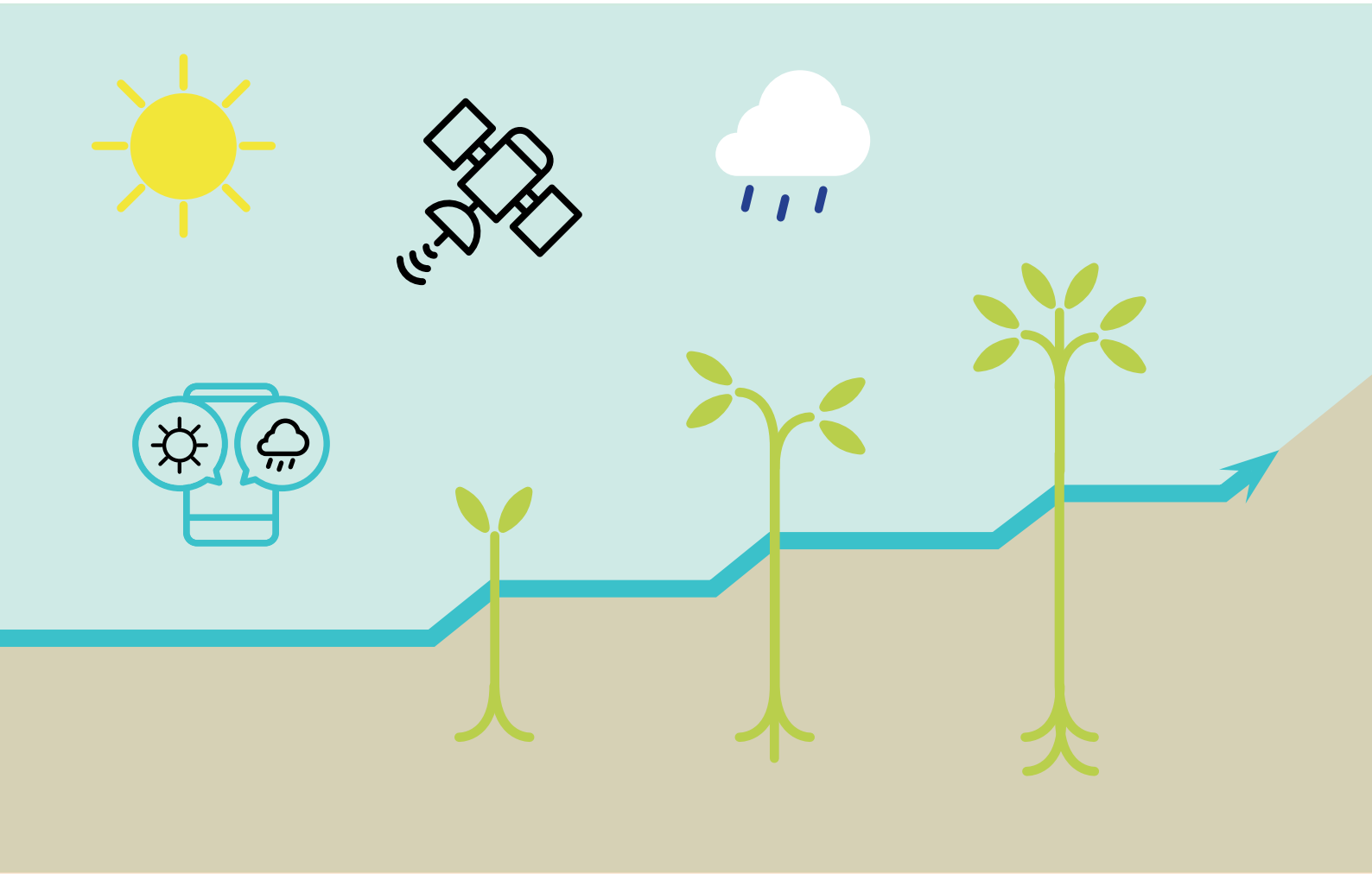
CTA Discussion Paper

Why Invest in ICTs for Agriculture?



ABOUT CTA

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU).

CTA operates under the framework of the Cotonou Agreement and is funded by the EU.

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ISBN: 978-92-9081-640-9

CTA Discussion Paper

Why Invest in ICTs for Agriculture?

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Acronyms

ACP	African, Caribbean and Pacific
AFA	Mercy Corps' AgriFin Accelerate
AIS	Agriculture Innovation System
AR4D	Agriculture Research for Development
CARICOM	Caribbean Community
CED	Chief Ecosystem Director
CFA	Connected Farmer Alliance
CKW	Community Knowledge Worker
CSP	Cross-Sectoral Partnership
CWA	Caribbean Week of Agriculture
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IAF	Impact Assessment Framework
ICT	Information and Communication Technology
ICT4Ag	Information and Communication Technology for Agriculture
ICT4D	Information and Communication Technology for Development
INGO	International Non-Governmental Organisation
IoT	Internet of Things
ITU	International Telecommunication Bureau
KPI	Key Performance Indicator
LWR	Lutheran World Relief
ME&L	Monitoring, Evaluation and Learning
MFI	Micro-Finance Institution
MMAP	Malawi Mobile Money Accelerator Project
MNO	Mobile Network Operator
MUIIS	Market-led User-owned ICT4Ag-enabled Information Service
NGO	Non-Governmental Organisation
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
PPP	Public-Private Partnership
R&D	Research and Development
ROI	Return on Investment
SDG	Sustainable Development Goal
UAV	Unmanned Aerial Vehicle
USAID	United States Agency for International Development

Executive summary

With the ability to reach many farmers with timely and accessible content, the use of information and communication technologies (ICTs) for agriculture (ICT4Ag) has the potential to transform farming and food production, worldwide. ICT4Ag supports new methods in the monitoring and management of soils, plants and livestock (precision agriculture), access to online markets, and improved communication between value chain stakeholders, among others. The services provided are vital in connecting farmers with the information they need to improve their agricultural productivity and reduce poverty.

Through case studies and examples of ICT4Ag initiatives from across Asia, the Caribbean and sub-Saharan Africa, the first chapter looks at how ICT4Ag actually works to drive economic development across developing economies. Further, the chapter reviews the ICT applications, infrastructure and resources built, as well as the policies and frameworks put in place by international bodies, governments and practitioners to ensure that ICT4Ag becomes viable for investment.

To ensure longevity of ICT4Ag services and initiatives, ongoing finance is required after any initial funding runs out. The second chapter outlines the need for viable business models – with profit as the end goal – to entice private sector players to become involved in the provision of ICT4Ag services, and to ensure sustainability of the sector. Suitable areas for potential investment, such as food traceability, reducing post-harvest losses, and remote sensing for precision agriculture are explored.

Universal access to ICT4Ag has not yet been achieved, especially in the rural areas of developing countries. By drawing on case studies and interviews with practitioners from the field, and by outlining the nature of the challenges facing ICT4Ag, the third chapter explains the constraints to widespread adoption. The chapter also explores how the challenges identified can inform investment opportunities, as well as policy recommendations, in order to unleash the full potential of ICTs in development programmes.

To accommodate future scaling of ICT4Ag applications and platforms, an integrated, cross-sectoral partnership (CSP) approach that includes, for example, farmers, agribusinesses, financial institutions, mobile network operators and donors, is necessary. The fourth chapter explains the theory behind CSPs as entities with the expertise and vision to successfully deliver ICT4Ag solutions, and provides examples of CSPs already in practice, along with lessons learned. The chapter also provides a three-step framework for ICT4Ag investment, which includes the implementation of ICTs into payment systems, marketing, agriculture extension and supply chain management by CSPs.

In this final chapter, the different types of CSP investors are also described, as well as their roles within the partnership, and their investment priorities within the three-step framework. According to the author, priority investments for donors and foundations include the design and delivery of training to raise awareness of ICT4Ag and market research to assess the demand for ICT services. Mobile network operators, on the other hand, should increase their investment in the training of personnel to better understand the challenges facing agribusinesses in order to increase subscriptions, and scale-out their services among agricultural stakeholders.

Introduction

Farming is the most important economic activity in many developing countries. In Africa alone, about 65% of the labour force is employed in the agricultural sector, which generates about 32% of gross domestic product (GDP). It is therefore interesting to note that millions of farmers are still trapped in poverty. The reasons are multiple but notably include the unavailability of credit, lack of market information, limited availability of agricultural extension and advisory services for farmers, as well as the lack of information and communication technologies (ICTs) for agricultural development (Aker and Mbiti, 2010).

The urgent need to meet the world's food demand in a productive and sustainable way presents enormous opportunities for innovations using ICTs for agriculture (ICT4Ag). Technologies such as SMS applications, mobile banking and satellite data, for instance, are successfully providing agricultural stakeholders with access to farm mapping and weather data, marketing tools, financial credit and advice from extension workers. Greater access to such information enables farmers to make more informed daily decisions regarding their agricultural activities, leading to improved productivity and profitability, and increased resilience to the impacts of climate change.

However, ICT4Ag faces obstacles that prevent the dissemination and utilisation of ICTs in rural settings – particularly the lack of infrastructure and reception coverage, cost of purchase, management and maintenance of ICT facilities and products, as well as the almost non-existence of institutional structures to govern ICT4Ag initiatives. A further constraint to ICT4Ag is funding. Piloting and development of ICT4Ag technologies and initiatives in developing countries has mainly relied on donor funding, and this has been dwindling in recent years. There is also little action in the areas of innovative financing, such as microfinancing by financial institutions, to help transform the sector from donor-driven funding and aid to sustainable business models.

And yet, with significant investment gaps in the sector, there is huge potential for the scaling out of ICT4Ag technologies and services. The areas for investment include, but are not limited to, the rolling out of farm management software solutions in rural areas of low- and middle-income countries; ICT solutions that address post-harvest losses and reduce wastage; data analysis software that helps both large and small-scale farmers understand their data; affordable technologies for remote sensing; and the extension of 3G networks to rural areas in order to facilitate increased access to ICT4Ag.

The mainstreaming of ICT4Ag initiatives is a challenge in many developing countries due to a lack of clear strategy and the failure to create synergies with other sectors. If ICT4Ag is to help address the problems of, for example, access to credit and market information, as well as the Sustainable Development Goals, agricultural transformation increasingly requires "all stakeholders – including governments, donors and the private sector to align and target their investments" (Mayaki, 2016). Cross-sectoral partnerships (CSPs) in the field of ICT4Ag would help to institutionalise the use of ICT4Ag, and would strengthen linkages, mitigate risks, overcome complexities, and dramatically increase the likelihood of successful ICT4Ag products and services along the value chain (Sarni *et al.*, 2016).

This publication analyses the outcomes and impact of ICT4Ag use and adoption across developing countries through selected country and area-specific case studies. The evidence highlights which services and initiatives are benefiting agricultural stakeholders and commodity value chains, and draws attention to the constraints that need to be addressed to achieve universal access to ICT4Ag. The publication concludes with a three-step framework for ICT4Ag investment and looks to the future of ICT4Ag delivery via 'bundled functionalities' and a cross-disciplinary, partnership approach.

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CHAPTER 1

Evidence of the development and use of ICTs in agriculture for investment

Using evidence derived from developing country case studies and a political, economic, social, technological, environmental and legal (PESTEL) analysis, this chapter looks at how ICT4Ag is working across developing economies. Results from this chapter show that there is much potential for investors and entrepreneurs to take advantage of enabling environments created by governments and related partners to invest in the ICT4Ag sector, across the developing world.

Introduction

In the last two decades, ICTs have become formidable tools used by many development (Aina, 2012; CTA, 2013), research, academia, and industry practitioners (David *et al.*, 2011) to reach out, as well as disseminate knowledge and expertise to target groups, communities and individuals (World Bank, 2012; CTA, 2014; FAO-ITU, 2016). In the year 2000, there were only 738 million mobile phone subscribers worldwide; as of 2015, there were over 7 billion subscribers constituting more than half the world's population (ITU, 2015). In Africa alone, there were over 650 million users of mobile phones in 2010 (Aker and Mbiti, 2010), this has risen to about 226 million, with the average price of mobile phones hovering around €135 in 2015 (GSMA, 2015). Thus, there is hope for agricultural information delivery through the use of ICTs such as radios, videos, digital cameras, emails, telephones, televisions, the internet and mobile phones.

Harnessing mobile phone technology and using it appropriately can build trust in transactions with farmers, leading to increased confidence in ICT services and the content they provide. This is crucial for economic development in all African, Caribbean and Pacific (ACP) countries. To do this, scholars, policymakers, lobbyists, as well as related practitioners, suggest that farmers should not be given information that is unreliable or of poor quality and difficult to use (FAO-ITU, 2016; CTA, 2014). It is argued that the content of the information delivered should be more important than the mode of delivery (Dentoni *et al.*, 2012; Mabe and Olade, 2012). Ideally, local farmers benefit from ICT devices and data, but most of the time these datasets are large and complex, and therefore cannot be used by their target group (Mabe and Oladele, 2012).

ICTs have a transformative influence on farming and food production in countries where the government and policymakers are committed to developing comprehensive e-agricultural strategies. In many countries, infrastructure is being developed to speed up the use of ICTs to improve livelihoods and advance national and cross-regional development (Waddock *et al.*, 2015; Dentoni *et al.*, 2012). Furthermore, a number of countries have advanced the implementation of ICT applications by building policies and infrastructure. Some examples of such countries are Côte d'Ivoire, Jamaica, Papua New Guinea, Rwanda and Suriname. In Trinidad and Tobago, farmers use ICTs such as mobile phone applications to transform their agricultural activities and business transactions. As e-extension services, mobile phone applications that focus on weather, price sourcing at markets, and knowledge and information sharing, among others, enable farmers to make informed daily decisions. Maasai cattle businesses, for example, are thriving by using the market and weather information they receive via their mobile phones as it enables them to move to a specific traditional market in Maasailand, which covers part of Kenya and Tanzania, for business transactions (Msuya and Annake, 2013). Similar activities are carried out throughout many rural and disadvantaged settings across developing economies.

However, more needs to be done in the area of ICT4Ag not only to improve existing agricultural value chains, but also to scale up agriculture-related businesses (Latesteijn and Rabbinge, 2012). This is so because agriculture in developing economies, and more specifically within many ACP countries, has received less attention – in terms of funding and investment

– when compared to other sectors such as education and health (Saravanan, 2010). This chapter therefore seeks to document evidence of the potential and possible areas that could be of interest to investors (CTA, 2016; 2013). Awuor *et al.* (2016) identified the potential role ICTs can play in improving, as well as investing in agriculture in Kenya to include the following;

- Increasingly 'precise' applications and tools – ICT and digital signatures or labels of various types will be used to track products from producer to consumer, to monitor local soil, weather and market condition; to tailor data and information services to the demands of a specific audience or individuals. Applications will come in many shapes and sizes, to suit even the most specialized needs.
- Increasingly 'acceptable' data and information – Vast quantities of public data and information held by institutions and individuals will become visible and re-usable at the click of a device. More intermediary skills and applications will be needed to help harvest, make sense of, and add value to these layers of data and information.
- Increasingly 'diverse' set of applications available across digital clouds – The digital 'identities' of scientists and their collaborators will give them access to a wide range of online tools and applications, accessible from any location and across different devices, enabling collaborations across boundaries as never before. Local firewalls and server configurations conditions will not restrict global sharing.
- Increasingly 'inter-connected' tools and knowledge bases – Different communities and their knowledge will be able to connect and share with each other, and along the research cycle and across disciplines, including people with different engagement in science such as farmers, traders, politicians among others. A whole new breed of products and services will emerge to inter-connect and re-present diverse knowledge.

Source: Awuor *et al.*, 2016, pp. 79.

The above give credence to the potential of knowledge and information sharing that will define the landscape in the use of ICTs to advance agriculture development in Kenya in particular, as well as related developing countries that share more agrarian economic traits with Kenya. Furthermore, Caribbean countries such as Barbados, Jamaica, Trinidad and Tobago, as well as Guyana have developed ICT-related policies, tools and national connectivity infrastructure that guide the agriculture sector to take up ICT4Ag to enhance their activities at various levels of development (CTA, 2014).

The introduction of ICT4Ag products and services has seen some level of impact investments within ICT4Ag fields. For example, impact investors have invested in applications that help farmers compare prices from diverse local and regional markets on their mobile phones, for which the farmers pay a small fee. These serve as a good starting point to look at the potential areas, as well as specific sectors of agricultural value chains that will be viable areas for entrepreneurs and investors to take advantage of.

There is no doubt in the key role ICT is playing in transforming the entire agricultural value chain. The future holds great promise for the impact ICTs will continue to contribute to agricultural transformation as their potential is further harnessed. Whilst this chapter tries to document the main achievements, as well as success stories as evidence of ICT4Ag use, the chapter further categorises thematic areas of concern, as well as direct benefits recorded in the field. Selected country and area-specific case studies are highlighted by looking at commodity value chains that have improved due to the introduction of ICT4Ag tools and business models.

The task

This chapter highlights the outputs, outcomes, impact, as well as general evidence that has emerged from the development, introduction, use and adoption of ICTs for agriculture-related tools with the vision to enhance agriculture-based activities globally, and specifically within ACP countries.

The method

A value chain analysis and modified PESTEL approach were used to collect, analyse and present the results for this chapter. The chapter highlights changes that have emerged due to the introduction of ICT4Ag initiatives and businesses across developing economies. The chapter further looks at how these changes have enhanced the delivery of extension services and market and weather information to farmers, and how they have improved the governance of agricultural value chains.

Specific case studies and interventions mainly from Asia and ACP countries are the units of analyses. The rationale behind exploring these case studies is to identify the synergies and variations that might exist in the delivery of ICT4Ag initiatives and business models that deliver similar services, such as the provision of weather/market information. Findings of the reviewed literature have been grouped by region and categorised under sub-themes of the services provided by ICT4Ag initiatives and providers. Furthermore, extensive desk research was carried out to reconcile data found in both scientific and policy documents, as well as grey literature. This approach helps to inform the potential investors, practitioners and general audience of this chapter on the roles, impacts, effects and activities of ICT4Ag in ACP countries in particular.

A mixed method questionnaire was developed by the team to collect quantitative and qualitative data to support the research question. Phone and Skype interviews with experts, practitioners and beneficiaries from the ICT4Ag sector were conducted to provide further insights.

Data analysis

A PESTEL analysis (Fahey and Narayanan, 1986) was used to present the results of this chapter. PESTEL is an analytical tool that is used by organisations to provide diverse perspectives on the environment in which they are working. This chapter adopts the PESTEL framework to document evidence of ICT4Ag in the current market, as well as to assess its viability for potential investment.

The following are important considerations used to conduct such an analysis:

- What is the political situation of the country and how does it affect the industry?
- What are the prevalent economic factors?
- How much importance does culture have in the market and what are its determinants?
- What technological innovations are likely to emerge and affect the market structure?
- Are there any current legislations that regulate the industry or can there be any change in the legislations for the industry?
- What are the environmental concerns for the industry?

(Source: http://pestleanalysis.com/what-is-pestle-analysis/, 2016)

Table 1: PESTEL analysis of ICT4Ag in developing countries

Political	Political factors determine the extent to which government and political policies and procedures affect and influence divergent industries. as well as the economy of a given state, region, country and/or continent. Policies related to taxes, trade, fiscal, infrastructure, budget, and related others may affect the business environment. As an example, policies related to ICT4Ag are likely to influence the ease or otherwise of doing business or investment in the agricultural sector.
Economic	Economic factors include determinants that directly and indirectly influence as well as impact the economic performance of businesses and organisations. Issues related to budget, inflation, Foreign Direct Investment, interest rates and foreign exchange rates influence investors' willingness to do business in particular countries and regions. How businesses price their products and services is influenced by economic issues that prevail in developing and emerging economies. Economic issues of a country or region are likely to serve as an incentive or disincentive for investment in ICT4Ag, especially in developing economies where such business models and initiatives are needed.
Social	The social environment of a target market is said to influence investment drive. Social issues such as cultural trends, population and demographic balance, and behaviour and trends of new business and venture acceptance, are likely to influence the decision to invest in a country, region or continent. This holds for ICT4Ag investment as well.
Technological	Innovation in technology, ease of the design, and use and adoption of the technologies – in this case ICT4Ag – are likely to influence the dissemination, as well as investment in such businesses and ventures. This is further critical for ICT4Ag which mainly relies upon technological inputs and gadgets to thrive as a business.
Environmental	To some extent, the surrounding environment of business ventures influences the sustainability and viability of the products and services provided. Factors such as climate, weather, geography, environmental variability, topography of land and country, as well as flora and fauna can influence the ease or otherwise in ICT4Ag investment.
Legal	Laws of a country, continent and regional affiliations, as well as membership of international bodies, such as the United Nations, African Union and the Asian Development Bank, are likely to influence certain cross border investment. International corporate organisations may like to keep as many universal legal frameworks and regulations across their investments as possible, across geographical spaces. Similarly, investment friendly legal frameworks of countries may influence investments in ICT4Ag.

Extensive literature reviews to look at the broad picture of the research questions were done on grey and secondary/anecdotal information available online. This was compared with other case study materials sourced from related organisations and institutions such as the African Development Bank, the Forum for Agricultural Research in Africa (FARA), the Technical Centre for Agricultural and Rural Cooperation (CTA), Dissemination of New Agriculture Technologies in Africa (DONATA), the Caribbean Agriculture Research and Development Institute, the Rural Agriculture Development Authority (RADA) in Jamaica, the Asian Development Bank, the Food and Agriculture Organization of the United Nations (FAO), and the World Bank Group, among others.

Results

Evidence of ICT4Ag in developing economies

Many ICT4Ag initiatives and business models focus on three thematic areas within the agricultural value chain: (1) agronomic and extension issues; (2) natural and climatic issues; and (3) market and business issues. However, in the first two decades of their inception, the ICT tools and applications developed were initially influenced by 'top-down' thinking in the areas of design, experimentation and implementation, as well as review and evaluation. Therefore, in the

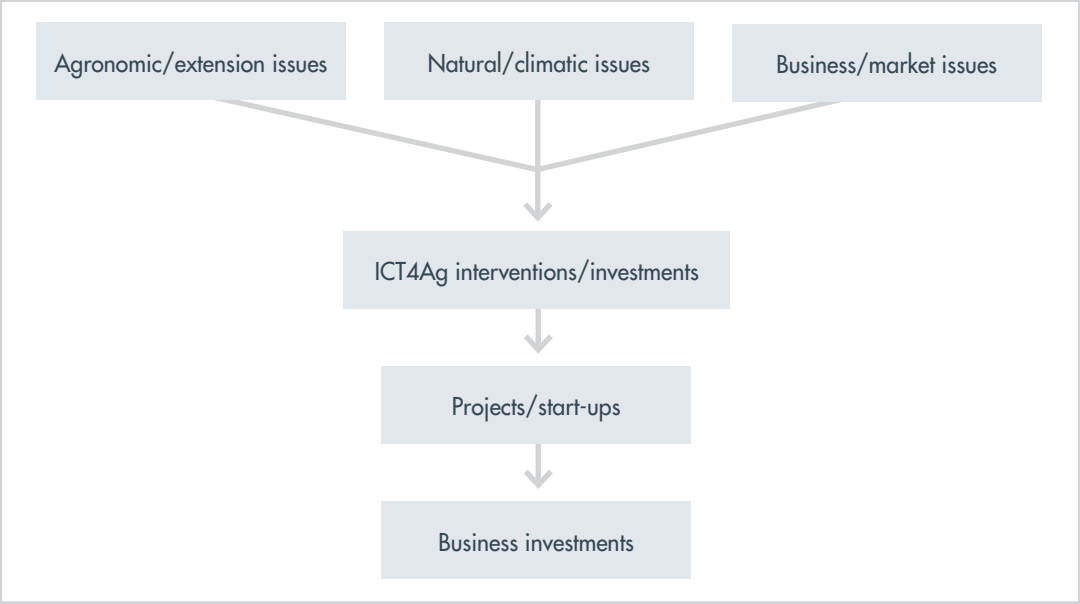


Figure 1: Conceptual model on evidence of ICT4Ag in developing economies (modified from Nuer, 2015)

absence of 'bottom-up' input from target users, these ICTs have been technically challenged to solve the problems they were meant to address.

In the last decade, however, many competitions and investment drives have been introduced as a way to psyche youthful participation and entrepreneurial investment, in order to sustain the many initiatives and start-ups that are ongoing within ICT4Ag fields (London, 2015; Dentoni, 2012).

Whilst impact investors and start-ups/ incubations have seen a level of increase, in part, due to the implementation of talent competitions such as CTA's AgriHack and hackathons, it is evident that a lot more effort is needed to scale-up these initiatives and turn them into real businesses that can become self-sustaining (London, 2015; Dentoni, 2012).

PESTEL analysis on evidence of ICT4Ag use in developing economies

This section looks at how ICT4Ag has penetrated not only the world's agricultural value chain, but also how various governance structures across ACP countries have created opportunities that could be of interest to investors as well as entrepreneurs. The case studies highlighted exhibit how political, social, economic, environmental, legal and technological issues influence ICT4Ag successes.

Political

Various national governments have embraced, enacted and given consent to many ICT4Ag policies and initiatives. Governments have various ICT4Ag policies and initiatives that have been embraced by donors, not-for-profit organisations and non-governmental organisations (NGOs), as well as business start-ups.

Ghana

The Ghanaian Government worked on its ICT for Accelerated Development Policy (ICT4D, 2003) with development partners and prioritised the expansion of infrastructure such as fibre optics, communication busts (physical structures used by Telcos to transmit signals to its target clients/communities) and satellites to enhance ICT development as an avenue to entice private sector investment.

The aim at the time in 2003 was to woo investment, as well as donor-driven support to create employment for Ghana's productive labour force. Specifically, the policy document stated that "Ghana's development process can be accelerated through the development, deployment and exploitation of ICTs within the economy and society" (ICT4D, 2003, pp. 8).

In the context of infrastructural and agricultural development and production, as well as market access, the policy document had the following as its core vision:

The strategies

- Modernise and expand Ghana's information and communication infrastructure and services to improve universal access and quality of services
- Expand the physical infrastructure of Ghana, including those of power and transport
- Promote the development and deployment of basic and broadband and multi-platform communications infrastructure to facilitate public access to information and services
- Put in place special ICT promotion packages, policy instruments and incentives to facilitate the expansion of the information and communications infrastructure
- Employ science and technology in ensuring the supply of sustainable, affordable, safe and reliable energy
- Develop human resources to support the deployment and rehabilitation of modern and state-of-the art ICT infrastructure
- Promote research and development (R&D) programmes relating to alternative energy sources such as solar energy, biomass, nuclear, wind and other renewable energy sources to supplement the current traditional energy sources

Source: Ghana's ICT4D Policy Paper, 2003, pp 63.

The Government of Ghana has developed a four tier implementation plan related to ICT4D. The country's mission is to carry out a complete overhaul to improve the ICT sector, as well as the use of ICTs in all aspects of its national and socio-economic development agenda (including the agriculture sector) for the period 2003 and 2022. The last two tiers of the policy document are presented as follows:

The 4th Rolling ICT4AD Plan [2015-2018]

Goal: To further enhance and strengthen the production base of the economy to accelerate development and growth towards achieving an information-rich knowledge-based society and economy.

Priority policy areas of focus

- Developing an export-oriented ICT product and services industry
- Modernization of agriculture and the development of an agro-business industry
- Developing a globally competitive value-added services sector
- R&D and scientific and industrial research capacity development
- Promoting foreign and local direct investment drive in ICTs

Strategic focus of the plan

Laying more emphasis on the production, development and delivery of ICT products and services and less emphasis on ICT deployment and exploitation.

The 5th Rolling ICT4AD Plan [2019-2022]

Goal: To facilitate the process of sustaining economic development and growth towards improving national prosperity and global competitiveness.

Priority policy areas of focus

- Developing an export-oriented ICT product and services industry
- Developing a globally competitive value-added services sector
- R&D and scientific and industrial research capacity development
- Promoting foreign and local direct investment drive in ICTs

Source: Ghana's ICT4D Policy Paper, 2003, pp 81

The above policy documents created an enabling environment that has seen many donor-driven interventions, as well as ICT4Ag start-ups that have impacted the sector in Ghana. The rise of initiatives and start-ups, such as Farmerline and Esoko – who both have a diverse range of local and international partners – are evidence of how the initiation of these policy frameworks and strategies have created the right environment for investors, entrepreneurs and hackathons to invest in ICT4Ag-related products and services.

Rwanda

In the case of Rwanda, its National ICT Strategy and Plan (NICI, 2015), which has the ultimate goal of creating 'a knowledge-based economy', supports identified trends of national interests in fields including mobile application developments, outsourcing of data management and cyber security mechanisms. This is to ensure that businesses and the country at large thrive on the use of ICT-related tools, products and services by the year 2020 (NICI, 2015; Bryan Harrison, 2012). Though not directly mentioned as a core theme, ICT4Ag initiatives are spearheaded within the facilitation of ICT infrastructure development, i.e. within the establishment of legal, regulatory and institutional provisions and standards; through the deployment and spread of ICTs in communities and the development and facilitation of the private sector (NICI, 2015, pp. 15). ICT development, as well as the initiation of policies by the government to enhance ICT development, have served as incentives for the country to invest in ICT-related business. Rwanda has become the most sought after place to invest in ICT business, including ICT4Ag, which is sanctioned by the Ministry of Trade and Commerce, the Ministry of Agriculture and the Ministry of Finance. The government has created an enabling environment for Esoko in the provision of incentives such as tax reliefs and policies for both the company, agriculture related actors, and communities. Community ICT centres and logistics have been established in many provinces of the country. Community members, which include farmers, therefore have access to information for their activities (NICI, 2015, pp. 38; NICI, 2010).

Rwanda has further contextualised its ICT4Ag policy document by commissioning its National ICT4RAg (R standing for Rwanda) Strategy 2016-2020 entitled *eTransforming Agriculture in Rwanda 2016-2020*. Positioned and implemented by the Ministry of Agriculture and Animal Resources, the policy document seeks to use ICT4D tools and products to transform and improve agriculture development, its marketing, as well as the creation of an enabling environment for agriculture to be seen as a business, and also attract investors to venture into the field. In summary, the policy document's vision for 2020 identifies six interwoven pillars, including good governance and an efficient state, skilled human capital, a vibrant private sector, world-class physical infrastructure and modern agriculture and livestock, all geared towards national, regional and global markets (ICT4RAg Strategic Plan, 2016, pp. 8).

Tanzania

The national agriculture policy 2013, which was implemented by the then Ministry of Agriculture and Cooperative in Tanzania and evolved from the national information technology policy of 2003, gives credence to the importance placed by the national government on ICT4Ag. The policy document gives tax leverages and provides other incentives, such as the building of community information centres with implementing partners that seek to enhance the use, adoption and optimisation of ICT4Ag products and services to improve livelihoods in the country.

Caribbean

Caribbean countries such as Dominica, Grenada and St. Kitts and Nevis have recorded significant improvement in the 2016 ICT Development Index presented by the International Telecommunication Union (ITU), which monitors and records ICT/telecommunication activities across the world.

Economic

Many mobile applications that look at gathering information along agribusiness marketing chains to help with price negotiations, weather updates and warehousing (Esoko, Farmerline, M-Pesa, etc.) have enjoyed government support in the last decade. Tax incentives and tax holidays have been given to many start-ups, investments and innovative business models that use ICTs to improve agriculture development across developing economies (CTA, Pacific Agriculture Policy Project (PAPP), FAO, the World Bank). Public-private partnership (PPP) initiatives have been further launched by various governments across developing economies in the last five years. Bangladesh, Ghana, Jamaica, Kenya, Rwanda, South Africa, Tanzania and Trinidad and Tobago, are among the countries that have documented PPP arrangements in their national

development plans, as well as tax incentives and holidays for would-be investors venturing into ICT4D businesses in the so called 'vision 2020'-related development plans for these countries.

Economic incentives to encourage investment in ICT4Ag initiatives and business models have become prevalent on many platforms across many developing countries. National organisations such as RADA-Jamaica and PAPP have initiated hackathons and projects on a piloted basis; scale-up incentives are on-going with technical and financial support provided by international partners such CTA and the EU.

National economic teams implementing ICT-related policies have included experts such as designers and implementers of start-ups and businesses, from companies such as M-Pesa and Esoko, among others.

The policy framework of PAPP, initiated by development partners and Pacific countries, has embedded in its value chain analysis the need to integrate PPPs into initiatives that focus on agricultural development. Whilst this is laudable and already well integrated in many ICT4Ag initiatives, the missing link seems to be the delinking of entrepreneurs and direct business investors to turn these initiatives into potentially viable businesses (London, 2015; Dentoni *et al.*, 2012; PAPP and CTA, 2016). This seems to have been addressed with the inclusion of entrepreneurs in these ICT4Ag initiatives and highly advocated investment drives, as well as through resolutions made at the 2016 Caribbean Week of Agriculture (CWA) that concentrated on the theme 'Investing in food and agriculture'. The regional gathering saw all countries that form the Caribbean Community (CARICOM) pledging to ensure they will provide the necessary economic incentives to woo investors into the agriculture sector, which employs about 80% of their population as peasant farmers.

Many developing economies have, at various levels, initiated as well as instituted infrastructural development agendas to enhance ICT4Ag investments. Whilst many countries have got to the level of scaling up and sustaining an ICT4Ag-related economy, it behoves investors and entrepreneurs to take advantage of the created infrastructure such as communication busts, satellites, and offices and road constructions across these countries to venture into businesses that will bring them higher return on investment (ROI). Such investments will also potentially open up the currently agrarian economies that rely upon traditional extension services and agricultural production models.

Social

The adoption of ICT tools means that actors across the spectrum of society can use such gadgets to advance and improve their livelihood activities. This has been seen with the penetration and use of mobile phones and applications to reach out to targeted clients and audiences. The agriculture sector has not been left out in the transition towards mobile technology use and related gadgets. Farmers and extension staff have been empowered (directly and indirectly) to take advantage of the wave of ICT tools that are likely to enhance the way businesses are run at the community level. Notable organisations spearheading these trainings include FAO, CTA, World Bank, FARA, RADA, DONATA and PAPP.

ICT4Ag 'spaces' to advance training, development and use of ICT4Ag-related activities have been created online and at the community level by service providers and NGOs that operate in traditional and neo-agrarian settings in developing economies, such as the GRAMEEN Foundation and the MasterCard Foundation. The following are case studies that support ICT4Ag initiatives that have focused on providing solutions to societal needs across developing economies.

Ensibuuko-Uganda

Ensibuuko is a 'Software-as-a-Service' (SaaS) provider that aligns its incentives and services to the needs of microfinance institutions and savings groups services – such as the provision of credit to the smallholders – across regions and countries. Basic needs identified include provision of credit facilities to smallholders, as well as provision of financial services and linkages to local financial institutions. The service provider developed a mobile and web application in 2015/2016, which enables cooperatives of smallholder and rural farmers to mobilise savings, and receive and disburse loans. The service provider had a financial forecast of €293,600 for 2016 and €490,000 for the period 2017.

The company provides mainly microfinance management systems and only collects savings, loan and repayment information from farmers. A summary of areas of intervention and

investment by Ensibuuko is summarised in Appendices 1 and 2.

FarmDrive-Kenya

FarmDrive connects financial institutions, insurance companies and smallholder farmers through mobile phones to access loans and related financial and insurance services. Smallholder loan acquisitions are tied to the crops, land size and season under which the crop has been cultivated. The company, through the use of its software application, ensures that the information gathered, such as plant growth, harvest time/period and the sale of crops, falls within the instalment plans of the loans acquired by the farmers. A weather insurance package further helps to provide security for both the loan lender and recipient. Payments and defaults are tracked by the company via the FarmDrive mobile app, which is monitored by the stakeholders.

Case study iCow-Kenya

In Kenya, a mobile phone application called iCow has been developed by Green Dreams TECH. The application includes a cow calendar which dairy farmers use to register their cows by gestation date, and then receive text messages from the iCow app to alert them when to carry out artificial insemination. About 128,000 Kenyan dairy farmers have benefited from the application. Farmers have seen an increase in milk production by 2-3 l a day, and an increase in their incomes of €25 per month.

Agrinfo-Tanzania

Agrinfo is an ICT-based online database that uses GIS to record farmland ownership in Tanzania. Agrinfo has partnered with farmer cooperatives, financial institutions, and input and output suppliers to access information for the database. The database service provider, also a start-up, stores information such as farm area size and areas suitable for agriculture investments, as well as a platform for mapping farms using GPS software on mobile phones. The start-up serves as a bridge in bringing financial institutions and potential investors to areas where they could invest in farm-related businesses in rural Tanzania.

Pacific-Caribbean Countries

mFisheries West Indies

Fishing communities are also benefiting from ICTs. An example is the mFisheries mobile and web application developed by the University of the West Indies. In Trinidad, this application is used to improve the efficiency and welfare of small-scale fishers. By using a smart phone, fishermen are able to use the app to receive weather reports, navigational tools, training tips and first aid and emergency boat repairs. The application can also be used to find the fish prices from different markets.

Technological

The introduction of many ICT-related tools means that there is good market for ICT4Ag, not only along the agricultural value chain, but within the entire ICT4D arena. The introduction of competitions such as hackathons, bootcamps, and impact hubs has incentivised youths to create new technology applications. As an example, the Meltwater Entrepreneurial School of Technology currently trains young graduates across sub-Saharan Africa to design and pitch innovative initiatives after a year of training. The rise of partnerships within the technology arena further serves as a potential incentive for investors and entrepreneurs looking to get into the area. The following case studies support technological investments and initiatives that show the need for potential investors and entrepreneurs to invest in ICT4Ag.

The Asian Development Bank case studies and examples

The Asian Development Bank has initiated many ICT4Ag projects that aim to increase yield and production, as well as market access and post-harvest enhancement. The bank has targeted a water resources information system in Viet Nam that has a funding portfolio of €588,000. The bank also supports the implementation of the Greater Mekong sub-region's Core Agriculture Support Program (Phase 2) that has composite funding from Swedish and Nordic funding sources, running into the millions of dollars. Another area of the bank's funding and investment is in the application of remote sensing technologies in river basin management for countries like Bangladesh, Philippines and Viet Nam.

Case study: Vodafone Connected Farmers in India

Vodafone Connected Farmers is expected to provide an average improved income of about €105 for over 60% of smallholder farmers in India by 2020. This case study focuses on how mobile technologies can impact Indian farmers who live on under US$2 a day. Specifically, the foundation and its partners explored how mobile solutions are helping to improve agricultural

productivity and efficiency, and rural livelihoods in emerging markets across the developing world (cf. India, Kenya, Tanzania and Turkey). Findings from the explored areas have been contextualised to suit the agricultural production needs of farming families in India. With international development organisation Accenture as its main partner, the Vodafone Foundation has earmarked six services that the telephone sector can provide to help improve livelihoods, as well as create markets for farmers and encourage investment in India. A projected turnover of just under €5.5 billion is forecasted for farmers who are likely to adopt and use services to be provided by the Vodafone Foundation. A summary of the six main services is presented below.

	Type of service	Case study
Information services	Provides tailored agricultural information over mobile phones to the farming communities	**Reuters Market Light** Organisation: Reuters Market Light Location: India
Receipt services	Provides transparency in daily commodity supply chains through use of mobile registration services and receipts	**Ndumberi Dairy receipting services** Organisations: Ndumberi Dairy Farmers Co-operative Society, Vodafone, USAID, Technoserve, Safaricom Location: Kenya
Payments and loans	Integrates farmers into a registered database and enables access to loans and payments via mobile money	**Multiflower payment and loans services** Organisations: Multiflower, Vodafone, USAID, Technoserve, Vodacom Location: Tanzania
Field audit	Uses tablets to improve efficiency for auditors monitoring quality, sustainability and certification requirement	**ECOTAB** Organisations: Unilever, Vodafone, Rainforest Alliance Location: Turkey
Enabling access to local markets	Enables small-scale producers to transact with local co-operatives through a buy/sell platform with integrated mobile payments.	**RUDI Sandesha Vyavhar** Organisations: Self-Empowered Women's Association, Vodafone Foundation, Cherie Blair Foundation for Women Location: India
Smartphone-enabled services	Provides a combination of smartphone-enabled information services, with mobile payments, loans, insurance and receipting and a virtual marketplace	**Vodafone Farmers Club** Organisation: Vodafone Turkey Location: Turkey

Source: Vodafone foundation, 2015

Whilst a lot of the above-mentioned investment started from impact investment and social entrepreneurship systemic thinking, new businesses with profit as their sole motive have emerged in Asia. Examples include initiatives spearheaded by the Yunus Foundation in Bangladesh, Pakistan and Viet Nam, as further described below.

The Yunus Foundation example

The Yunus foundation through its Social Business Fund Mumbai has an estimated €2 million from co-financiers to build and support many social ventures that have society and community development as core to their vision in India. The Yunus centre, and related networks, rely on ICT4D tools to provide various forms of microinsurance and microfinance products and facilities to many smallholder farmers within and outside of rural and peri-urban communities. The combination of PPPs and foundations venturing into ICT4Ag in South-East Asia is expected to reach about 20% of the entire business portfolio in the next two decades (Asian Development Bank, 2016; Yunus Centre for Social Business Mumbai, 2016). This notwithstanding, it is interesting to note that there is a lot of room for investment in the Asian market. The prevailing challenges for investments continue to relate to extreme weather events due to climate change, such as drought and flooding, as well as institutional and cultural issues such as the traditional land tenure system (Chapter 3 of this work conveys some of these challenges).

Whilst ICT4Ag activities are supported by local and foreign agencies and bodies, international impact investors – through diverse networks such as the Global Impact Investing Network – have identified opportunities created in Asia and are doing business in countries such as Bangladesh, India, Myanmar, Nepal, Pakistan and Sri Lanka. Private investment in ICT4Ag in Asia is estimated to be in the range of €84 million (FAO, 2016; Asian Development Bank, 2016).

Sub-Saharan Africa

Kenya, Ghana, Rwanda, Tanzania and Uganda are among the leading countries in sub-Saharan Africa that have made advancements in ICT4Ag in Africa. Rwanda, for example, was the second country in Africa after Namibia to introduce 4G high speed broadband. This became possible because the country got involved in ICTs and launched a network that provided high speed broadband access to 95% of Rwanda within three years (Lwakabamba, 2005). Due to this advancement, the country has been able to progress towards its 2020 vision of developing a path that seeks to transform the country into a middle income ICT-based economy. The ICT network launched led to a rapid growth of Rwanda's mobile phone usage from 6 to 60% in just five years, which ultimately lead to transformation of the agricultural sector.

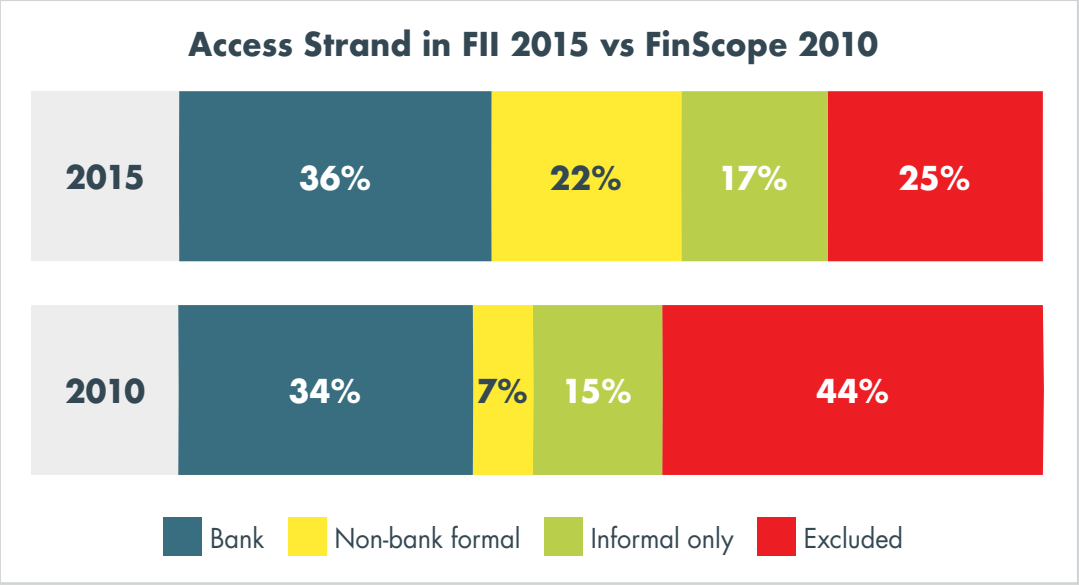
Farmers have been able to use ICT-related applications such as mobile phones to access financial and climatic information, thus enhancing their production functions (Harrison, 2005).

Other countries such as Cameroon, Ghana, Niger, Nigeria, South Africa, Tanzania and Uganda have their own telecommunication companies, start-ups and international collaboration, including with CTA, the MasterCard Foundation and the African Development Bank, who have initiated technology-based activities and investment. Kenya, as an example, has witnessed an agriculture-related business boom due to the influx of many agricultural web-based app initiatives coordinated by telecommunication and investment companies, such as Safaricom, Orange and the African Development Bank, and through the use of mobile money app M-Pesa (CTA, 2016; Eldon, 2005). For example, to advance the use of ICT4Ag in sub-Saharan Africa, Susan Oguya and Jamila Abass, the founders of start-ups M-Farm and Akirachix, developed a mobile application for farmers in rural Kenya. Using the M-Farm app, farmers are able to predict their estimated production and yield based on the size of their land.

The Consultative Group to Assist the Poor (CGAP) case studies of mobile banking as e-financial services in Ghana, Kenya, Rwanda and Tanzania

Kenya and Tanzania were among the first countries to witness the proliferation of ICT4D tools and services in the mobile banking sector. A GCAP study between 2013 and 2015 found that the adult population with access to financial services, as well as inclusion in access to financial services due to the introduction mobile banking, stood at 65 and 50% for Kenya and Tanzania, respectively. In Ghana and Rwanda, 48 and 37% of their adult populations have been reached since the introduction of e-financial services in 2015 (CGAP, 2015). In Kenya and Tanzania, 28 and 21% of the adult populations now have access to a bank account due to the introduction of mobile banking, and Ghana and Rwanda have seen similar growth with 34 and 16% of adults accessing a bank account. Kenya and Tanzania recorded 63 and 38% of their adult populations owning a mobile money account; in Ghana and Rwanda, figures for the same stood at 20 and 23%, respectively.

The above figures show that ICT4D initiatives have great potential for investment. In Kenya in 2015, the percentage of urban and rural populations with access to mobile banking stood at 44 and 56%, respectively (GCAP, 2015). Tanzania recorded 45 and 55%, Rwanda had 39 and 61%, and Ghana recorded 60 and 40%, respectively. A FinScope study carried out between 2010 and 2015 in Ghana found that financial exclusion had almost halved to about 43% due to the introduction of mobile banking.



Source: CGAP, 2015

Environment

Environmental factors such as climatic issues continue to influence the use of ICT tools in many developing economies. Poor mobile connectivity for instance is experienced when there is heavy rainfall. Interestingly, environmental factors also affect the use and sustainability of many ICT4Ag initiatives embarked in the rural settings of ACP countries, where 70% of agricultural production is carried out. It is estimated that over 200 million small-scale farmers are affected by environmental factors including climate and soil-related issues that when tackled, can lead to about a 50% increase in production. Start-up companies have emerged to bring in solutions in the area of weather forecast information, however, it is estimated that many farmers are currently not reached with such initiatives due to a low level of investment.

Sub-Saharan African examples

Esoko and FarmerLine are examples of ICT4Ag companies that provide weather forecast information to farmers as well as climate mapping data, which includes information on agronomic conditions. Across countries like The Gambia, Ghana, Nigeria, Rwanda, Sierra-Leone and Uganda, data generated by the two companies is sold to farmers (at the below prices) and not-for-profit organisations that engage in agriculture-related interventions.

Farmerline is a software developing company with 'a social soul' that provides voice content services to farmers in their local languages. The company provides weather forecast, good agronomic and marketing tips to farmers. For example, a weather forecast subscription costs $3 per season per farmer (6 months).

An impact study conducted by Farmerline has shown that a 50% increase in farmers' income is achieved when relevant information, such as weather forecasts and the price of agricultural products, is provided to them. As of May 2016, about 200,000 farmers are benefiting from the solution provided by the company in the form of data and information. The company intends to reach about 1,000,000 farmers by 2020 in order to achieve its targeted impact of curbing negative shocks to farmers due to environmental-related challenges, such as climatic variability, across the African continent.

Legal

Many governments have sanctioned and approved various policies and legal frameworks that support the use of ICT tools to enhance agriculture. International organisations such as CTA, FAO-ITU and the World Bank have initiated legal frameworks that many developing countries currently subscribe to (CTA-ITU, 2014). The Harmonization of ICT Policies in Sub-Saharan Africa serves as an example of related legal frameworks that cut across geographical boundaries. The policies within this framework complement national policies like Rwanda's vision 2020, which aims to make ICTs one of its main tools to advance its national development plans.

The FAO/ITU/CTA example

The e-agriculture strategies developed by the above organisations have created an enabling policy environment for those countries subscribing to the framework. Furthermore, the framework document has created the desired outcomes in the use of ICT4Ag tools and products. This has become a benchmark that many developing countries such as Bangladesh, Ghana, India, Jamaica and Kenya, among others, subscribe to. The e-agriculture framework is gradually helping to harmonise local policy frameworks and policies of national governments in the ease and use of ICT4Ag tools, as well as to synchronise incentives to drive investment in the agriculture sectors of their economies.

In the last decade, the FAO/ITU/CTA framework (c.f. Appendix 4) has gradually become the core document and strategy that governments, development partners, NGOs and not-for-profits rely upon to initiate and implement their ICT4Ag policies and business models. The framework could become an important strategy in agriculture investment business models for investors and entrepreneurs to take advantage of, and invest their resources and core competencies in. Further, it is a document that can be used as a guide to scale-up ICT4Ag policies and project initiatives within the agriculture sector.

Evidence from CARICOM

CARICOM, an organisation of 15 Caribbean nations and dependencies, has imbibed many contexts of e-agriculture strategies into national development plans. Political documents and strategies such as the Community Agriculture Policy, the Regional Food and Nutrition Security Policy, and the Agribusiness Strategic Plan have integrated ICT4Ag strategies such as e-extension and data banks that store and provide information to researchers, farmers, investors, policymakers and the international community (including the EU that has previously and continues to sponsor development policies with significant budgetary support to the community).

Modern knowledge and information systems to improve decision making and encourage R&D, actor interactions and information sharing, have been set up in member states since 2013. The aim has been to help create an enabling environment whereby extension services, market access and information, and food and nutrition security issues are handled to improve agriculture production across the Caribbean community.

A 2016 CWA – endorsed by all countries in the community – with the theme 'Investing in food and agriculture', has seen many strategies and enactment of agriculture-related policies, shared by countries such as Belize, Guyana, Jamaica and Vanuatu. In the Caribbean community, over 60% of the productive labour force are subsistent farmers, representing opportunities for investment.

A Council for Trade and Economic Development seminar was held in the Cayman Islands by representatives of CARICOM in October 2016. The aim was to forge and develop further strategies, which included ICT4Ag incentives, to help woo investors and entrepreneurs into agriculture-related investments across food value chains in the Caribbean region.

Evidence from sub-Saharan Africa

The Eastern Africa Community, especially the so-called 'Great Lakes Region', as well as countries within the Common Market for Eastern and Southern Africa, have initiated a 'vision 2050' accelerated development plan that includes ICT4Ag as a major strategy to improve agricultural production, with PPP as one of its core objectives.

Kenya and Tanzania have included ICT4Ag in their national policies, and encourage innovative investment mechanisms to improve agricultural production. Kenya and Tanzania have great potential to act as significant export markets to Europe due to their proximity to seaports such as Mombasa and Dar-es-Salaam, and as such, have seen their governments initiate robust

infrastructure developments and tax relief policies to serve as incentives for potential investors to take advantage of this point.

The creation of an enabling policy environment aimed to woo investors to capitalise on products and services, such as ICT4Ag, to advance the national vision of improving agricultural production. Investors needed to look at how best to take advantage of the political environment for investment, whilst not contravening the state security of governments.

Other areas of ICT4D initiatives creating avenue for investment

Financial service provision to unbankable rural populations, and within informal economies, was a challenge until the introduction of e-financial products and services by telecommunication organisations and related providers in the last decade (CGAP, 2015). Financial inclusion strategies such as the introduction of mobile money services have seen evidence of success as outlined below (CGAP, 2015).

Musoni mobile microfinance app example

This mobile application is a multipurpose device that uses multiple services and products to provide financial services to clients across Kenya. Loan officers do not have to have extensive knowledge in information technology. The devise computes as well as self-generates data and information on client performance in loan repayment, credit delivery and use. In collaboration with existing financial service providers, Musoni has integrated its services and expertise with known farmer and smallholder client service providers like M-Pesa, Airtel Money and Payway in Kenya and Zimbabwe, among others. The software application company currently has about 350,000 clients from 78 institutions across 14 countries. Their success led to the company winning the BBVA Financial Inclusive Special Award in 2016.

Synergy

The introduction of, and investment by, the Asian Tigers in countries such as Bangladesh and Viet Nam aimed to combat the effects of climate impacts that affect agricultural production and environmental sustainability, such as flooding, typhoons, heavy rains, sea level rise and droughts. It is suggested that ICT4Ag initiatives have really improved production functions, and at the same time enhanced smallholder knowledge whilst improving their agricultural practices. Investments in Asia's ICT4Ag initiatives to enhance and improve total production show that the region has a robust and holistic interest in creating an enabling environment for investors. This win-win approach is a great lure for investors within Asia and the western world.

Sub-Saharan Africa has also seen investment in weather and other environmental-related fields. This paves the way for potential investors and entrepreneurs to harness their resources to venture into a market that is still young, but has the potential of digitising agricultural production, as well as creating businesses, jobs and markets across the developing world.

There are however some bottlenecks in the area of solidifying ICT-related regulations, as well as creating an information and knowledge base as to where investors and entrepreneurs can invest. These bottlenecks which hover around the completion of paper work, transportation of bulk documents, manual filing, etc. are themselves opportunities for digital/ICT-related investment to improve efficacy. It is expected that the many ICT4Ag collaborations established will serve as added incentives to open the market for scale-ups, and enable agriculture-related businesses to thrive, as well as become self-sustainable. Whilst the financial sector seems to enjoy massive investment drives, sectors including the provision of ICT4Ag data, storage, processing and postharvest handling needs are in need of such funding. Standout start-ups and hackathon winners such as Esoko, Farmerline, mFarm, as well as the introduction of initiatives by governments and international donors, have set an example to entrepreneurs to venture into ICT4Ag investment.

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CTA's Strategic Plan (2016-2020) https://publications.cta.int/media/publications/downloads/1966_PDF.pdf

Appendix 1
Ensibuuko-Uganda Funding Strategy (2016-2017)

Current funding strategy is based on this plan.

Cost factor	% age	2016 annual budget (USD)	2017 annual budget (USD)
Costs of technology and software	20%	70,000	112,000
Staff costs	30%	105,000	168,000
Client acquisition and retention costs	50%	175,000	280,000
Total	**100%**	**350,000**	**560,000**

How we will be financed	2016	2017	2018	2019
Self funding				
Private investment				
Grants				

We made major investments in technology in 2014, we shall shift our financing towards activities to acquiring and maintain customers; including promotion, training and data migration. In this regard, we shall also build our HR capacity to meet our rate of growth. In 2014, we started generating revenue, we anticipate that in mid 2016, our revenue earning will start to offset some significant costs. We will however only be self-financed in 2018. So, we shall continue to access grants from like-minded partners and will open our investment window in 2016.

Appendix 2
Ensibuuko Strategy and Solution

The solution

Harnessing the power of digital banking to increase delivery of financial service BoP market in Africa

Ensibuuko offers financial service providers the means to grow and scale rapidly and to reach underserved communities. Through a management software embedded with mobile money capabilities for Savings and Credit Cooperative Societies (SACCOs), we are helping SACCOs build operational efficiency, cut costs and to improve their reach. We are making it possible for banks to remotely link with and partner with SACCOs.

	Intervention	Outcomes
MOBIS	**Management Information Software:** We offer SACCOs an efficient and robust management software. The software is built to meet core-banking standards and has advanced data processing and reporting functionalities with an easy-to-use interface.	• Improved efficiency and lower costs • Quicker and better informed decision making • Financial control and minimised risk loss
ChapChap	**Mobile wallet:** Our software comes with mobile money capabilities that is powered through a USSD platform accessible on any basic mobile phone. Members and clients of SACCOs can transact with and manage their account while enjoying added benefits of SMS features.	• Higher liquidity • More accessibility • Improved customer satisfaction and loyalty • Improved efficiency and reduced costs
	**Capacity building:** We implement a curriculum on digital finance and mobile banking. The curriculum was developed using Human Centred Design methodologies and is interactive and practical. This training package develops the capacity of staff and clients at financial institutions to utilise digital solutions in banking.	• Higher skills levels and know-how • Higher uptake and usage
	**Cloud banking:** We offer better connectivity for rural-based financial institutions while minimising their own investment in equipment. We provide shared space at our centralised servers on which users may work remotely using modems and router configured for our dedicated Access Point Network (APN). In areas with no 3G/4G network, our connection runs on Edge/GPRS network.	• Better connectivity • Seamless and great user experience • Data security and tamper-proof • Improved effeciency and lower costs

Impact: Our disruptive software solutions combined with an ecosystem of digital financial experts and an existing cloud infrastructure to allow connectivity in hard-to reach places, will enable easy and affordable access to financial services for people at the bottom of the pyramid.

Source: Ensibuuko 2015 Report

Appendix 3
Framework for a national e-agriculture vision

Strategic context: *Rationale for e-agriculture*	• The role of agriculture in national and more specifically rural development; • The current and likely direction of agriculture, including challenges and opportunites; • The structure and linkages of the agricultural system; • The rational agricultural strategy, goals and priorities; • National social and economic development goals and priorities; and • The implications of e-agriculture.
E-agriculture vision: *Desired outcomes*	• E-agriculture outcomes to meet agriculture goals and overcome challenges; • Positive changes and impact on the livelihoods of people involved in the agriculture sector; • Improve investment potential in agriculture sector; • Reduce individual and institutional risks of the family community.
E-agriculture components: *Enabling environment*	• Leadership and governance; • Legislaton, policy and compliance; • Strategy and investment; • Infrastructure; • ICT services and applications; • Standards and interoperability; • Content, knowledge management and sharing; • Workforce and capacity development.

Source: FAO

CHAPTER 2

Potential for investment in ICTs for agriculture

Introduction

There are currently over 3.5 billion internet users globally, 2 billion of whom are from developing countries. The use of mobile devices has also increased globally from below 1 billion to over 7 billion in 2016 according to the International Telecommunication Bureau (ITU) (ITU, 2015). However, universal access to ICTs has not yet been achieved, especially in the rural areas of developing countries.

People living in rural areas still experience lower access to the internet than their urban counterparts. For instance, 3G internet access for rural areas is at 29% compared to 89% for urban areas, globally. Household internet access in developing and least developing countries remains very low with only 34% and 7% of households having access, respectively. This may be due to the cost of internet services in these countries where prices are reportedly three times the global average. Between 2008 and 2011, the prices have stagnated and even increased slightly in least developed countries (ITU, 2015).

An affordable universal service is one in which the "cost of average monthly usage is a small percentage of monthly gross national income per capita" (Dymond *et al.*, 2010).

This chapter seeks to reveal areas within the field of ICT4Ag that are suitable for further investment – with a specific focus on 'for profit' investment.

Why 'for profit'?

The focus on 'for profit' investments has been informed by a number of studies that have revealed that most ICTs in agricultural initiatives, when government and donor funded, do not become sustainable after the initial funding runs out. This observation was made as early as 2009 by Gakuru, Winters and Stepman in their inventory of ICTs that provide information services to farmers. They observed that among other challenges, the end of donor or government funding often led to the end of the provision of these ICT-related services to farmers.

More recently, a 2016 report by the Technical Centre for Agricultural and Rural Cooperation (CTA) titled *Lessons for Sustainability: Failing to scale ICT4Ag-enabled services*, highlights the issue of the lack of viable business models for ICT4Ag applications. The report notes that most ICT4Ag developers are not very business minded and often do not consider the need to commercialise their solutions, or the ability of users to pay for the services, particularly in government and donor-funded projects (Shepherd, 2016).

This failure to scale and achieve sustainability can be attributed, in part, to the 'free information' model adopted by ICT4Ag developers in the development and provision of these services. As such, the consumers of the services, mainly farmers and agricultural extension officers, have become accustomed to receiving free services over time and are unwilling to pay for them. It is therefore understandable that most private sector players have not been sufficiently attracted to the provision of ICT4Ag services due to the lack of business models with profit as the end goal. As such, this chapter – and book in general – seeks to address the lack of 'for profit' investment in certain ICT4Ag areas by specifically revealing where such investment is possible.

The infographic below by FAO and ITU aptly summarises various ICTs presently available, as well as their applications in agriculture.

Figure 2: Uses of ICTs in Agriculture

Additionally, according to The World Bank's *ICT in Agriculture e-Sourcebook* (2011) (The World Bank, 2011) there are three main areas of application for ICTs in the agricultural sector.

1. **Enhancing productivity on the farm**
   ICTs have been utilised to: (i) increase farm productivity, (ii) support research, extension and advisory services, (iii) for the provision and access to financial services and (iv) for the management of farmer organisations.

2. **Accessing markets and value chains**
   ICTs have been utilised for: (i) accessing market and price information, (ii) facilitating the exchange and flow of information in supply chains, (iii) risk management, information collection, storage, processing and dissemination and (iv) in the implementation of traceability solutions.

3. **Improving public service provision**
   ICTs are also utilised in: (i) enhancing governance in rural agricultural communities, (ii) improving land administration activities and (iii) forest governance activities.

Potential areas for investment

This chapter identifies and maps out existing and future gaps within the sector that need to be filled in order to fully exploit ICT4Ag. The identified gaps have been innovatively classified as follows in order to clearly reveal these potentials:

1. New agricultural management options
   a) Traceability of food products
   b) Applications that build on production information for access to credit
   c) ICT solutions for reducing postharvest losses

2. Current and future technological trends
   a) Big and open data applications for agriculture
   b) Remote sensing and precision agriculture
   c) Artificial intelligence and robotics for agriculture

3. Entrepreneurship and human resource development
   a) ICT access and affordability
   b) Viable business models for ICT4Ag
   c) Growth and scaling up of ICT4Ag

New agricultural management options

Traceability of food products

The European Union food legislation documented in Regulation (EC) No 178/2002 – general principles and requirements of food law, establishing the European Food Safety Authority and procedures for food safety states that "food businesses must: guarantee the traceability of food, feed and food-producing animals at all stages of production and distribution"(European Union, 2002).

"Traceability means the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing and distribution." (European Union, 2007).

The objective of traceability of food products in Europe and other markets is to ensure food safety for consumers, to ensure compliance with standards and to facilitate communication along the supply chain, among other needs (Fisher, 2015). The end goal is that of consumer protection.

Case study – beef traceability systems in Southern Africa

Traceability systems for beef have been developed in some African countries such as Namibia and Swaziland, with significant levels of success (Prinsloo & De Villiers, 2016). The authors review the application of cattle traceability in these countries and observe that it has had a significant and positive impact on beef exports to Europe – even for smallholder farmers. For example, in Swaziland, the adoption of traceability using ear tags on livestock, which has been uploaded to an information system for consistent data capture, has enabled communal farmers to access export markets. In Namibia, the same system has enabled cattle farmers to gain greater acceptability of their products in European export markets such as Norway, thus improving their incomes and potential to export more beef products to other European countries.

Case study – horticulture traceability systems in Kenya

Efforts to introduce traceability systems in Kenya in 2016 have been implemented by a number of players such as Feed the Future (Feed the Future, 2016), and various government agencies in collaboration with Kenya's Agricultural Value chain Enterprise (Fresh Plaza, 2016). The Horticulture Traceability System by Feed the Future makes use of QR codes to identify individual smallholder farmers' produce. Use of the system has seen the removal of Kenya's beans from the EU mandatory inspection list, and has resulted in the export of products previously rejected by the EU.

The challenge

Traceability systems are not as widely adopted across the African continent as compared to developed economies like Australia, Europe and North America, and continue to lock out smallholder farmers in countries like Botswana (Boy, 2013) and Kenya (Nanzala, 2007) from premium markets such as the EU, Japan and the United States.

The lack of traceability limits the ability of value chain players to keep track of production and processing processes and thus, their ability to address issues of produce quality. Untraceable products receive blanket bans (Waitathu, 2016), which results in economic declines for the country and for the smallholder farmers who are not able to find high value markets for their produce.

Potential for investment

There is great potential for the development and implementation of traceability systems in the beef and horticultural value chains across ACP countries. This will impact in a very significant way on the ability of many smallholder farmers to access stringent but profitable European food markets. Other supply chain players such as transport agents and supermarkets will also benefit through the improved volume and value of business.

Applications to collect production information for agricultural credit provision

Small-scale farmers require credit to grow their enterprises. Credit evaluation procedures by most lenders require assessment of the performance of an enterprise with respect to profitability, solvency, liquidity, repayment history and the availability of collateral. In order to provide this information, borrowers need to provide accurate financial records such as balance sheets and income statements, among other documents (Ellinger & Barry, 2016). Providing this kind of information is especially challenging for smallholder farmers because most do not keep

accurate expenses, input and production records. Where these can be obtained, they are often manual records that are difficult to analyse (Salami, Kamara, & Brixiova, 2010).

Case study – Farmis Kenya

A recently launched online application, Farmis software, is enabling farmers to automate their record keeping for expenses and incomes. This information can then be used by financial institutions to evaluate farmers' viability for credit facilities (Farmis Kenya, 2016). Farmers add their expenses information via their phones and the Farmis system provides record keeping, market information and linkages, promotional services, farming tips and access to credit services. There is however no evidence as yet as to the level of adoption and impact that the system has had despite its rollout in Kenya, Tanzania and Uganda.

Case study – Farmsoft US

Farmsoft is a mobile phone app developed by Tenacious Systems Limited in the United States, which makes record keeping of farm yields and profits easier by providing farm and produce business management solutions, including food processing and traceability, and food manufacturing and cold chain management. By improving their traceability, efficient record keeping enables farmers to adhere to industry standards of the British Retail Consortium, Hazard Analysis and Critical Control Points, Global Good Agricultural Practices and the Euro-Retailer Produce Working Group – Good Agricultural Practices. It also enables financial institutions to assess farmers' credit worth (FarmSoft, 2017).

The challenge

There are a number of applications such as Ensibuuko (http://www.ensibuuko.com/), Farmdrive (http://farmdrive.co.ke/) and Musoni (http://musonisystem.com/) that have demonstrated significant success in extending credit to small-scale farmers. However, these are mainly microfinance management systems and only collect savings, loan and repayment information from farmers. The main challenge still remains the lack of reliable and consistent production and income records that can be used to assess farmers' credit worthiness.

"Farmers cite unavailability of credit and capital as one of the major constraints in their business. Financial institutions on the other hand cite lack of proper farmer records as a major constraint when evaluating farmers' viability for credit' (Farmis Kenya, 2016).

Potential for investment

There is potential for investment in the rolling out of farm management software solutions in areas such as in smallholder farms in low and middle income countries where they have not been adopted. These solutions need to be simple in the technologies they require for operation, as well as in the processes whose data they seek to capture. These systems have the potential to improve the ability of smallholders to access credit by making information on daily and seasonal production available during credit application processes.

ICT solutions for reducing postharvest losses

While some aspects of the postharvest system, such as marketing, have been well addressed with respect to ICT solutions, the majority of the other aspects such as records of inputs and productivity remain untouched (Rarngirwa & Addom, 2013).

Case study – Chowberry in Nigeria

There are solutions already in existence, such as Chowberry in Nigeria, that help retailers sell products that are about to expire (Chowberry Ltd, 2016). The system allows buyers to search using their computers or mobile devices for soon to expire products, order, pay and collect them from grocery stores. The products are priced lower than usual to encourage purchases and in the process, reduces postharvest food losses. During the 3 month trial of this app, over 200 families and 150 orphans were fed while at the same time, over 20 participating grocery stores in Abuja were assisted to sell groceries that would have been thrown away.

Case study – YieldWise by the Rockefeller Foundation

The Rockefeller Foundation has an ongoing strategy to help combat postharvest food losses. YieldWise creates tools needed by businesses to measure and track supply chain losses and invests in financing models and technology innovations that drive mutual economic growth. Their strategy focuses on fixing broken links between farmers and buyers by facilitating buyer agreements between farmer groups and multinational companies; aiding farmers to access technologies for curbing crop losses e.g.

metallic silos and hermetic bags; investing in financial models for farmer growth; and engaging various supply chain actors to monitor and prevent food losses globally (Rockefeller Foundation, 2016). A 2017 review of the impacts of this initiative shows that there will be a 5% reduction in global food loss and wastage between 2016 and 2018 with governments and organisations alike either embarking on the process of introducing food loss and waste regulations, or fully effecting them in some cases (Lipinski *et al.*, 2017).

The challenge

Postharvest food losses are still a major threat to food security in the developing world. There are however solutions that use ICTs as a core strategy in the reduction of postharvest food losses.

Potential for investment

There is potential for investment in ICT solutions that address postharvest losses and reduce wastage. These solutions can take the form of demand and supply forecasting, for example, USDA's monthly World Agricultural Supply and Demand Estimates (WASDE). Using global weather forecast information, the WASDE report advises US farmers, policy makers, commodity traders and the agricultural industry. Moreover, with increasing use of ICTs, decision makers and stakeholders in the agricultural sector can exchange and receive necessary postharvest information, and rural farmers can receive information that affects their harvest time as well as how they preserve their harvests. In addition, training videos and other materials can be shared via apps like WhatsApp and used to guide farmers and processors on best practices.

Current and future technological trends

Big and open data applications for agriculture

Big data, described as "high-volume, high-velocity and/or high-variety information assets" (Gartner Inc, 2012), has in recent years demonstrated impact in improving agricultural decision-making and subsequent production (Bronson & Knezevic, 2016). Increasingly, it is used for comparing practices and yields of farmers in North and Central America based on variables like tillage methods, seeds planted, soil type, water, and pesticide and fertiliser application using tools developed by agribusinesses like Monsanto, DuPont, Valley irrigation and Farmlink (Roach, 2016).

A closely related concept is that of open data being "data anyone can access, use and share" (Scott, 2015). This free access to agricultural data from governments and research organisations is poised to have a significant impact on farming activities globally. To this end, there exists a lot of open data for agriculture from a great number of sources such as The World Bank (The World Bank, 2016), the Kenya Open Data (Kenya Open Data, 2016) and the Global Open Data for Agriculture and Nutrition (GODAN) (Global Open Data, 2016).

Case study – The Dutch Ministry of Foreign Affairs' Geodata for Agriculture and Water (G4AW) programme

The use of big data in the food chain is already widespread with applications for the development of new seeds, precision farming and food tracking (Estes, 2016).

The Geodata for Agriculture and Water (G4AW) programme by the Dutch Ministry of Foreign Affairs is sponsoring the development and deployment of applications for decision support, crop monitoring and weather information systems among others, that use satellite and other geo-data such as shape files, geodatabases and coverage to inform farming activities, such as the selection of seeds, by providing early warning of drought, flooding and crop disease. This data is then delivered to farmers via mobile apps and SMS messages (G4AW, 2016). These programmes are being implemented in 26 G4AW African and Asian partner countries.

Case study – Transparency, land rights and land tenure regularisation in Rwanda

The use of open data was adopted by the Rwandan government between 2004 and 2014 – particularly for the development of a national digital land registry. The project, executed with financial support from the International Development Association, sought to provide registered land titles to all landholders in the country. It has been a success with over 10.3 million land parcels in the country (84%) receiving approval for land titles. The data collected has been availed to other government agencies such as the Ministry of Agriculture and,

in particular, lending institutions, who have in turn been able to extend credit to rural communities for expansion of their businesses and farming enterprises (Compton, 2016). Farmers then use the titles as collateral to secure credit facilities from the financial institutions.

The challenge

The benefits of big, open data for prediction and analysis in the practice of smart farming activities is mainly felt by large scale farmers and other stakeholders such as agricultural input providers in developed countries. These farmers and other stakeholders are better informed and equipped to make use of data collection and analysis tools like the Open Data Kit and Hadoop – a software library that allows for the distributed processing of large data.

Access to big, open data has not spread to smallholder farmers due to the lack of suitable tools for the collection, processing and retrieval of such information (Roach, 2016). Additionally, there is a critical lack of access to tools to facilitate these smallholder farmers to access and utilise the open data available.

Potential for investment

The farming community, smallholder farmers included, stands to benefit from the greater adoption of data driven agricultural techniques (Roach, 2016). Due to this, there is potential for the development of tools such as Tableau – a data analysis software that helps people see and understand their data, and the IBM SPSS Modeler which can be used by both large and small-scale farmers to access relevant open data for use in diverse farming activities.

The development of such apps also stands to benefit the developers if they succeed in producing commercially viable solutions for use by the farming community. There is also potential for research and government organisations to invest in making open data more accessible to researchers and application developers in organisations and countries where this is not already in place.

Remote sensing and precision agriculture

Gathering of the right information from the field enables farm managers and owners to make informed decisions on the interventions needed at farm level, without the need to visit the farm. This has the potential to facilitate data-driven decision-making by making data collection easier and more effective.

Case study – National Remote Sensing Centre, India

One successful example of remote sensing is that of the Indian National Remote Sensing Centre. The various areas of application are depicted in Figure 3 below.

Figure 3: Remote sensing applications in India (National Remote Sensing Center: Indian Space Organization, 2017)

Remote sensing has been used to inform agricultural policy decisions; to monitor drought situations; for crop damage assessment and crop planning purposes; to tailor agronomic practices; and for demand-based irrigation scheduling. The remote sensing centre has seen the development of a number of operational products and services, for example, measurement of acreage and production estimates of major crops, annual land use mapping for crop intensification, cropping system analyses and the development of satellite-based bio-geophysical products (National Remote Sensing Center: Indian Space Organization, 2017).

Case study – GIS analysis by the World Food Program's Operation Department of Emergency Preparedness (ODEP)

The World Food Program's ODEP uses GIS analysis, alongside additional data from the Famine Early Warning Systems Networks of US government agencies, to understand the vulnerabilities of populations living in areas prone to natural disasters. This approach helps monitor a variety of structures such as dams – to ensure they can withstand rising flood water; buildings – to determine their structural integrity; hillsides – after deforestation and land use patterns – to reduce mudslides. This knowledge aids in preparation efforts for emergency response activities.

The challenge

The greatest challenges in remote sensing and precision agriculture resources emanate from their lack of availability, and the often prohibitive costs associated with acquiring and using them (Plant, 2001; Zhang & Kovacs, 2012). For these reasons, alternative low cost technologies have emerged involving small unmanned aerial vehicles and low altitude remote sensing platforms. These alternatives have high spatial

and temporal resolution, flexibility in image acquisition programming and low operational costs (Xiang & Tian, 2011).

Potential for investment

There is great potential for additional investment in the development of affordable technologies for remote sensing. This was first occasioned by the US government's decision to allow satellite images to be marketed commercially, and has resulted in increasing demand for digital satellite imagery to meet various commercial end-user applications. Additionally, significant investment and action in increasing awareness of their availability and associated benefits is required if smallholder farmers are to realise said benefits of high quality information gathering, and informed decision-making.

Artificial intelligence and robotics for agriculture

"Artificial intelligence [AI] refers to the ability of a computer or a computer-enabled robotic system to process information and produce outcomes in a manner similar to the thought process of humans in learning, decision-making and solving problems. By extension, the goal of AI systems is to develop systems capable of tackling complex problems in ways similar to human logic and reasoning." (Price Waterhouse Coopers, 2017).

For agriculture in developed countries, AI and robotics have been used mainly for monitoring crop conditions, plant populations and soil moisture content (Shehzadi, 2017). Additionally, they are used for automated irrigation, crop health monitoring, crop spraying using drones, facial recognition of cows, crop harvesting and early warning systems (A.I Business Team, 2017).

The challenge

Whilst the potential for AI application in agriculture has been recognised, its application has not succeeded in practice – due to a lack of adoption by smallholders – in most developing countries. Agriculture, unlike other areas of AI practice, such as medicine, operates in a very unpredictable environment, for instance, there are frequent weather changes; soil quality can vary in a single field; pests and diseases affect different sections of a farm, and the variations are even greater when the scope changes from a locality to a country or continent. Thousands of factors must therefore be taken into account for the implementation of AI solutions in agriculture (Byrum, 2017).

Potential for investment

There is great potential for the development of more AI technologies and approaches that can find practical application on small farms, as well as in advocating their use among smallholder farmers. Where the relevant environmental factors have been considered within the technology, the adoption of AI can enable smallholder farmers to benefit from smart farming techniques through the utilisation of sensors and intelligent systems in the management of crop and livestock production.

Entrepreneurship and human resource development

ICT access and affordability

Universal access to ICTs, broadly described as the geographical spread of ICTs to allow access to the greater population in a country (The World Bank, 2011), has not yet been achieved, especially in rural areas of developing countries. People living in rural areas still experience lower access to the internet than their urban counterparts. 3G internet access for rural areas is 29% globally as compared to 89% in urban areas. Household internet access in developing and least developing countries remains very low with only 34% and 7% of households respectively having access.

The cost of internet services remains high in developing and least developed countries with prices reportedly three times the global average. Between 2008 and 2011, the prices have stagnated and even increased slightly in least developed countries (International Telecommunications Union (ITU), 2015).

An affordable universal service is one in which the "cost of average monthly usage is a small percentage of monthly gross national income per capita" (Dymond *et al.*, 2010).

The challenge

A greater percentage of new ICT4Ag are being developed to make use of the internet and for use by farmers, most of whom live in rural areas. The lack of universal access and challenges with respect to affordability has the potential to limit uptake and effective utilisation of these ICTs among target populations.

A 2015 article by Mobilink cites the case of limited 3G network access hindering the utilsation of 3G-dependent apps and technologies for remote monitoring, field equipment automation, tracking, geofencing, surveying and marketing for agriculture in Pakistan. There are however some current efforts by mobile network operators to increase the 3G and 4G network coverage in Pakistan as a measure to facilitate the use of ICTs in agriculture and other sectors (Baloch, 2016).

According to a 2015 Groupe Speciale Mobile Alliance (GSMA) Intelligence report, the use of mobile applications in agriculture is limited by, among other issues, poor network coverage, particularly in rural areas in emerging markets (GSMA, 2015).

Potential for investment

There is great potential for investment in extending 3G networks to rural areas in order to facilitate access to ICT4Ag by stakeholders in these areas.

The utilisation of mobile-based applications and other equipment also requires access to reliable and affordable power. This is an area for investment that can facilitate the setting up of base stations – short-range trans-receivers that connect mobile phones and other wireless devices to a central hub that allows network connection – in rural areas.

With respect to affordability, there is room to develop solutions that can reduce the cost of broadband in developing and least developed countries.

Viable business models for ICT4Ag

Businesses that incorporate ICT4Ag demonstrate its potential to deliver sustainable and profitable enterprises. Examples of these include the highly successful weather-based index insurance product, Kilimo Salama (ACRE Africa, 2016). Optiserve Technologies is another example of ICTs being used successfully in agriculture (InfoDev, 2016). The company has developed the ePinoysFarm, a monitoring and evaluation system for government agencies and a farm management tool for coconut, buffalo dairy production and apiculture enterprises. The application helps manage daily agricultural and fisheries operations, including monitoring the implementation of community-based interventions using record keeping and data validation information. In addition, it helps collect agricultural information for various agencies including research institutions, agricultural state universities and the local governments.

Whilst examples of success abound, an even greater number of ICT4Ag failures are documented by CTA, among others, in their recent 2016 report *Lessons for Sustainability: Failing to Scale ICT4Ag-Enabled Services* (Shepherd, 2016). The lack of viable business models is documented as a key challenge to the scaling up and sustainability of ICT4Ag in the nine case studies documented.

The challenge

Incidentally, the majority of ICT4Ag developers are young, tech-savvy and forward thinking. However, among other things, they tend to lack backgrounds in agricultural-related areas of study. As a result, apps, products and services that are developed using ICTs are not an exact fit for end users (Bascombe, 2014).

"Encouraging more people, especially youth, to engage in app development and helping them materialise their ideas through proper facilities and training by competent authorities is still lacking in many areas," says Suchiradipta Bhattacharjee, agricultural extension PhD scholar at the Central Agricultural University in Meghalaya, India.

Additionally, application developers have also been found to have a great dependency on donor funding and lack sustainable business models for their applications (Shepherd, 2016).

"We did not have a business model. Who would pay? How much should they be charged? How would they pay? We eventually realised that farmers could not pay." (Shepherd, 2016).

Potential for investment

There is great potential for investment in agricultural business incubation hubs that have proven viable mechanisms for nurturing small and start-up agricultural enterprises (Essiet, 2016).

"Business incubation is a unique and highly flexible combination of business development processes, infrastructure and people designed to nurture new and small businesses by helping them to survive and grow through the difficult and vulnerable early stages of development," (Diogenes Business Incubator, 2016).

Investment can be modelled on the highly successful Agri-business Incubation Programme by the International Crops Research Institute for the Semi-Arid Tropics (ABI – ICRISAT), that brings together a wide variety of resources, networks, training and capital. Such resources are invested to foster agribusinesses to bring ICRISAT's research for development innovations to the market for a faster and wider scale impact.

Case study – ABI – ICRISAT agri-business incubator

The business incubator promotes commercialisation of agricultural technology through public-private partnership. So far, the programme has incubated over 108 ventures and the incubator has also made a profit from its operations (Peer, 2015). One agri-venture to receive incubation, Bioseed, has expanded from India to Bangladesh, Cambodia, China, Laos, Nepal and Thailand and is among the few biotechnology companies with expertise in various fields, including research and development, field and lab testing, and farm and production management.

The framework presented in Figure 4 incorporates a very wide variety of approaches that, when combined for the benefit of an agricultural enterprise, ultimately lead to its success in the market.

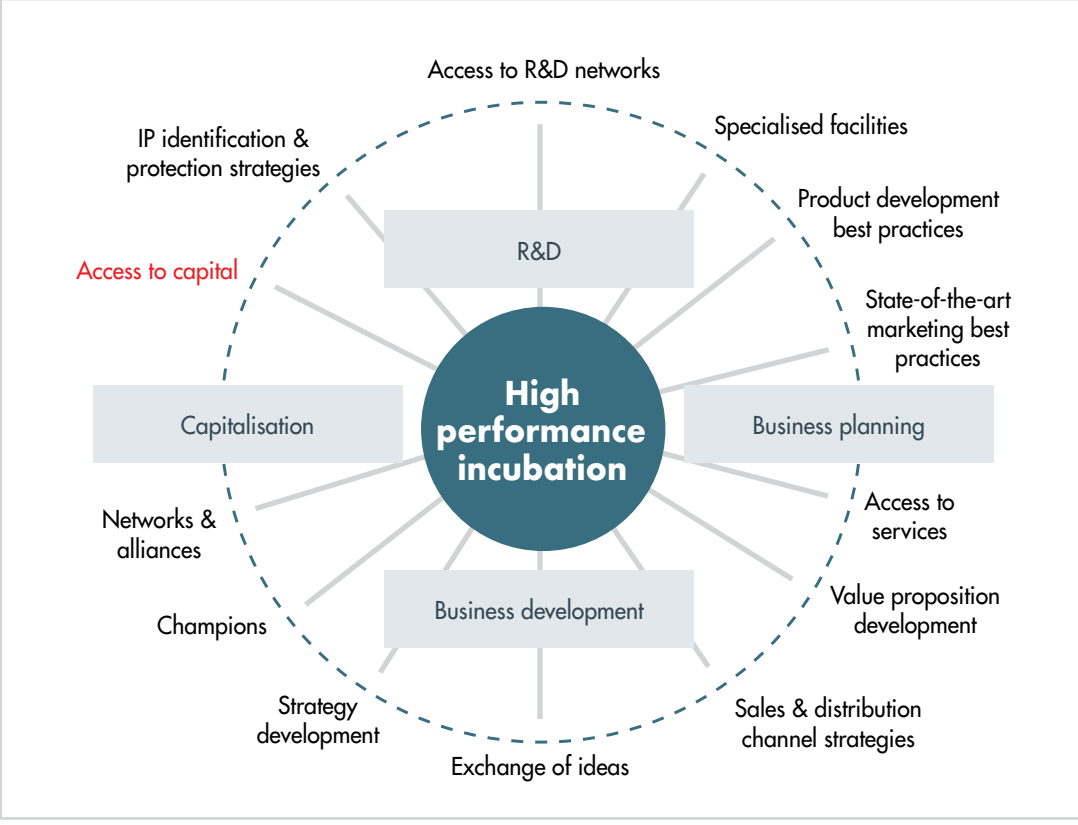

Figure 4: Business framework for incubation (Karuppanchetty, 2007)

Growth and scaling up of ICT4Ag

There are numerous ICT4Ag applications that have demonstrated potential and impact, albeit on small scales, in specific geographical areas and value chains. Some of these applications are in the post pilot and proof of concept stages, and often only require capital injection to enable them to grow and scale in greater levels of impact and profitability.

"Scaling is about adding revenue at an exponential rate while only adding resources at an incremental rate" (Fundable LLC, 2012).

Scaling up is the ideal end goal of any solution with the aim of reaching more users and generating more revenue for investors.

Case study – CTA initiatives to identify and promote apps ready for scaling up

CTA has a number of initiatives aimed at identifying and promoting applications that are ready to scale.

These efforts include:

- The development of a database called the Apps4Ag database that documents ICTs in agriculture with a demonstrated potential for greater utilisation and scaling.

  "By sharing app details via Apps4Ag, application developers develop business opportunities with potential users or partners and investors through increased visibility," says Serge Kedja, ICT for development consultant, CTA.

- Hosting of events such as the 'Plug and Play' that bring together ICT4Ag innovators, investors and users to review existing applications.

"The investors are provided with a unique platform to identify viable areas for investment" says Kedja.

- Offering grants for the scaling up of applications that already have an existing market presence and could extend their impact to more beneficiaries (CTA, 2014).

The challenge

The CTA publication *Lessons for Sustainability: Failing to Scale* brings to the fore a number of issues that cause otherwise potentially useful ICT4Ag applications, not to have a greater impact beyond their pilot or proof of concept stages.

Applications may fail to scale due to a lack of capital, a lack of enabling partnerships for growth, use of technologies and development approaches that limit growth, poor promotion and user training, or poor implementation processes (Shepherd, 2016).

Potential for investment

There is great potential for investment in ICT4Ag that have passed the post pilot and proof of concept stages. These are applications that already have a market presence and revenues are in need of capital injection to enable them to grow into new geographical regions, reach more clients and venture in to new value chains.

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CHAPTER 3

Challenges of ICTs in agriculture

Contents

This chapter identifies the challenges faced by ICT4Ag that need to be addressed, as well as how the identified challenges can inform investment opportunities. The chapter categorises ICT4Ag challenges into three main areas: (1) national and international policy environment and protocols that govern the design, use and regulation of the entire ICT4D sector, (2) available infrastructure and capacity building/available expertise, and (3) the nature of the rural setting, as well as the knowledge and cultural inclinations of local communities that influence their ability to use the technology to access information for their day-to-day activities.

This chapter further explores the three main areas more broadly to cover the following points as modified from Devex Impact editor review (Devex Impact, 2013): sustainability and scale; limited knowledge on design, use, adoption and management of ICT technologies; pace of changing roles and norms; high cost of available ICT-related technologies in developing economies; weak institutions; inadequate collaboration; awareness of existing ICT facilities and resources and inadequate ICT policies and regulations.

Introduction

FAO projects the world's population will reach about 10 billion by 2050, and the expected urban population will increase to 70% from the current 49%. This would require smallholder farmers, who dominate in food production, to increase their production by over 60%. At current growth rates, most developing countries' agricultural sectors will fail to meet these targets due to challenges posed by, among others, climate change, limited land availability, competition for uses of arable land, and an aging population of farmers.

There are a growing number of ICT-based initiatives seeking to solve and improve aspects of societal challenges whilst ensuring the economic value of the solutions they offer in, for example, agricultural extension services, especially in Asia and Africa. However, although agriculture is one of the largest economic sectors in the world – with a net income estimated at €100 billion and assets of about €1.7 trillion – compared to other sectors, such as manufacturing and trading, it has received less investment in ICT innovations (Dutia, 2014).

Very little rigorous, evidence-based impact evaluations of ICT4Ag have been conducted. From the available literature, most studies have looked at the impact ICT4Ag initiatives and interventions have had on helping farmers access market and price differentials. However, such studies have been shy in identifying, as well as stating possible solutions to the challenges faced by ICT4Ag initiatives in the areas of design, implementation, monitoring and evaluation, and regulation and institutional structures.

Finance and related sustainability measures that would lead investors and entrepreneurs to advance the ICT4Ag sector, from a business perspective, have also mostly been omitted from such studies. In trying to fill this gap and the others mentioned above, this chapter discusses the nature of the challenges facing ICT4Ag and derives most of the examples from ACP countries where such challenges are more evident than in many advanced economies (Asenso-Okyere and Mekonnen, 2012; FAO-ITU, 2016; CTA, 2016). Challenges that could also serve as opportunities to entice investors and entrepreneurs to invest in ICT4Ag initiatives are also presented in this chapter. All findings have been linked to cases identified in an extensive literature review.

Data analysis

Data for this chapter was collected from primary and secondary sources. Interviews were held with ICT4Ag businesses and start-ups, investors, entrepreneurs, researchers, investors, regulators and scholars from the field of study. Case studies of challenges encountered in agricultural value chains, as well as the agricultural field more broadly, were analysed. In particular, the use of ICT4Ag tools and business models to enhance and improve agriculture development in ACP countries formed the unit of analysis.

Results

This section presents the results from data analysis of the challenges identified.

Sustainability and scale

International organisations have been the main initiators of ICT4D and for that matter, ICT4Ag initiatives across countries and continents. Most of these initiatives and projects have been temporal, involving small-scale and pilot projects. These do not help to create sustainable elements that are expected from ICT4Ag-related business investments and their scale-up (Devex Impact, 2013; Duncombe and Heeks, 2005).

Whilst it is evident that governments have created some enabling economic environments for start-ups and projects to explore the use of ICT4Ag tools, it is also clear that issues of taxes and income generation have affected scale-ups as well as exploration of business opportunities by investors (Asenso-Okyere and Mekonnen, 2012). Investors consider involvement in ICT4Ag business initiatives to be expensive. It is suggested that the high cost of ICT tools, gadgets and machinery, as well as the training of human resources to manage, maintain and move such businesses to break-even before making profits, serve as disincentives for investors.

Many developing countries have inadequate infrastructure for the widespread use of ICTs, such as unreliable mobile reception and electricity, particularly in rural areas where the majority of production is carried out. Furthermore, inadequate infrastructure and services such as ICT centres, gadgets, and management and maintenance challenges affect the use of and investment in ICT4Ag initiatives and businesses.

Sub-Saharan Africa

Wabwoba *et al.* (2012) identified that the fluctuations and high costs of electricity were challenges in sub-Saharan African countries. Other scholars found that income and attainment of ICT-related education, as well as social and cultural constrains, are other factors that affect the likelihood of individuals having ICT skills. These challenges thus affect the optimum use of ICT4Ag technologies in communities across sub-Saharan Africa (Gillwald *et al.*, 2010; Huyer, 2003; Hafkin and Odame, 2002). Furthermore, looking at panel data from Uganda, Muto and Yamano (2009) found that the total value of assets and the education level of both male and female household members are directly related to the possession of mobile phones.

In rural areas of developing countries where investment in ICTs is desperately needed, most ICT operators are not willing to invest due to the poorly diversified and 'risky' production systems which generally focus on rain-fed staple crop production, and raising livestock. There is also a huge cost in investing in limited or non-existing infrastructure. Therefore, unless investors and entrepreneurs have a strong incentive to do so, investments tend not to enhance agricultural production and entire value chains. This is seen even where projects initiated by donors and international organisations have reached the stage of scale-up.

Literature shows that in Nigeria, an investment of €420 per week would be required to finance the production and broadcast of 3-6 hours per week of an interactive farm radio programme (Agwu *et al.*, 2008). India, Mozambique and Tanzania have documented case studies of this challenge (Scott *et al.*, 2005), which implies that many rural households simply cannot afford the use of modern ICTs to advance the production and scale of many agriculture commodity chains.

Farmerline

In partnership with worldwide foundation initiatives, the GhanaWeb foundation created Farmerline in 2013 with an award of €250 to start the company. Funding from the Indigo Trust enabled Farmerline to test their voice communication software, which focused on aquaculture, in consultation with extension officers and farmers. Aside from voice technology, the company provides a data collection platform for agribusinesses to manage their supply chains, profile farmers, map farms, and conduct traceability and audit assessments. The messaging technology delivers content to farmers in local languages on weather alerts, market prices and good agricultural and financial tips. The technology developed by Farmerline has been rebranded as MERGDATA and is used in other sectors such as education, health and finance.

As of 2016, the company had 21 members of staff (having started with four in 2013). Farmers and businesses have helped to shape the focus of the company – which is to increase smallholders' access to information, inputs, and resources for increased productivity – by providing feedback. As a technology-based company and service provider, Farmerline suggests to investors that they are a start-up with the potential for scaling-up.

Challenges: Obtaining funding to scale operations and recruiting high level experts to enable the company to move into other sectors was a challenge. Direct incentives from governments, such as tax breaks and support systems, were not provided to the company during its start-up stages. Start-ups in the ICT4Ag sector would benefit from the development of policy, investment and funding mechanisms to help them to thrive from the National Communication Authority/Ministry of Communication, the Ghanaian Government, investors and telecommunication companies.

Business implementation strategy: Rely on local talents; provide capacity building for staff; build strategic partnership.

Source: Worlali Senyo, Farmerline representative, December 2016

Limited knowledge on design, use, adoption and management of ICTs

Technological challenges have emerged as areas that need much input and attention in the ICT4D field. FAO summarised this as follows:

'...A serious gap at global and regional levels is the inability of ICT professionals to comprehend the complexity of challenges in AR4D (Agriculture Research for Development) and AIS (Agriculture Innovation Systems). Experience shows that ICT professionals tend to make oversimplified assumptions about the production and value-addition processes in agriculture, and therefore, tend to offer off-the-shelf solutions that often would not meet the requirement of AR4D. It is therefore necessary to establish a dialogue with interested ICT experts and help them build their capacities to understand the nature of agriculture...' (FAO-ITU, 2016).

In the rural areas of many developing countries, the provision of infrastructure for public utilities such as electricity and mobile phone networks is lacking. Therefore, it becomes very difficult to deploy ICT devices to such communities, and ultimately leads to higher costs of internet provision. In some instances, private companies have invested in the provision of electricity to villages, which has reduced the high cost of ICT provision. Where electricity is unreliable and where government and private investment is lacking, teaching and capacity building on the use of ICT4Ag tools to improve and enhance agriculture-related activities are found wanting.

Extension services, such as the provision of farm marketing and management advice, are almost non-existent in many ACP countries since most agricultural extension staff have low capacities to deliver such services. Furthermore, most rural folk cannot afford computers or smart phones due to their lower income statuses as compared to their urban counterparts. This impounds the digital divide between urban and the rural areas, which negatively affects agricultural production because most agricultural activities are carried out in the rural areas.

The Asian countries

India, Best and Maier (2007) studied the role of ICTs in empowering rural women in India and concluded that, whilst most ICT initiatives are disseminating new information and knowledge useful for rural women, many are not able to make use of them due to low literacy rates and lack of financial support to acquire ICT appliances.

Data management issues, such as inadequate data to assess the real situation on the ground and identify possible areas for investment, further serve as disincentives for entrepreneurs and investors to become involved. In recent years however, these challenges have been tackled through collaboration among NGOs, governments, extension staff and ICT service providers (MTN, ORANGE, SAFARICOM, etc.) across the developing world.

Caribbean countries

The University of the West Indies (St. Augustine) identified a lack of data, as well as a lack of knowledge on ICTs and their use among farmers, as an important challenge facing the use and scale-up of ICT4Ag. The university responded by developing AgriNeTT – a series of mobile apps which help farmers geo-spatially understand the characteristics of their land and the most suitable crops to plant. The apps can also be used to track expenses and profitability of crops as well as real time prices. The technology is helping to improve data availability and ICT awareness among farmers.

The development of, and investment in, context and content specific ICT4Ag applications to solve identified challenges continue to be sponsored by donor-driven initiatives as well as private organisations and collaborations such as the EU, CTA, the Asian Development Bank, the African Development Bank, the Standard Bank of Africa (Stanbic Africa), the MasterCard Foundation, the Grameen Foundation, Vodafone, MTN, Safaricom and FAO-ITU, among others. It is therefore important that investors and entrepreneurs take advantage of the pre-laid foundation to help invest, as well as scale up ICT4Ag applications and initiatives across the developing world.

Pace of changing roles and norms

The business sector is either excluded or not exploited to harness their core competencies to create ICT4Ag tools and initiatives that can become investible, self-sustaining and profit-oriented businesses. There is a tendency for organisations, farmers and institutions that have worked in agriculture-related interventions and extension services, as well as the management of such, to find it difficult to embrace new ways of performing the same old tasks. The use of ICT4Ag approaches changes the roles and norms for these actors and they do not always embrace, use and adopt the technologies. The last 10 years have however seen an increase in the use of ICT4Ag applications by farmers, organisations and institutions to help mitigate challenges encountered in the agriculture sector of developing economies (Devex Impact, 2013; Duncombe and Heeks, 2005).

According to Carden (2009), the emergence of new ICT possibilities presents some potentially fundamental and far-reaching questions that challenge or even undermine the assumptions on which actors and donors came into being. There are also gaps in terms of access, communication, and resources that actors such as governments, donors and international non-governmental organisations (INGOs) have historically played an important role in addressing. While some of these gaps still exist, they are, arguably, not as clear or compelling as they once were.

High cost of available ICT-related technologies in developing economies

There is a significant challenge in adequately planning and financing the use of ICTs in development and agriculture initiatives (Bhatnagar, 2000). With cyclical donor funding and pressure to minimise administrative and management costs, it is often difficult for actors such as farmers and INGOs to properly plan, resource finances, and engage human investment in ICTs as core capacities for such initiatives. The telecommunication sector for countries such as Ghana, Kenya, Nigeria and Senegal are very dynamic, primarily due to the high costs of the ICT services (Calandro *et al.*, 2010).

There are however interesting areas that need further focus including the use of unmanned aerial vehicles to capture data and disseminate information, products and services such as the delivery of inputs to farmers (see Appendix 1).

Financial challenges that comprise high estimated costs and capital intensive initial investment costs, also serve as disincentives to investors and entrepreneurs. Limited investments are thus recorded in ACP countries due to insecure and undocumented finance and viability analyses that prevail around ICT4Ag investments.

Weak institutions, inadequate collaboration, awareness of existing ICT facilities and resources

Calandro *et al.* (2010) argue that the national objective for most African countries to achieve universal and affordable access to a full range of ICTs has been undermined by poor policy constraints, weak institutional arrangements and low level infrastructural development. As an example, Warid telecom in Côte d'Ivoire operates under very high service charges.

Furthermore, Gilwald, Milek and Stork (2010) argue that in addition to competition and open access regimes of ICTs, effective regulation of other factors such as spectrum, interconnection and tariffs is required to stimulate market growth, improve access and ultimately lower prices of ICTs in most African countries.

The issues of national security, as well as the need to regulate unwarranted use of cyberspace as a precautionary measure, have become challenges that ICT4Ag initiatives are currently confronted with. The use of ICT4Ag as a tool to scale-up and create high level niche markets is thus faced with institutional and governance challenges.

Whilst there is the need to lobby governments and decision makers to make explicit policies that enhance and encourage the utilisation of, and investment in ICT4Ag, such policies should look at how investments in the use of e.g. drones for agriculture can help enhance, as well as improve agricultural value chains in ACP countries. The creation and enactment of policies and frameworks that include these considerations, can thus help address current challenges.

Inadequate ICT policies and regulations

Regulations that enhance the design, use, and adoption of ICT4Ag technologies in many ACP countries seem non-existent, or not fully created in the statute books or legal frameworks for most developing countries. This serves as a disincentive for investors who may not feel protected when investing in ICT4Ag businesses.

Most ACP countries also lack formalised legal frameworks that govern ICT4Ag initiatives and investment portfolios. Therefore, it is very difficult to grant incentives for investment in ICT-related agricultural business models. Interestingly, many policy-related actions have been taken by international organisations and governments like FAO, the African Development Bank, the Asian Development Bank and CARICOM, etc. across the developing world. FAO, as an example, has identified in its framework the following main actors and stakeholders that ought to be considered in e-agriculture initiatives:

- Government ministries and regulators, such as ICT/telecommunications, finance, commerce, e-governance agencies, rural development and other sector regulators (banking, insurance, disaster management, etc.)
- Mobile network operators/TSPs
- Non-agriculture research organisations
- Industry associations (e.g. ICT, banking, etc.)
- Financial institutions (banks, insurance companies, micro-finance institutions (MFIs)
- National statistics bureaus
- NGOs/INGOs working outside agriculture in sectors that impact agriculture
- Arbitration authorities
- Media

Source: Stakeholder Identification FAO Framework on E-Agriculture

Whilst the above framework includes ICT experts and the business environment, it is evident that direct business investors and entrepreneurs have not been highlighted as important stakeholders to engage. As many countries have adapted the FAO framework in their national policy documents on ICT4D/Ag, they are again not highlighted within the national frameworks. The information provided in the e-agriculture framework above presents interesting areas for discussion on politics and governance.

Interviews with experts and practitioners from the ICT4Ag field of enquiry (i.e. researchers, service providers, start-ups, policy officers and NGOs) highlighted the lack of collaboration among ICT4Ag product/service developers, which according to them is a major challenge that needs to be urgently addressed. Global application designers need to network to learn from each other and build on knowledge that has already been developed by others. Donor driven organisations have created boot camps across the developing world to initiate joint start-up projects and start-up businesses. The outcome of such has seen the establishment of ICT4Ag companies like mFisheries, Agrinfo-Tanzania, Esoko and Farmerline, and whilst these new businesses have experienced mixed successes and challenges, most have reached the level of scaling-up.

Vand Zila Technology

This is an ICT for development company that works in the education, health and agriculture sectors in Ghana for the past 8 years. Currently, this service provider is a lead facilitator for mapping social entrepreneurs in Ghana on behalf of the Dutch Ministry of Foreign Affairs and Development Cooperation. The company identified the main challenge in ICT4Ag to hover around the lack of information and knowledge that farmers can use to improve production, yield, as well as information on market. The CEO of the company further noted that the current wave of intervention on ICT4Ag centres on activities introduced by international organisations. This to him will need private sector investments to help scale up, as well as yield profit.

'...There are limited investments by investors and entrepreneurs to take advantage of the current wave of ICT4Ag activities on going in Ghana and the developing world.... There is the need for a lot of stakeholders that cuts around business and policy to lead the mission to help start-up companies scale to reach their potentials...'[Maxwell Vand Zila, CEO Vandzila Technology Ltd].

Mr. Vand Zila further noted that local and foreign investments are needed to take advantage of the many opportunities that hover around ICT4Ag in the area of data storage, management and access, as well as provision of services and products that can help improve the ICT4Ag business model across developing economies.

Source: Maxwell Vand Zila, CEO Vand Zila Technologies, January 2017

Synergy/policy recommendations

To unleash the full potential of ICTs in development programs, a new level of collaboration, both internally and with other organisations, and a new approach to scaling solutions to achieve a tangible impact are needed. This will necessitate significant coordination between INGOs, technology companies, private sector organisations, universities, and government entities (central and local), as well as with traditional development partners.

It is incredibly difficult to conceive new ways of working with organisational constructs that are fundamentally different from the status quo and require a shift in terms of strategy, competence, skills, and organisational structure.

Investment drives for the increased participation of entrepreneurs and investors in ICT4Ag initiatives and business models, entail that there is the need for governments and initiators to involve such actors' from conceptualisation, through to the development, testing, and review. This will create added interest, zeal and passion in the projects from such actors, and encourage them to invest at the time of scale-up.

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Appendix

The following are summaries published by CTA and its partners, on the status of Unmanned Aerial Vehicle (UAV) rules and regulations in African countries published by CTA. UAVs are defined as aircrafts without pilot (http://www.theuav.com/).

Table 2. Status of UAV rules and regulations in African countries, as of April 2016

Status	Countries
In place	Botswana, Côte d'Ivoire, Kenya, Madagascar, Nigeria, Rwanda, South Africa
Pending	Mauritius, Namibia, Zambia, Zimbabwe
None	Angola, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Dem. Rep.), Congo (Rep.), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Lesotho, Liberia, Malawi, Mali, Mauritania, Mozambique, Niger, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda

Table 3. Status of UAV rules and regulations in Caribbean countries, as of April 2016

Status	Countries
In place	Barbados, Belize, Cuba, Dominican Republic, Guyana, Jamaica, Trinidad
Pending	The Bahamas, Grenada and Suriname
None	Antigua and Barbuda, Dominica, Haiti, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines

Table 4. Status of UAV rules and regulations in Pacific countries, as of April 2016

Status	Countries
In place	Fiji
Pending	None
None	Cook Islands, Kiribati, Marshall Islands, Micronesia, Fed. St., Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor Leste (East Timor), Tonga, Tuvalu, Vanuatu

CHAPTER 4

Areas of investment

Introduction

While mobile penetration at the genesis of ICT4Ag a decade ago was low, mobile networks in emerging economies currently reach 90% of the population and mobile phone ownership will be over 90% of adults by 2020 (Manyika *et al.*, 2016). In the meantime, internet of things (IoT) sensors "will grow from 13.4 billion in 2015 to 38.5 billion by 2020" enabling "a global digital mesh yielding a planetary nervous system reaching into individuals, their homes and communities" (Ibaraki, 2015). Within Africa, there will be 500 million smartphones by 2020 (Shier *et al.*, 2016) further accelerating the use of precision agriculture and other technologies and for which "partnerships and collaboration (will be) critical for ecosystem development" (Matich, 2016). The combination of these mobile and sensor technologies will create a global IoT market worth US$11.1 trillion by 2025 (Manyika *et al.*, 2015) within which will be the deployment of precision agriculture. In addition, Christine Lagarde, managing director of the International Monetary Fund, states that "virtual currencies could be extremely beneficial to reach out to people who live in very remote areas" (Valero, 2016). These mobile, sensor, digital/virtual currencies and numerous other technologies will be powerful tools for helping to solve 'wicked problems' in agriculture.

Despite the rapid growth in ICT4Ag initiatives, the deployment of the majority of solutions is still at a pilot stage, with few capable of scaling sustainably (CTA, 2016). Many initiatives have been solely supported by donors and foundations and have provided tremendous 'proof of concept' evidence, yet they still need continued support. Agriculture's transformation across Africa therefore requires the "design of new models for investment to engage the private sector" (Mayaki, 2016).

To accommodate future scaling of ICT4Ag applications and platforms, the private sector must invest in ICT4Ag initiatives. However, there is a structural problem in the ICT4Ag sector because there are currently very few such investments being made.[1] This structural problem is the dearth of ICT4Ag CSPs to coordinate new investment models that deliver digital solution sets into rural areas. As stated by FAO *et al.* (September 2015), "many e-agriculture pilot projects are not implemented in a coordinated way and are not sustainable. Mainstreaming e-agriculture initiatives has been challenging in many countries because of a lack of a clear strategy and a failure to create synergies with other sectors" (p. 3).

ICT4Ag CSPs require a systems theory approach to problem solving by promoting investments and "innovations in technology, human capacity and organisational/network design" (Peterson, 2013), which will lead to sustainability. At the same time, Peterson (2013) defines agriculture sustainability as "simultaneous demands for economic feasibility (profit), benign environmental impact (planet), and enhanced social outcomes (people)." CSPs are therefore about bringing together new stakeholders who "engage with each other to co-create new knowledge, connect and enhance values, and collectively learn their way to new priorities" (Peterson, 2013) rather than exchanging what they already know. In addition, according to Dentoni *et al.* (2016), "by interacting with multiple stakeholders and tackling wicked problems,[2] organisations mitigate and share risks, which in the long run increases their chances of survival." Or, as stated by Blok *et al.* (2013), "the involvement of multiple stakeholders is a necessary condition to promote sustainability and economic independence of the small-scale farmers, and profit enterprises have a leading role to play" (p. 41). As such, ICT4Ag CSPs provide a framework for the co-creation of new investment options and opportunities for each partner while mitigating each partner's risk.

To achieve an integrated approach that is woven into the fabric of core business operations, traditional thinking must transition beyond 'hard' constraints – such as applications and platforms, devices and network connectivity – and the notion that ICT4Ag is an 'application', and instead focus investments and attention on

1 Rutten, L. (28 July 2016) Skype interview.
2 A wicked problem is a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements.

the challenge of 'soft' constraints – such as market research, business analysis, requisite internal change management policies and procedures, management/staff buy-in, internal and external awareness, and education. As hard constraints have been mitigated by increasing mobile phone uptake, as well as increased network and internet connectivity, soft constraints have emerged as the key for the successful implementation of ICT4Ag initiatives. Investments to address the soft constraints also align with rapidly emerging megatrends[3] germane to agriculture, such as CSPs.

To introduce pathways to institutionalise the use of ICT4Ag, and seamlessly inject these into an organisational culture – or corporate DNA[4] – of global, regional and local agribusinesses and other stakeholders that lead CSPs, this chapter provides a three-step framework for investment, and describes the types of investments within each step for each type of partner in a CSP (farmer, agribusiness, donor/foundation, financial institution, etc.).

Three-step framework

To mitigate hard and soft constraints for successful ICT4Ag schemes, there are three steps or areas of investment recommended for pre-project, project formulation and project implementation:

1. Feasibility study, research and analysis;

2. Formation of CSPs with selected agricultural actors and integration of the ICT4Ag initiative into internal operations of all relevant entities, including agribusinesses, mobile network operators (MNOs), financial institutions, and local technology solution providers; and

3. Implementation of ICT4Ag into payment systems, marketing, agriculture extension, supply chain management and other programmes by way of awareness raising and training for agribusinesses, farmers and other stakeholders.

These three key steps for investment have also been highlighted by the Sustainable Development Goals (SDGs) as a requisite for leveraging the capacities and capabilities of individual private, public and civil society partners. To do this, CSPs first have to be understood within the context of the agriculture sector.

3 Megatrends include: Sustainable Development Goals (SDGs), growth of mobile phone uptake, IoT, big data analytics (finance, supply chain, traceability, etc.), precision agriculture, cloud computing, blockchain decentralised ledger technology, machine-to-machine learning, crops adapted to withstand the effects of climate change, and a shortage of qualified ICT professionals in agriculture (GIC Directors, 2015).

4 As with a living organism, corporate DNA encodes the genetic instructions for the behaviour and business operations of private sector companies.

Building on a 20th century management approach

A worthy analogy for comparing the integration of ICT4Ag into agribusinesses and CSPs is the integration of total quality management (TQM)[5] into industrial manufacturing within the automobile and steel industries – a process that dates back to the Second World War in Japan.

TQM played an integral part in Japan's efforts to rebuild its economy in the aftermath of the Second World War and altered perceptions regarding quality of production and Japan's competitiveness as it sought to reverse the moniker that 'Made in Japan' was indicative of inferior quality. The key differentiator that influenced the resurgence of Japan's competitiveness was the disciplined focus on the end user – the same mantra often preached by those tailoring ICT4Ag solutions to smallholder farmers – and after about a decade, Japan's concerted effort to produce high-quality and customer-centered automobiles and steel began to threaten the economic viability of the booming auto and steel industries in America.

Losing market share and their competitive edge against Japan, corporate and sector clusters across the US and Western Europe began to weave TQM processes and procedures into the fabric of their core businesses processes, standard procedures and business cultures. In no time, the benefits stemming from an increase in intensive training for line workers, listening to customers and consumers, and calculating decisions based on their desires and needs were immediate.

Since the Second World War, developments, iterations, practices and procedures linked to TQM have altered the trajectory for countless industries. For instance, the acceptance and proliferation of TQM ushered in a new era of rigorous oversight in terms of a business' ability to assess the costs of quality.[6] Building on TQM, several other tools emerged. The emergence of the DMAIC tool (Define, Measure, Analyse, Improve/install and Control), for example, has informed industry's ability to improve planning, controls, measurement and analyses, and installation processes, while the quality management maturity grid (Crosby, 1980) sharpened the readiness of a corporate environment along a 5-point scale – uncertainty, awakening, enlightenment, wisdom and certainty.

Unfortunately for ICT4Ag, despite its proven utility, there have been few initiatives that have scaled successfully, largely due to deficiencies in business and deployment processes, and team composition. Cost analysis, DMAIC, corporate assessment and other TQM tools should therefore be reviewed by the ICT4Ag community to continue to develop the ICT4Ag space.

ICT4Ag CSPs in theory

A significant topic of discussion during the 2015 G20 Roundtable on Innovation in Agricultural Finance (Antalya, Turkey, 2015) was about the need for CSPs between agribusinesses, MNOs, financial institutions, software solution providers, NGOs, governments and others to bundle agriculture digital payments together with ICT4Ag. A CTA report on digital payments in agriculture (Babcock, 2015) identified several critical components that are also germane to broader ICT4Ag models including: the need to form intelligence-driven CSPs built around extensive market research; and mobilising shared resources to promote awareness, education and adoption among farming communities and other stakeholders.

The formation of CSPs that aggregate partner capacities and capabilities are essential to help solve wicked problems in agriculture (Dentoni, Hospes & Ross, 2012). Wicked problems are numerous and highly complex and include, how to feed 2+ billion more people by 2050, the chronic poverty of smallholder farmers that produce 70% of food worldwide, food insecurity, impacts of climate change on crop production, child labour, environmental degradation, and biodiversity loss. Such wicked problems require companies to "take actions with a diverse set of stakeholders both inside and outside the supply chain at levels that have been uncommon in the agri-food sector," yet "agribusiness managers do not always recognise that these are wicked problems that require not only adoption of technological innovations but also organisational change management" (Dentoni, *et al.*, 2012).

Unfortunately, agriculture CSPs have not been studied in agribusiness or general business

5 TQM is a management approach to long-term success through customer satisfaction, i.e. all members of an organisation participate in improving processes, products, services and the culture in which they work.

6 Cost of quality: the costs associated with providing poor quality products or services, including failure (costs as a result of defects before and after the customer received the product or service), appraisal costs (costs incurred to determine the degree of conformance to quality requirements), and prevention (costs incurred to keep failure and appraisal costs to a minimum).

literature (Dentoni & Peterson, 2011). As the body of research and evidence grows, concepts become proven and the expanded role of ICT4Ag in CSPs is tested, the notion that ICT4Ag is about the use of individual applications will be overcome. A mindset that ICT4Ag is a multi-disciplinary, systems approach to streamlining, professionalising, and commercialising a connected and digitised agricultural supply chain by way of bundled functionalities that enhance the value proposition of agricultural goods, must be adopted. This needs to be accepted by all stakeholders in order to advance the ICT4Ag movement and the role of CSPs in addressing the SDGs.

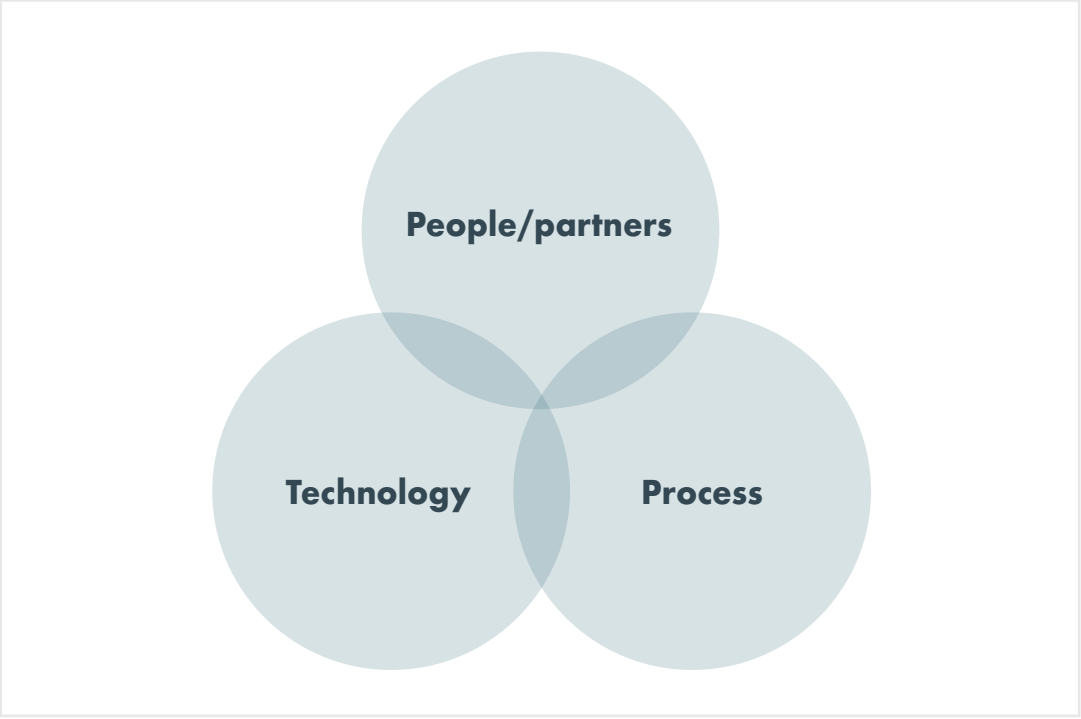

Figure 5: ICT4Ag CSP balance between people/partners, process and technology
Source: Adapted from Bell (2006)

Figure 5 illustrates the optimal balance required between people, technology and process to maintain effective ICT4Ag CSPs.

While a CSP must agree on its vision and goals from the outset, as well as its business plan, there must be some level of flexibility to provide room for the CSP to adapt to evolving interests throughout the project's lifecycle. Each partner requires clear roles and responsibilities aligned with their self-assessment of strengths, weaknesses and capabilities. Dedicated personnel are also required, one of whom should be designated as the chief ecosystem director (CED).[7] A senior-level position, the CED's knowledge base should be strongly founded in agribusiness, but also extend to general business, development and technology, and project and change management – all areas that will enable them to effectively develop and manage competing interests, ever-shifting priorities, and bring order to controlled chaos and mutually equitable benefits for each of the partners involved (London, 2016). Effective CEDs will demonstrate a balance of strategic decision-making ability, diplomatic yet decisive negotiation skills, and business acumen to foresee change, manage expectations, and capture results to articulate strengths and weaknesses among CSPs as initiatives evolve.

For the CSP to pursue its shared vision and goals, there must be an agreed upon monitoring, evaluation and learning (ME&L) process that will be used during implementation. A series of checklists and systems must be in place that

7 A CED is a person in charge of community management who oversees partnerships and dynamics within a specific industry.

capture rich supply chain data and provide deep insight and analytics to facilitate decision-making by the CSP as well as by each of its partners. For example, emerging from the growing call for better performance measurement is the impact assessment framework (IAF) (London, 2009). The IAF measures the negative and positive impacts of changed economics, behaviours and relationships between private sector buyers, farmers and the communities with whom they interact. As the bundling of ICT4Ag functionalities continues to evolve (see text box below) and multi-sectoral platforms emerge that aggregate agriculture together with health, education and other sectors (Babcock, 2015c), robust investment in IAF and similar tools will be critical for comprehensive performance measurement(s).

From performance measurement tools, to establishing governance and management structures that rely on key personnel to drive the vision and goals of the CSP forward, there is an overarching need for sound systems, approaches, and processes. To that end, a farmer-centred focus must be maintained as part of a broader, more 'systems theory' approach that recognises the inherent value brought into the CSP by its partners. Linking the voice of the farmer with business processes (as well as moving cash around to pay them) is ultimately the main concern of agribusinesses.[8]

Bundled ICT4Ag platforms

An outcome of CTA's seminal ICT4Ag conference in Rwanda in 2013, and its subsequent work in the sector, is a realisation of the need for a cohesive vision for the development and deployment of platforms that incorporate a range of functionalities in order to avoid duplication and to maximise value. The need for bundled ICT4Ag platforms must be aligned with the requisite three key steps of investment. A comprehensive list of functionalities include: digital payments/finance, surveillance, marketing, agriculture extension and supply chain management. The strategic insertion of digital payments and finance into agriculture supply chains addresses a key inefficiency – the expensive, non-transparent and inconvenient use of cash by buyers to pay farmers. Enabling digital finance channels for the distribution and capture of value (e.g. payments, savings, credit, micro-insurance, etc.) is complementary to and enables the digital distribution and capture of information for surveillance, marketing, agriculture extension and supply chain management.

This convergence of ICT4Ag functionalities has happened with well-known platforms, such as Esoko and Farmerline. In August 2016, the ICT service, Esoko,[9] entered into a US$868,000 CSP with the Alliance for a Green Revolution in Africa (AGRA) and the Mastercard Foundation to provide digital finance services for smallholder farmers. Others such as Farmerline in Ghana have recently reached agreements with MNOs to add bulk mobile money payment services to their platform.

ICT4Ag CSPs in practice

Mercy Corps' AgriFin Accelerate[10] (AFA) is an ideal model of an ICT4Ag CSP. The 6-year $25 million initiative, funded by the Mastercard Foundation, works in Kenya, Tanzania and Zambia, and supports the expansion of digital financial services bundled with farm management information services to over 1 million farmers by orchestrating linkages with core partners (i.e. financial institutions, MNOs, etc.) and software solution partners. AFA has had the additional benefit of learning from lessons as a result of Mercy Corps' previous Agri-Fin mobile project in Indonesia, Uganda and Zimbabwe.

AFA's engagement model includes market research, selection of partners for bundled ICT4Ag functionalities, farmer training and ME&L. AFA have well-defined selection criteria for projects they will orchestrate. They also have a highly structured due diligence process flow map for these selections that require go/no go decisions at the pre-due diligence, interim diligence and final diligence stages. AFA's highly structured approach is a worthy reference for any initiative to create one or more ICT4Ag CSPs.

In Uganda, CTA's €4.6 million Market-led User-owned ICT4Ag enabled Information

8 Shrader, L., Madara, A., Hokans, J., Stephen, O., Gatabaki, S., Makau, E. (8 August 2016). Personal interview.
9 https://www.esoko.com/
10 http://www.mercycorpsafa.org/

Service (MUIIS) is another example of a successful CSP. It brings multiple partners together[11] to deliver bundled ICT4Ag functionalities across a network of 350,000 farmers along the maize, soybean and sesame value chains. MUIIS uses the Ensibuuko Mobile Banking and Information Service platform as a delivery channel.

Another example of a CSP is the United States Agency for International Development (USAID)/Vodafone Connected Farmer Alliance (CFA) which seeks to promote commercially sustainable mobile agriculture solutions and increase productivity and revenues for 500,000 farmers in Kenya, Tanzania and Mozambique. Created in 2012, CFA is a CSP between USAID, Vodafone, TechnoServe and various agribusinesses. CFA's ICT4Ag platform includes mobile payments, communications and data collation/management functionalities and is replicable across different agricultural value chains. It addresses value chain management inefficiencies and increases productivity of both agribusinesses and smallholder producers.

As part of the CFA partnership, implemented by TechnoServe, a useful checklist[12] (TechnoServe *et al.,* n.d.) for the CSP was compiled to ensure its effectiveness:

1. Is there a genuinely shared vision and set of goals?
2. Are there sets of identified aims that all partners can articulate?
3. Is the purpose and role of the CSP clear?
4. What skills and competencies are needed?
5. To whom will the CSP report? What does the reporting process look like?
6. Is there an accepted process for decision-making?
7. Is there an accepted performance management assessment framework?

Unfortunately, AFA, MUIIS and CFA CSPs are the exception rather than the rule in the ICT4Ag space. The lessons learned from these initiatives reveal worthy areas of investment that are less about the technology and more about organisational change management and training within the context of CSPs. These learnings inform the key areas of investment by agribusinesses, donors/foundations, financial institutions and other stakeholders.

Similar learnings emerged from the performance evaluation (Babcock *et al.*, 2016) of the USAID/Malawi Mobile Money Accelerator Project (MMAP), which aimed to accelerate the development of the digital payments ecosystem in Malawi. The programme linked a range of public and private initiatives into a coordinated set of activities designed to promote broad adoption and use of mobile money in Malawi.

MMAP carried out a number of CSP pilots including four that were for agriculture. In the rush to secure farmer adoption of mobile wallets and solutions, there was little regard for the need to have internal management and staff buy-in, as well as mobile wallet adoption by management, staff and field agents for disbursement of salaries and allowances. There was also little or no analysis of the underlying business case for how digital supply chain payments/information management would decrease costs, increase yields, improve quality and reduce spoilage. In addition, there was also little or no analysis of the many benefits that directly accrue to farmers, as well as the financial and other benefits for agribusinesses. In one initiative, some of the agribusiness field agents did not have a mobile wallet and yet they were trying to promote mobile wallet uptake by farmers!

These types of shortfalls – lack of management/staff buy-in, internal adoption, business analysis and more – are not surprising given the rapid advance of these types of ICT4Ag CSPs. Nevertheless, we must close these gaps by investing in the requisite change management necessary to successfully implement ICT4Ag initiatives.

While evaluating MMAP, Babcock *et al.*, (2016) also briefly looked at Kenya Nut[13] which linked M-Pesa (mobile money transfer) payments and a farm management information system to farmers. Before the Kenya Nut pilot started, there had been no pre-project analysis of cost savings, yet the post-project case study revealed cost savings of US$228,000 for Kenya Nut. Such analysis pre-project might have helped the pilot to better align the awareness, education and

11 MUIIS Partners: CTA, Mercy Corps, aWhere Inc., AGRA, EARS-E2M, EAFF and eLEAF.

12 This informative guide specific to agribusiness adoption of ICT, and MNO comprehension of agriculture, considers impediments to selling mobile technology, technology adoption lifecycle, a matrix of change, roles/responsibilities in change management and more.

13 http://www.technoserve.org/files/downloads/case-study-connected-farmer-alliance.pdf

buy-in of the management, staff and field agents for less problematic implementation. Such type of pre-project analysis should lie within the first step of the three-step framework.

A review by Vodafone (2015) of six ICT4Ag initiatives[14] revealed that: business plans must be developed based on market research, the most successful initiatives bundle functionalities, and investment is required to promote awareness and provide training. USAID's Feed the Future (2014) also emphasised the importance of the following areas of investment: research, awareness raising, and education and training in order to mitigate risks related to market, product, financing, production and adoption.

Three-step framework for investment

The three-step framework for investment is informed by CTA's previously developed three steps specific to agriculture digital payments (Babcock, 2015a). The three steps were: cash usage behavioural research, strategic alliance formation, and embedded mobile finance. CTA's previous work revealed that there must be pre-project investment in market research and analysis in order to inform an understanding of the patterns of daily life of farmers to include their needs, wants and desires as well as their levels of literacy, digital literacy and levels of trust (step one). Only with this understanding can value propositions be crafted to create viable CSPs (step two) so that digital solution set(s) can be successfully implemented and delivered to farmers (step three).

Throughout the three-step framework (Table 5) are discreet tasks like research, analysis, design and delivery of training. Of greatest importance, though, from an investment perspective, is the need to build human capacity. It is clear from empirical evidence (GIC Directors, 2015; key informant interviews) that there is a particular shortfall of ICT expertise within the agribusiness sector and the rest of the agricultural community. Closely related to that is a shortfall in senior level CED professionals with project and change management experience. As with other C-level executives, a transformation of the ICT4Ag sector requires a senior level professional with expertise in agribusiness, telecommunication, technology as well as development sectors. Agribusinesses, as well as MNOs, must prioritise investment in the building of human capacity in order to maximise the benefit of ICT4Ag for their respective bottom line profitability!

Table 5: Three-step framework for investment

Step	Rationale
Step 1: Feasibility study/ research/analysis	This step should include development of high-level operational models, high-level business cases and cost/revenue analysis, activity plans and implementation budgets. Having this information available allows a board of directors to give senior managers the remit to implement strategy, and enables them to be aware of and understand the opportunities and implications of implementation. All of these aspects are integral to securing internal management and staff buy-in.
Step 2: Formation of CSP/ integration into internal operations	Staff of each CSP partner should know the features and benefits of planned ICT4Ag implementation. Each CSP partner should know their role and responsibility as well as that of other partners. Requires internal change management.
Step 3: Implementation of ICT4Ag into services and programming	The goal is for ICT4Ag to be integrated into the overall business operations of the agribusiness and other CSP partners. It is essential for staff/field agents to be trained and to champion adoption and uptake of ICT4Ag by farmers. Farmers and other stakeholders must be made aware of and educated about features and benefits of the ICT4Ag product and service.

14 Reuters Market Light (India), Ndumberi Dairy receipting service (Kenya), Multiflower payment and loans service (Tanzania), ECOTAB (Turkey), RUDI Sandesha Vyavhar (India), and Vodafone Farmers Club (Turkey).

Step 1: Feasibility study/research/analysis

This first step is absolutely vital but noticeably absent from almost all ICT4Ag initiatives to date! Consistent with the parameters of an ICT4Ag CSP, and the roles and responsibilities of its partners, an agribusiness and MNO must take the lead in conducting and analysing the research. Their efforts can be supported by donor or foundation investment in technical assistance.

Data about the needs, wants and desires of smallholder farmers (understood through the lens of their levels of illiteracy, financial illiteracy, digital illiteracy and lack of trust, relating specifically to digital agriculture solutions) must be understood. Such research will not only ensure the most appropriate bespoke design of a bundled ICT4Ag solution for the farmer but will also inform the requisite business case and value proposition for each of the partners in the CSP. Whether done together or separately, such research is comparable to the common practice of value chain or market systems analysis that is often carried out to inform the design of an agriculture development project. In fact, this research should be integrated into market system analysis.

The research will convert farmer and farm data into information. From the perspective of the ICT4Ag solution, though, that research information is merely data that must be mapped into the design of the ICT4Ag solution in such a manner that the outcome of the solution provides visibility into, and information about, the market system.

Step 2: Formation of CSP/integration into internal operations

Given their position throughout the agriculture and economic landscape, donor and foundation investors are well-positioned to initiate and aggregate a list of potential CSP partners. Initial discussions and negotiations between potential partners will inform the subsequent formation of an ICT4Ag CSP. While the initial lead on this can be the donor or foundation, by virtue of the fact that it will be an agriculture CSP, the lead agribusiness must lead the CSP. If this cannot occur, the donor may take the lead during the pre-formation phase, before handing leadership over to the agribusiness.

During the formation of ICT4Ag platform, business analysis conducted in step one must be used and translated into system requirements by the technology service provider. Farmer and other stakeholder uptake can then be forecasted, the profit-related key performance indicators (KPIs) for the private sector partners (e.g. agribusiness, MNO, technology solution provider, etc.) and the beneficiary-related KPIs for development partners (e.g. government, NGOs) can be calculated and understood. Each partner must then reaffirm their commitment to the CSP.

Step 3: Implementation of ICT4Ag into services and programming

It is clear from empirical evidence (Accion, 2015; Babcock *et al.*, 2016; Moceviciuten and Babcock, 2016; Waruingi and Muriithi, 2016) that the absence of management and staff buy-in has been a shortfall in sustainable ICT4Ag initiatives. Buy-in comes from awareness of – and education about – the features and benefits of ICT4Ag functionalities. This absence of buy-in often originates from a lack of internal business analysis of the financial and other benefits (addressed by step one) that accrue not only to farmers but to the agribusiness and other stakeholders as well.

With a more strategic approach of the ICT4Ag CSP, business analysis will not only promote awareness amongst management of all partners but will also inform the design of training and curricula – about the digital solutions – that will be key to integrating the ICT4Ag platform into the corporate DNA of the lead firm and other CSP partner/investors. Donor and foundation investors are well positioned to take the lead in the creation of training/curricula – on financial and digital literacy – for corporate management/staff (e.g. agribusiness, MNO, etc.), farmers and field agents (e.g. corporate, government, NGOs). Their interest will be to create content that can be scaled to similar value chains as well as be collated for public consumption worldwide. Global, regional or local agribusiness and MNOs will also have interest in extracting specific content that can be customised for their awareness raising and training needs, and codified into their internal standard operating procedures for the other value chains and countries they work in.

In addition, implementation of ICT4Ag platforms will leverage existing government and/or private-sector infrastructure that supports knowledge transfer about good agricultural practices. This knowledge transfer happens on an on-going, season-after-season basis because knowledge advances require constant

reinforcement to promote farmer uptake. Therefore, one of the aims of the CSP is to ensure that information about the ICT4Ag functionalities are weaved into existing knowledge transfer infrastructure.

Within the scope of any ICT4Ag CSP vision will be the expansion of an existing, or development of a new, network of field agents for the transfer of knowledge, including knowledge about ICT4Ag. The integration of an ICT4Ag into a CSP framework can further boost these efforts, while increasing its impact and creating pathways for the inclusion of more youth and women into these knowledge transfer initiatives.

The anchor agribusiness and MNO investors will also need to collaborate to identify potential agents such as input suppliers, cooperatives, traders, processors, and agri-equipment vendors. Existing and future distribution channels of products and services in areas where farmers live and work also need to be developed. These distribution channels will need to supply mobile money and other ICT/mobile functionalities. In the case of mobile money, potential agents must comply with an MNO's selection criteria.

Investment matrix

What follows is a mapping of various options for investment by different types of investors: agribusiness, cooperative, MNO, donor/foundation, technology solution provider, venture/social investor, financial institution and farmer. Further, the future of ICT4Ag enabled by the three-step framework and mapping of investment options by type of investor will no doubt spawn multiple new business models and 'spin offs' that will benefit farmers and their households in terms of: new distribution channels for products and services, micro-payments (i.e. PAYGO solar), layaway plans,[15] school tuition payments and more (Manyika *et al.*, 2016).

As the CSP is formed, and the roles and responsibilities for each partner are designed, the words of one key informant are instructive. According to Muchiri Nyaggah,[16] Executive Director at the Local Development Research Institute, "technology is pain relief" for a headache. Therefore, the investment into, and implementation of, a solution must match the perceived level of financial pain – caused by inefficient supply chain, fraudulent behaviour, poor yields – with the requisite level of investment in an ICT4Ag solution. In other words, the CSP in the aggregate and its individual partners must determine if the ICT4Ag 'headache' requires investment in "a medical prescription, general practitioner or a neurologist".

Investment options/considerations by type of investor

Type of investor: Farmers

Farmers have heard about mobile solutions but facts and figures about how much these solutions might benefit them financially have not been widely available. The value proposition for the farmer is that the technology is free, or subsidised (within a corporate business model), and makes their life easier while increasing their overall farm income. Their investment metrics will include: convenience, transparency, increased production and increased income.

Research with smallholder farmers in Niger revealed feelings of empowerment from ICT4Ag solutions that provided them with security and independence. Farmers greatly valued the independence that mobile payments gave them because they saved 1–3 hours on time spent traveling or waiting for payments (Aker *et al.*, 2015). Citing an appreciation for security, a mobile survey conducted with USAID/Vodafone's CFA pilot with Kenya Nut revealed that 85% of nut farmers in Kenya valued M-Pesa payments over cash, which is often paid out at crowded aggregation points. Echoing this preference for "increased privacy that mitigates community and social pressures to give loans and gifts" (Babcock, 2015), rice farmers in Ghana, who were paid with TigoCash, also highlighted this inherent benefit of mobile payments.

Despite the potential benefits, the financial capacity and behaviour of farmers indicates that they will not, themselves, pay for ICT4Ag (GSMA, 2015). As such, investment into sustainable ICT4Ag will benefit from moving higher up the value chain to other stakeholders with investment capacity and who will benefit

15 A layaway plan is a retail sales promotion scheme under which a customer deposits a fraction of the cost of the merchandise they want but cannot buy. The store then holds the merchandise until a certain date by which time the customer must complete the payment and then take delivery.

16 Nyaggah, M. (9 August 2016). Personal interview.

directly by linking with farmers. While there is a shortage of research, studies are increasingly pointing to how producers prioritise investments. Having long endured protracted periods of food insecurity, impoverished farmers often exhibit short-term focused behaviour patterns. As a result, farmers are less likely to sacrifice income in the short-term that would allow them to cover ICT4Ag subscription costs even if it would benefit their farm business in the long-term. Many farmers also have limited capacity to invest in an ICT4Ag, favouring long-term investment in input supplies, with remaining funds invested in short-term food and other immediate needs.

Lutheran World Relief (LWR) found this short-term behaviour pattern to be the case in their programmes with Esoko and the Grameen Foundation Community Knowledge Worker (CKW) projects in Kenya and Uganda. Esoko provides smallholders with access to inputs and finance through a virtual marketplace, in addition to crop advice and information on prices and weather. Meanwhile, in Uganda, CKW combined the use of mobile technology and local peer advisors to produce accurate, timely information to improve farmers' businesses and livelihoods. Spanning four separate Esoko and CKW projects, all of which came to an end in 2016, LWR paid for the services (about US$2,400 per year for Esoko and about US$12,00 per year for CKW) in the absence of farmer interest in doing so. While noting benefits throughout the lifespan of each project, individual farmers were not willing to absorb the costs to maintain subscriptions with Esoko and CKW.

Type of investor: Agribusiness

For transformation of the ICT4Ag sector, the CSP must have the agribusiness as the anchor partner. While directly connecting farmers and other stakeholders into the supply chain, the digital solution set(s) will be designed by the CSP to align with the core business model of the agribusiness. Given its leadership role and responsibility, the agribusiness must commit by way of internal reallocation of manpower resources and/or invest in hiring and/or developing key personnel as well as a CED to lead the CSP.

There is a trend in agribusinesses to attempt to digitise supply chains. A key value proposition is to be the first to secure a competitive advantage by successfully implementing a bundled ICT4Ag solution set. Another value proposition is to make a direct connection with smallholder producers and otherwise streamline the efficiency of their supply chain. Metrics will include: digitised farmer databases, reduced side-selling (increased loyalty), improved and faster decision-making, cost savings and increased profit.

ICT4Ag can now provide real-time and accurate planning and forecasting, efficient bookkeeping, traceability, quality control, transactional overviews and more. Due to the nature of ICT, these benefits can be made technically available to all stakeholders including: farmers, agribusinesses, traders and other stakeholders. To streamline the efficiencies and effectiveness of their supply chains, global agribusinesses are either building their own multi-functional farm management information platforms or sourcing ready-made platforms from technology service providers such as the global solution provider, SAP.[17] The functionalities of these platforms might include: SMS receipts, digital ledgers for farmer financial management, issuance of know-your-customer[18]-compliant identity cards, delivery of agronomic and other information, capture of descriptive, diagnostic, predictive and prescriptive analytics, and digital payments. Unfortunately, according to Moceviciute and Babcock (2016), as well as Muchiri Nyagah,[19] there is a lack of senior level experience inside front line global, regional and local agribusinesses, cooperatives, aggregators and input suppliers of ICT, preventing the adoption of ICT4Ag into core business operations in order to drive organisational transformation.

Regional or local agribusinesses might have fewer resources to build their own platform or source from a global technology service provider. Therefore, options for regional and local agribusinesses might include smaller, local technology service providers such as Farmerline, Esoko, Votomobile or ImageAd. The subscription fee structure for such platforms are usually tiered for varying number of records (i.e. for 10,000, 5,000 or 1,000 farmers) and functionalities (i.e. surveys, information distribution, traceability, payments, etc.). The

17 https://www.sap.com/

18 KYC is the process of a business obtaining information to verify the identity of its clients. KYC enables banks to prevent fraud, understand their customers better and manage risks.

19 Nyaggah, M. (9 August 2016). Personal interview.

selection of the appropriate fee structure is determined after a process that usually entails an initial product demonstration by the technology service provider. After learning about the potential customer's business and its needs, the technology service provider then submits a specifications proposal. Upon review, the potential customer might ask clarification questions. Thereafter, precise terms are negotiated and the contract is signed. Throughout this process, the agribusiness should be proactive and as clear as possible regarding its aims and objectives to avoid confusing an already complicated process (Figure 6).

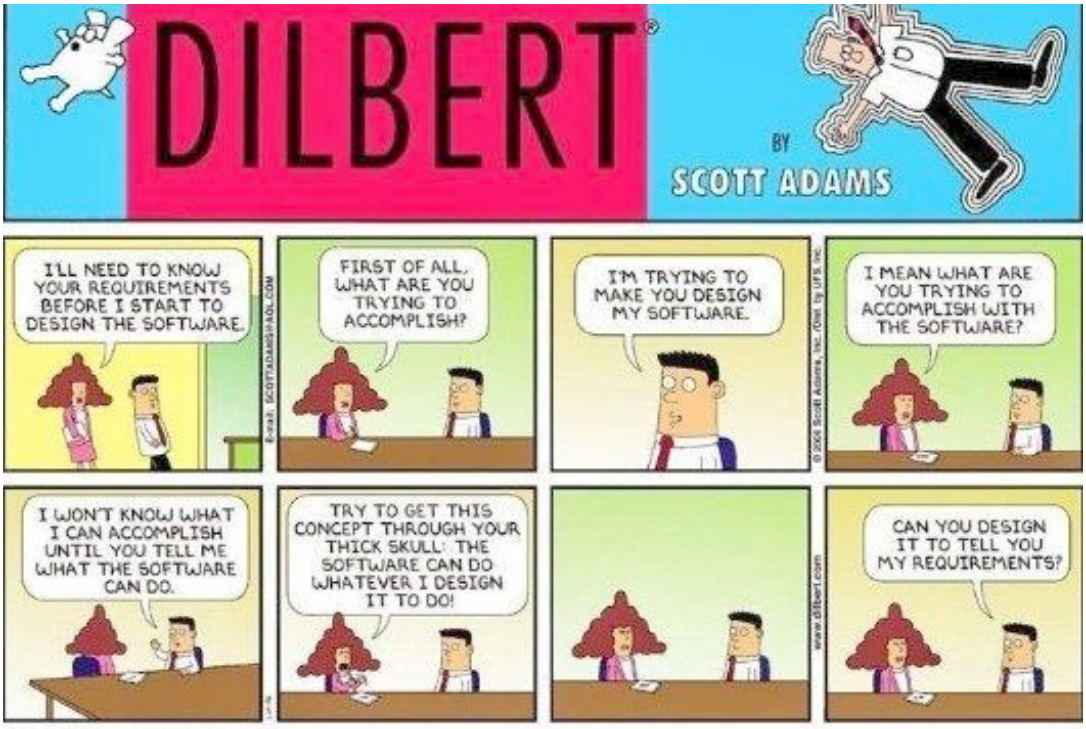

Figure 6: A complicated process.

Available at: https://image-store.slidesharecdn.com/319f280c-5de4-4363-bc0b-af264a3f4932-original.jpeg

Whether designed internally, or a subscription is paid for use of an off-the-shelf platform, the agribusiness will own the underlying data. In both cases, the data can be securely stored in the cloud. If internally designed, then the agribusiness must also commit the requisite investment to conduct ongoing maintenance and upgrades throughout the life of the platform. As this is usually outside the core capability of an agribusiness, it is very likely that ICT4Ag technology service providers – both global and local firms – will continue to expand because the cloud offers the same or more degree of control over the data than any internal design/build.

In the case of British American Tobacco (BAT)[20] in Uganda in 2011, they sought to streamline their supply chain by partnering with banks to transition cash payments to 25,000 farmers to electronic payments into farmer bank accounts. At that time, mobile money and other solutions were not as ubiquitous as they are today so this BAT initiative was not bundled with any other ICT4Ag functionalities. Extensive research they carried out with farmers after each of the five pilots (with five different banks) revealed that small-scale fraud by their employees, which had occurred through the cash payment system, was costing BAT and its farmers about US$250,000 per season. This small-scale fraud occurred at the three points: field agents registering farmers, tobacco buyers awarding fraudulent quality certification, and payment cashiers miss counting or otherwise taking advantage of the farmer.

After the five pilots in 2011, BAT rolled out electronic payments in 2012 in partnership with Post Bank. To open each of the 25,000 bank accounts required a US$1.5 investment; the requisite photo for each farmer required an additional US$1.20 investment. BAT also invested in a software development firm as well as developing very precise standard operating procedures for the integration of electronic payments into BAT's core business operations. BAT also invested in extensive training to every farmer before each season.

Due to the US$250,000 fraud, the scheme paid for itself in 2 years rather than the 5 years originally estimated by removing the leakage through electronic payments.

Type of investor: Agriculture cooperative

Cooperatives with a mandate to serve their members know that there are multiple digital technologies and applications that will revolutionise agriculture. A key investment option for a cooperative is to hire key personnel and/or build capacity of skills/knowledge in ICT. These personnel will be key to integrating the cooperative into upcoming ICT4Ag CSP initiatives.

Farmers are increasingly aware of mobile money in urban areas and are driving demand for mobile money in agriculture as well. Cooperatives need to be responsive to their members and ensure that ICT4Ag will improve delivery of services and information. Metrics include: member satisfaction, indirect income for the cooperative as farmer income increases and increased membership.

In Kenya and Uganda, LWR works with agriculture apex organisations and farmer groups in coffee, horticulture and grains to improve yields. As a development agency, LWR has a four-step approach to capacity building: policies and procedures, business planning, implementation and training. Using their four-step approach, LWR developed four projects that implemented either the Esoko or Grameen Foundation CKW information systems, as well as electronic weigh scales and electronic payments, for a coffee cooperative. In Uganda, LWR also provided a US$120,000 loan guarantee mechanism as their vote of confidence in the cooperatives when they sought financing. The mechanism provided a 60% guarantee for any financing the cooperative might secure.

After conducting two or three 'design workshops' for the digital solution, the ICT4Ag designs were linked into a business plan. Thereafter, in the case of the Esoko, CKW and electronic weigh scale/payments, LWR worked to develop the human capacity of the cooperatives and their member farmers. As mapped out in the business plan, LWR provided 100% support in the first 2 years. In years 3–5, LWR expected the farmer organisation to provide 50%, 75% and 100% of the support, respectively.

When working with Kenyan coffee societies to install electronic weigh scales they were met with internal resistance on the part of graders and purchasing clerks, however overcoming the resistance was manageable for two reasons: 1) the level of the corruption was so bad that farmers were outraged; and 2) LWR was already embedded in capacity building efforts at the coffee cooperative level so significant training was carried out to promote behaviour change and adoption. The use of electronic scales provided a transparent, summary print-out with details about payments due to each farmer. The coffee society chairman then took the print-out to the bank, which then made electronic payments into the bank account of each coffee farmer.

Farmer interest in paying for information services has not been enough to make them economically sustainable. Even though farmers might have derived benefit and see long-term value, their focus is on the immediate future. This dynamic has informed the shift in focus for ICT4Ag services

20 Elphinstone, A. (2 September 2016). Skype interview.

toward agribusinesses which have the financial capacity, and rapidly growing interest in bundled platforms, to streamline their supply chains.

Within this context, agricultural cooperatives must determine what their role and responsibility should be. If the cooperative has enough financial capacity, it might similarly prefer its own bundled ICT4Ag platform to streamline the supply chain on behalf of its member farmers. If they don't have enough financial capacity, cooperatives must recognise their significant contribution to the value chain by aggregating farmers, inputs and outputs. Therefore, to ensure its farmer members have maximum opportunity to participate in any ICT4Ag initiative, the cooperative should invest in a digital database of its members. In addition, it should invest in developing and/or hiring its own internal ICT4Ag capacity to liaise with ICT4Ag initiatives.

Type of investor: Donor/foundation

Development advocates want to understand how they might shift their role and responsibilities in this new era ICT4Ag CSP initiatives, which are SDG-endorsed and private sector-led. In the last decade, donors have played a key role in providing 'proof of concept' evidence ICT4Ag, but in the next decade, donors will provide more of a 'support' role. Their options for investment in ICT4Ag CSP initiatives include market research, technical assistance, awareness raising, education and training.

For donor agencies, the value proposition of ICT4Ag is that it can improve the quality of life of beneficiaries. Metrics include: numbers of 'connected' farmers, numbers of 'financially included' farmers, integration of youth and women, increased transparency and the improved quality of farmers' livelihoods.

The donor model is one of development and empowerment of trusted intermediaries whether they be in agriculture, health, education and other sectors. A donor's convening authority and empowerment of trusted intermediaries are strategic tools for the roll out of ICT4Ag. MNOs have realised the importance of partnering with intermediaries such as agribusinesses, farmers, cooperatives, NGOs and other actors in rural areas to leverage the relationships they have with farmers and to overcome challenges of illiteracy and digital illiteracy.

Intermediaries' collaboration with, and the convening authority of, donors can and has promoted ICT4Ag awareness, education and trust amongst agricultural communities. For example, in Uganda, where there have been highly visible scandals related to cash disbursements of donor aid, Dan Kleinbaum, CEO of Beyonic – a mobile financial services provider – states, "66% of USAID implementing partners have switched to the use of mobile payments and probably half of those were motivated because of cash leakage."[21] In the case of "one customer working in the agriculture sector, they suspected that some of their agents were bribing farmers, but didn't know just how much money they were losing. Once they switched internal payments to mobile money, they were able to eliminate these losses and their operations became far more efficient."[22]

Separately, the Bill and Melinda Gates Foundation funded an initiative, implemented by Vital Wave, in which several agribusinesses and exporters transitioned from making cash payments to bulk mobile money payments to their farmers and seasonal labourers. The funded pilots revealed the clear need for ongoing training of internal personnel, as well as farmers, to overcome resistance due to a lack of digital literacy. Ongoing training was also necessary to refresh knowledge, as well as provide training to new employees/farmers. In fact, according to Darkwa[23] agribusinesses "rarely accept the solution for its own sake" so training and retraining has to be offered by the solution provider to ease the institutionalisation of the solution into the corporate culture.

The Mastercard Foundation-funded AgriFin Accelerator (AFA), implemented by Mercy Corps, plays a key role as a network orchestrator[24] because MNOs and financial institutions do not understand farmers, agriculture and aggregation. AFA provides internal change management, management consulting, and research for the CSPs the network orchestrates.[25] For the partnerships and projects that AFA orchestrates, AFA requires an 80/20 cost share split with their private sector partners to digitise informational

21 Kleinbaum, D. (19 August 2016). Phone interview.
22 IBID
23 Darkwa, D. (24 August 2016). Skype interview.
24 Network orchestrators create a network of peers in which the participants collaborate to create value.
25 Shrader,L., Madara, A., Hokans, J., Stephen, O., Gatabaki, S., Makau, E. (8 August 2016). Personal interview.

access and payments to farmers. AFA projects can be as short as 3 weeks or as long as 6 months and the private sector partner must provide 80% of the budget. In a departure from the past practice of donors/foundations, AFA will not work with any 'proof of concept' projects; they only work with partners that are already bought in to the idea of ICT4Ag. Therefore, any market research that AFA might support will be less about helping to build a case and more about understanding the demographic for which their partner is providing a product or service.

While Mercy Corps is a non-profit, development implementer, AFA's successful performance as a network orchestrator can be attributed to the private sector agribusiness, MNO, financial institution and digital finance services backgrounds of the AFA team members. These backgrounds have served the team well in gaining the credibility and respect of their private sector partners. This includes working with their partners to secure non-disclosure agreements, craft a strategic approach, provide general advice, and guide partners' internal change management to integrate ICT4Ag into core business operations. As stated by London (2016), the network orchestrator "must be fluent in the language of the business community, including understanding what drives business performance and how these enterprises measure success. He or she must also be fluent in the language of the development community". As previously stated, there is a shortfall of professionalism[26, 27] in the ICT4Ag community which can be mitigated by engaging with more business professionals.

Type of investor: Technology solution provider

Global, regional or local technology solution providers know that there are multiple digital technologies and applications that will revolutionise agriculture. Agriculture, though, is not a sector with which technology solution professionals are familiar. In addition, the depth and breadth of agriculture can be a challenge for software design. A technology solution provider's options for investment could include hiring key personnel with an agribusiness background.

Technology solution providers must be profitable in order to remain in business. Bottom line metrics include: revenues, margins and profit by way of serving the needs of global, regional and local agribusinesses. Social venture metrics include: numbers of farmers served (indirectly via paying agribusinesses) and mitigation of information asymmetries[28] between farmers and other value chain stakeholders.

The experience of global technology solutions provider, SAP, is a worthy reference.[29] SAP Research was set up to leverage public funding from various sources (e.g. European Union, German ministries, etc.) to reduce risk for longer term initiatives with unknown profit potential. Accordingly, SAP Research became a partner in the African Cashew Initiative, which is now known as the Competitive Cashew initiative (ComCashew).[30] This PPP is co-funded by Germany's Federal Ministry for Economic Cooperation and Development (BMZ) and the Bill & Melinda Gates Foundation. ComCashew has four implementing partners: the German development agency, Gesellschaft für Internationale Zusammenarbeit (GIZ), Technoserve, the African Cashew Alliance (ACA) and FairMatch Support. In addition, ComCashew's partners include the private sector, governments, donors, foundations and apex organisations. SAP designed a platform that supported organised farmers to streamline their business with traders, buyers, processors, retailers and wholesalers. The platform was able to utilise barcode tagging, electronic buying receipts, price and logistics information and multiple other applications. SAP also integrated a digital payments module (mobile money) onto the platform in Uganda. Although subsequent public funding of SAP Research has been reduced, SAP's overall income has increased because its products – including the ComCashew platform – have proved the economic viability of serving these new markets.

In Côte d'Ivoire, the SAP Rural Sourcing Management platform – which combines mobile and desktop access to track produce from the farm to the factory – has helped improve traceability and analysis within the cocoa value chain.[31] In the final analysis, the public funding provided a good ROI for the European Union as well as for SAP.

26 Rutten, L. (28 July 2016). Skype interview.
27 Asare-Kyei, D. (6 September 2016). Personal interview.
28 Farmers typically lack market information leaving them disadvantaged in negotiations with traders and other actors for the sale of their crop.
29 Merz, C. (29 August 2016). Phone interview.
30 http://www.africancashewinitiative.org/
31 https://news.sap.com/sap-helps-barry-callebaut-realize-sustainable-cocoa-farming/

Global technology solution providers, such as SAP, design bundled turnkey solutions[32] that are paid for by corporate and agribusiness customers. While locally grown technology solution providers initially focused on individual solutions (i.e. market pricing data) paid for by farmers, as the space has evolved in the past decade these local solution providers – that contribute their unique insights, nuanced understanding, local language capacity and commitment to impact – have evolved and now also provide bundled turnkey solutions. While the local technology solution providers now offer similar platforms those designed by global firms, they have been operational for longer than the global platforms.

Esoko and other for-profit local solution providers such as Farmerline and VotoMobile are smaller and nimbler than global platforms and are well-positioned to continue serving farmers, if only as a loss leader in order to enhance their overall value proposition to corporate agribusiness customers. Local solution providers have lower costs, are closer to farmers, and are better able to provide them with free or subsidised services in order to build goodwill, understanding and a farmer database; all of which can be leveraged in negotiations with agribusinesses. Herein lies a key competitive advantage for technology solution providers and justifies their internal investment and short-term losses in return for long-term investment gains.

For a truly aggressive technology solutions provider, there is another business model that has not yet been observed in practice. Rather than selling subscription fees to agribusinesses, a technology solution provider could secure a percentage of the costs saved, increased revenues and/or increased profit. Such a revenue model will require the formation of an analytical business case up front in order to make the value proposition for shared participation in savings, revenues and/or profits. This will require establishing an agreed upon baseline or index against which the business performance of the ICT4Ag platform will be compared. Such a type of arrangement will be more of a partnership between the agribusiness and technology solution provider rather than a customer/vendor relationship. It could also open the door to regional and local agribusinesses that might not feel they have the financial resources to pay a monthly subscription fee for a confined range of functionalities.

Type of investor: MNO

There is a very recent trend of MNOs partnering with global, regional and local agribusinesses in order to roll out their service offerings in rural areas. A key value proposition is to be the first MNO to secure a competitive advantage by successfully implementing a bundled ICT4Ag solution set in partnership with an agribusiness. Metrics include: increased subscriptions, reduced churn[33] and increased bottom-line profitability for the mobile voice and mobile money service offerings.

Within MNO corporate environments for any ICT4Ag initiative, there needs to be a roadmap that creates a clear value proposition.[34] An MNO that pursues a mobile agriculture initiative will seek to understand the core KPIs of the agribusiness in order to work with them to find a budget for a mobile agriculture solution. MNOs typically will have enterprise departments that include business verticals[35] of strategic interest to that MNO. These verticals might include: agriculture, bulk payments, utilities, transportation fleet management, government-to-people payments, etc. If an MNO chooses to add an agriculture vertical to their enterprise department they will usually only do so if agriculture in that country contributes 30% or more to national GDP. Unfortunately, few MNOs understand agribusiness so MNOs must increase their investment in human capacity in agriculture in order to coordinate and collaborate better with agriculture stakeholders. In the case of GSMA, the apex organisation for 800+ MNOs worldwide, they partner with donors and foundations to fund grant mechanisms that work with MNOs to develop products and services for agriculture (as well as health, women, youth, disaster response, etc.).

32 Also known as 'off-the-shelf' solutions.

33 Churn is the loss of customers to another company. One common practice is for mobile phone subscribers to have SIM cards from two or more MNOs and to switch between SIMs based on promotions and other incentives. A metric for a MNO is to have reduced churn by creating more customer loyalty so there is less switching of SIMs (churn).

34 Pshenichnaya, N. (25 August 2016). Skype interview.

35 A vertical business is one that offers goods and/or services that are specific to a single industry, trade, profession or other group of customers with specialised needs.

Vodafone is a mobile network operator with operations throughout Africa and elsewhere. Their first foray into agriculture was an initiative at Vodafone-Turkey. The Farmers Club CSP was started in 2009 and provides SMS text information about weather, market pricing, agronomic and general agriculture information to 903,000 active users in the country. The Farmers Club CSP was championed by the then CEO of Vodafone-Turkey who had an intimate understanding of the lives and needs of farmers from her previous role as general manager for the agriculture and food company Danone-Turkey.

Farmer Club's content partner is TABIT, a Turkish social enterprise focusing on ICT enablement for smallholder farmers. It should be noted that while Farmers Club-Turkey provides freemium (i.e. free and paid) pricing for information services to farmers they do not have a sustainable revenue or cost model. Nevertheless, Vodafone-Turkey have accrued indirect benefits including reduced churn and increased brand awareness (GSMA, 2015). It is also important to note there has been less traction for the Farmers Club model in Eastern and West Africa because of lower levels of literacy than in Turkey, as well as the lower appetite of farmers to pay for services (AGRA, 2016).

Perhaps informed by Vodafone's experience with the Farmers Club model in Turkey and Africa, Vodafone's second CSP – the CFA – did not rely on payments by farmers for its commercial viability. Instead, the intent was to rely on investment by agribusinesses that received improved supply chain efficiencies.

Type of investor: Venture/social capital investor

Venture capital firms want to deploy a cogent approach for combining several ICT4Ag ventures into a single investment strategy. Their primary option for investment is to take equity in a local technology solution provider, thereby contributing to the professionalisation of the business by participating on the board of directors. Their sole metric is receiving an ROI. Depending on the venture capitalist they may entertain a lower than usual ROI if the potential for social impact is great.

World renowned ICT expert/futurist and partner at REDDS Venture Investments,[36] Stephen Ibaraki,[37] considers our digital era of hyper-extreme connectivity as the catalyst for massively disruptive innovations. So significant is the current 'digital quake' that nearly 60% of the US workforce will be replaced by automation. Component manufacturing, that has been a key element of the modern economy, is being replaced by algorithm-based production. In developing countries, the normal path to wealth creation has been the provision of cheap labour, but that is no longer the case. These and other massive disruptions in society and the economy will create even more extremism, and political and economic instability leading to 'planetary chaos'. However, in about a decade, new societal, economic and political structures and dynamics will have constituted and a new normal will emerge.

This overarching philosophy about the 'digital quake' has resulted in REDDS Ventures investing in opportunities that will be part of the upcoming 'new normal'. REDDS Ventures focuses on ICT investments globally, within which 20% of their overall portfolio is focused on ICT4Ag. For their ICT4Ag investments, 70% of their portfolio is expected to generate ROI and the remaining 30% philanthropic portfolio must at least break even. REDDS focuses on applications that can scale to any crop and therefore generate robust ROI. A promising application that is more localised in nature becomes a harder decision because it will have less of an ROI potential. If promising enough, though, it might be included within REDDS' CSR/philanthropic portfolio.

One of REDDS Ventures' potential investment targets is business contests and incubator initiatives. In the past decade, young African entrepreneurs have often focused on the technology without taking into account underlying economics and business planning. The benefit of business contests and incubator initiatives, however, is that start-ups are forced to think about and adopt a more business-like approach. These contests and incubators, therefore, increase the rate at which REDDS Ventures receives business proposals and investment offers. To continue to improve the level of professionalisation, which ICT4Ag technology solution providers often lack, there is a need for continued investment, whether by

36 https://reddsvip.com/

37 Ibaraki, S. (18 July 2016). Skype interview.

financial institutions, foundations or another class of investor in contests and incubators.[38] [39]

For example, the Barclays Accelerator[40] provides a 13-week programme (in Cape Town, London, New York and Tel Aviv) that provides mentoring from leading entrepreneurs, access to technical expertise, networking and access to key decision-makers within Barclays Bank. Barclays also provides up to US$120,000 of debt and/or equity investment to each mentee.

Safaricom, the MNO in Kenya that invented M-Pesa, started their own US$1 million venture capital Spark Fund[41] in 2014. Its objectives include transforming and supporting the development of mobile ICT start-ups through capacity building and partnerships in order to transform the lives of Safaricom customers. Spark Fund covers multiple sectors and while US$1 million is a modest sized fund, it seems their intent is to secure minor equity stakes in ICT business models that use Safaricom's voice, data, information and payments infrastructure, and then refer them to Safaricom's wider partnership and funding networks. Spark Fund is currently considering a framework for how to review and select investment opportunities in the ICT4Ag space.

Type of investor: Financial institution

Financial institutions are embracing the potential of ICTs – particularly digital data/information capture platforms – that improve their credit decision-making, as well as new digital platforms for distribution and repayment of loans to farmers. They are equally interested in improving their service provision to existing customers. Of greatest interest, though, is the potential to increase their customer base and therefore their overall loan portfolio. Metrics include: cost savings, increased customers, size of loan portfolio and reduction of portfolio at risk.

According to Manyika *et al.*, (2016) financial institutions can save 80–90% by shifting from traditional to digital accounts. By making this transition, financial institutions in emerging economies worldwide will expand their customer base and increase their balance sheets by US$4.2 trillion by 2025. Their options for investment can include conducting requirements analysis based on market research done by others as well as hiring and/or developing key personnel with agribusiness experience.

A recent study by Accion (2015) analysed the adoption of a converged, multi-functional digital solution set for three microfinance banks in India, Kenya and Serbia, concluding that other financial institutions and agribusinesses would also benefit. Financial institutions and agribusinesses are both looking to increase the use of digital applications by field-based loan officers and agriculture extension agents to capture data on borrowers or farmer's business activity, and then pull the data back to the main bank branch/agribusiness head office for collation and decision-making. As such, Accion's lessons learned in terms of investment, technology and deployment costs are comparable to agribusinesses as well. The study also found there was a requisite need for organisational change management to ensure management and staff buy-in.

38 Rutten, L. (28 July 2016). Skype interview.
39 Asare-Kyei, D. (6 September 2016). Personal interview.
40 http://www.barclaysaccelerator.com/#/
41 http://www.safaricom.co.ke/spark/

	Lessons learned
Investment	There is a need for: • requirements analysis • business process reengineering • development of clear data collection plan • monitoring of pilot results before scaling • identification of key champions
Technology	There is a need to: • cater to poor connectivity • decide where to store data • consider security protocols • field test devices and the operating system • work closely with the technology solution provider
Deployment costs	Capital expenses (CAPEX) include: • the platform itself • implementation • infrastructure (devices, servers) • operating expenses (OPEX) include: maintenance of the platform • support/training to farmers and other borrowers • connection charges • insurance (optional) • batteries for devices and data storage

The experience of Umati Capital[42] in Kenya also echoed the need for internal change management.[43] Launched in 2012, Umati Capital is a financial services company that provides working capital financing to agribusiness supply chains. They embed technology into agribusinesses to automate processes, capture data and distribute information, as well as for the distribution and repayment of working capital loans. Their website even provides a convenient calculator that instantly computes Umati's fee based on a customer's expected invoice amount. Umati's services can inform any foray by a financial institution into technology driven agriculture finance.

Regarding internal change management, Umati's first experience was with a dairy processor, but conflicting management issues within the dairy company detracted the management's focus from making the most of the Umati project. In addition, Umati encountered resistance from dairy graders and clerks who did not welcome the transparency of Umati's platform which would prevent them from taking a cut of dairy farmers' profits. In Tanzania, a Vodafone (2015) dairy case study revealed that platform transparency eliminated fraud that had been causing losses of 20% of daily milk deliveries to the processor.

For Umati's dairy processor, there was also significant need to train the graders and clerks on the Android platform. This was a hard lesson learned for Umati because they had not anticipated the need for training so relied on their platform developers/designers who were ill equipped to be trainers. Further, Umati imagined that training was only needed once at initial implementation and not on an ongoing basis to ensure behaviour change.

With the benefit of these lessons, Umati's next implementation was markedly more successful. Their second client, a Kenyan nut processor, had internal champions in the form of the CEO as well as the COO due to their close analysis of costs, savings and increased revenues. Internal resistance from graders and clerks was responded to and managed by the CEO and COO. This committed management buy-in translated to staff buy-in as well as extensive staff training when management periodically convened personnel nationwide in locations throughout Kenya. Aside from the benefits that accrued to the farmer as a result of the platform's transparency, the nut processing company was able to streamline its supply chain mitigate the potential of customer fraud.

42 http://www.umaticapital.com/

43 Mbowa, I. (September 2016). Personal interview.

Conclusion

ICT is truly revolutionary in nature because there is no problem for which a technical solution cannot be designed. Importantly, according to Dr Daniel Asare-Kyei, CEO of Insyt.co and former managing director of Esoko, the technology is "only 5% of the solution (while) 95% is the business process, deployment process and team composition."[44]

The time is now for investment in ICT4Ag. Mobile phone penetration rates are high and rising. Smartphones, that provide a channel for the internet, are also rapidly entering the African marketplace. Cellular coverage throughout Africa is 90% and growing. Meanwhile, multiple other technologies reliant on the phone and/or internet – such as IoT/sensors, big data analytics (finance, supply chain, traceability, etc.), precision agriculture, cloud computing, blockchain decentralised ledger technology, machine-to-machine learning and more – have already emerged and are rapidly expanding.

The future of ICT4Ag should be bundled functionalities and be paid for primarily by agribusinesses. It must be designed and delivered by way of a CSP that aggregates the skills and expertise of selected partners, all of whom agree upon a common vision and plan of execution. Agribusinesses and MNOs must be aggressive about substantially investing in the hiring and/or development of human capacity. Meanwhile, research as well as training design and delivery are the key investment priorities for donors and foundations. This aligns with their core objective of understanding beneficiaries (research) and developing (training) content that can be scaled to other value chains and countries. The agribusinesses, MNOs, technology service providers, financial institutions, donors/foundations, venture capital investors and farmers that embrace a CSP partnership now, to pursue what ICT can do, will secure the advantage.

The need for CSPs to successfully deliver ICT4Ag solutions seems to be a foregone conclusion, however a lack of management and staff buy-in, as well as requisite analyses of the modelling and design of the underlying business case and value proposition for each partner, reveals that the importance of managing these partnerships has not yet been recognised. There are three steps of bespoke investment that are required to overcome these challenges: pre-project research/feasibility study/analysis; formation of a CSP; and project execution of the ICT4Ag solution *vis-à-vis* awareness, education and training. Within each of these areas, there must be investment and commitment towards the requisite levels of internal change management amongst all CSP partners.

Regarding the ICT4Ag solution, it is no longer about a single application but is, instead, about a bundled set of applications that provide an approach that must be integrated into the core business of each partner, including operations, training, client education, accounting, IT, marketing and human resources. In addition to these internal challenges there are also external steps related to bundled ICT4Ag business models that need to be implemented, *vis-à-vis* business case and value proposition analysis for CSPs, awareness raising, education and training. Given these internal change management and business model challenges a broader spectrum of CSP-sponsored activities that are less about the technology and more about business process reengineering must be pursued.

While ICT4Ag CSPs will be driven by the agribusiness, it is clear that farmer acceptance and trust in the technology is paramount for the scalability and viability of the business model. As stated by Gates (2016), "The power of a phone in every pocket is turning out to be extremely disruptive in exciting ways and the poor finally have a chance to use technology in ways that solve the real problems they face in their lives." The voice of the farmer can now be heard individually or in the aggregate and if they don't feel listened to, the interests of all the CSP partners will be in jeopardy!

Acknowledgement

Chapter four has had the benefit of review and iteration by Kevin Wilkins, Component Lead for coffee and cocoa for ÉLAN RDC in the Democratic Republic of Congo.

44 Asare-Kyei, D. (6 September 2016). Personal interview.

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The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). CTA operates under the framework of the Cotonou Agreement and is funded by the EU.

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