

AFRICA AGRICULTURE STATUS REPORT 2016

Progress towards Agricultural
Transformation in Africa

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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. Amos 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.



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CHAPTER 8

Modernization of Agriculture through Digital Technology

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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 continen-

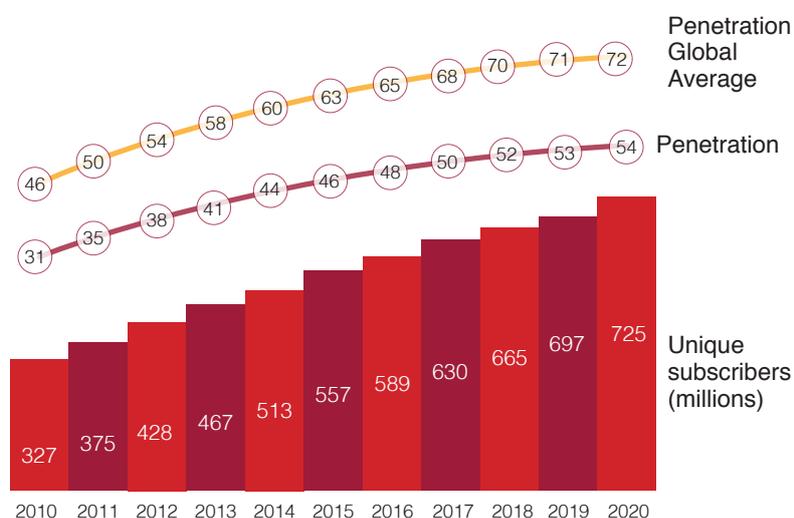
tal and regional markets (Husman et al., 2015). Rapid technological change is also helping economies leapfrog the limitations of physical infrastructure, bringing about growth and change in key sectors (Barton & Leke, 2016). Africa's smartphone penetration is currently at 23 percent and is projected 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).

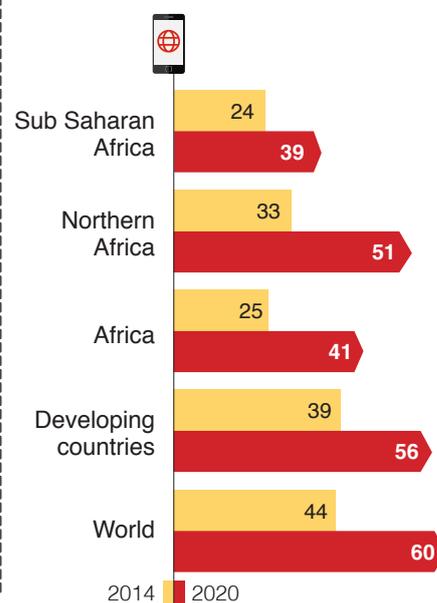
Agriculture accounts for 32 percent of GDP in most countries in SSA, with 65 percent of the population employed by the sector (World Bank, 2015). Several countries have broken through the two-ton per hectare threshold for staple crops, meeting the benchmark for overall agricultural land productivity (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 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

Figure 8.1:
Mobile phone based services
penetration in Africa (%)



Mobile internet Subscriber
penetration in Africa (%)



Source: GSMA 2016 (*The Mobile Economy Africa*)

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; qual-

ity 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 institu-

tions (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 aggra-

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*

vates 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 (Syngenta 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 Develop-

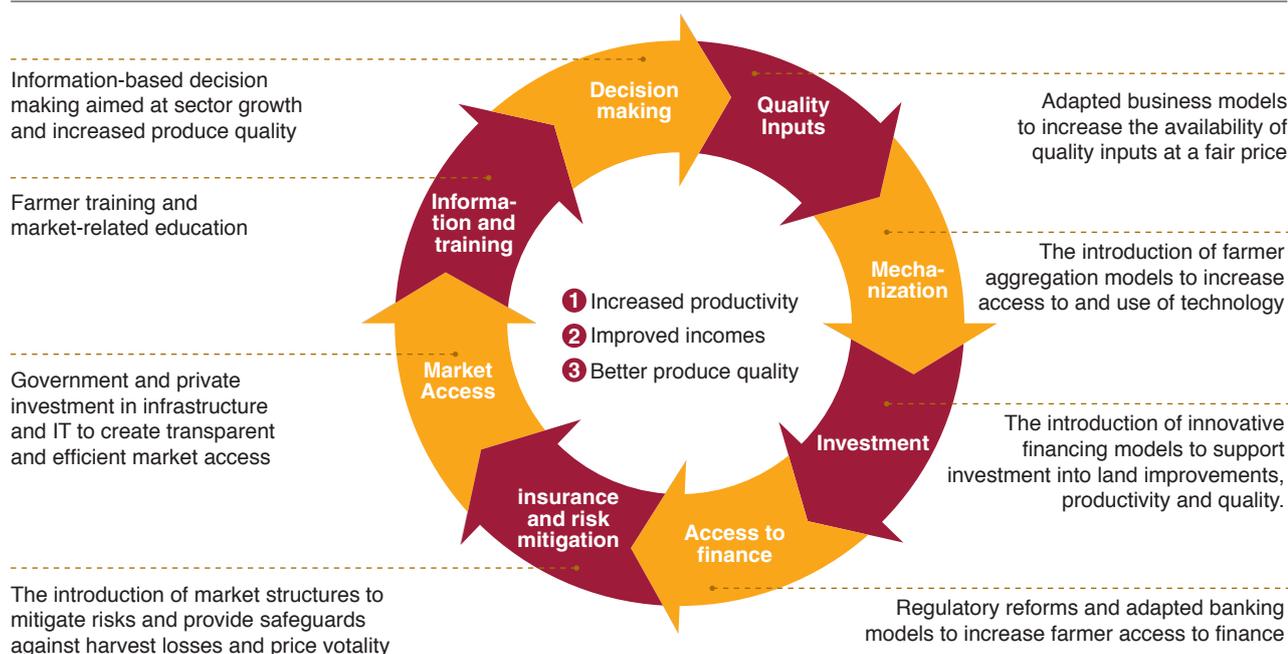
ment (ICT4D) conference form the main references from where lessons can be learnt to target future interventions .

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 available through less high-tech devices, like mobile phones, currently offer the most promise (World Bank, 2011).

Figure 8.3: Agricultural transformation across the value chain



Source: A.T Kearney, *Africa's Agricultural Transformation Opportunity*, 2016

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.

- **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,

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.

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.

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

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.

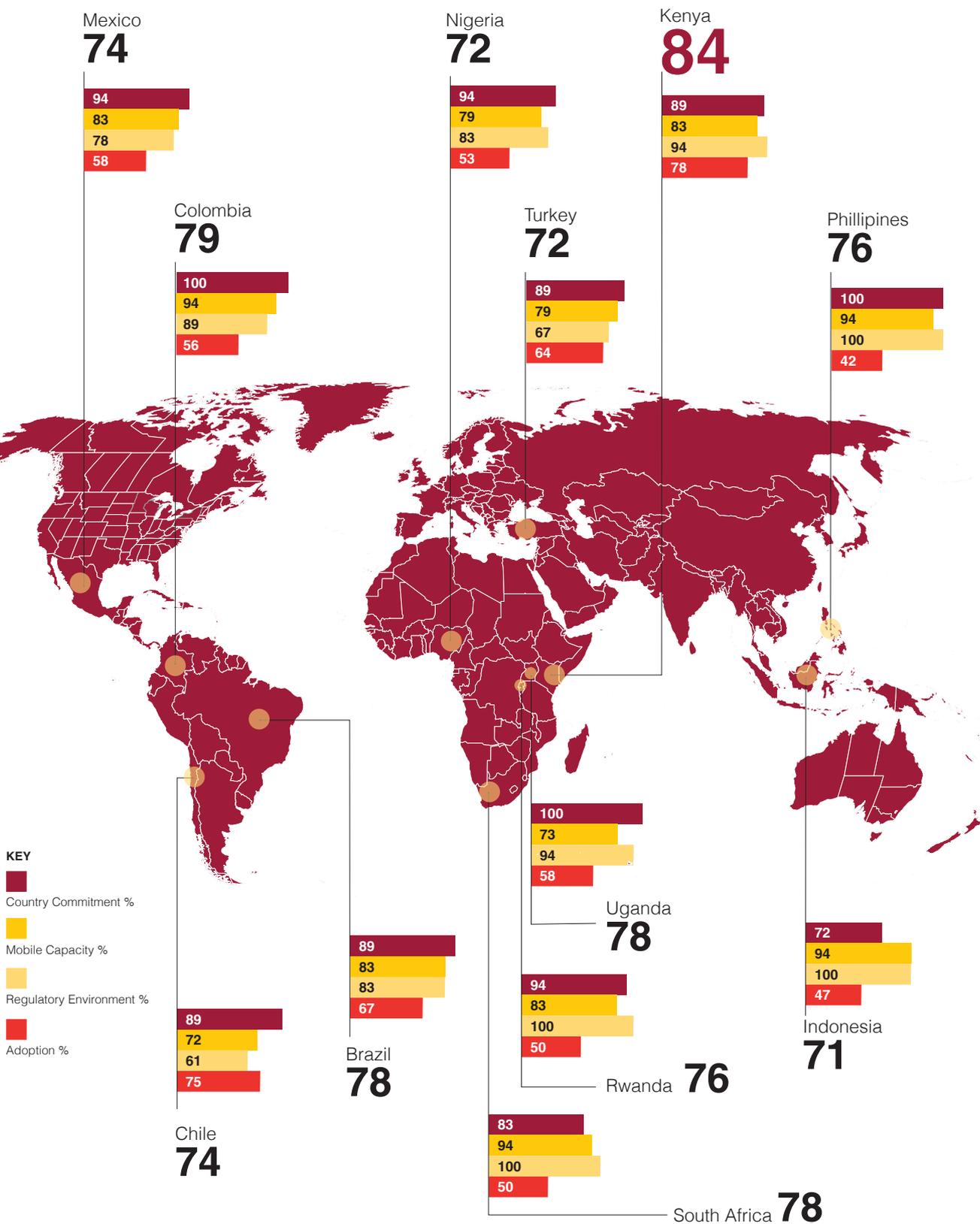
Apart from providing each farmer with an additional and simple method for accessing credit, the switch from cash to digital payment also resulted in an average saving of US\$10.75 in transport costs and 8 hours per payment per farmer with participating farmers saving a total of approximately 6,000 hours over the duration of the pilot.

Source: McKay C, Buruku, B, 2016

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).

- 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

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

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

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>

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 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).

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).

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

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)

¹⁶ <http://ictupdate.cta.int/Regulars/Q-A/Sustainable-and-scalable-business-models/%2880%29/1439915106>

¹⁷ <https://www.cgiar.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 model 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*

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).

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

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*

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 infor-

mation 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 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

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)

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

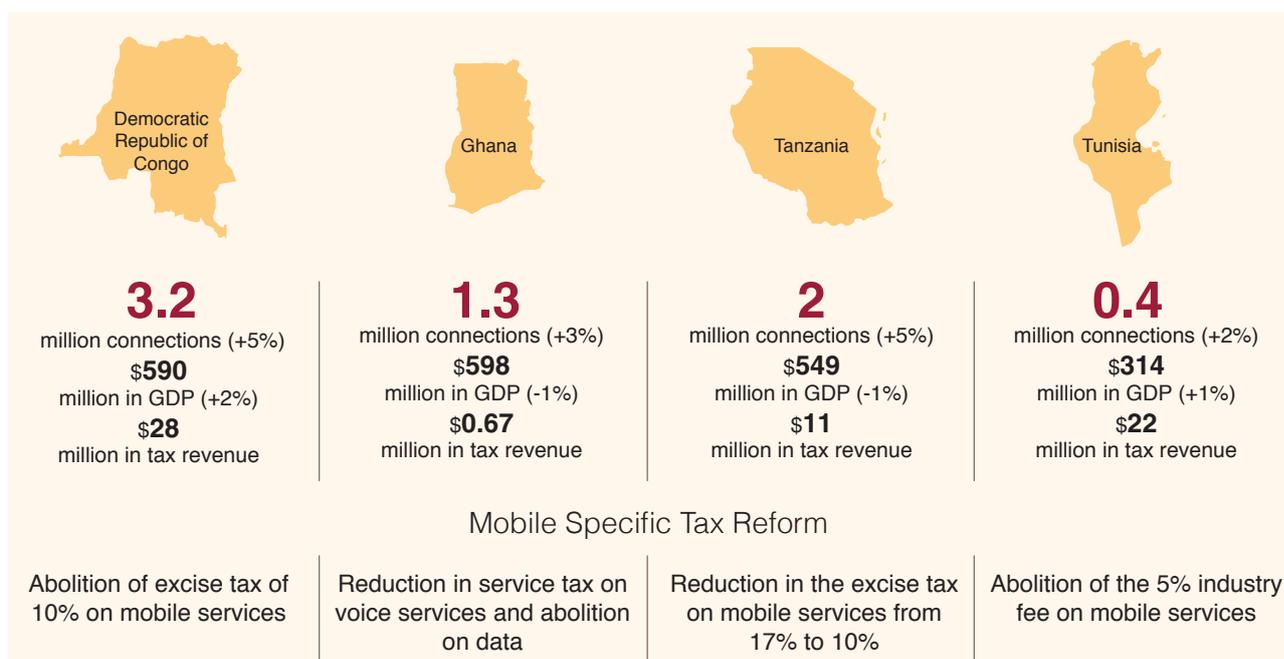
The surge in digital technologies has been the result of an increase in accessibility to and affordability of technological devices and infrastructure such as mobile phones. This has resulted in the radical transformation of the agricultural sector across the globe and in SSA primarily, helping improve 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. 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,

Table 8.1: Impact of mobile tax reforms in a few SSA countries



Source: GSMA 2016 (*The Mobile Economy Africa*)

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 busi-

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)

ness 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 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

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)*

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 provid-

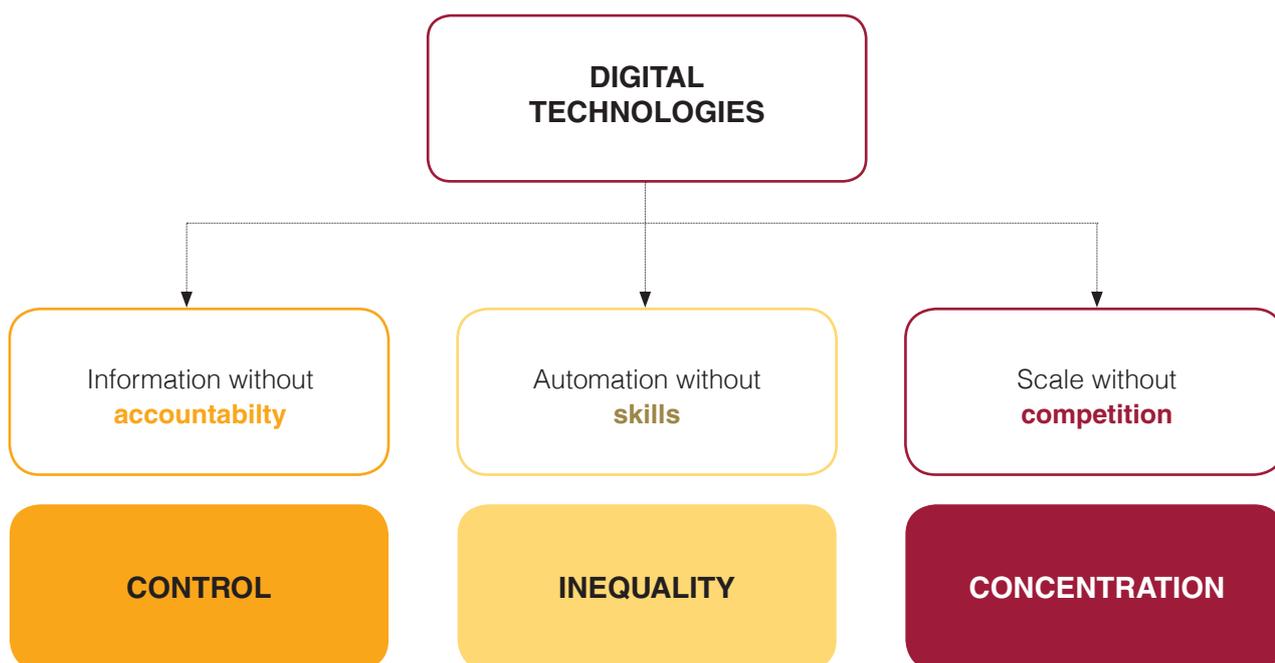
ers serve as a transitional inter-phase between digital technology and the farmers. Lessons from Plantwise show that farmers have confidence in agricultural extension officers who give effective and practical solutions quickly, without involving the farmers in the burdensome infrastructural (paper-based 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, 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 farmers' investment in the technology (Williams et al, 2015). Although farmer organizations with relatively

Figure 8.5: Potential risks and constraints with Digital Technologies



Source: *World Development Report, Digital Dividends, 2016*

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).

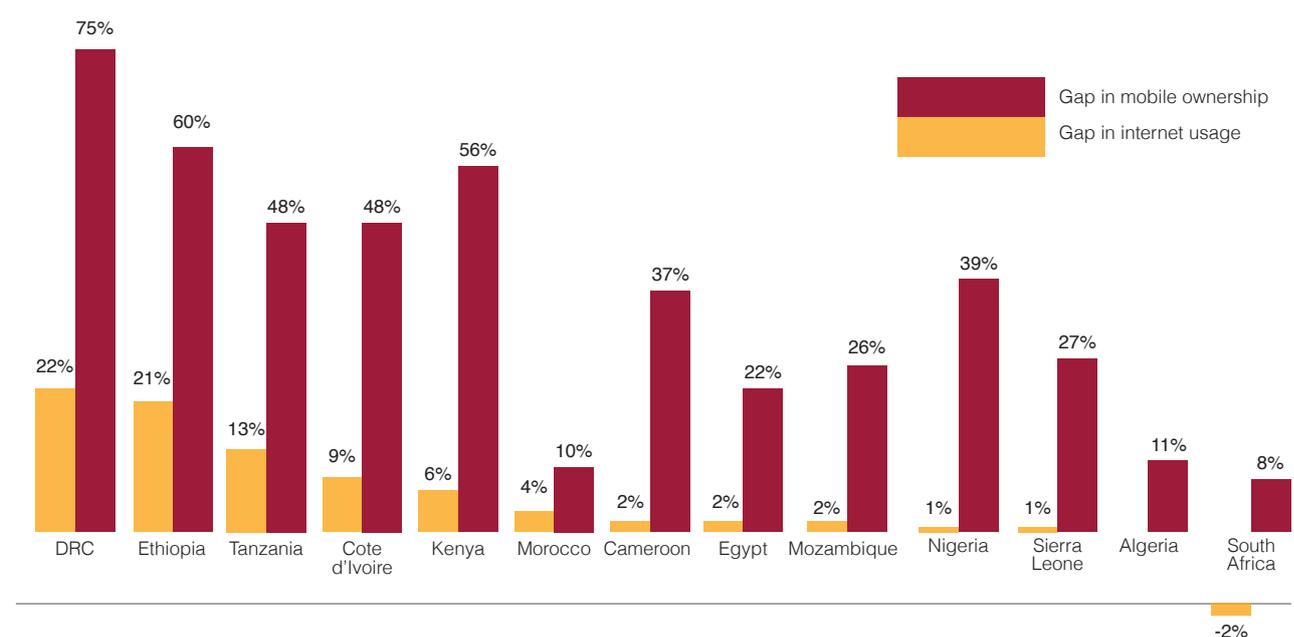
Poor Infrastructure and Connectivity: Significant access gaps remain and need to be addressed to ensure inclusive growth. The use of computers and the Internet is still limited in remote areas of SSA, limiting access to timely and relevant information (World Bank, 2011). Only 38 percent of the population 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 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

Figure 8.6: The gender gap is larger in Internet usage than ownership



Source: GSMA 2016

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

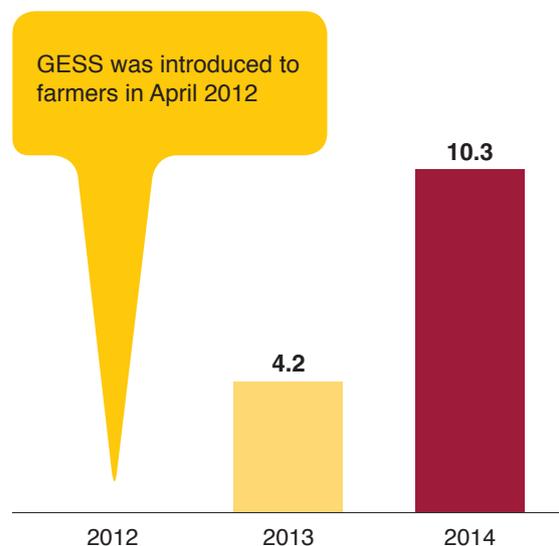
Feed Africa and the Comprehensive African Agricultural Development Programs, CAADP: The implementation of the Feed Africa and CAADP initiatives have led to an increase in growth and productivity in the agricultural sector of several countries in SSA. The CAADP initiative for example, resulted in Nigeria 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).

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, Mapi-la, & Okello, 2013). To optimally exploit synergies across

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 input 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*

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).

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, in-

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)

complete 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 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 commer-

cial 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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