



PARTNERSHIPS, PLATFORMS AND POLICIES

**STRENGTHENING FARMER CAPACITY TO HARNESS
TECHNOLOGICAL INNOVATION FOR AGRICULTURAL
COMMERCIALISATION**

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ABBREVIATIONS AND ACRONYMS

ADAPT	Agricultural Application Data Model
AGRA	Alliance for a Green Revolution in Africa
AIS	agricultural innovation system
AU	African Union
CAA	Cocoa Agrabopa
CARD	Coalition for African Rice Development
CBO	community-based organisation
COCOBOD	Ghana Cocoa Board
COMESA	Common Market for Eastern and Southern Africa
CRIG	Cocoa Research Institute of Ghana
EAC	East African Community
EIAR	Ethiopia Institute of Agricultural Research
ESE	Ethiopia Seed Enterprise
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
FFS	farmer field school
FTA	free trade area
GDP	gross domestic product
GMO	genetically modified organism
ICCO	International Cocoa Organization
ICT	information and communications technology
IFAD	International Fund for Agricultural Development

IPRs	intellectual property rights
IRRI	International Rice Research Institute
ISSER	Institute of Statistical, Social and Economic Research
JICA	Japan International Cooperation Agency
KKFU	Kuapa Kokoo Farmers' Union
NAIS	National Agricultural Information Service
NGO	non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PPP	public-private partnerships
R&D	research and development
SAA	Sasakawa Africa Association
SADC	Southern African Development Community
STI	science technology and innovation
STISA	Science, Technology and Innovation Strategy for Africa
UNDP	United Nations Development Programme
WAMCO	West Africa Mills Company
WARDA	West African Rice Development Association
ZFNU	Zambia National Farmers Union
ZICTA	Zambia Information and Communication Technology Authority

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SUMMARY

Innovation capacity presupposes capacity to harness science, technology and innovation (STI) for agricultural commercialisation. Agricultural commercialisation requires an enabling policy environment on STI issues such as impact of climate change, nutrition, improved seed and inputs, emerging technologies, infrastructure, research and extension, and financing. These issues are consistent with the Science, Technology and Innovation Strategy for Africa (STISA) 2024 (African Union Commission undated).

This paper uses three STI revolution storylines (case studies on rice, information and communications technology (ICT) and cocoa) to highlight the enabling factors that make STI a vehicle for agricultural commercialisation. The case of rice commercialisation in Ethiopia followed a more green revolution-type storyline, with expected better yield-enhancing technologies, in which research and development (R&D) – especially seed sector development – has played an important role. The ICT and agricultural commercialisation storyline in Zambia followed application of an ICT and mobile platform, which has been seen as an innovative way to transform agribusiness in Africa. The cocoa commercialisation storyline in Ghana shows impressive growth as its supply has responded to policy reforms, allowing a larger share of world cocoa prices to be passed on to producers. The storylines based on the three case studies were identified considering their relevance to the different types of farming (small, medium and large scale), the importance of commercialisation linked to STI, and the diversity of production systems. The paper draws the following conclusions.

- Human capital and education of women and girls is important – especially youth, who innovate and represent the future of agriculture in Africa. STISA-2024 recognises the need to train young men and women in technology systems beyond the traditional use of mobile phones in agriculture to make it more resilient to climate change.
- Producers' organisations facilitate their members' access to research, technologies, knowledge, markets, financial services and policymaking influence. The case of cocoa in Ghana shows that cocoa farmers are increasingly being facilitated

to organise in groups as a prerequisite for certification and for accessing technical, business and credit services.

- Market mechanisms for farmers can provide strong incentives for innovation. The case of ICT and agricultural commercialisation in Zambia is enabling market access for farmers through a mobile platform. This has been seen as an innovative way to transform agribusiness because it can offer a wide range of solutions for smallholder agricultural commercialisation in Africa.
- Networks and linkages (e.g. partnerships, innovation platforms) can provide a space for information sharing, negotiation, planning and action in an innovation system. This is exemplified by a well-networked Ghana Cocoa Board (COCOBOD), which implements government programmes for farmers and other actors in the cocoa value chain.
- An enabling environment for innovation should involve representative producers' organisations in policymaking to take into account the needs of farmers. Again, cocoa supply in Ghana has shown impressive growth in response to pro-producer policy reforms.

Further, the paper identifies key areas for future research:

- How is STI enabling commercialisation of agricultural value chains to have positive impacts on rural poverty, women's and girls' empowerment, and food and nutrition security?
- What are the specific contributions of the different domains of innovation capacity in promoting agricultural commercialisation?
- What is the role of STI in promoting non-farm rural economies and rural-urban linkages?
- What attention should be given to youth in agriculture?

1. INTRODUCTION

The central argument of this paper is that developing innovation capacity for individuals, organisations and systems creates an enabling environment to link diverse knowledge and policies for agricultural commercialisation in Africa. This argument is based on the demonstrated successes and failures of three closely linked science, technology and innovation (STI) revolutions of the twenty-first century, which are strongly associated with the diversities of innovation capacities of the countries involved. The paper describes three agricultural-related revolution storylines that have played a crucial role in agricultural development in general and agricultural commercialisation in particular: the green revolution, the biotechnology revolution, and the recent information and communications technology (ICT) and mobile technology revolution (see Table 1).

The first storyline has two related components of 'biorevolution' – namely green revolution and biotechnology revolution (see Table 1).

was thereafter applied in some African countries, but the results were not as effective. The reasons behind this are explored in Box 1.

From the 1980s, there were several initiatives for the second green revolution to spur agricultural development in Africa. For instance, based on research specifically targeted to African conditions, more suitable crop varieties were made available to farmers. Also, improved varieties of sorghum, millet and cassava started to emerge around the middle-to-late 1980s. But according to Cooke and Downie (2010), agricultural productivity declined, with farms producing almost a fifth less in 2005 than they did in 1970 (per capita). The authors attribute Africa's low agricultural productivity to several factors: low soil quality; scarcity of water; shortage of inputs; weak access to markets, credit and finance; the effects of climate change and its variability; inadequate government support to policy and infrastructure; and barriers to international trade

Table 1: Global revolutions: food and agribusiness implications

Revolution	Period	Benefits	Impact
Green revolution	1960–1970	Yield-enhancing technologies	Better nutrition Higher per capita incomes Food security
Biotechnology revolution	1990–2000	Yield-enhancing disease and insect	Genetically modified foods Food security/health issues
ICT and mobile revolution	2000–2010	Access to input and product markets	Market information Systems Transaction costs

Source: Authors' compilation; FAO 2014

There are two related green revolutions. The first occurred in Asia, and then expanded into Latin American countries during the 1960s and 1970s. It was the new model of agricultural development applied through a package comprising four components: irrigation and improved seed, fertiliser and mechanisation, especially targeting rice and wheat. The initial green revolution

(*ibid.*).

The other component of biorevolution, which is not the focus of this paper, is biotechnology revolution (1990–2000), which has been sparsely adopted in Africa. Most African governments are cautious of the biotechnology revolution and especially genetically modified organisms (GMOs) because the role of this

Box 1: The limitations of green revolution in Africa

There are various factors behind the limited success of the first green revolution in Africa. First, it was not easy for African farmers to apply the model that was used in Asia, which took advantage of homogeneous and impoverished farmland for rice production and application of different technologies, fertilisers and pesticides. In Africa, farming systems are rather more diverse and more complex, with land fragmentation, limited specialisation and limited accessibility of service providers. Second, the diversity of ecological systems means that African farmers cultivate many types of crops in the same field, unlike in Asia, where farmers tend to cultivate only two or three rice crops. Application of Asian modern cultivation techniques was less suited to African farms. Third, most African governments and farmers were less aware of the scientific and technological importance of modern agricultural development. Many African countries did not have capacity to build national research systems for agricultural development. Where such systems existed, research results did not meet the needs of diverse groups of farmers.

Source: Duc Dinh and Lan Huong (2010)

technology in African smallholder agriculture is not well understood. Today, there are few transgenic crops that have been commercialised (i.e. developed and successfully introduced) among African smallholder farmers (Odame 2014).

The second storyline is about the ICT and mobile revolution (2000–2010) and its role in enabling input and output market access to farmers. This has been seen as an innovative way to transform agribusiness because it can offer a wide range of solutions for smallholder agricultural commercialisation in Africa (Maumbe 2012).

The third and final storyline is about commercialisation of cocoa in Ghana, which adopted both the green revolution and ICT and mobile revolution. As one of the oldest and leading commercial export crops in Africa, cocoa has shown impressive growth as supply has responded to policy reforms, which have allowed a larger share of world cocoa prices to pass down to small-scale producers and workers who initially developed the crop by drawing on their own savings, local knowledge and labour (Kolavalli and Vigneri 2011). These storylines of global revolutions and their implications for food and agribusiness in eastern and southern Africa and West Africa raise the issue of building innovation capacity to link diverse knowledge and policies for agricultural commercialisation. The storylines are based on three case studies, which were identified considering their relevance to the different types of farming (small, medium and large-scale), the importance of commercialisation and associated linkages to STI, and the diversity of production systems.

The rest of this paper is organised four sections. Section 2 highlights the role of STI for Africa's development agenda and emerging STI issues influencing commercialisation on the continent. Section 3 examines the concept of innovation capacity for individuals, organisations

and systems by defining its key elements: (1) building skills and capacities; (2) strengthening producers' organisations; (3) developing market mechanisms; (4) strengthening networks and linkages; and (5) creating an enabling policy environment. Section 4 examines the three case studies in detail, focusing on how key actors innovate, drawing on the literature and secondary data. Section 5 presents conclusions, and Section 6 identifies future areas for research.

2. SCIENCE, TECHNOLOGY AND INNOVATION IN AFRICA'S DEVELOPMENT

The role of STI for Africa's development agenda is anchored in the 23rd Ordinary Session of African Union (AU) Heads of State and Government Summit, in June 2014, which adopted a ten-year Science, Technology and Innovation Strategy for Africa (STISA-2024). The strategy supports the AU Agenda 2063, which has STI as an enabler for achieving continent-wide development goals. The Agenda stresses a strong need to diversify sources of growth and sustain Africa's current robust economic performance in order to lift a large section of its people out of poverty.

STISA-2024 defines four mutually reinforcing pillars as prerequisites for its success: (1) building and/or upgrading research infrastructures; (2) enhancing professional and technical competencies; (3) promoting entrepreneurship and innovation; and (4) providing an enabling environment for STI development in the African continent (ibid.). Given the cross-cutting nature of STI, STISA-2024 is consistent with the key elements of innovation capacity for individuals, organisations and systems that are the focus of this paper.

According to Jayne et al. (2011), the following STI issues are influencing agricultural commercialisation in Africa. First, training of young men and women in new methods that take the environment into consideration can reduce agriculture's ecological footprint and make it more resilient to climate change. Second, there is increasing use of emerging technologies beyond the traditional use of mobile phones in agriculture, including precision agriculture, sensors, satellites and drones. For instance, the UK-based growmoreX (GMX Consulting) operates drone-based farming services in Nigeria. It conducted a survey of 3,000ha of land suitable for irrigated rice farming in New Bussa, Niger state. The area is 700km from the capital, Abuja, and has limited access to roads, electricity, clean water and other amenities (The Conversation 2016). Third, productivity in agriculture is enabling economic growth in Africa because agricultural productivity is a key driver of long-term economic transformation, especially where it is more than just producing food and is a driver for overall economic growth. Fourth, STI initiatives, including cold storage and new methods of drying and storage,

would reduce post-harvest losses while adding value to agricultural produce.

Fifth, STI policy is enabling African agriculture to finally gain momentum, which shows how long-term policy commitments and funding are key to the sector's growth. STI is contributing to GDP per capita increases in Africa through communication, transportation, wholesale and construction, which has led agricultural value addition to grow; it is also contributing to formulation and enforcement of standards in negotiations to create free trade areas (FTAs). These areas are expected to significantly expand trade in agricultural products by building on current growth in the sector. For instance, a proposed African free trade agreement (or tripartite free trade area) between the Common Market for Eastern and Southern Africa (COMESA), the Southern African Development Community (SADC) and the East African Community (EAC) creates a market of more than 620 million people in 26 countries valued at \$1.5 trillion (Soinin 2104); Investment in rural infrastructure also plays an important role, particularly transportation, energy, telecommunications and irrigation. Reliable energy is a key element for the creation and growth of agro-industries in rural and urban areas. More importantly, the use of renewable energy can help African countries generate energy more sustainably. Similarly, irrigation is essential for crop production, and there is increasing use of solar power for irrigation.

Finally, food security, including nutrition, is important in overall agricultural strategies –especially in improving maternal and child nutrition by encouraging research and dissemination of dietary diversification information.

In summary, modern agriculture involves STI policy decisions on topics such as the impact of climate change, nutrition, improved seed and agricultural inputs, emerging technologies, infrastructure, research and extension, and financing (e.g. index-based insurance, etc.). In line with STISA-2024, African countries have responded to the need for up-to-date information by creating offices of science and technology advice and design of STI policies. For instance, STI policy in Ethiopia, which was enacted in 2012, aims to

build national STI capacity to ensure (1) technology accumulation and transfer, (2) learning and adaptation, and (3) promotion and commercialisation of knowledge and technologies (Weldegiorgis 2015).

In view of the issues raised on STI revolutions and agricultural commercialisation in Africa, this paper attempts to answer the broader question: What enabling factors make an innovation/technology a vehicle for agricultural commercialisation? The three specific research questions are:

1. 1) What pathways for an innovation/set of innovations (related to a technology) lead to agricultural commercialisation?
2. What are the enabling factors?
3. What is the new methodological framework for commercialisation pathways?

To address these questions, this paper employs innovation capacity as a potentially useful framework for analysing agricultural innovation/ technology as a vehicle for agricultural commercialisation in Africa.

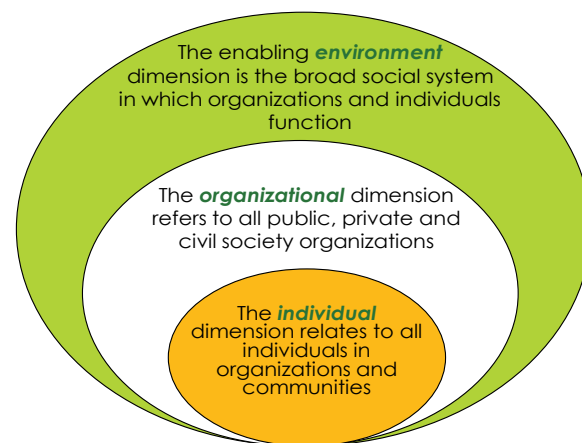
3. INNOVATION CAPACITY

What is meant by the capacity to innovate? According to some authors, its broad features include a combination of: scientific and non-scientific knowledge and skills; partnerships, alliances, and networks linking different sources of knowledge and different areas of social and economic activity; routines, organisational culture, and traditional practices that pattern the urge to innovate; an ability to continuously learn and use knowledge effectively; and a set of knowledge-driven policies and incentives, governance structures, and the nature of the policy process (Hall and Dijkman 2006). To strengthen the capacity for innovation it is necessary to invest in learning and skills development while ensuring that incentives are in place to encourage people to put these skills into use and nurture the desired attitudes and practices (Rajalahti, Janssen and Pehu 2008).

The capacity for innovation can be developed through three areas: (1) upgrading the skills, competencies and confidence of individuals and organisations by building human capital; (2) improving the processes within organisations, businesses and households involved in identifying and/or developing, adapting, scaling out and scaling up innovations; and (3) creating a policy environment that is conducive to fostering these elements of capacity development, and forging links, communication channels and networks to allow individuals and organisations to access and exchange new ideas and expertise for innovation. This approach conforms to the three levels of a capacity development strategy, as defined by the United Nations Development Programme (UNDP) and the Food and Agriculture Organization of the United Nations (FAO) (FAO 2010; OECD 2006).

In this paper innovation capacity means developing the ability of individuals, organisations and systems to learn, adapt and improve. It involves being creative and joining up knowledge and policies for agricultural commercialisation. Farmers are part of the solution for achieving food security and sustainable rural development (see Figure 1).

Figure 1: Capacity development at different levels



Source: FAO (2014).

3.1 Building individual capacities: investing in human capital

Human capital is about the knowledge, skills and experience that individuals possess which make them innovate to be economically productive (Parts 2003). In this regard, education and training represent an investment in people as the most important way to build the skills and competencies of individuals, be it farmers, service providers, researchers or policymakers. Thus, innovation capacity depends on capabilities of individual receivers and providers of educational and training services. The individual's capacities start from the human capital of farmers/pastoralists all the way through to policymakers. Table 2 summarises the different types of individuals as receivers and/or providers of education and training in building human capital, which is strongly linked with the development of organisational capacities, improved marketing for inputs and outputs, and development of an enabling environment.

Table 2: Type of individuals and required capacities to innovate

Type of individuals	Organisations	Knowledge and skills required
Farmers/pastoralists		Ability to adopt innovations and to innovate (Kahan 2011; Davis 2008; Anderson and Feder 2007)
Basic education providers	Schools as basic education providers	
	Ability to provide appropriate basic education (FAO 2010; Davis, Ekboir and Spielman 2008)	
Agricultural researchers	Agricultural research organisations,	
agricultural universities, private research organisations	Ability to supply innovations and technologies (Wettasinha, Wongtschowski and Waters-Bayer 2008; Scoones and Thompson 1994; Long and Long 1992; Röling and Engel 1989)	
Agricultural education and training service providers	Agricultural universities, faculties of agriculture, vocational and technical colleges and farmer training centres	Building the knowledge and skills of agricultural extensionists and farmers (Cletzer et al. 2016; FAO 2011; Eicher 2006)
Agricultural extensionists	Ministry of Agriculture	
Private extension service providers	Ability to effectively transfer available innovations and technologies (Kahan 2011; Davis 2008; Anderson and Feder 2007; Leeuwis and Van den Ban 2004)	
Innovation brokers	Individuals or organisations that are focused neither on one organisation nor the implementation of innovations	Enabling other organisations to innovate (Klerkx, Hall and Leeuwis 2009; Spielman, Ekboir and Davis 2009)
Polymakers	Ministry of Agriculture,	
other relevant public organisations	Ability to improve policy environment to innovate (Pardey, Alston and Ruttan 2010; Davis 2008)	

Source: Authors' compilation.

3.2 Building organisational capacity of farmers: investing in social capital

Strong, effective and inclusive producers' organisations can facilitate their members' access to research, extension and advisory services, markets, technologies and financial services. They can also help small-scale farmers gain a voice in policymaking to counter the influence of larger, more powerful interests. Greater understanding is needed on how to foster a culture of collective action and promote innovation-oriented organisation of producers. Collective action is essential for providing voice and creating platforms for networking in innovation processes, but prevailing structures stand in the way of realising the potential contribution to equitable rural development. Collective

action and networking mechanisms are often subject to distrust between public research organisations, the private sector and non-governmental organisations (NGOs) as well as rivalries between different branches of science (World Bank 2007). The asymmetry of power needs to be recognised and addressed by farmers, advisory service providers and policymakers through knowledge-driven technology that creates easy access to information and control over resources (Ton et al. 2013; Kahan 2011).

Successful farmer organisations are those that tend to develop the following:

- organisational innovation (clearly articulated purpose, mission and vision)

- organisational cultures that allow change
- effective learning routines
- strong technical capabilities
- skills to participate in innovation networks, interact with the political and economic environment, and mobilise resources
- effective and transparent governance structures and leadership that prevent them from being captured by donors, governments or elites
- active participation of members (Ekboir et al. 2009).

Without the capacity to organise themselves, farmers have little influence on the social, economic and political processes affecting them. The social capital generated through farmer organisations creates the momentum for technological and institutional innovations by accessing knowledge sources, inputs and markets.

However, the contribution of farmer organisations to agricultural innovation varies depending on their mission, knowledge background, technological assets and networks. Farmer organisations typically contribute to so-called product and process innovation functions within the agricultural innovation system – e.g. input supply, credit and savings schemes and marketing of produce. They can also develop their capacity to demand services from other actors within the innovation system (Wennink and Heemskerk 2006). Therefore, the centrality of networks built through ICT and mobile phones has opened up greater opportunities for social capital among farmers and producer organisations that is vital at all levels of the agricultural innovation system.

3.3 Developing market mechanisms

Developing market mechanisms is crucial for the promotion of agricultural commercialisation. Improved access to local or wider markets for inputs and outputs can provide strong incentives for innovation. Spielman and Kelemework (2009) provide useful indicators for evaluating innovation capacity of business and enterprise. These include: performance of business, quality of institutions and infrastructure that impact on the performance of smallholders, and potential for technology transfer (through foreign direct investment (FDI) and public–private partnerships (PPPs)); use of certified seed, fertiliser and machinery as a sign of commercialisation (and hence differentiating between subsistence and commercial production); access to

production assets (land, water, tools and equipment owned or leased by smallholders); quality of institutions and infrastructure that support smallholder farmers (e.g. roads, information flows, technology supply system, etc.); conditions for accessing financial services; and level of farmer aggregation (farmer groups) to achieve economies of scale in accessing inputs, information, credit and product markets and commodity lobby groups for policy change.

Small-scale farmers and especially those in remote areas and from marginalised groups often face severe barriers, whereas sustainable agricultural practices often have high start-up costs and long pay-off periods, so farmers may need incentives for key environmental services. There is need to support the development of farmer organisations and cooperatives to mobilise inputs and finance and provide collective marketing at scale. These organisations often face management challenges as they involve more complex business activities. They also require considerable investment and time to develop to a point that they are able to take on collective functions (Ekboir et al. 2009).

The knowledge economy has liberalised access to information and technology, which in turn have created opportunities for small-scale farmers to organise for collective action. The internet and mobile phones have allowed small-scale farmers to exchange information on technology and hence engendered their ability to innovate. It allows them to access markets for inputs and outputs, to participate in value chains, and to engage effectively with other actors in the innovation system such as research institutions, and private and public advisory services (Maumbe 2012).

The ADAPT Project in Zambia highlights successes and lessons learned in building a scalable network of rural agro-dealers (Box 2). The project, funded by the Alliance for a Green Revolution in Africa (AGRA), was set up in 2007 by CARE Zambia, focusing on scaling of maize production using the ADAPT (Agricultural Application Data Model). This was a market-based approach aimed at sustaining interventions well beyond the end of a project. Using criteria that included sustainability and scalability, CARE prioritised two areas for intervention: (1) improving access to agri-inputs, especially high-yielding varieties, by smallholder farmers with the potential to triple productivity from an average of 1.4 t/ha to nearly 5 t/ha; and (2) identification of the input supply model that would enable agro-dealers to get closer to smallholders. The project partners set up their own trained agro-dealers while farmers accessed

Box 2: Principles for sustainable and scalable rural agro-dealer networks

The partners involved in the ADAPT Project in Zambia adopted six core values to build a sustainable and scalable network of rural agro-dealers.

- Recruit agro-dealers based on distance from town, financial management, and past experience of business viability, and train them, in order to increase smallholder farmers' access to high-yielding varieties.
- Conduct demand-creation activities among smallholder farmers through field days, seed fair and direct seed marketing by supply chain actors, with CARE's intervention as a facilitator.
- Facilitate linkages between supply chain actors and output markets.
- Use an innovation fund to mitigate agro-dealers' risks of rapid expansion into smallholder markets.
- Develop agro-dealer associations in targeted districts to support the needs (such as access to credit facilities) of individual agro-dealers and to advocate on their behalf.
- Conduct monitoring and evaluation (M&E).

Source: Fawley-King and Pennotti (2010).

improved inputs through the E-voucher platform. The one-year intervention saw CARE provide more than 35,000 smallholders with vouchers worth more than \$30 each, which were redeemed by one of 60 participating agro-dealers.

3.4 Building an enabling environment for innovation

Building human and organisational capacities is insufficient to foster innovation capacity. A well-functioning enabling environment, including the policies and rules that govern the mandates and operations of research and extension organisations and their engagement with other actors in the system, is vital for individuals and organisations to perform more effectively.

The enabling environment creates the conditions necessary for innovation to occur within society at large and is essential at the international, national, and local levels for effective innovation processes (Rajalahti et al. 2008). The 2012 edition of *The State of Food and Agriculture* discussed the enabling environment required to foster private investment in agriculture, including by smallholders. This included key issues such as good governance, rule of law, adequate infrastructure and public services, macroeconomic policies, economic incentives, secure property rights, taxation and environmental policies, as well as the importance of supporting small-scale farmers, and especially women, in overcoming the constraints they face to invest in their productive activities (FAO 2012). It also highlighted the importance of channelling public

expenditures towards essential public goods with high returns – notably agricultural research and extension. The discussion in the 2012 edition of the report is largely of the same degree of relevance for innovation by farmers and will not be repeated here. The following section will discuss two broad issues of particular significance for the development of innovation capacity: the forging of networks and partnerships, and the need for an overall agricultural innovation policy.

3.4.1 Forging networks and partnerships

The capacity to engage with stakeholders is a critical aspect of networks and is vital to a culture of learning about new technology and innovations among stakeholders within a country and also abroad. This form of capacity requires the knowledge and skills to identify, motivate and mobilise stakeholders; to create partnerships and networks; to raise awareness; to develop an enabling environment that engages civil society and the private sector; to manage large group processes and open dialogue; to mediate divergent interests; and to establish collaboration. As we have seen throughout this report, innovation at farm level is increasingly occurring within a network-based setting, where farmers interact and learn from other farmers, input suppliers, traders, advisory service providers, etc. Science and technology have made it cheaper and feasible for farmers to innovate and commercialise farming without being left in isolation from other sectors of the economy. One remaining challenge is to identify effective coordination mechanisms and systems that can facilitate interaction and coherence between actors in the value chains and innovation systems as well as

policymakers and programme managers supporting family farming. Two key mechanisms being promoted and discussed are innovation platforms and innovation brokers.

Innovation platforms are a mechanism to help stakeholders interact in a concerted manner. These platforms provide a specific space for information exchange, negotiation, planning and action by bringing different stakeholders together to work towards a common goal. They have been promoted as a practical approach to put the agricultural innovation systems (AIS) concept into action (Nederlof, Wongstchowski and van der Lee 2011; Klerkx, Aarts and Leeuwis 2010; Spielman et al. 2009).

An innovation platform is defined by Kilelu, Klerkx and Leeuwis (2013), as ‘a multi-actor configuration deliberately set up to facilitate and undertake various activities around identified agricultural innovation challenges and opportunities, at different levels in agricultural systems’. First applied in natural resource management as a way to solve problems that require collective action among multiple stakeholders (Kilelu et al. 2013; Adekunle and Fatunbi 2012), platforms have been used for this purpose in agriculture at a tactical scale by bringing together and providing a space for relevant stakeholders to interact (Box 3).

Box 3: Innovation platform as an enabler

This enables collective action by linking the technical and functional capacities of the individuals and organisations involved with the institutional environment, thus changing the patterns of interaction needed to support technological innovation (Kilelu et al. 2013). This enhances the systemic capacity to innovate by aligning the knowledge and capacities that are scattered across diverse actors in different dimensions (ibid.).

Diverse composition with relevant role(s) is a key part of a platform. As Thiele et al. (2009) point out, a producer organisation would not be a platform because it is only made up of and works for the interest of producers. In a similar vein, farmer field schools (FFSs) are not necessarily platforms. While they may have linkages to other stakeholders, they do not have other types of actors, such as researchers or traders, explicitly involved in addressing issues shared by all stakeholders. Instead, they focus on developing farmers’ individual and organisational capacities. A FFS can lead to a platform if the farm group involved connects with other stakeholders to solve systemic issues. Often, such

platforms are set up at local level in order to improve the efficiency of a specific value chain, and are particularly useful in engaging the private sector in targeted innovation processes. Platforms at national or regional levels often set the agenda for agricultural development, and allow farmers (through their representatives) to be involved in policymaking for investments and services needed to support them. The complexity of the innovation platform means that it needs to be facilitated (Spielman et al. 2009). The facilitator can be networked individuals and/or influential organisations, also known as innovation brokers (Klerkx et al. 2009).

3.4.2 Policies to foster innovation

Government has a role to set clear objectives for the agricultural sector and formulate an agricultural policy that addresses agricultural innovation policy concerns. A central question is whether African countries should create an umbrella national innovation policy or a single innovation policy for agriculture. Alternatively, they may develop a set of policies that work together to shape innovation (Anandajayasekeram 2011). A national innovation policy provides direction for how to coordinate a wide spectrum of policy domains – science and technology policy, education policy, economic policy, industrial policy, infrastructure policy, taxation policy, among others – in such a way that together they create an environment that enables and stimulates innovation in the most positive way (Roseboom 2012). A national innovation policy needs to define the roles of the different contributing ministries and other stakeholders in the system and set priorities across sectors for public sector investment. Innovation policy can make coordination at scale much easier and cheaper, given the increasing number of actors in the system. It can also eliminate gaps and duplication of services, determine an appropriate division of responsibility and establish a framework for information sharing, policy agreements, programme collaboration and joint planning.

The regulatory environment similarly affects innovation among farmers by setting standards, reducing risks, decreasing the administrative burden and responding to market failures. Inappropriate regulations often delay technological progress and the transfer of technology, and impose excessive transaction costs on farmer organisations and other organisations. The regulatory environment which fosters smallholder agricultural commercialisation encapsulates issues such as: access to markets, particularly where markets are weak; access to land where a land market and security of tenure are absent; laws pertaining to contracts to promote

contract farming; intellectual property rights (IPRs); health and food safety; bio-safety and environmental regulations; and the legal arrangements for farmer organisations, which could reduce risk for farmers and thus encourage innovation. In many countries, specific regulations applying to farmer organisations can reduce competition and influence the adoption and adaptation of technologies and practices, depending on their behaviour.

Innovation policy can help to improve the existing regulations that impact on smallholder agricultural commercialisation and, where possible, simplify them (OECD 2013). The participation of small-scale producer organisations in the design of public policies and in public-private dialogue is an effective way to guarantee that public policies take into account the voices of rural people. It can enhance innovative approaches to participatory mechanisms that reveal farmers' needs by providing timely and quality information to governments and public institutions to help them design appropriate and effective agricultural policies.

Innovation policy is especially important for emerging technologies. The public sector is involved in technology development, and in technology transfer through the extension departments of ministries of agriculture. It is also involved in policy formulation and implementation based on pertinent issues such as regulations, IPRs, licensing, imports and exports of technology. Some of the policies support production and utilisation of various agricultural products, regions and people while others do not. Women farmers can benefit from agricultural technologies if they are actively involved in innovation processes. Women farmers play a critical role in agriculture and rural production. They employ indigenous knowledge in response to changing weather patterns and land use but lack access to modern knowledge and other resources such as credit and loan facilities.

4. INNOVATION CAPACITY SHAPING AGRICULTURAL COMMERCIALISATION: CASE STUDIES

4.1 Capacity to innovate

This section employs three case studies – on rice, ICT and cocoa – to examine the idea of innovation capacity for individuals, organisations and systems to join up knowledge and policies for agricultural commercialisation in Africa using the following elements: (1) skills and capacities of relevant actors in the agricultural value chain, with special attention to the involvement (or lack of) of women and girls; (2) strengthening producers' organisations to facilitate members' access to research, extension and advisory services, markets and collective voice in policymaking to counter the influence of larger, more powerful interests; (3) developing market mechanisms for improved access to local or wider markets for inputs and outputs, including through government procurement from farmers to provide strong incentives for innovation; (4) strengthening networks and linkages in the innovation system for innovation brokers and innovation platforms to provide a space for information sharing, negotiation, planning and action among different actors; (5) creating an enabling environment for innovation involving effective and representative producers' organisations in policymaking. The case studies are rice commercialisation in Ethiopia, ICT and agricultural commercialisation in Zambia, and cocoa commercialisation in Ghana.

4.2 Challenging the failure of the green revolution in Africa: the case of rice in Ethiopia

4.2.1 Background

Rice was introduced to Ethiopia in the 1970s by North Koreans to the Fogera plains in the north-western part of the country, which was known for serious food insecurity linked with excessive water, which affected production of indigenous crops. Following the introduction of rice, its production started to increase considerably, along with its adaption to the local consumption tradition. The major production areas recognised as the rice production and marketing hubs in recent years are Fogera plain in Amhara, Gura Ferda

in SNNPR, Chewaka in Oromia, Gode in Somali, Assosa in Benishangul Gumuz, May Tsebri in Tigray, and most of the areas in Gambella region (Ethiopian Institute of Agricultural Research (EIAR) 2016).



Rice Harvesting in Ethiopia

Considering the innovation capacity in the evolution of the sector's development, rice production and commercialisation in Ethiopia can be presented in three phases. The first phase is the introduction of rice to the country (1970–1991); the second phase is linked with the start of full-fledged rice research (1991–2009), where a number of improved rice varieties were released and demonstration of the available technologies started; the third phase is from 2010 and is associated with the recognition of rice in the country's agricultural research and development endeavours, translated through the development of a National Rice Research and Development (R&D) Strategy and its implementation at national and regional levels.

The innovation capacity in the transition process over these phases has been very important in the knowledge-based domains of farming ecosystems, agricultural research, bridging institutions, rice value chains, network systems and an enabling environment. The details of actors and their innovations in each of the three phases are presented in Table 3.

4.2.2 Farming ecosystems

The agro-ecosystems required to ensure competitive production in rice that could support its commercialisation were not well-recognised in Ethiopia until the 1970s, when rice was introduced by North

Koreans who had been working as agricultural experts to support two farmers' cooperatives in Fogera plain (the Jigna agricultural producers' cooperative in Dera district (woreda) and Shaga agricultural producers' cooperative in Fogera woreda). Rice was first introduced at Fogera plain, which was well known for food insecurity mainly associated with flooding during the rainy season and lack of alternative commodities that could be produced under such conditions.

The existence of suitable agro-ecosystems in the country began to be recognised in the early 1990s with the start of rice research and extension during the second phase (Table 3). In the third phase, with the development of the national strategy, the full potential in terms of area was estimated to be over 20 million ha, of which 5.6 million were highly suitable (Ministry of Agriculture and Rural Development 2010). This has also led to rice being regarded as one of the priority crops for large-scale commercial investment in the country, and a number of foreign and domestic investors have started commercial production, especially in Gambella and Oromia.

4.2.3 Agricultural research and education systems

Over the three phases, the role of agricultural research and extension has been very important, though it is in the second phase that research and extension activities started to play a role in rice promotion in the country. The first introduction of rice in the country is strongly linked with STI, in terms of scientific observation of the

performance of wild rice, testing of improved varieties imported from abroad, and promotion using adapted varieties in the first phase of rice sector development. The identification of wild rice in Fogera plain is reported to be the initiation of rice production in Ethiopia.

The North Korean experts, together with experts in South Gondar Department of Agriculture, had started research on rice in the cooperatives in the early 1980s, which discontinued when the cooperatives were dismantled in 1991. When the Department's agricultural expert moved from South Gondar to Adet Agricultural Research Centre in the early 1990s, formal research on rice began, which marked the start of the second phase of rice sector development.

In 1993, about 30 farmer households started growing rice (Gebey et al. 2012; Astewul 2010). The name of the variety X-jigna, which is considered a local variety, is linked with the kebele named Jigna, where the North Koreans first introduced a rice variety.

In parallel, there were initiatives in the late 1980s linked with promotion of large-scale rice production by the then Tanna Beles Project and the Institute of Agricultural Research at Pawe area and by the government, with the support of IRRI international rice testing programme at Gambella. These initiatives were in turn linked with the huge government-run resettlement programmes from drought-affected areas to Pawe and Gambella. Through these initiatives, different varieties were in use without formal research support and formal variety

Table 3: Rice commercialisation phases and contribution of innovation domains in Ethiopia

Innovation system domains	Rice commercialisation phases		
	First phase [1970–1993]	Second phase [1993–2010]	Third phase [2010 – present]
Farming ecosystems	Limited recognition by policymakers of existing opportunities for rice production (land, agro-ecology, rural labour absorption, etc.) Validation of the agro-ecosystem potential through foreign innovation at Fogera plain	Formal research in rice and formal release of improved rice varieties Testing at different agro-ecologies in different parts of the country Scientific documentation of the existing biophysical potential	Recognition at policy level of existing biophysical potential
Agricultural research and extension	North Korean expert-driven variety and agronomic practice testing Introduction of X-Jigna variety	Release of a number of varieties for different agro-ecologies (upland, lowland, and irrigated rice agro-ecologies) Start of location-specific extension activities through the research system	Establishment of a national centre of excellence for rice research and training at Fogera Ethiopia become member of AfricaRice National rice extension package developed

Innovation system domains	Rice commercialisation phases		
	First phase [1970–1993]	Second phase [1993–2010]	Third phase [2010 – present]
Bridging institutions	Cooperatives at Fogera plain North Korean expert team as part of the cooperation between the two countries	Adet research centre at Fogera plain playing important role in introduction of rice-related technologies SG -2000 engagement in demonstration of rice technology packages, including demonstration of post-harvest implements and the provision of training in food processing	Ethiopia become member of Coalition for African Rice Development (CARD) initiative National Rice R&D steering committee established; National Rice R&D technical committee established with a national secretariat within the Ministry of Agriculture and Rural Development
Rice value chains and commercialisation	Negligible level of domestic production at Fogera plain No production data available Almost no commercial production Almost no market for domestic rice Limited amount of imports	Domestic production starts to expand to different niche areas in the country (Gura Ferda, Chewaka, Mai Tsebri, Assosa, Gambela, Gode, etc.) The Central Statistical Authority starts to estimate data on rice (number of smallholders engaged, production and productivity) Imports increased dramatically Commercial investment in rice production starts (both domestic and foreign investors) Increased domestic consumption and adaption of rice to domestic recipes, emergence of processors in niche production areas Low level market linkage of domestic production to the national rice market, which is dominated by imported rice	Expansion of domestic production to almost all regions of the country Increased commercial investment in production and processing of rice Relatively developed value chain (wholesalers, retailers, supermarkets, etc.) with domestic rice entering the national supermarket networks Engagement of MEDA (Mennonite Economic Development Associates) to empower the domestic rice value chain Huge import of rice linked with increased domestic consumption Considerable decline in the level of self-sufficiency
Networks and linkages (e.g. partnerships, knowledge brokerage, innovation platform)	Limited engagement of public institutions	Linkage with International Rice Research Institute (IRRI) and AfricaRice (formerly the West African Rice Development Association or WARDA) started	Formal engagement of IRRI and AfricaRice (ex-WARDA) in knowledge and technology transfer Initiation of establishment of rice innovation platform in the Fogera area by MEDA
Policy and enabling environment	No specific strategy or policy on rice sector development	No specific strategy or policy on rice sector development	National Rice R&D strategy approved in 2010 along with implementation plan Special attention for commercial rice farms

Source: Authors' compilation.

release and registration. It was at this time that both Abobo research centre (Gambella) and Pawe research centre (Pawe) were established and started formal rice research as part of the national agricultural research programme within the then Institute of Agricultural Research (Ethiopian Agricultural Research Organization 2000). It was in 1998 that the first variety called Pawe 1 (M-55) was released (Ministry of Agriculture and Natural Resources 2016).

4.2.4 Bridging institutions

A number of institutions and organisations have contributed to ensuring the introduction, expansion of production, processing, marketing, and domestic consumption of rice in Ethiopia. The institutions include public organisations and NGOs.

Research institutes: Formal research on rice as part of the second phase of the commercialisation process started during the late 1980s at Abobo research centre in Gambella and Pawe research centre in Pawe areas as one of the national agricultural research program within the then Institute of Agricultural Research (EARO 2000). Adet Agricultural Research Centre followed suit in early 1990s, which was followed by the expansion of research coverage linked with the expansion of rice production across the country. Currently, Fogera, Pawe, Assosa, Werer, Tepi, Jimma and Mehoni research centres (federal) and Gondar, Bako, Bonga, Shire-Maitsebri, Gambela, Gode and Dupiti research centres (regional) are engaged in rice research.

Technology multiplication: In terms of multiplication of seed of the released improved rice varieties, the public seed enterprises, namely the federal Ethiopian Seed Enterprise (ESE), and regional seed enterprises (Amhara, Oromia and South seed enterprises) are involved. However, given the limited profitability of seed production and marketing, the composition and volume of certified rice seed produced has been much below demand (Lakew and Alemu 2017). Rather, seed cooperatives play an important role in multiplication and distribution of seeds of different improved rice varieties through informal channels.

Technology transfer and extension: The main actors in ensuring technology transfer and extension are the Ministry of Agriculture and Natural Resources and members of the national agricultural research system, as well as public actors and NGOs, including Sasakawa Global 2000 (SG 2000) MEDA. SG 2000 was instrumental in ensuring the expansion of rice production through promotion of available technologies, mainly

improved varieties, post-harvest technologies, and introduction of recipes to potential areas of rice production. They adopted the technology option plots approach to demonstrate different ways of using the technology to farmers in selected areas of Gambella, Amhara, Oromia, Tigray, SNNPR, Somali, and Afar regions. Similarly, MEDA implemented rice-specific technology transfer and value chain empowerment programmes in two rice niche areas (Fogera in Amhara and Gura Ferda in SNNPR).

4.2.5 Rice marketing

Rice is a relatively well-developed value chain (wholesalers, retailers, supermarkets, etc.) with domestic rice currently entering the national supermarket networks. This is a rapid development because initially there were negligible levels of domestic production at Fogera plain. In particular, there was almost no commercial production, no market for domestic rice, and limited amounts of imports.

Domestic production of rice started to expand from Fogera plain to different niche areas in the country (Gura Ferda, Chewaka, Mai Tsebri, Assosa, Gambela, Gode, etc.). Commercial investment in rice production started, with domestic and foreign investors. The engagement of MEDA to empower the domestic rice value chain increased commercial investment in production and processing of rice. Consequently, rice imports and domestic consumption increased dramatically along with adaption of rice to domestic recipes and emergence of processors in the niche production areas. However, there were low levels of market linkage of domestic production to the national rice market, which was dominated by imported rice. Huge imports of rice, combined with increased domestic consumption, led to a considerable decline in the level of self-sufficiency.

4.2.6 Networks and linkages

The national-level networks and linkages are undertaken by the Ministry, with specific follow-up by the National Rice Steering Committee supported by the National Technical Committee. The committees get day-to-day support from the Rice Secretariat established within the Ministry. The National Steering Committee comprises representatives from the Ethiopian Institute of Agricultural Research (EIAR), Ethiopian Seed Enterprise (ESE), Japan International Cooperation Agency (JICA), Sasakawa Africa Association (SAA), regional bureaus of agriculture and regional agricultural research institutes from Afar, Amhara, Benishangul-Gumuz, Gambella, Oromia, SNNPR, Somali and Tigray regions, and

private sector actors.

The steering committee and technical committee, established in 2009, helped to take timely measures to ensure improved livelihoods for small-scale rice producers through facilitation of relevant actors' engagement to promote better access to improved rice technologies, extension services, and market linkages for domestic rice. Even though domestic rice is not yet competitive in relation to imported rice, it is beginning to enter niche markets like supermarkets in big cities and towns.

4.2.7 Policy and enabling environment

The policy and enabling environments in support of rice sector development are of two types: general macro policies and rice sector-specific policies. With the development of the National Rice R&D Strategy, a number of rice-specific policies were put in place to enhance development of the sector. The most important are the public support for rice research (trends in the allocation of research budget) and the recognition of rice as one of the priority commodities for large-scale commercial investment.

The policy on rice research support has resulted in the establishment of a national Rice Research and Training Centre in 2013 as one of the federal research centres within the EIAR. Linked with this, financial resources have been allocated from public sources. The average

annual public fund in the past five years was about US\$85,000/year. Moreover, the development of the National Rice R&D Strategy has also led to rice being considered one of the priority crops for large-scale commercial investment, such that a number of foreign and domestic investors have started commercial production, especially in Gambella and Oromia. This has also allowed preferential treatment for interested investors for land lease in potential rice production areas. However, the data from the Ethiopian Investment Commission indicates that to date, only four large-scale commercial investors received an investment licence. The dominant investment in rice is by the Saudi Star Agricultural Development PLC, with 200,000ha of land licensed.

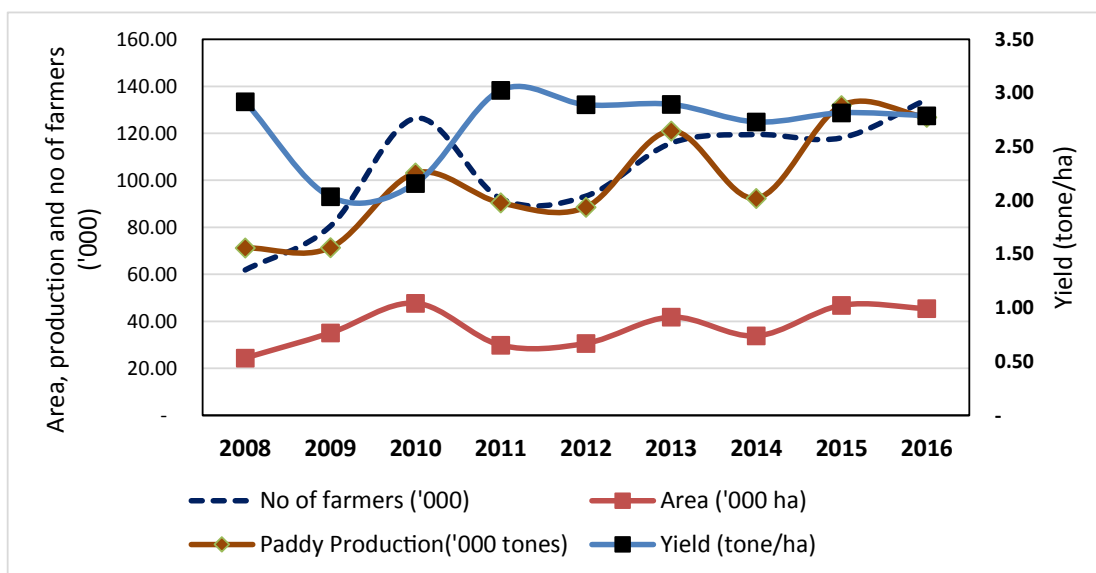
4.2.8 Emerging trends in production and consumption

The combined effect of innovation capacity in rice commercialisation has resulted in: (1) increased domestic rice production; (2) increased number and diversity of actors in the sector's R&D; and (3) increased domestic consumption and a considerable increase in rice imports.

Trends in production

As Figure 2 shows, in recent years there has been a steady increase in the number of farmers engaged in rice production, area under cultivation, and total

Figure 2: Trends in rice cultivation and production in Ethiopia



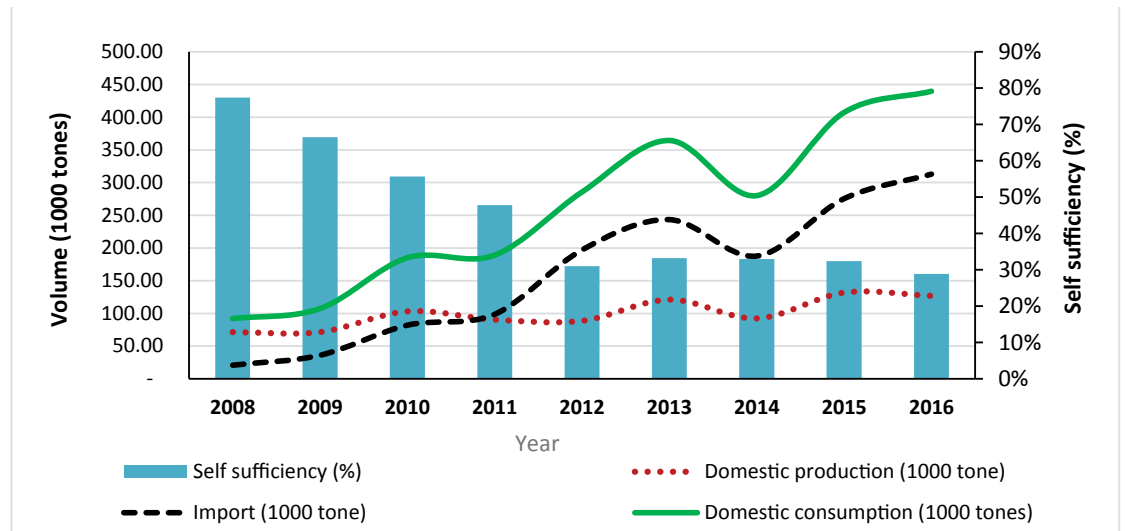
Source: Various CSA publications, 2008–2016.

Note: Actual trends in changes in numbers of growers, cultivated area, and production are shown as lines. The on-farm yield levels (q/ha) are represented as scattered points (squared markers) against secondary axis and a simple regressive linear trend on yield data is shown.

paddy production. What is more significant is that rice is being produced either in areas where other crops cannot do well or in areas where there was no crop production previously. Fluctuations within this trend are highly associated with yield variability from year to

production and consumption has prompted national markets to import rice from other countries. As Figure 3 shows, the level of self-sufficiency has steadily declined from about 80 percent in 2008 to 30 percent in 2016. This indicates that about 70 percent of imported rice is

Figure 3: Trends in domestic production, imports and self-sufficiency in rice (2008–2016)



Source: Various CSA (2008–2016) and ERCA (Ethiopian Revenues and Customs Authority) publications (2008–2016).

year, linked with the dependence of rice production on rainfall patterns (as rice is mainly produced under rain-fed conditions).

Note: Actual trends in changes in numbers of growers, cultivated area, and production are shown as lines. The on-farm yield levels (q/ha) are represented as scattered points (squared markers) against secondary axis and a simple regressive linear trend on yield data is shown.

Trends in imports and domestic consumption

Linked with the increased cultivation, rice has been gaining popularity in recent years due to its relative versatility. Rice grains can partially or fully substitute teff (flour) in making enjera (flatbread), or they can be stored, cooked and consumed. Rice by-products such as straw, husks, and bran can be used for different purposes, including as animal feed. Rising incomes and a more modern way of life, linked with outside home consumption, have also propelled the shift in demand towards rice.

Despite this substantial increase in rice production, consumption requirements (market demand) have outpaced domestic production, in quantitative and qualitative terms. This widening of the gap between

fulfilling domestic demand.

In summary, although it is a recent introduction to Ethiopia, rice has demonstrated a considerable increase in domestic production and consumption along with huge imports. The role of STI in this process has been considerable, starting from identification of the country's production potential to testing and promoting improved rice technologies, to empowering different actors in the rice value chain. This indicates the partial success of the green revolution-type approach in promoting agricultural transformation.

However, the steady decline in the level of self-sufficiency and the limited exploitation of existing production potential create an opportunity to enhance the contribution of STI for rice sector development in the country. These are in the areas of: (1) global engagement in rice STI as rice is an international crop with state of the art technologies in different developed and developing nations, especially in Asian countries; (2) enhancing domestic innovation through increased extension services; and (3) further empowering the domestic rice value chain, especially in the areas of value addition so that domestic rice can compete with imported rice.

4.3 Facilitating market access: the case of ICT and mobile phones in Zambia

4.3.1 Background

Mobile telephony has increasingly gained usage in Zambia, with more than 65 percent of the population

services also continue to grow, with the introduction of 3G networks by all mobile operators (Gilissen et al. 2015). Although the uptake of mobile phones in Zambia is increasing, the number of ICT tools in agriculture is small. A study undertaken by the World Bank to identify which ICT tools could support smallholders identified the following major ICT tools and projects (see Table 4).

Table 4: ICT tools by sector and function

Sector	ICT Tool	Service/ Function
Mobile banking and payment	XAPIT	Mobile banking platform of ZANACO Bank: account balance, payments, money transfer, ATM, internet banking
	Airtel and MTN money	Banking through the mobile phone operators Airtel and MTN: account balance, payments, money transfer
Agriculture	ZNFU 4455 (SMS)	SMS-based market information service of the Zambia National Farmers Union (ZNFU), offering market prices for 16 non-perishable commodities from more than 200 companies
	NAIS (radio, SMS, Internet)	National Agricultural Information Service (NAIS) of the Ministry of Agriculture and Livestock offers general agricultural information via daily radio programmes (each weekday one programme is broadcast in one of the seven local languages); also offers service in which farmers send questions that are answered by SMS; provides a computer with internet connection in one of the district offices. Radio reaches the largest audience
	E-transport	Web-based transport info service of ZNFU links users needing transport services with transport companies
	Lima Links	Mobile phone-based or Unstructured Supplementary Service Data (USSD) market information service with vegetable wholesale prices in four main markets; supports submission of prices by traders and messages between traders and farmers
	E-extension	USSD extension information service of ZNFU provides market information and general agricultural information on prices, events, production and serves as a communication tool and trading platform
Weather	RANET	Climate information service of the Zambia Meteorological Department: weather reports available on the website; also promotes solar/wind-up radios and community radio
Education	I-school	Education platform that provides interactive lessons based on the Zambian national curriculum on a tablet; designed for students to go through the lessons individually

Source: Gilissen et al. (2015).

subscribing to various mobile networks. Mobile phones are changing the ways Zambians communicate, transact business, make payments, bank, and even travel. With two major operators, Airtel and MTN, the use of mobile phones continues to grow as the telecommunications network expands, 3G networks are introduced, mobile phones and calls become cheaper, and more smartphones are in use. Internet

4.3.2 Approach to innovation capacity

An example of an ICT innovation in agriculture is the Zambia National Farmers Union (ZNFU) SMS Market and Trading System (see Box 4).

A survey to understand farmers' use and attitudes to the ZNFU SMS Market and Trading System found that:

Box 4: Zambia National Farmers Union SMS Market and Trading System

Supported by the International Fund for Agricultural Development (IFAD), the Smallholder Enterprise and Marketing Programme (SHEMP) was developed and launched in 2006 in cooperation with the Zambia National Farmers Union (ZNFU). This is an innovative SMS market information service for trading commodities via SMS. It provides up-to-date market prices and a listing of buyers for major commodities in a cost-effective, accessible and reliable manner. Smallholder producers obtain the best commodity prices by sending an SMS message; within seconds, they receive a reply with the contact name and number of the buyer, the full name and address of the company, and simple directions for reaching both. Farmers are then able to make contact directly and start trading.

Smallholder farmers are able to compare current prices and make the best decision on where to sell their output. This system also spurs competition among traders and processors based on price movements. The system has achieved about 1,000 hits per week with 15 percent of SMS messages directly leading to farmers selling their outputs, and more than 130 traders updating their prices on the system weekly. In a similar manner, Cropserve, a supplier to the farming community, is piloting an SMS- and web-based service that provides guidance and pricing for inputs such as seeds. They are in the process of offering veterinary services through the same channels.

Source: IFAD (2007)

40 percent could negotiate better prices; 50 percent claimed to have increased incomes; 21 percent now bulk their products before they sell; 52 percent now sell to different buyers; 23 percent say they have built new trading relationships; and more than 30 percent report increased confidence to grow cash crops or rear animals. Small-scale traders use the system to find markets for the commodities they trade, find prices at which they can sell their products, and learn which commodities provide the highest margins. Large-scale traders use the system for procuring produce and discovering prices offered by their competitors (Gilissen et al. 2015).

In spite of these various reported benefits, the system does have some shortcomings. Few companies send notifications of price changes in real time. It is also expensive to promote the system since training new users requires more time and resources. Gender participation is also expressly defined in the system.

Aside from the output market linkages, the system has incorporated pre-cultivation and cultivation options to a limited extent. These include land planning, crop selection, access to credit and mobile agri-banking, land preparation and sowing, input procurement, supply and management, pest management, e-extension and food traceability. The system has untapped potential to do more to benefit all stages of the product value chain.

4.3.3 Use of ICT by women in Zambia

Access to information is critical for women since they form the majority of the population and are the foundation of communities in many regions. Women's entrepreneurship also plays an important role in the economic development of the country. Thus, the country's social and economic development largely depends on women having access to information and knowledge. Integration of ICTs in women's businesses has the potential to spur competitiveness and engender growth. Access to information is critical in addressing problems facing women such as health, education, agriculture, good governance, environment, water and sanitation, which are key in promoting sustainable development (United Nations 2005). Information can



Innovation platform

potentially enhance women's knowledge and skills and promote their social, economic, political and cultural empowerment, which would also benefit the wider community. It is therefore critical that women are encouraged to adopt and embrace new technologies

service providers; designing two-way ICT programmes to collect and disseminate information; and developing gender-equitable national or regional policies (Gilissen et al. 2015; Deloitte 2013).

Box 5: Kalomo Bwacha Women ICT Club

Women in Kalomo district, South Lusaka (Zambia) are transforming and contributing to economic development by using the internet to market their produce. This initiative is supported by the International Institute for Communication and Development (IICD) of the Netherlands and Step Out Firm in Zambia.

The ICT Club established a resource centre in 2004 and equipped it with telephones, computers, internet, printers and digital cameras. The women meet, share ideas and market their produce physically in one place and through the internet.

The club markets foodstuff, clothes and crafts. With this technology, the women email market producers, are able to express their offer, answer questions, and if successful arrange ways to transact business. This mode of interaction is challenging though because they can only interact with the potential buyer through the internet and sales are not assured. Also, the club does not have a website to place adverts.

The resource centre also faces challenges with computer faults and little technical assistance available. Members also operate the resource centre as a part-time activity when they are not working. There is limited infrastructure to support ICT in rural and peri-urban areas generally.

Source: The Communication Initiative Network (2006).

that would advance their chance of entrepreneurial success (ibid.).

In Zambia, many women are household heads, thus empowerment through technology is important to women so that they can earn sufficient income for their families. As the Kalomo Bwacha Women ICT Club shows (box 5), empowerment through ICT also has a snowball effect, creating grass-roots awareness among rural communities that eventually leads to a strong entrepreneurial sector that can attract foreign investment and contribute to economic empowerment (Maltés 2006).

Several recommendations have been made on strategies and enablers to consider while developing tools that address shortcomings in the use of ICT in agriculture, especially in relation to gender. These include: gender analysis to identify opportunities on how ICTs can enhance current practices; developing appropriate content to meet the needs of women and men farmers; ICT as a complement to existing information channels; developing direct relationships with men and women farmers; identifying employment opportunities for women with agriculture-related ICT

4.3.4 Enabling policy environment

The Zambia Information and Communication Technology Authority (ZICTA) is the body responsible for regulating the ICT sector in Zambia. Its vision is 'To be the catalyst for a better Zambia transformed through the use of ICT in all sectors of the economy'. The country has a national ICT policy but does not have specific agricultural sector policy on ICT, though the national ICT policy aims to make the agricultural sector more productive and competitive by applying ICT in planning, implementation, monitoring, and information delivery. Communications and transport policy also supports the use of ICT tools to mainstream women's issues in all economic activities (Republic of Zambia 2014).

4.3.5 Challenges of ICT in agriculture

In spite of ICT providing substantial transformations in agriculture, the sector faces many challenges. These include the stagnation of mobile subscriptions due to saturation levels, lags in institutional arrangements and policy implementation due to policy and incentives, affordability of airtime and internet charges, irrelevant e-content and language barriers, poor infrastructure coupled with low transmission signals, load shedding,

ever-evolving technology, customised user needs, contextualisation into local culture, information credibility, optimal use and sustainability (Maumbe 2012).

A synthesis of ICT systems in promoting commercialisation of agriculture identifies the following gaps and challenges.

- Zambia has a national ICT policy but does not have a specific agricultural sector policy regarding ICT.
- Few ICT tools are commercially oriented for small-scale farming.
- ICT tools have not been developed specifically for women farmers; gender participation is expressly undefined in ICT systems.
- Many ICT tools are developed for specific projects, whose sustainability is compromised when the project funding ceases. Also, there is limited information on ICT tools with respect to quality, impact and lessons learned from using them.
- Most agricultural ICT systems are biased on the output market component, with the input (pre-cultivation and cultivation) component incorporated to a limited extent only. Updates of mobile technologies on agricultural market platforms are not real time, especially for price changes of commodities (see Box 4).

In summary, the mobile platform has been seen as an innovative way to transform agribusiness because it offers a wide range of solutions at the various levels of the agricultural value chain. However, more work needs to be done to tap into the potential of mobile technology beyond output market linkages to include input market components. There is a need to develop: a specific agricultural sector policy and programmes on ICT that focus on smallholder farmers; real-time updates on critical changes that inform decision-making; gender ICT models to address tailored gender needs; evaluation on quality, impact and lessons learned from use of ICTs; and sustainability of ICTs beyond funding for specific projects.

4.4 Creating an enabling policy environment for cocoa in Ghana

4.4.1 Background

Cocoa is the leading foreign exchange-earning crop

for Ghana, which is the second largest producer in the world after Côte d'Ivoire (Appiah 2004). It contributes about 25 percent annually to the country's total foreign



Collective sorting of Cocoa in Ghana

exchange earnings and is also a source of livelihoods for rural farmers and other value chain actors (Essegbey and Ofori-Gyamfi 2012). Cocoa was developed in Ghana, largely by commercial farmers, many of whom were smallholders and labourers drawing on their own savings and labour, in response to market opportunities and the development of infrastructure (Kolavalli and Vigneri 2011). The crop has gone through four key innovation phases since its introduction in Ghana: exponential growth (1888–1937); stagnation and growth post-independence (1938–1964); downturn (1964–1982); and recovery and second expansion (1983–2008).

These four phases provide a foundation for STI, which plays a critical role in the success of the cocoa value chain in Ghana. These phases briefly provide a background for cocoa production, which has five main components of innovation capacity in commercialisation of cocoa in Ghana: research and extension, farmer organisations, networks and linkages, marketing, and an enabling environment (Kolavalli and Vigneri 2011).

4.4.2 Innovation capacity in cocoa value chains

Various actors play important roles in the innovation system, not just farmers but also researchers, buyers, transporters, public officers, consumers and policymakers (Obuobisa-Darko 2015; Essegbey and Ofori-Gyamfi). Six key building blocks are identified for sustainable sectorial transformation.

4.4.3 Farming ecosystems

Farmers and their changing farming ecosystem were the main drivers of innovation in the introduction and

development of cocoa in Ghana. A fall in the world price of palm oil after 1885 pushed farmers to search for alternative export crops. They used capital from rubber exports in 1890 to purchase new land for production of cocoa. Increasing population pressure in the Akuapem area forced commercial farmers to go further afield in search of alternative export agriculture opportunities. But with insufficient money with which to buy land, new farmers practised sharecropping with earlier settlers under a system called *abusa*, in which labourers were paid one-third of the sales price of the harvested cocoa.

Cocoa farmers reinvested profits in cocoa production in the western end of Ghana's Forest zone, rapidly shifting the production frontier into the Ashanti and Brong Ahafo regions, and consolidating Ghana as the leading world producer between 1910 and 1914. Outbreaks of pests and diseases (cocoa swollen shoot virus disease (CSSVD) in particular) reduced production in the Eastern region in the early 1940s, pushing cocoa cultivation further into the western Brong Ahafo frontier (Amanor 2010). Moreover, farmers in former cocoa production areas, who found that sales prices barely covered their costs, increasingly turned from cocoa to food production (Amanor 2005). Therefore, they were using local knowledge and market mechanisms to grow and expand cocoa production.

4.4.4 Agricultural research and education systems

Research education and extension plays a key role in the generation and use of new knowledge. The Cocoa Research Institute of Ghana (CRIG), which operates under the Cocoa Marketing Board (hereafter COCOBOD), is the key centre for new knowledge. Its objective is to provide farmers with a package of improved husbandry practices for sustainable production, as well as extension and advisory services for effective technology transfer, and developing techniques for the processing of cocoa by-products from waste (Adu-ampomah 2013).

CRIG has made various achievements in the development of cocoa. Its innovations include: elite cocoa materials tolerant to drought for marginal production; pheromone lures and traps for monitoring mirid infestations on farms; screening and use of new and efficient pesticides for the management of cocoa pests, diseases and weeds; materials for extension agents and farmers; evaluation and release of efficient chemical and organic nutrients to replenish soil nutrients; and identification of critical bottlenecks to

farmers' adoption of technologies (ibid.).

COCOBOD's Seed Production Unit obtains new genetic resources from CRIG. In the recovery and second expansion phase (1983–2008), following the downturn of cocoa in Ghana, CRIG introduced high-yielding cocoa tree varieties, encouraging farmers to replace the trees infected with cocoa swollen shoot virus. This boosted production, which rebounded to 400,000 tons by 1995/96 and productivity increased from 210kg to 404kg per hectare. Other institutions like the Institute of Statistical, Social and Economic Research (ISSER) support the cocoa industry.

4.4.5 Bridging institutions

Transforming a sector in a sustainable manner requires effective producer organisation for service and product markets. In Ghana, about 25 percent of producers (200,000) are organised in some way, although a majority (75 percent) of farmers are not organised. NGOs and donors are often involved in setting up cooperatives, whereas the private sector is involved in organising farmer groups via the lead farmer model or around licensed buying companies, through which they deliver inputs and services. Increasingly, cocoa farmers are being encouraged to organise themselves in groups as a prerequisite for certification and for accessing technical and business training, extension and inputs on credit.

There are two formal cocoa farmer groups: Cocoa Abrabopa (CAA) and Kuapa Kokoo Farmers' Union (KKFU). Other small groups exist and are organised around a particular need (viz. exchange of labour, access to certification and access to credit). CAA and KKFU have access to niche/certified markets that offer premium prices, and also access inputs on credit as well as training. KKFU members benefit from fair trade prices and dividends as shareholders of Divine Chocolate Company, while CAA members benefit from higher levels of productivity of the business model. An institutional innovation promoting farmer participation in the production of organic and fair trade cocoa for the export market is attracting higher premiums (see Box 6).

A common shortcoming of farmer organisations is that there is little incentive for farmers to organise themselves into cooperatives. However, cooperatives have had a bad reputation of rent-seeking and benefits to their members are not clear; prices are fixed and there is no room for collective negotiation.

Box 6: Innovative market approach of farmer

Cocoa Abrabopa (CAA) and Kuapa Kokoo Farmers' Union (KKFU) are farmer groups that have an innovative approach to trading. They obtained certification for fair trading in cocoa, which provides an opportunity for a more structured and direct relationship with buyers. The groups have a license to produce for the Dutch market. Group members are trained to build their capacity and organise. After one year, trained farmers and applied inputs on their farms apply for certification, which brings a better price.

Buyers and service providers involved in certification become supply chain managers. Certificate holders such as CCA and KKFU provide services and inputs to farmer groups, linking farmers to their organisation and creating a kind of parallel vertical value chain. In these certified chains, farmers do not have more influence; rather, farmer groups are locked into the chain for as long as there is demand for their cocoa.

Members of the certified farmer groups receive a package of services and inputs on credit (in kind) and they sell their cocoa to a prearranged Cocoa Marketing Company or Licensed Buying Company, thus becoming part of the value chain that competes with other value chains. Farmers benefit by accessing recommended inputs, get advice to apply inputs and in turn productivity levels increase. Trained farmers can access certification for premium cocoa markets. They also receive protective gear, fertiliser supplement and shade trees. These farmers also have access to credit, health care and pension schemes.

Source: Laven and Boomsma (2012).

4.4.6 Cocoa marketing

Before 1947, marketing of cocoa was conducted through a network of private agents, brokers, traders and middlemen who controlled internal marketing. In 1947, the Cocoa Marketing Board (CMB), a subsidiary of COCOBOD, was established as a monopoly over the purchase and marketing of beans. Exports grew steadily and production reached an unprecedented level of 430,000 tons despite the significant decline in world prices between 1960 and 1962. The world price of cocoa collapsed in 1965, resulting in inflation and a drop in the real producer price due to heavy overvaluation of the currency. This situation triggered smuggling of cocoa across Ghana's densely forested border to Côte d'Ivoire, where it fetched much higher prices.

In the recovery and second expansion phase, the Cocoa Rehabilitation Project influenced a change of policy to increase farm gate prices paid to Ghanaian farmers relative to neighbouring countries. This was a disincentive to smuggling. Also, licensed buying companies reduced the monopoly of the produce buying companies, which used to buy all the cocoa produced by farmers. Therefore, various institutional and product/ process innovations put in place have enabled the transformation and revitalisation of cocoa marketing in Ghana.

Institutional innovations: Reforms in 1990 saw the deregulation of the cocoa sector and

liberalisation of purchases. COCOBOD adopted a multiple purchasing system internally to introduce competition. This has introduced many actors into the value chain, such that currently, produce buying companies control only 33 percent of cocoa purchases, competing against 26 licensed buying companies. Another institutional innovation is the creation of the New Products Unit at CRIG in an effort to diversify into new cocoa products such as alcoholic beverages, confectionaries, cosmetics and agro-industrial products.

Product/ process innovation: This involves value addition of cocoa before export in products such as cocoa butter, cake, roasted nibs and chocolate. The major objective of the cocoa sector in Ghana is to process 50 percent of cocoa before export. However, processed and value added cocoa, as a proportion of total exports, is still relatively low (less than 20 percent).

Until recently, cocoa was only processed by the West Africa Mills Company (WAMCO), a private initiative. But the share of processed cocoa was minimal compared with the 50 percent target. The role of cocoa processing has become very important in achieving this target of five¹ large processing companies in Ghana. Privatisation of the public processing company has led to expanded capacity and processing of diversified products for export and local consumption. Currently, there is an installed capacity of 343,000MT, with the prospect of additional processing capacity of 30,000 MT from Archer Daniels Midland, which is likely to move it closer to realising the target of 50 percent processed cocoa before export (Essegbey and Ofori-Gyamfi 2012).

Farmer organisations are participating in fair trade market systems by producing organic and fair trade cocoa that attracts high premiums. The fair trade concept is an innovation that offers good opportunities for creating market niches.

A major challenge of the cocoa value chain is weak linkages between processing companies and scientific institutions, which slows down the innovation process in the sector. Also, there are weak linkages among processing companies for joint strategizing, which would give them greater power in the market. For instance, cocoa paste and cocoa butter rank top on the value-added exports, however, they do not rank among the high value-added such as chocolates, sweets beverages and cocoa-based cosmetics. There is a need to establish networks to break into high value-added diversified products that fetch premium prices.

4.4.7 Networks and linkages

COCOBOD plays a dominant role across the cocoa value chain. In production, COCOBOD supplies inputs to farmers and the produce buying company located in each of the cocoa districts to enable farmers to sell their produce at guaranteed prices. Licensed buying companies and the processing, transportation, and trucking components of the value chain are also very important in the industry. Cocoa production comes with extensive support services from various COCOBOD divisions, such as quality control, seed production, Cocoa Marketing Company, and CRIG. Quality control includes pests and diseases (capsids and blackpod disease) eradication efforts, while a special unit addresses CSSVD. Its quality control division assisted farmers in adopting good agricultural practices to optimise yields, control diseases and pests, and maintain good seed.

The quality assurance institutions also encourage links with enterprises, especially in relation to products destined for supermarkets and export markets. The International Cocoa Organization (ICCO) is a powerful body that brings together all the main international players, and decides how to structure the global cocoa market for the mutual benefit of all stakeholders. Individual global companies – such as Cadbury International (now Kraft Foods), Mars, Unilever, and several other companies whose food industry depends on raw materials such as cocoa – play a role in stimulating cocoa (Essegbey and Ofori-Gyamfi 2012). The Alliance of Cocoa Producing Countries, which accounts for about 75 percent of the world's cocoa, is also one of

the key actors in the industry. Its main contribution is in the facilitation of exchange of scientific and technical information around cocoa production, contributing to ensuring sustainability of cocoa supply. But members have been unable to take unified positions on the world market.

A key challenge facing COCOBOD is that it still serves as the central point in coordinating activities for cocoa production, purchasing, and marketing. Agribusinesses have shown the potential for innovation in the cocoa sector to have a huge impact on Ghanaians' livelihoods and incomes, but face constraints in finance and policy. It is important to break COCOBOD's monopoly but, more importantly, there is a need to strengthen the linkages between knowledge centres of COCOBOD and enterprises, for effective knowledge flow (see Box 7).

4.4.8 Enabling policy environment

The cocoa sector in Ghana has strong governance and policy support. There are clear policies and regulations to guide all actors and actions, from production to marketing.

The policies play a key role in coordination, public investment and finance, pricing, and as an incentive for revitalising the cocoa sector.

COCOBOD was established in 1947 and mandated with a monopoly of purchasing cocoa until the policy reforms of the 1990s and 2000s, which have led to more efficient public institutions and opened space for enhanced private sector participation in the industry. The reforms deregulated market monopolies into many licensed buying companies, which have enabled effective competition. For instance, the producer buying company that used to enjoy a monopoly is currently in competition with about 26 licensed buying companies. Other market mechanisms have emerged, including the fair trade concept, while corporate social responsibility and human (child) rights issues offer good opportunities for niche markets. Such external market stimuli create opportunities for further innovation. In summary, these policy reforms and market stimuli have enabled a greater share of the cocoa price to be passed on to cocoa farmers in Ghana.

4.4.9 Emerging issues in commercialisation of cocoa

A key emerging issue is that the government is concerned with value addition and domestic consumption of cocoa products. However, as already

Box 7: Breaking the monopoly of COCOBOD

The cocoa sector is managed centrally by government, via COCOBOD, which has implemented government policies and programmes on cocoa since its establishment in 1947. It has five main subsidiaries, which include the Quality Control Company and Cocoa Marketing Company, which ensure premium and high-quality exports. Others include the Cocoa Research Institute of Ghana (CRIG), which conducts research and development, the Seed Production Division and the Cocoa Health and Extension Division. Licensed buying companies coordinate internal marketing of cocoa directly from farmers and sell to the statutory body.

As far back as the 1960s, there was an effort to process cocoa before export. The West Africa Mills Company (WAMCO) was established by private initiatives to process cocoa beans into cocoa paste, cocoa butter and other products. Currently, there are about five large processing companies operating in the country, all at various levels of processing. These are the Cocoa Processing Company (CPC), Barry Callebaut, Afrotropics, Cargill and Archer Daniels Midland (which has been acquired by Olam). There is primary processing into the pastes, butter and nibs and there is secondary processing into confectioneries and chocolates.

Cocoa farmers engage in on-farm production and pre-harvesting whereas civil society organisations promote the rights and corporate responsibilities. Cocoa farmers primarily sell to purchasing companies whose business is to buy the cocoa beans from farmers for export. Until June 1993, the Produce Buying Company (PBC) of COCOBOD held a monopoly for cocoa purchasing.

With deregulation of the cocoa industry, licensed buying companies have broken the monopoly. Today, cocoa farmers do not simply cultivate the crop and harvest; they also ferment the cocoa bean to give it a distinct flavour. Cocoa farmers carry out this semi-processing and dry the cocoa for the buying companies.

Source: Goodman AMC website, 'Ghana's Cocoa Processing Industry: An Attractive Investment Option', www.goodmanamcllc.com/2017/05/ghanas-cocoa-processing-industry.html

noted, the share of processed and value-added cocoa as a proportion of total exports is still relatively low (less than 20 percent, against a target of 50 percent). This is an area that requires a research focus on value addition.

CRIG is mandated to coordinate research and development of COCOBOD's programmes and policies (Essegbey and Ofori-Gyamfi 2012). However, research institutes and the universities carry out very little consultation with businesses in setting out their research agenda. New knowledge on products often comes from business enterprises abroad. But national knowledge centres do not adequately interact with domestic businesses. At the same time, there are no incentives for firms to put a high priority on research and knowledge creation. For instance, WAMCO, a leading cocoa processing company in Ghana, has no research department outside of its quality control unit, which deals with quality assurance of its products for the export market. This may be the reason for limited innovations in value addition. There is a need for specific policy actions to improve the investment climate and develop market niches and provide incentive systems to encourage the private sector to engage the public

sector in partnership (ibid.).

In summary, the cocoa sector has gone through various stages of development in Ghana. Transformation in the commercialisation of cocoa has been achieved, from state control to public-private partnership, and the sector is currently on a pathway of entrepreneurial engagement. The cocoa commercialisation storyline reveals untapped opportunities for technological innovation in the following five areas:

- Research has led to high-yielding varieties and farming technologies but weak institutional synergy and strategy have limited innovation.
- Farmer organisations and civil society organisations have influenced reforms in the cocoa sector, thus reducing public and private control. But this is yet to lead to a sustainable governance system with strong farmer entrepreneurship.
- Marketing of cocoa has focused on beans for export. However, there is potential for expansion into niche markets and domestic consumption of

cocoa products through investment in research and policy on value addition.

- COCOBOD regulates the activities of the cocoa sector in Ghana and also maintains functional linkages with the critical actors in the value chain. However, there is greater potential for stronger linkages and networks among processing companies for joint strategies; and between scientific institutions and processing companies to facilitate innovations in the cocoa value chain.
- Policy reforms in Ghana's cocoa sector have allowed a larger pass of world cocoa prices to producers. But there is potential for more innovation by implementing existing and new policy actions on: local consumption of cocoa; support for the cocoa value chain; good manufacturing practices and quality standards (including attractive packaging for products); and regulation of cocoa products such as chocolate exported to Europe.

5. SYNTHESIS AND CONCLUSIONS

The central argument of this paper was that developing supporting, facilitating, encouraging (through incentives) innovation capacity for individuals, organisations and systems creates an enabling environment to join up knowledge and policies for agricultural commercialisation in Africa. This paper has attempted to answer the broader question: What enabling factors make an innovation/technology a vehicle for agricultural commercialisation? The three specific questions addressed are: What pathways for an innovation/set of innovations (related to a technology) lead to agricultural commercialisation? What are the enabling factors? What is a new methodological framework for pathways?

To address these questions, this paper employed innovation capacity as a potentially useful framework for analysing agricultural innovation/ technology – taking rice (Ethiopia), ICT (Zambia) and cocoa (Ghana) as case studies – as a vehicle for agricultural commercialisation in Africa. The following elements of innovation capacity were used in the analysis: (1) building skills and capacities; (2) strengthening producer organisations; (3) developing market mechanisms; (4) strengthening networks and linkages; and (5) creating an enabling policy environment for innovation.

The key findings in each of these cases are as follows. First, investment in human capital through education and training builds the skills and capacities of individuals involved in all aspects of the agricultural innovation system -- farmers, researchers, extension service providers, etc., and this will spur agricultural productivity in Africa. The case of rice commercialisation in Ethiopia followed a more green revolution-type approach, with better yield-enhancing technologies. STI through R&D, especially seed sector development, has played an important role in rice commercialisation, mainly in terms of increased domestic production, marketing and demand. However, the steady decline in the level of self-sufficiency and the limited exploitation of existing production potential creates a further opportunity to strengthen the contribution of STI for rice sector development in Ethiopia and across the continent.

Here, special attention needs to be given to women and girls, and young people, who innovate and represent

the future of agriculture. STISA-2024 recognises the need to train young men and women in new methods that take the environment into consideration to reduce agriculture's ecological footprint and make it more resilient to climate change.

Second, strengthening producer organisations facilitates their members' access to research, extension and advisory services, markets, technologies and financial services. They can also help small farmers gain a voice in policymaking to counter the influence of larger, more powerful interests. As highlighted in the case study of cocoa in Ghana, approximately 25 percent of cocoa producers (200,000) are organised in some way. Increasingly, cocoa farmers are being stimulated to organise themselves in groups as a prerequisite for certification and for accessing technical and business training, extension and inputs on credits. These factors are promoting farmer participation in the production of organic and fair trade cocoa for the export market, attracting higher prices.

Third, developing market mechanisms improves access to local or wider markets for inputs and outputs. It can also provide strong incentives for innovation. Farmers in remote areas and from marginalised groups often face severe barriers, as sustainable agricultural practices often have high start-up costs and long pay-off periods. This category of farmers may need incentives for key environmental services. The ZNFU SMS Market and Trading System is an innovation that provides up-to-date market prices and listings of buyers for major commodities in a cost-effective, accessible and reliable manner. However, promoting agro-preneurship and innovation in Africa requires increasing use of emerging technologies beyond their traditional use, including precision agriculture, sensors, satellites and drones.

Fourth, strengthening networks and linkages in the innovation system provides space for innovation platforms and innovation brokers to share information, negotiate, plan and facilitate action among the different stakeholders. Innovation brokers work across scales, even helping to make linkages between foreign markets and local producers (Klerkx et al. 2009). They need to be highly knowledgeable about the sector, have trust

and gain respect from the different players, as well as be able to communicate across the boundaries of business, government, producers and NGOs.

The cocoa sector in Ghana is regulated by COCOBOD, which serves as the exclusive marketing intermediary between primary producers and processors of cocoa beans in the country. COCOBOD has undergone various transformations in structure and mandate since the 1980s until today. However, a key challenge is to remain relevant by reflecting the modern trends in the global cocoa industry and Ghana's socioeconomic and political aspirations.

In Zambia, ADAPT was a market-led and Care-facilitated project designed to give households in rural Zambia access to an increased range of affordable, high-quality agricultural inputs by developing a network of rural agro-dealers (see Box 2). Although with some challenges, the respective roles of COCOBOD and Care have been instrumental in brokering innovation partnerships in Ghana and Zambia.

Fifth, creating an enabling policy environment enables farmers to innovate. This involves building and/or upgrading research infrastructures and enhancing professional and technical competencies to enhance agricultural productivity. Productivity in agriculture is enabling economic growth in Africa because it is a key driver of long-term economic transformation. The enabling environment also includes good governance, stable macroeconomic conditions, transparent legal and regulatory regimes, secure property rights, risk management tools and market infrastructure. Involving effective and representative producer organisations in policymaking can ensure that public policies take into account the needs of farmers. In Ghana, for example, new areas of policy and programme intervention include the need for research and market incentives on value addition to promote domestic consumption of cocoa, development of infrastructure to support the value chain, adherence to good manufacturing practices and quality standards, and regulation of tariffs for cocoa products exported to Europe.

As espoused by STISA-2024, modern agriculture requires enabling policies on issues such as impact of climate change, nutrition, improved agricultural inputs, emerging technologies, infrastructure, research and extension, and financing. STISA is enabling African agriculture to finally gain momentum, which shows how long-term policy commitments and funding are key to the sector's growth in terms of formulation and enforcement of standards, and investment in rural infrastructure (notably transportation, energy,

telecommunications and irrigation for crop production). Further, food security and nutrition are important in the overall agricultural strategies of STISA-2024 – especially improving maternal and child nutrition by encouraging research and dissemination of dietary diversification information.

6. FUTURE AREAS FOR RESEARCH



This section proposes the following areas for future research in response to the question: What is the new methodological framework for pathways of an innovation or set of innovations (with the focus on rice, ICT and cocoa) that lead to agricultural commercialisation?

- a. How is innovation for agricultural commercialisation impacting on rural poverty, women's and girls' empowerment and food and nutrition security specifically in the study areas, and in the country in general?
- b. What are the specific roles of innovation capacity in promoting agricultural commercialisation along the value chain?
 - How has the role of farmers (drawing on their own savings, local knowledge, and labour) been recognised in commercialisation?
 - What are the emerging trends in agricultural research and extension, and in how international organisations (and other development partners) are contributing to commercialisation? What needs to be done to add value?
 - What role have farmer organisations and cooperatives played in ensuring good governance and benefits for their members (e.g. better prices, room for collective negotiation, etc.)?
 - What are the existing challenges within agricultural value chain governance to enhance commercialisation? What needs to be done to establish networks that enhance high value-added diversified products that fetch premium prices?
 - What can policy and regulation contribute to wider use of the technology/ innovation for commercialisation?
- c. What is the role of STI in promoting rural economies, non-farm rural economies and rural-urban linkages, and livelihood resilience? What special attention needs to be given to youth, who innovate and represent the future of agriculture?

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