.2	2.4	6.7	13.3	22.6	27.4	41.7	48.0	54.7	58.0	66.8	73.3	77.8
Rwanda	0.7	0.9	1.4	1.5	2.4	3.3	6.4	12.9	23.1	32.7	39.9	49.7	56.8	64.0
Sao Tome and Principe	0.0	1.4	3.3	5.1	7.7	11.6	18.4	30.0	46.7	57.6	62.8	65.0	64.9	64.9
Senegal	3.0	5.3	7.3	10.2	15.4	25.8	30.5	44.0	54.8	64.4	70.2	83.6	92.9	98.8
Seychelles	45.2	54.1	58.5	63.4	67.5	79.7	86.7	104.0	122.2	128.9	137.9	147.8	147.3	162.2
Sierra Leone	0.6	1.5	2.4	..	..	..	14.3	18.2	20.6	34.8	36.4	37.0	65.7	76.7
Somalia	1.1	1.3	2.5	6.1	5.9	6.3	6.7	6.9	6.8	6.7	18.2	22.6	49.4	50.9
South Africa	23.7	29.7	36.0	43.8	70.4	81.1	85.3	89.5	91.2	97.9	123.2	130.6	145.6	149.2
South Sudan	..	..	..	..	..	..	..	..	..	14.4	17.3	21.2	25.3	24.5
Sudan	0.3	0.5	1.4	2.8	4.8	11.9	20.4	29.0	36.1	41.5	68.8	74.4	72.9	72.2
Swaziland	5.1	6.3	7.8	13.2	18.1	22.4	33.5	46.1	56.6	60.8	63.2	65.4	71.5	72.3
Tanzania	0.8	1.7	3.5	5.1	7.6	14.0	20.1	30.7	40.0	46.7	55.4	57.0	55.7	62.8
Togo	1.9	3.2	4.6	6.2	7.8	12.5	20.4	25.9	35.6	41.3	41.6	49.9	62.5	64.6
Uganda	1.1	1.5	2.9	4.2	4.6	6.8	13.7	26.9	28.6	37.7	47.5	45.0	48.1	52.4
Zambia	1.2	1.3	2.2	4.2	8.3	14.1	21.8	28.4	34.4	41.2	59.9	74.8	71.5	67.3
Zimbabwe	2.5	2.7	2.9	3.4	5.1	6.7	9.6	12.9	31.0	58.9	68.9	91.9	96.3	80.8

Source: World Bank Development Indicators

Spending, Total (As a Share of Agriculture GDP, %)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Benin	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.6	0.5	0.5	0.6
Botswana	3.9	5.0	4.4	3.9	4.4	7.4	6.2	5.3	3.8	3.7	3.3	2.6
Burkina Faso	1.4	0.6	1.5	1.0	1.3	0.7	0.7	0.8	0.5	0.7	0.7	0.8
Burundi	0.3	0.5	0.4	0.5	0.5	0.6	0.7	0.9	0.7	0.7	0.5	0.5
Cabo Verde	..	..	..	..	..	..	..	..	..	1.2	1.4	1.5
Central African Rep.	..	..	..	..	..	..	..	..	..	0.1	0.1	0.2
Chad	..	..	..	..	..	..	..	..	..	0.1	0.1	0.1
Congo, Dem. Rep.	..	..	..	..	..	..	..	..	..	0.1	0.2	0.2
Congo, Rep.	0.5	0.5	0.5	0.6	0.7	0.9	1.0	1.0	1.2	0.9	0.9	0.9
Cote d'Ivoire	0.7	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.4	0.4
Eritrea	2.1	1.4	1.4	1.4	1.1	0.4	0.5	0.4	0.6	0.4	0.4	0.3
Ethiopia	0.3	0.5	0.6	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
Gabon	0.2	0.2	0.3	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1
Gambia, The	0.8	0.9	0.9	1.1	1.1	1.0	1.2	1.0	0.7	0.5	0.4	0.9
Ghana	0.6	0.5	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.7	0.7
Guinea	0.6	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2
Guinea-Bissau	..	..	..	..	..	..	..	..	..	0.0	0.0	0.0
Kenya	1.3	1.4	1.2	1.1	1.1	1.2	1.4	1.3	1.2	1.1	1.0	0.9
Lesotho	0.8	0.7	1.0	1.0	1.1	1.2	1.4	1.4	1.3	1.3	0.9	1.0

Liberia	..	..	..	..	..	..	..	..	..	0.4	0.5	0.5
Madagascar	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2
Malawi	0.9	1.0	0.8	0.7	0.7	0.8	0.7	0.7	0.6	0.8	0.9	1.0
Mali	1.0	1.0	0.9	0.6	1.0	0.7	0.6	0.7	0.5	0.6	0.6	0.6
Mauritania		0.4	0.9	0.7	0.7	0.6	0.8	0.8	0.4	0.5	0.5	0.5
Mauritius	3.4	3.6	4.7	4.1	3.9	4.0	3.8	3.9	4.0	4.8	5.8	4.9
Mozambique	..	..	..	..	..	..	..	..	..	0.4	0.4	0.3
Namibia	..	3.1	3.2	3.2	2.6	3.5	2.5	2.1	2.8	2.7	2.9	3.8
Nigeria	0.4	0.5	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.2	0.3
Rwanda	..	..	..	..	..	..	0.6	0.6	0.6	0.6	0.6	0.7
Senegal	1.0	0.9	1.2	1.1	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.8
Sierra Leone	..	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
South Africa	2.6	2.4	2.2	2.0	2.2	2.8	2.5	2.0	1.8	1.8	2.0	2.0
Sudan	0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Swaziland	..	..	..	..	..	..	..	..	..	1.8	1.9	1.4
Tanzania	0.5	0.3	0.4	0.5	0.4	0.2	0.3	0.4	0.4	0.4	0.4	0.3
Togo	0.9	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.3	0.4	0.4
Uganda	0.8	0.7	1.0	1.3	1.4	1.1	1.0	1.2	1.3	0.8	0.9	0.9
Zambia	0.8	0.5	0.5	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.5	0.4
Zimbabwe	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.5	0.4	0.7	0.8

ASTI (Agricultural Science and Technology Indicators). ASTI database. International Food Policy Research Institute (IFPRI).

Government Agriculture Expenditure (% of Total Government Expenditure)

Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Angola	0.8	1.3	0.5	0.9	1.1	1.7	1.7	2.8	2.3	2.0	1.6	1.3	1.0	1.1	0.8
Benin	8.0	4.1	5.3	5.5	5.3	6.4	7.5	6.3	5.7	7.1	5.9	4.8	6.2	6.1	8.0
Botswana	3.9	4.1	4.1	3.9	3.1	4.5	3.7	3.4	2.9	2.4	3.4	2.7	2.9	2.1	2.1
Burkina Faso	11.1	9.7	10.1	8.9	8.9	8.5	9.5	12.6	11.3	10.8	8.7	9.7	11.3	9.0	9.6
Burundi	1.5	1.4	1.9	1.5	3.1	3.5	6.5	4.3	3.4	2.6	2.2	6.2	5.0	4.4	3.9
Cameroon	2.6	3.1	3.0	3.3	3.7	3.8	4.0	4.3	4.6	4.8	5.2	5.5	5.9	6.2	6.6
Cape Verde	..	..	3.7	3.4	3.2	2.9	3.1	2.8	2.6	2.8	2.7	2.7	2.7	2.6	2.6
Central African Republic	5.0	3.1	2.8	3.5	3.3	1.7	1.3	1.2	1.0	1.7	2.6	2.7	4.0	4.1	5.3
Chad			5.5	5.7	4.7	3.9	7.8	5.5	5.6	5.8	5.9	6.1	6.2	6.4	6.5
Congo, Dem. Rep.	3.3	1.0	0.8	1.9	0.8	0.7	1.1	1.8	2.0	3.8	2.4	2.5	5.0	2.7	7.2
Congo, Rep.	0.5	0.6	0.6	1.1	1.4	1.9	1.7	1.6	1.5	1.4	1.8	2.4	1.4	1.4	1.4
Côte d'Ivoire	2.8	2.9	2.9	2.9	2.9	2.2	2.7	2.4	2.3	2.7	3.0	3.3	5.9	5.0	5.3
Djibouti	..	..	0.6	0.7	0.8	0.8	0.8	0.7	0.7	0.6	0.7	1.0	1.0	0.9	0.9
Equatorial Guinea	..	..	..	..	..	..	..	1.7	0.8	0.8	..	..	..	..	..
Eritrea	5.5	5.1	5.1	4.4	4.6	4.3	5.9	6.1	6.0	6.6	5.6	5.1	5.1	4.9	4.7
Ethiopia	5.8	8.1	10.2	12.1	13.9	16.5	18.2	16.3	15.5	18.4	11.1	10.0	10.9	9.1	8.2
Gambia	7.2	7.1	7.1	7.0	7.0	6.9	5.7	7.3	6.4	6.0	5.9	9.6	3.7	3.5	3.3
Ghana	2.4	1.2	1.4	1.4	1.8	2.6	2.2	2.5	3.5	2.5	2.7	2.9	2.9	3.4	3.6
Guinea			11.8	11.2	9.9	7.1	7.5	10.9	8.6	6.4	4.4	7.2	7.3	6.7	6.1
Guinea-Bissau	1.8	1.5	1.5	1.1	1.4	1.1	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7
Kenya	5.5	4.8	5.0	4.6	4.2	3.9	2.8	3.4	3.2	3.9	4.1	4.3	4.1	3.4	2.7
Lesotho	3.7	4.9	3.8	4.2	4.0	3.8	3.2	2.7	2.4	2.1	1.9	1.8	1.9	1.7	1.7

Liberia	2.0	1.9	1.8	1.7	1.5	1.3	1.5	3.4	3.4	7.2	8.2	6.7	8.2	9.1	10.5
Madagascar	5.6	6.1	4.3	3.5	3.3	5.0	3.4	3.6	16.3	25.1	10.5	10.6	8.5	9.8	6.1
Malawi	5.2	5.0	7.3	4.1	4.4	7.0	11.7	14.2	19.6	28.9	15.9	18.7	11.4	14.1	23.4
Mali	8.9	12.8	8.9	9.6	11.4	15.5	10.6	10.9	12.5	10.0	11.8	6.6	6.4	6.3	5.4
Mauritius	4.4	3.6	3.5	3.1	3.0	3.1	2.9	2.1	2.0	3.5	3.7	2.3	2.3	2.4	2.4
Mozambique	3.0	2.2	6.2	5.8	7.6	7.7	5.9	4.7	5.5	4.6	4.2	3.2	2.9	12.5	13.6
Namibia	5.6	5.3	5.2	5.0	4.0	6.1	4.6	4.2	3.8	3.0	7.1	6.4	5.7	4.4	5.0
Niger	12.4	15.8	16.6	18.7	24.3	20.2	16.1	18.4	7.9	5.4	7.4	14.8	7.8	8.6	9.2
Nigeria	2.9	3.2	3.5	1.9	3.1	3.4	4.1	3.8	3.1	3.6	3.3	2.9	3.3	3.1	3.1
Rwanda	..	..	1.8	2.1	2.4	2.8	3.3	3.4	4.4	3.1	3.0	6.9	7.4	7.6	9.1
Sao Tome and Principe	..	..	16.2	5.4	3.1	4.0	4.4	5.9	6.2	6.5	6.9	7.2	7.6	8.0	8.4
Senegal	7.5	4.7	7.0	7.2	4.9	7.9	7.2	8.9	6.4	9.6	7.6	7.4	9.1	6.0	7.8
Seychelles	1.6	1.7	1.7	1.8	2.2	1.7	1.3	1.3	0.9	1.0	1.2	1.8	0.9	1.4	1.4
Sierra Leone	0.9	1.1	1.0	1.2	1.1	0.9	1.2	2.4	3.6	5.8	8.9	7.5	5.9	6.2	6.6
South Africa	1.5	1.8	2.0	2.1	2.1	2.3	2.1	2.4	2.0	1.8	1.7	1.7	1.7	1.5	1.5
South Sudan	..	..	..	..	..	..	1.5	1.4	1.5	1.6	1.1	0.8	1.3	1.2	1.1
Sudan	8.2	6.3	5.6	5.3	8.1	6.8	6.1	7.8	4.5	3.5	3.9	3.4	2.9	2.5	2.2
Swaziland	3.5	3.5	3.8	4.1	5.1	3.6	3.0	3.0	2.6	2.2	3.0	2.0	2.2	3.9	3.6
Tanzania	6.4	4.9	4.3	7.3	11.0	6.3	3.8	3.1	5.9	6.5	7.1	6.8	4.2	4.3	3.9
Togo	5.5	3.1	4.9	4.4	3.9	3.5	3.9	7.7	9.5	5.1	6.4	5.7	6.6	7.8	5.8
Uganda	6.3	4.0	4.2	4.2	2.4	3.1	3.4	4.0	5.0	4.6	4.8	3.7	3.4	4.6	4.5
Zambia	5.6	6.2	5.2	6.1	6.1	7.2	9.3	13.2	12.5	9.3	11.4	6.1	5.9	6.3	9.4
Zimbabwe	2.8	4.3	7.5	10.4	7.0	4.0	17.3	18.8	44.7	12.5	15.0	14.5	4.9	5.5	9.5

Source: ReSAKSS (2015)

AGRA
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ALLIANCE FOR A GREEN REVOLUTION IN AFRICA (AGRA)
Email: enquiries@agra.org
www.agra.org

West End Towers, 4th Floor
Kanjata Road, Off Muthangari Drive
P.O. Box 66773
Westlands 00800
Nairobi, Kenya

Telephone : +254 (20) 3675 000
Mobile: +254 703 033 000
Fax: +254 (20) 3750 400/401

CSIR Office Complex
No. 6 Agostino Neto Road
Airport Residential Area, PMB KIA 114
Accra, Ghana
Telephone: +233 21 740 660/768 597/768 598
Fax: +233 21 768 602