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Mobile Landscape Analysis: Tanzania

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LIST OF ABBREVIATIONS

2G	Second generation cellular networks
3G	Third generation network, the UMTS (Universal Mobile Telecommunications System)
4G	Fourth generation network called LTE (Long Term Evolution)
Agri VAS	Agricultural Value-Added Services
AKFED	Aga Khan Fund for Economic Development
ARI	Agricultural Research Institute
ARPU	Average Revenue Per User
ASHC	Africa Soil Health Consortium
CFL	Converged Licensing Framework
DAICO	District agriculture, irrigation and cooperative officer
DTMF	Dual tone multi frequency
EASSy	Eastern Africa Submarine Cable System
EPOCA	Electronic and Postal Communications Act
FARMIS	Farmer Record Management System
FRI	Farm Radio International
G8	Group of eight industrialized nations
GAP	Good agricultural practices
GCARD	Global Conference on Agricultural Research for Development
GDP	Gross domestic product
GPS	Global positioning system
HNI	Human Network International
ICT	Information and Communication Technology
IVR	Interactive voice response
KES	Kenyan Shilling
mAgric	Mobile agriculture
MNO	Mobile network operator
NGO	Non-governmental organization
QoS	Quality of Service
SMS	Short message service
SMSC	Short message service centre
SSA	Sub-Saharan Africa
SSTP	Scaling Seeds and Technologies Partnership
TCRA	Tanzania Communications Regulatory Authority
TEAMS	The East African Marine System
TSH	Tanzania Shilling

TTCL	Tanzania Telecommunications Company Limited
UH	Uyole hybrid
UPTAKE	UP-scaling Technology in Agriculture through Knowledge and Extension
USD	United States dollar
USF	Universal Services Fund
USSD	Unstructured Supplementary Service Data
WAP	Wireless Application Protocol
WRC-15	World Radio Communication Conference 2015

EXECUTIVE SUMMARY

By the end of 2016 it was estimated that more than 420 million people in Africa owned a mobile phone, a penetration rate of 43%.

In the agriculture sector in Africa, mobile-mediated services therefore appear to be well placed to deliver the information that smallholder farmers urgently need to boost their productivity and profitability. But what is the reality on the ground and the potential for establishing sustainable services?

This mobile landscape analysis for Tanzania was undertaken to help answer these questions. It has drawn on literature and specially conducted research, including key informant interviews with representatives of leading players in the agriculture added-value services (Agri VAS) landscape in Tanzania.

A key finding is that the main mobile network operators (MNOs) and other organizations have struggled to develop sustainable business models to deliver validated agronomic and up-to-date market information to farmers on a useful scale. Some services have been discontinued, and a major constraint identified by the service providers was the unavailability of the 'right content', i.e. validated and up to date.

Other constraints identified by the authors of this review included:

- Difficulty with distinguishing farmers from non-farmers among MNOs' subscribers to enable targeting of services;
- Difficulty of effectively marketing and creating awareness of Agri VAS;
- Cost and difficulty of developing databases of farmers, including mobile phone numbers and other relevant details;
- Difficulty with recruiting and retaining subscribers to Agri VAS;
- Failure of Agri VAS to be financially viable;
- Low literacy and computer literacy amongst farmers; and
- Low penetration of smartphones amongst farmers.

The UP-scaling Technology in Agriculture through Knowledge and Extension project (UPTAKE) provided some useful lessons from the team's experience of running short message service (SMS) campaigns. These included:

- The need for flexibility and rapid response; for example, when the rains are late and farmers need to be advised to plant fast-maturing varieties.
- The importance of involving stakeholders, including local officials, experts, farmers and input suppliers, in the design and execution of the campaign. Under UPTAKE, messages were ratified by the zonal authority and input suppliers provided information on local varieties available for sale. Farmers were represented and listened to as SMS campaigns were developed and messages pre-tested with focal groups. Farmer feedback also needs to be collected after a campaign.
- Trade-offs are needed between the number of messages sent per farmer and the number of farmers reached.
- Farmers share information within their communities, including information that is delivered via SMS. This means it may be more cost-effective to target fewer farmers and cover more communities, although this may not be optimal in terms of developing a sustainable business model where farmers are expected to pay.
- It is a great advantage to build on the outcomes and knowledge of previous initiatives, in this case technologies previously promoted by the Scaling Seeds and Technologies Partnership (SSTP).

Finally, the landscape analysis identified a number of opportunities and implications for knowledge organizations, whose mandate is to provide small-scale farmers with information, including:

- Since there are already a number of existing Agri VAS initiatives which are struggling to be sustained and are as yet unprofitable, it could make sense for knowledge organizations to partner with these.
- Agriculture is a high-priority sector in Tanzania for the government and development partners alike. An increasing proportion of the projects and programmes initiated by these actors are likely to require the inclusion of an Agri VAS component, and will be seeking partners to develop and deliver these.
- Given the huge amount of content available, covering a wide range of crops, pests and diseases, and other agronomic information, careful consideration needs to be given in deciding what sort of content should be prioritized, including which crops, and what would trigger the sending of a specific piece of information.
- Unstructured Supplementary Service Data (USSD) menus can be used to enable farmers to select the information they need, which can then be sent via SMS, but computer and reading literacy is an issue and the system and messages need to be as simple as possible.
- Care needs to be taken to avoid creating demand for inputs that are unavailable or encouraging production of crops for which there is no market.
- Databases which contain profiles of farmers and their mobile phone numbers are potentially valuable assets. However, to avoid any data protection issues, or contravention of any other regulations, organizations which own or use such databases must ensure that the way they plan to use the database is lawful.

These opportunities raise important questions about knowledge partners' capacities to provide factually correct, relevant information in formats that have been tested and found to be farmer friendly, which do not create any unforeseen consequences and which can be delivered promptly, such that subscribing farmers can act on the information within their cropping cycle.

None of the farmer-focused information services covered in the survey were sustainable and the UPTAKE campaign was dependent on donor funding. This raises important questions about how the knowledge partners' input should be funded; key amongst these questions is: is it desirable to extract revenue directly from poor farmers or should the costs be covered by grants, at least in the short to medium term?

1. INTRODUCTION

By the end of 2016 it was estimated that more than 420 million people in Africa owned a mobile phone, a penetration rate of 43% (GSMA, 2017). Mobile technology is transforming the economies of many African countries. Its impact is being felt in all sectors and it directly touches the lives of the majority of its people. Although there is a trend towards increased urbanization, the majority of Africans are still rural. Across Sub-Saharan Africa (SSA) agriculture contributes on average 15% of gross domestic product (GDP) with a range from 3% to 50% in individual countries and accounts for more than half of the continent's jobs and livelihoods (OECD-FAO, 2016).

Increasing populations, urbanization and rising incomes are creating rapidly growing demand for more food and also for more diverse and better-quality food. This offers a huge opportunity for Africa's farmers, including the small-scale farmers who currently produce most of the food. To meet this rising demand, however, there need to be significant improvements in productivity, including the use of improved technologies and better and more efficient practices. And with the impact of climate change being increasingly felt, including more erratic weather and outbreaks of new pests and diseases, farmers also need to be more resilient and able to adopt appropriate and timely mitigation measures.

Currently Africa's smallholder farmers are poorly served in terms of provision of the information and inputs, as well as market linkages that would enable them to take better advantage of this opportunity and become more resilient. To illustrate the pressing need for productivity improvements, whereas in 1990 there were three African farmers for every urban dweller on the continent, by 2020 each farmer will be expected to feed two urban dwellers (AGRA, 2016). By the end of the current century, the population is forecast to increase four-fold from just less than one billion now to 4 billion (UN Department of Economic and Social Affairs, 2017).

In the agriculture sector, mobile technology and mobile-mediated services appear to be well placed to deliver the information, provide the services and enable the linkages that smallholder farmers urgently need to boost their productivity and profitability, enhance resilience and to make agriculture more attractive to the next generation. But what is the reality on the ground?

In this document the phrase 'mobile agriculture' solutions (mAgric) is used to describe the broad use of mobile phone-based technology to support actors along agriculture value chains. Such services include mobile money, which are useful to farmers and also the wider population, as well as services targeted mainly at farmers. The term 'agricultural value-added services' (Agri VAS), a subset of mAgric, is used to describe non-core services provided by mobile network operators (MNOs) and other value-added service providers that are targeted specifically at farmers.

'Non-core' means services beyond standard voice-calls, text messages and data: such services are designed to add-value for the mobile phone subscriber. From the MNO's perspective this should encourage their subscribers to use their mobile phones more and so to increase the average revenue per user (ARPU). Compared with more developed regions, ARPUs in Africa are low because the majority of subscribers have very low incomes and their expenditure on mobile services is low as a result. Non-core services are widely considered to be a major opportunity for MNOs to increase their profits (GSMA, 2016a).

These Agri VAS can be delivered over voice (interactive voice response (IVR) and helplines), text channels (short message service, SMS), unstructured supplementary service

data (USSD) and rich media (online content and apps). Typically they involve some form of advisory service delivering information on good agricultural practices (crops and/or livestock), local weather and market prices. Beyond information, other types of Agri VAS include mobile-mediated agricultural insurance products and input quality-assurance verification systems.

2. BACKGROUND

2.1 The UPTAKE Project

The 2007/2008 food crisis served as a wake-up call to the global community. As a result, development of a highly productive and sustainable agriculture and food system became a much higher global priority.

One manifestation of this was that, at the 2012 Group of Eight (G8) industrialised nations meeting at Camp David, G8 and African leaders launched the New Alliance for Food Security and Nutrition to accelerate agricultural growth and productivity (MEAS, 2012).

The New Alliance agreed to support four integrated enabling actions aimed at significantly improving agricultural productivity. One of these was the Information and Communication Technologies (ICT) Extension Challenge. The ICT Extension Challenge was launched at the Second Global Conference on Agricultural Research for Development (GCARD) meeting in Punta del Este, Uruguay, at the end of October 2012. Its goal was to improve extension and information systems for smallholder farmers, farmer organizations and agribusinesses so that they could make informed and effective decisions about technology adoption, harnessing developments in ICT and technology and information platforms.

The UP-scaling Technology in Agriculture through Knowledge and Extension project (UPTAKE) has been established through support from the ICT Extension Challenge Fund. UPTAKE's goal is to increase uptake and adoption of agricultural innovations promoted under the Scaling Seeds and Technologies Partnerships (SSTP) in Tanzania. The ICTs employed in the project are radio and mobile (SMS). CABI leads the mobile component and currently disseminates good agricultural practices (GAP) in the form of SMS through the Esoko platform, while Farm Radio International (FRI), a Canada-based not-for-profit organisation, leads the radio component (ASHC, 2017).

Esoko is a technology company, founded in 2004 as Tradenet, with offices in Ghana, Kenya and Tanzania. It provides information and communication services for agricultural markets in Africa, i.e. Agri VAS. Esoko seeks to ensure that critical information reaches the 'last mile' though mobile technology, such as SMS for feature phones or via a training and extension smartphone application (Knowledge Plus). They also operate an innovative m-commerce product (Tulaa) which offers a service for smallholders to enable them to save in advance for a package of inputs using mobile wallets, and then they can access discounted inputs and finance through a virtual marketplace. Through these platforms, they aim to provide advice to farmers on market prices, weather forecasts and tips to help them increase yields and profits. Solutions are also provided to businesses and not-for-profit organizations, including marketing products, monitoring activities and sourcing goods, and helping them to connect with farmers.

The Esoko platform offers: automatic and personalized SMS alerts, buy and sell offers, bulk SMS, SMS polling and surveys. The bulk SMS option means that Esoko acts as an SMS aggregator, delivering SMS messages to subscribers' handsets through the MNO's short message service centre (SMSC).

The CABI-led component of UPTAKE began in 2016 and support from the ICT Extension Challenge Fund comes to an end in 2018. For continuity of the service, the UPTAKE project sought to identify key stakeholders who could sustainably continue to provide services beyond the end of the project.

It is in this context that this mobile landscape analysis for Tanzania was undertaken. It has drawn on published and grey literature, and specially conducted research, including key informant interviews with representatives of leading players in the Agri VAS landscape in Tanzania. The objectives of the mobile landscape analysis were to:

- Identify key players providing Agri VAS and the types of services offered to the varied audiences/farmers.
- Provide insights into the Agri VAS business models with a view to determining which are sustainable or have a reasonable chance at sustainability – particularly with regard to delivering technical agricultural information.
- Use the outcomes to guide UPTAKE and other projects/organizations with similar aims on suitable services through which they can disseminate agronomical information and seek to build the necessary partnerships to ensure sustainability.

Interviews were conducted with the following organizations in Tanzania: five MNOs, seven Agri VAS and a number of other organizations with an interest in agricultural development, who are supporting mAgric activities and working with Agri VAS providers and MNOs, but not operating an Agri VAS themselves (Table 1).

Table 1: Organizations interviewed for this study*

Organization	Type
Vodacom	MNO (market share of 32%)
Tigo	MNO (market share of 28%)
Airtel	MNO (market share of 26%)
Halotel	MNO (market share of 9%)
Zantel	MNO (market share of 2%)
Agrimark	Agri VAS
Arifu	Agri VAS**
FIT-Uganda	Agri VAS
Esoko	Agri VAS and SMS aggregator
HNI	Agri VAS and SMS aggregator
Sibesonke	Agri VAS and SMS aggregator
Starfish Mobile East Africa Limited	Agri VAS and SMS aggregator
FARM Africa Tanzania	International non-governmental organization

**Note: the authors do not claim to have identified all Agri VAS operational in the country; others may exist.*
***Note: Arifu has a technology platform which provides customized learning content based on consumers' preferences and responses. They partner with other organizations to offer Agri VAS services related to training and learning.*

2.2 Key features of the mobile landscape in the context of African agriculture and UPTAKE

In the context of agricultural development in Africa and the UPTAKE project, the mobile landscape consists of a number of different elements. The main ones are: state-owned infrastructure and the global networks they link to; the national regulatory environment in which the mobile industry operates; the mobile network operators (MNOs), that is the businesses which provide the infrastructure and services to support calls, texts, data and other mobile services; SMS aggregators, that is businesses that link MNOs with organizations that wish to send out bulk SMS; MNOs, other businesses and not-for-profit organizations that, in partnerships and alone, provide non-core mobile mediated services, known as mAgric and Agri VAS, that target actors along agricultural value chains, especially farmers, and that are delivered via a number of different protocols; general applications (apps) which are useful in an agricultural context; and finally, the subscriber base and the

handsets and other devices they own, which include basic, feature and smartphones. Below, all these elements are briefly described, but the detailed analysis of the mobile landscape in Tanzania will focus on those parts most relevant to information dissemination to small-scale farmers, i.e. Agri VAS.

2.2.1 State-owned infrastructure: African governments usually control and manage the links to the high-speed undersea fibre-optic cables that directly link Africa to Europe, North and South America, the Middle East and Asia. The connection to the first of these cables in 2009 resulted in large decreases in the cost of data transmission and much faster internet connections. There are a number of competing services, including SEACOM, Eastern Africa Submarine Cable System (EASSy) and TEAMS (The East African Marine System). Some governments also own terrestrial national fibre-optic cable networks that extend the benefits of high-speed broadband connectivity throughout the parts of the country reached by the networks.

2.2.2 The regulatory authorities: Regulatory authorities act on behalf of national governments to ensure the mobile phone industry operates within the law and the mobile network operators abide by the terms of their licences. This includes increasingly rigorous enforcement of regulations related to bulk sending of unsolicited messages (spam) and outlawing the trade in mobile phone numbers and other subscriber information. Other duties include managing the country's frequency spectrum, managing competition within the sector, regulating tariffs, facilitating e-commerce and protecting consumers' rights.

Governments organize auctions or make other arrangements whereby interested parties can acquire licences for the provision of mobile phone services based on the available frequencies. This can raise very significant amounts: for example, in Kenya the three major mobile network operators were offered licences to operate 4G LTE (Fourth Generation/Long-Term Evolution) services for USD 25 million each. Mobile phone networks also make significant contributions to national economies via taxation and through enabling of other business opportunities and efficiency and productivity gains, including in the agricultural sector.

2.2.3 Mobile network operators: Within a country, a number of mobile network operators (MNOs) are usually licensed by the relevant authorities to provide mobile services within a competitive business environment. They provide subscribers with an offer that includes calls, text, data and often a range of other mobile-mediated services, such as mobile money. The MNOs invest in the infrastructure and the technical support that enables these services to function; sometimes they share some infrastructure, especially in rural areas.

The platforms over which mobile networks operate have evolved over the past decade or so from 2G (the first digital platforms – 1G was analog) to 3G and 4G, with 5G beginning to be rolled out in some parts of the world. While 2G supports calls and text message services, 3G also enables users to access the internet over devices like mobiles and tablets. 4G offers the same benefits as 3G but at much faster data transmission speeds. In addition to providing even faster speeds, 5G networks will also enable new uses, such as the Internet of Things (internet connected devices), although in an African agriculture context this lies in the future.

2.2.4 SMS aggregators: MNOs can deliver bulk SMS at a low cost to their own subscribers. SMS aggregators are specialized service providers that provide a gateway to send and receive bulk messages on behalf of clients to one or more networks. They usually charge on a per message basis, with costs per message reducing as the total number of SMS sent increases. SMS can be sent out free to the recipient, with the aggregator's client paying the charges, or the recipient can pay. There are national, regional and international

aggregators operating in the Tanzanian mobile landscape. Generally, international aggregators are more expensive but more reliable, and avoid the need to make agreements with multiple MNOs. An MNO can also deliver to other MNOs operating in the same country; however, where there are high numbers of SMS to be delivered, delivery tends to be slow compared to the international aggregators.

2.2.5 Mobile agriculture solutions (mAgric): The MNOs, partnerships between MNOs and other for-profit and not-for-profit organizations, and for-profit and not-for profit organizations working alone or in other partnerships, offer a variety of mobile-mediated services. These go beyond the MNOs' core business of providing calls, text and data. Services that specifically target farmers are known as Agri VAS, however there are a number of other services not specific to agriculture (e.g. mobile money or mobile insurance) that also support the agriculture sector. Collectively these are known as mAgric solutions.

Usually MNOs prefer to partner with other platform providers, e.g. Esoko, Human Network International (HNI), Sibesonke, Starfish and others, to manage Agri VAS and other types of mAgric – some preferring to aggregate Agri VAS under a single platform provider. This simplifies their businesses and avoids the need to handle problems such as gateways going down themselves. For example, in Tanzania, any Agri VAS wishing to offer services through Airtel has to pass through the Starfish technology platform. Starfish Mobile has a proprietary gateway known as the Griffin Platform, which is used to connect to mobile operators' SMSC and USSD systems, including the prepaid and postpaid billing systems.

2.2.5.1 Key types of mAgric

Mobile money services: These provide safe, secure and affordable financial services to consumers at the bottom of the pyramid who are otherwise unbanked. Such services are now available in at least 97 countries; in terms of deepening financial inclusion, mobile money services are available in 85% of countries where less than 20% of the population has an account with a financial institution. Sub-Saharan Africa (SSA) accounts for more than half the world's active mobile money services (GSMA, 2015a).

MNOs are increasingly interconnecting their mobile money services so clients can transact between services offered by different operators. In 2015, at least 18 countries had more mobile money accounts than bank accounts: Burundi, Cameroon, Chad, Democratic Republic of the Congo, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Paraguay, Rwanda, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Penetration of mobile money is highest in East Africa, where 55% of mobile connections are linked to mobile money accounts. As of December 2015, in SSA there were 222.8 million registered accounts, of which 84.1 million were active. Transactions via mobile money services are dominated by person-to-person transfers compared to bill paying, merchant payments, topping-up airtime, international transfers, government to person and other types of transaction. Mobile money services are commonly used to support transactions along an agriculture value chain (GSMA, 2015a).

Esoko is running a mobile commerce service known as Tulaa (previously called FASIBA) in Ghana and Kenya that is yet to be launched in Tanzania. The service allows farmers to access inputs, finance, information and markets in a virtual marketplace. The platform encourages smallholder farmers to save money so that later on they can use the savings to buy quality agricultural inputs when needed.

Mobile-mediated insurance: A number of different models of mobile-mediated insurance have been piloted and are being rolled out in various African countries. The key features of them all are: premiums are low; claims are triggered automatically by data collected independently of the insured; and interactions between the insured and the insurer, including payment of premiums and pay-outs, are mediated via mobile phones.

Mobile-mediated insurance is used to support agriculture. In Kenya, for example, small-scale farmers can insure themselves against drought and other extreme weather events. They pay a premium of 5% of the cost of inputs, such as seeds and fertilizer, and communicate with the insurer via SMS. In the event of failure of rains within a specified period after purchase, payments are triggered automatically via weather data from local weather stations and payments made via mobile money. This enables the insured to repurchase inputs if they choose to do so. In some cases, premiums are paid by development agencies or governments on behalf of small-scale farmers.

Agricultural information services: Agriculture value-added services (Agri VAS) have developed rapidly over the past decade to help plug the knowledge gap facing small-scale farmers and also to connect them to other actors in agricultural value chains. In early 2015, across Africa, Asia, Latin America and the Middle East, there were about 100 Agri VAS initiatives in operation, reaching 35 million users; by 2020, this is forecast to rise to 80 million. The biggest challenge facing Agri VAS is the development of sustainable business models that will allow them to reach their full potential; until now, small-scale farmers have traditionally relied on governments, development organizations and to a lesser extent the private sector to provide agricultural information free-of-charge (GSMA, 2015b).

There are two main types of information delivered via Agri VAS: information that needs to be regularly updated, such as market prices and weather forecasts, and information that remains relevant for a longer duration, such as advice on how to grow crops, although even here the information will need to change to reflect the emerging situation. For example, as new and improved varieties that are better suited to the local conditions are introduced, advice to plant short-duration varieties when rains are late, and information on the identification and management of new pests and diseases.

2.2.5.2 Protocols for delivery of mAgric

The mAgric solutions providers use different protocols to interact with their clients. These include SMS, USSD, interactive voice response (IVR) and rich media.

SMS: Short messaging service (SMS) is a text messaging service that allows mobile phones and other compatible devices to exchange short messages of up to 160 characters. Organizations can send the same SMS to multiple recipients from computers using a number of different software packages. Subscribers can be added by importing spreadsheets of contacts, or users can sign up by texting a specified message. Systems are also available that can receive incoming SMS and automatically respond with a message, or even a series of messages sent over a period of time, with specific messages sent on specified dates. This can be especially useful for messages that relate to time-sensitive agricultural activities.

USSD: Unstructured supplementary service data (USSD), sometimes referred to as quick codes or feature codes, is a technology that allows mobile device users to access various services through the use of short codes. These usually consists of a number that starts with * and ends with #.

USSD can be used for a range of services including WAP (wireless application protocol) browsing, prepaid callback services, mobile-money services, location-based content services, menu-based information services, and as part of configuring the phone on the network.

USSD messages are up to 182 alphanumeric characters long. Unlike SMS, with USSD the connection remains open, allowing a two-way exchange of a sequence of data between the mobile user and the service provider's computer. This makes USSD more responsive than services that use SMS.

IVR: Interactive voice response (IVR) is a technology that allows a computer to interact with people through the use of voice and dual tone multi frequency (DTMF) tones input via a keypad. It allows customers to interact with a company's host system via a telephone keypad or by speech recognition. IVR systems can respond with pre-recorded or dynamically generated audio to further direct users on how to proceed. IVR can be especially useful in low literacy environments. IVR systems can be used for mobile purchases, banking payments and services, retail orders, utility bills, travel information and weather conditions, amongst other uses.

Rich media: Rich media, which is online content and apps, enables the use of both static and dynamic content, including text, audio, still images, animation and video. It has the advantage that this approach can overcome the challenge of working in low literacy environments, and it can also provide an interactive experience. The use of rich media is dependent on the user having access to a smartphone. Other constraints to its use include small-scale farmers' ability and willingness to pay for data, technical and digital literacy of the farmers and the cost and skills needed to design the information materials in rich media formats.

2.2.6 Apps: There is an enormous and ever-growing number of applications (apps). These are computer programmes that enable various tasks to be performed using mobile devices. One example, which is widely used in agriculture as in all other aspects of life, is instant messaging services, such as WhatsApp. WhatsApp, which is owned by Facebook, had more than 1.3 billion active users in July 2017 (Statista, 2017). It allows smartphone owners to freely, securely and instantly communicate with each other and within defined groups via calls, text, images and short films. Telegram is another similar instant messaging app which exceeded 100 million monthly users in April 2016.

2.2.7 The subscriber base: The final element in the mobile landscape is the mobile subscriber base. Penetration of mobile phones has grown very fast in Africa: by the end of 2016, there were 731 million mobile phone subscriptions for a population of about one billion people, equivalent to a penetration rate (number of subscriptions divided by total population) of just under 74% (GSMA, 2017).

The number of subscribers can be reported as total users, which includes active and inactive subscribers: active subscribers are those that regularly use their phones and pay for services.

The handsets that individual subscribers own can either be basic, feature or smartphones, depending on the financial resources available to them and their needs. Basic phones allow users to make/receive calls, send/receive text messages and access USSD-based services. Feature phones have the basic phone features but are also internet enabled, support transmission of picture messages, allow downloading of music and in some cases have built-in cameras and radios. Smartphones offer a more advanced set of features in addition to those found on feature phones, including graphic interface and touchscreen capability, built-in Wi-Fi and GPS (global positioning system). The proportion of subscribers owning smartphones, though still relatively small in SSA compared to more developed regions, is growing rapidly as cheaper smartphones costing as little as USD 30 become widely available. In 2016, an estimated 226 million users had smartphone connections (GSMA, 2016a).

A major problem in effective targeting of Agri VAS is identifying which of the MNO's subscribers are potential users of the service. Accurate and up-to-date databases of potential users that include some demographic and socio-economic data, as well as mobile phone contact numbers, can be expensive to compile but are extremely useful and potentially valuable.

3. MOBILE INDUSTRY OVERVIEW IN TANZANIA

3.1 Mobile subscribers, market share and usage statistics

Tanzania is the second largest telecom market in East Africa behind Kenya**.** There are seven active MNOs in the Tanzania market (see Table 2). According to data provided by the Tanzania Communications Regulatory Authority (TCRA), three MNOs accounted for 86% of all subscriptions in March 2017: Vodacom, Tigo and Airtel have market shares of 32%, 28% and 26%, respectively.

Vodacom Tanzania is a unit of South Africa's Vodacom; Tigo Tanzania is part of Sweden's Millicom; Airtel Tanzania is part of Airtel Africa, the pan African mobile network (formerly known as Zain); Halotel is owned by Vietnam-based telecoms operator Viettel; Zanzibar Telecom (Zantel) is a subsidiary of Luxembourg telecoms group Millicom International Cellular (MIC); Smart Telecom is owned by Industrial Promotion Services the Kenyan-based infrastructure and industrial development arm of the Aga Khan Fund for Economic Development (AKFED); and Tanzania Telecommunications Company Limited (TTCL) is currently wholly owned by the government of Tanzania.

Table 2: Total number of subscribers and market share for MNOs active in Tanzania

MNOs	Total number of subscribers (million)	Market share (% of subscribers)
Vodacom	12.6	32
Tigo	11.2	28
Airtel	10.2	26
Halotel	3.5	9
Zantel	1.0	2
Smart	0.9	2
TTCL	0.3	1
TOTAL	**39.9**	**100**

Source: TCRA website accessed 30 May 2017. Rounded to nearest 100,000.

In March 2017, the average time used per subscriber in Tanzania was 106 minutes. This is relatively low compared to the USA where average time used is above 800 minutes a month (Ofcom, 2017). In the same month, 6.1 billion SMS were exchanged in Tanzania, equivalent to over 150 SMS per subscriber in the month, or 5 SMS a day. There are 16.5 million active mobile money accounts: Vodacom has 42% of these accounts, followed by Tigo with 31%, Airtel with 24% and Zantel with just 3% (TanzaniaInvest.com, 2017).

Mobile phone penetration in Tanzania, simply defined as number of subscribers divided by the total population, is 67.7%. This figure is, however, misleading as some people subscribe to more than one network and also because not all subscribers as reported by the TCRA are active. Vodacom estimate that of their total of 12.6 million subscribers, 8.5 million are active (two-thirds) (personal communication); applying that ratio to the total number of subscribers reported by TCRA suggests that the number of active mobile subscribers is likely to be around 26.9 million: using this figure, the penetration rate is 48.9%.

The mobile network dwarfs the fixed line network; there are less than 129,000 subscribers to fixed networks (landlines) in Tanzania (World Bank, 2017).

3.2 Regulatory environment

Telecommunication services in Tanzania are under the supervision of the Ministry of Works, Transport and Communication through the Tanzania Communications Regulatory Authority (TCRA). In an attempt to cope with convergence of ICTs, in 2003 the TCRA was established to license and regulate the postal service, broadcasting services and communications sectors in Tanzania.

In 2005, the Tanzanian government introduced the Converged Licensing Framework (CFL), a system that allows operators to offer any type of services with the technology of their choice with one single licence. With the introduction of the convergence in licensing, the telecommunication sector has become more appealing to both foreign direct investors and domestic capital, becoming one of the country's fastest growing sectors. CLF is being used as a key strategy to implement the full liberalization policy.

The introduction of the mobile number portability service by TCRA in 2014 has encouraged competition among telecommunication companies. The service allows users to keep their mobile phone number unchanged when moving to a different operator and they are able to maintain all the added services, for example mobile banking. The TCRA Quality of Service (QoS) regulations include measuring the QoS provided in cellular networks from time to time and comparing them with the norms so as to assess the level of performance. Several factors affect QoS in cellular networks from the viewpoint of customers, including limited coverage and capacity, poor government monitoring on standards, and lack of skills and training on the use of mobile phones. Other factors include lack of fairness from service providers, low quality handsets and delay in allocation of an adequate network infrastructure.

In 2016, the TCRA auctioned frequencies acquired at the World Radio Communication Conference 2015 (WRC-15) in order to boost mobile broadband usage in the country in a transparent manner. Tanzania, like several other African countries, has a provision for a Universal Services Fund (USF). This is supposed to cater for disadvantaged citizens or those who cannot get access to telecom services. The tariffs are not regulated, except when there is market failure. Interconnection rates (costs based on and determined using long run incremental cost) are regulated when the operator fails to agree on interconnection charges.

Retail tariffs are determined by market forces and tariff rates have been declining over time. TCRA regulations on interconnection are applicable to all network service providers wishing to terminate traffic onto operators' networks. Under local rules, interconnect agreements are required to be transparent and non-discriminatory; must be formulated on cost-based interconnection charges; and must provide an adequate level of quality of service.

In July 2016, GSMA announced the launch of the first active infrastructure sharing initiative in East Africa between MNOs Airtel and Vodacom. The MNOs committed to launch six 3G pilot sites across the country to test the sustainable provision of mobile broadband services to 13 million underserved people across rural areas of Tanzania (GSMA, 2016b).

3.3 Mobile Network Operators

This section focuses on the MNOs who were interviewed by CABI in May 2017.

3.3.1 Vodacom: Vodacom Tanzania Limited was founded in 1999 and provides telecommunication services for individuals and enterprises in Tanzania. It offers standard mobile service calls and SMS, and Vodacom M-Pesa, a financial service to send money with

a mobile phone primarily for person to person, customer to business, business to customer, and business to business. Vodacom has the largest share of subscribers of any MNO in Tanzania.

In March 2015, Vodacom established Kilimo Klub, an Agri VAS for farmers. In total around 500,000 of Vodacom's customers subscribed to the service of which there are reported to be about 200,000 active users. The Klub enables farmers to buy and sell commodities and provides information on agriculture-related jobs and market prices, the latter obtained from the Ministry of Agriculture. Farmers access the services they require via USSD and receive the information via SMS. The information is provided free-of-charge and the service does not generate any profits. Klub members can, however, access a savings and loan product and use Vodacom's M-pesa money transfer system, both of which do generate revenue and profit.

3.3.2 Tigo: Tigo Tanzania is the second largest mobile network operator in Tanzania, positioned closely behind Vodacom. Tigo offers standard mobile services such as calls and SMS, high-speed internet, mobile money services and mobile insurance.

In December 2012, Tigo introduced an Agri VAS for farmers called Tigo Kilimo. In 2014 it had approximately 400,000 subscribers, although only 10% were said to be active; farmers access the service more during the planting season and when it is promoted via SMS campaigns. When the service was tested on 4 May 2017 it was not operational. The service offered market prices and agronomic tips for 10 major crops (maize, rice, Irish potato, cassava, onions, banana, citrus, sweet potato, tomato and cashew) plus daily weather information. An app for smartphones was also designed to link buyers and sellers of agricultural commodities. Information for the service was sourced from the Ministry of Agriculture and further worked on by in-house content developers. Farmers would access the service via USSD menus and the information requested was delivered via SMS. Feedback from Tigo indicated that the service did not make a profit and it lacked up-to-date validated content.

3.3.3 Airtel: Airtel Tanzania provides telecommunication services to individuals and businesses in Tanzania. Its services include standard mobile services such as calls and SMS, internet, SMS information services and mobile money services.

Airtel have a mobile seed insurance product called Linda Mbegu, provided in partnership with ACRE Africa, Seed Co. Tanzania and UAP Insurance Tanzania. About 200,000 farmers were reported to have used the service. Participating farmers use a short code to submit a unique number found on a card in the maize seed pack. This activates the insurance product for 21 days: if rains fail and the seeds do not germinate, farmers can obtain replacement seed from their local agro-dealer to replant in the next season. The product is free for the farmer with the cost being met by the input supplier.

3.3.4 Halotel: Halotel has a total of 2.7 million subscribers. Halotel has no Agri VAS products. They have more focus on providing internet services and payment solutions (Halo Pesa). They have not ventured into offering Agri VAS because they consider that most of their subscribers are not farmers but live in urban areas, with most coming from Dar es Salaam.

3.3.5 Zantel: Zantel launched an Agri VAS, Z-Kilimo, in March 2013 with the aim of providing farmers with timely information on modern farming methods thereby improving their productivity. Content was to be sourced from the Ministry of Agriculture with Sibesonke providing the platform (see 3.5.6). It is understood that Sibesonke stopped providing the platform because revenues generated from the service were too low: when tested on 9 May 2017 the service was not operational.

3.4 SMS aggregators

In Tanzania both national and international SMS aggregators operate. International aggregators tend to be more expensive than local companies because they do not connect directly to MNO gateways but use alternative routes. Starfish Mobile offers messaging aggregation services allowing organizations to connect to mobile operators and send messages through their Griffin Platform. For example, through their Griffin Platform, it connects directly to Vodafone and uses short codes to link with other networks. MNOs provide personalized Sender ID (name or number which appears on the recipient's mobile phone when they receive a text message). Most MNOs accept/give up to an 8-character alpha-numeric string as Sender Identification. A sender ID can be purchased from each MNO, to allow recipients to associate messages received to organizations or particular services. In the UPTAKE Project, farmers were receiving agricultural messages from a sender named 'ESOKO'.

Some aggregators also offer Agri VAS services; more information on these operators is presented in 3.5, below.

3.5 Agricultural value-added services

This section focuses on the Agri VAS providers which are not also MNOs, representatives of which were interviewed by CABI during 2016 and 2017. Some also serve as SMS aggregators.

3.5.1 Starfish Mobile: Starfish Mobile is one of the main mobile value-added service providers in Africa. Founded in South Africa in 2002, it now operates in more than 20 countries and with over 50 MNOs. Its services include daily news via SMS, music downloads and caller ring back tones, trivia, competitions, video content, promotions, social media and bespoke community content and information.

In Tanzania, Starfish have around 2 million subscribers to their 'infotainment' services and their target is 5 million. Around 2000 subscribers access an Agri VAS that provides crop prices for maize, beans and Irish potatoes on a daily, weekly or monthly basis, with users paying TSH 50 (USD 0.02) per SMS. Starfish have not prioritized Agri VAS because the information available from the Ministry of Agriculture is not reliably up to date; however, the company believes they could grow the subscription base with prices that are accurate and timely, and with the addition of high-quality nationally-validated agricultural tips.

3.5.2 Agrimark Tanzania: Agrimark is a small, Tanzanian start-up company established in December 2015. In 2016, they introduced an input verification service where input providers include a scratch card in their inputs, such as seed or fertilizer, and the farmer sends the scratch card number via a short code; in return they receive an SMS confirming whether the product is genuine. The farmer pays a fee for each use, while input providers invest in including codes in their products as this increases trust amongst farmers and increases their client base. Agrimark also provide market prices. Prices are obtained from the Ministry of Agriculture and horticultural markets and are currently provided to farmers, free-of-charge, although they plan to introduce a fee structure.

3.5.3 Esoko: Esoko have been working with CABI in the UPTAKE project to extend services to Tanzania. From 2016 they have been profiling farmers in the UPTAKE project targeting farmers in regions where SSTP has activities; that is developing a database of names, mobile phone numbers and some demographic information. Agricultural tips have been delivered via SMS across a cropping season for three target crops (maize, cassava and potatoes) and delivery of tips on common beans is planned for the 2018 cropping season.

3.5.4 FIT Uganda Ltd: FIT Uganda, which is now called FIT Insights Limited, provide farmer record services, market information services, agribusiness feasibilities, market studies, value chain analysis, data for business growth and rural finance services. It has operations in Uganda, Zimbabwe, Ghana, Kenya and Tanzania (Moshi and Arusha). FIT connects farmers and traders to sustainable markets through the 'Infotrade' platform, where farmers access up-to-date and historical market information collected from within the country of operations.

FIT is also offering farm record management services to farmers in Uganda and Tanzania through the Farmer Record Management System (FARMIS) application platform that provides farmers with tools to carry out production data management, farm accounts and farm record keeping activities.

Farmers access the services through SMS and also a personalized website for those who have access to the internet. They are expected to subscribe to access the services through an annual fee.

3.5.5 Arifu: Arifu is based in Kenya and runs a platform that provides customer capability-building through mobile technology. Arifu has 18 partners, including the World Bank, TechnoServe, Vodacom, Syngenta and Mercy Corps among others. Training is delivered with partners, both businesses and not-for-profits, who pay a fee to include their content and receive feedback of various statistics which can help them refine their offer.

The Arifu platform is an Adaptive Learning System that measures individual user needs and capabilities over the internet and SMS in order to offer custom experiences that result in the greatest impact. Simple and robust, the platform works on any mobile device and over any mobile network to ensure the farthest reach possible.

In November 2016, they launched an agricultural pilot in Tanzania in partnership with Syngenta to offer training on high-yielding farming techniques to smallholder farmers. The service has registered 54,000 users, although not all the users are farmers. Arifu provided a platform containing training content on everything from land preparation to harvesting across four main crops, maize, potato, tomato and cabbage, in both Swahili and English.

The training is free for farmers and works on any feature or smartphone. Companies can integrate product information into the training, which drives sales and can provide them with a return on their investment.

In the case of Syngenta in Tanzania, they have successfully driven farmers to Arifu's learning platform through careful, low-cost investment in radio.

In Kenya, together with Syngenta, they have introduced a 'tell a friend' feature to increase usage: if learners recruit 10 of their friends to take the training they are rewarded with KES 100 (USD 1) airtime. Learners have an option of answering some questions at the end of each crop training module. Farmers who score 60% and above qualify for a digital certificate which they have to buy: in a recent trial, 11% of users chose to buy a certificate.

3.5.6 Sibesonke: Sibesonke Ltd is a Finnish company, established in 2009 as a spin-off from Nokia Siemens Networks, a multinational data networking and telecommunications equipment company. Sibesonke's stated aim is to bring 'life-empowering mobile services to lower-income people with only basic phones'.

In Tanzania, Sibesonke established its mFarming service in 2013 in partnership with all the major MNOs. The mFarming service uses both a USSD-platform and SMS. The company

reports that 3,000 to 4,000 users a day access agronomic and farm input information, mostly for free. Companies pay to have their inputs promoted on a per click basis.

3.5.7 Human Network International: Human Network International (HNI) is a not-for-profit organization based in Washington DC and founded in 2007. Its stated aim is to 'bring the benefits of technology to individuals and organiztions across all sectors working in the developing world'. Amongst their areas of operation are on-demand information services accessible from simple feature phones.

HNI describe their 3-2-1 service as a 'search engine where there is no internet'. It consists of a database of pre-recorded voice and text messages. The 3-2-1 service allows users to call free-of-charge (for most content – a minority of users pay to access additional information) at any time to access a decision tree of options. The caller first hears a welcome message and then has the choice to select from a range of topics via their phone keypad, such as agriculture, health and land tenure. If they select agriculture, the user can then choose from a variety of crops. To listen to an individual message takes between about 30 seconds and 1 minute. An advantage of the system is that the messages are permanently available for at least one year.

In HNI's business model, the MNO bears the cost of the phone calls: in exchange HNI suggest that there is evidence that the MNO benefits because its subscribers are less likely to switch to another MNO and also that they spend more each month on their mobiles.

In Madagascar, where the service was launched in 2010, HNI reported that in February 2015 the service had 210,000 unique users a month and received 800,000 enquiries.

3.6 Other organizations

3.6.1 FARM Africa*:* FARM Africa use smartphones to deliver training on agronomy and business skills to 10,000 farmers who grow sesame in northern Tanzania. Sesame is not a traditional crop in this area but was selected by FARM Africa because it is more drought tolerant than traditional crops, such as maize, and there is a good market for the harvest as well as potential for adding value. FARM Africa chose to use smartphones to deliver training rather than conventional approaches, such as demonstration plots, because they offered the opportunity to deliver training at scale: demonstration plots are costly to establish and require the farmers to invest their time in attending training sessions.

Although the training is delivered via smartphones, these devices are being used more as handheld devices than mobile phones. The training modules are preloaded on the phones before they are sold to willing farmers on credit. Farmers with the smartphones can then access the training modules themselves and they can also make the training available to farmers who do not have their own smartphones. FARM Africa make cash payment (about USD 0.20), delivered via mobile money, every time a smartphone-owning farmer trains another farmer, and they also have an instalment (USD 0.90) deducted from their loan. In this way, the more able farmers help spread the training to their less well-off neighbours. By pre-loading the training modules, any problems with bandwidth in rural areas or the cost of accessing data are avoided, although flexibility and ability to provide updates and time-sensitive information is sacrificed.

3.6.2 Yara: Yara Tanzania Ltd, a subsidiary of Yara International ASA, is the world's largest producer and marketer of mineral fertilizers. Yara provide advice to farmers free-of-charge on how to use their products via USSD. In addition, Yara promote their products and share knowledge on which products to use and how to use them via radio and demonstration plots.

4. UPTAKE'S EXPERIENCE OF USING SMS IN TANZANIA

Through the UPTAKE project, CABI is leading on a number of initiatives using SMS to enhance extension messages reaching small-scale farmers. One of these SMS campaigns, undertaken in late 2016/early 2017, targeted farmers growing maize in the Southern Highlands with messages about how to increase production, including through the use of certified seed, and reduce post-harvest losses. The campaign was designed to support actions in another intervention, the Scaling Seeds and Technologies Partnership (SSTP). The SSTP is working to increase the availability of high-yielding crop varieties and awareness of complementary technologies in a number of countries, including Tanzania. The SMS campaign included information on the new seed varieties being marketed in the country as a result of the SSTP programme.

To deliver the SMS campaign, CABI needed to partner with either an SMS aggregator or an established Agri VAS which had the capacity to handle sending out bulk SMS to thousands of farmers. On reviewing the options, it soon became apparent that working with major international companies that already had established mAgric services would be too expensive for the available project budget. Also, this approach would not allow the team to specifically target farmers in the SSTP areas.

CABI therefore negotiated with Esoko (an SMS aggregator and Agri VAS provider), to provide this service. Esoko wished to expand their operations into Tanzania and did not already have an operational Agri VAS. They were therefore willing to handle the SMS at a lower rate compared to their competitors' rates as part of their strategy to gain a foothold in the country. Esoko also led on compiling the database of farmers' mobile phone contacts and profiles (location, age, gender, crops, membership of farmers groups) in SSTP target areas, with an agreement that both CABI and Esoko could then use the database. Similar service providers who were already established in Tanzania had proposed working with their existing database of farmers, but these remained confidential to the company concerned, making it difficult to target particular districts. To compile the list of farmers, Esoko staff worked on the ground with district and village-based agricultural officers and members of the SSTP team. The end result was a database containing details for over 42,000 farmers who grew maize.

Through its Africa Soil Health Consortium (ASHC) project, CABI has developed a methodology for campaigns, including SMS, which are designed to provide farmers with information and facilitate access to inputs that enables them to adopt improved practices and technologies. The process has evolved over time, building on lessons learned. The current process in Tanzania involves a 5-day workshop:

1. During the first 2 days the brief is to collate technologies that are acceptable and practical. The goal is to engage with the key stakeholders to achieve consensus on the key technologies. Farmer representatives are present and their role is to highlight their key problems and knowledge gaps and keep the experts 'grounded'. To do this, CABI brings together a group of local experts from the relevant research institutes, representatives of private and public sector extension including district agriculture, irrigation and cooperative officers (DAICO) and field personnel, and input providers, along with representatives from other organizations, e.g. meteorological agency and relevant NGOs, and ministry plant protection officials who agree on the information they wish to communicate to farmers. This is documented in a detailed technology and messaging brief which is endorsed by all the organizations involved.

2. During the next 3 days, CABI communication specialists then facilitate the stakeholders in developing a series of text messages that convey important information and messages within the limits of 160-character SMS and arrange these in a logical sequence. This is achieved using an iterative approach where small groups develop crop calendars for different agroecological zones and work on different sets of messages and then share them with the whole group for refinement. Farmer representatives and extension staff play a more prominent role during this phase. Farmers are involved in making sure they make sense, thereby doing some initial validation. The CABI specialists ensure:

    - messages contain locally tested/agreed upon technologies according to the technology brief;
    - messages are farmer friendly and understandable by the target audience;
    - bias is not introduced, for example by input suppliers promoting their products; and
    - a compromise is achieved between the number of SMSs the scientists would like to send, and what is practical and cost-effective.

    On the last day of the five-day workshop (covering steps 1 and 2) a full set of messages is given a final review by the whole group. This is the technical validation part of the content development process.

3. The messages are signed off and an official certificate given by the zonal director of research-extension-farmer linkages (in the case of Southern Highlands). This can either take place at the workshop, if this official is attending, or afterwards, in which case the director organizes a final review prior to sign-off.
   Note: An additional pre-testing step was added for a recent workshop developing messages to support smallholders growing potatoes. This involved sending sub-sets of the draft SMS to different groups of farmers with whom a focal group discussion was then held to discuss their views on the relevance, acceptance, language and ease of understanding. Feedback from the farmers was incorporated into the revised messages prior to submitting for sign-off by the zonal director. This is the farmer validation part of the content development process.

4. The texts for the series of SMS are then sent to the SMS aggregator for sending out to farmers who have opted into the service, together with the validation certificate as proof that the messages have been certified. The SMSs are sent out on a pre-agreed schedule with each message timed to match the local farming (as per crop) calendar.

For the Southern Highland maize campaign, the initial plan was to send out a series of 20 SMSs to the farmers in time for the 2016/17 planting season; this would usually involve planting in November/December and harvesting in May in this unimodal rainfall area.

After initially forecasting average rainfall for the 2016/2017 planting season for the Southern Highlands, in early December the Tanzania Meteorological Agency, in its regular 10-day bulletin, reported below normal rainfall to date. For the unimodal rainfall area, it also forecast that while rainfall was expected in late December 2016, which would be favourable for planting, it would not sustain long-duration crops and therefore 'strongly advised to grow drought tolerant and early maturing crops'. The Agricultural Research Institute (ARI) Uyole, a partner in the maize campaign, picked up on the agency's warning and alerted the UPTAKE team.

The UPTAKE team responded by delaying the sending out of the previously agreed messages, so as to match the abnormal weather pattern, and also to develop some new messages encouraging farmers to plant improved Uyole Hybrid (UH) maize varieties. These are early-maturing improved hybrid varieties developed by ARI Uyole through its Maize Improvement Programme. The SSTP aims to improve commercialization of improved

varieties, including the UH series. The new messages included information about the UH varieties and contact details for the seed companies who stocked them. When farmers called the seed companies they guided them on appropriate varieties for the agro-ecological zone and advised them which local agro-dealers sold them.

Preliminary feedback from the research institute, farmers and seed companies indicated the SMS campaign had some impact, for example:

- ARI Uyole reported increased demand from seed companies for early generation seed of the improved, early-maturing UH varieties; the seed companies use this to bulk up so as to provide certified seed to farmers in subsequent seasons.
- The seed companies in the campaign area reported that they handled far more enquiries than usual and increased sales of the improved varieties; one leading company sold close to twice as much seed as in previous seasons. Four of the five companies that sold the UH varieties reported that, for the first time, they had no stocks to carry over to the next planting season.
- ARI Uyole also reported a 30-40% reduction in visits to the institute by farmers to enquire about the UH varieties, planting dates and varieties for different agroecological zones.

In March 2017, ARI Uyole raised a second alert, this time for an outbreak of stalk borer. Once again, the UPTAKE team were able to respond by developing and sending out revised messages advising farmers to inspect their fields and, if the pest was spotted, recommendations were made to spray with the appropriate pesticides. Preliminary monitoring confirmed that as a result some farmers identified stalk borer and saved their crop by spraying as recommended. Some farmers interviewed indicated that previously they thought pesticides could only be used on beans, not maize. Another interesting observation was that some farmers forwarded the information they received via SMS to other farmers, thereby extending the reach of the campaign.

The CABI approach to developing and delivering the SMS campaign for maize in the Southern Highlands, including the cost of compiling the farmer database, is estimated to have been about USD 2.40 per farmer: to reach over 42,000 farmers with a series of 25 SMS cost a total of about USD 100,700[1]. This was at a discounted rate for SMS delivery (USD 0.02 per SMS); if the market price, which was 25% greater, had been paid, the cost per farmer would have been about USD 2.50. The largest single cost element here was farmer profiling (USD 1 per profile), which made up over 40% of the total cost. The other main cost was bringing together the team of experts and stakeholders to agree what should go in the technology and communication brief, and refining this into a coherent document and set of messages.

Significantly, the seed companies involved in the 2016/17 campaign have requested a second campaign and have indicated that they are willing to make financial contributions. The costs of a second campaign should be lower than the first campaign; although the cost of sending out SMSs is scheduled to increase by 25% from the discounted rate offered previously and it is planned to recruit another 5,000 farmers, the costs of compiling the profiles of 42,000 farmers, a one-off cost, was paid in the first campaign and developing the technology and communication brief will likely only need minor revisions, as will the series of

[1] This costing is based on: compiling a database of farmers contacts/profiles at USD 1 per farmer, total USD 42,000; a 5-day residential, facilitated stakeholder workshop for around 20 people to develop the content for the technology and messaging brief and its subsequent editing, estimated at USD 35,000; sending out a series of 25 SMSs to over 42,000 farmers at USD 0.02 per SMS – total cost for SMSs is USD 21,000; ancillary costs associated with sending out SMS (licences, support, analytics) USD 2,700. Total USD 100,700.

text messages, so these aspects will cost less. Also, after more detailed monitoring and evaluation of the campaign has been completed, the messages that farmers found most useful can be identified and, perhaps, the total number of SMS sent could be reduced. Early indications suggest that the messages related to delaying planting and the management of stem borer were the most relevant and actionable.

Although having the content of the SMS signed off by a government official is not mandatory in Tanzania, CABI consider it to be good practice. CABI engages continuously with the Zonal Agriculture Office including having relevant officials present at workshops to facilitate the certification process. However, unless the relevant official is present at the workshops where the content is developed, this step risks introducing a delay; in the case of a time-sensitive campaign, this may jeopardize the campaign's success, or even render it obsolete – for example if the planting season is missed.

5. KEY FINDINGS

5.1 Challenges

The survey revealed that several MNOs and Agri VAS providers have introduced Agri VAS for farmers in Tanzania. However, even the largest MNOs struggle to sustain these and none have yet succeeded in establishing services at scale that can sustain themselves on the revenue and profits generated. A number of initiatives are currently not in operation; for example, Tigo Kilimo, which reportedly had 40,000 active subscribers, was not active when tested in May 2017.

The main type of information provided via these services is market prices, although some providers also supply weather information and services to link buyers and sellers of agricultural produce. Financial services, including special agricultural insurance products, are also provided. One provider supplies a service that verifies whether inputs such as seeds are genuine quality inputs, and another provides a seed insurance product.
Market prices for all districts, updated monthly or two-weekly, are in theory freely available from the Ministry of Agriculture. The information provided is not, however, always up-to-date. Also, ideally farmers need real-time market prices to help them make well-informed decisions on when to sell and at what price, so even month-old information may not be sufficient.

A key motivation for MNOs in providing Agri VAS is to increase penetration and usage, and hence revenues, of mobile services in rural areas. Currently most subscribers are in urban areas, where coverage is near saturation, leaving rural areas as a real growth opportunity. There are, however, a number of challenges to providing information to farmers through a sustainable business model:

5.1.1 Distinguishing farmers from other subscribers: The MNOs do not know which of their subscribers are farmers, except for the small proportion who have subscribed to services targeted at farmers, such as Vodacom's Kilimo Klub. In these cases, farmers represent a small proportion of total subscribers.

The regulator in Tanzania is taking an increasingly strict stance on spamming, hence MNOs and others are usually unwilling to risk penalties from sending unsolicited content to subscribers. They can, however, invite their subscribers to sign-up to a service. In addition to regulations on spamming, there are also restrictions on when messages can be delivered – not before 6.00am or after 8.00pm.

The implication of this situation is that large databases containing ground-truthed information about farmers, including up-to-date, active mobile phone numbers belonging to farmers who have expressed an interest in receiving agricultural information, ideally with an indication of their priority crops, and which comply with data protection and other regulatory issues, are extremely useful and potentially valuable. With the regulatory environment becoming increasingly rigorous in Tanzania, however, it will be important to ensure that any use of such data does not contravene data protection laws. In this context, the 2010 Electronic and Postal Communications Act (EPOCA) requires service providers to maintain the confidentially of customer information and requires protection against improper or accidental disclosure of consumer information.

5.1.2 Recruiting and retaining subscribers: The survey revealed that the usual business model in Tanzania is for any added-value service to be offered free-of-charge initially, say for 3 months, during which time the objective is to attract the maximum possible number of subscribers. After this period, subscription charges are often introduced. There is,

however, a very high 'churn rate', that is customers initially subscribe but then unsubscribe: possible reasons include poor customer service, disappointment with the content provided and unwillingness to pay for content. In addition, even if they do not unsubscribe, not all subscribers to a service are active users.

5.1.3 Financial viability: A consequence of low numbers subscribing, high rates of unsubscribing and inactive subscribers is that the revenue generated by a service may fall below the level considered to be viable. For example, Vodacom insist on minimum monthly revenue per service of TSH 10 million (about USD 4,500): falling below this figure sees the imposition of a monthly penalty of TSH 1.5 million (USD 670) to the Agri VAS provider. Some other MNOs have lower limits.

Where services are provided via short codes, this means a relatively high annual charge to the service provider to maintain access to those codes, reported to be USD 5,000 per year.

5.1.4 Profiling farmers: To enable effective targeting of Agri VAS and avoid the risk of being penalized by the regulator for sending spam, it is necessary to develop a database of farmer contacts who wish to opt in to a service, ideally with additional demographic information including gender, age and location. By knowing where farmers are located it would be possible to target a few farmers per community rather than to send the same message to everyone in the community. This approach could be cost-effective and takes advantage of the observation that many farmers share the information they receive with others in their local community. The problem with such profiling is that it is relatively expensive: Esoko, who provided this service as part of their SMS aggregation offering to CABI, charged USD 1 per farmer – in the costed example provided earlier, farmer profiling represented about 40% of the total costs of an SMS campaign targeting 42,000 farmers each with 25 SMS.

5.1.5 Marketing and awareness creation: Generally, marketing and awareness raising of Agri VAS is attempted using low-cost options, mainly social media, which may not be effective at reaching many farmers who do not have access to the internet. Operators report that they cannot afford costly radio and television advertising for these services, which currently do not make a profit. Other approaches include recruiting subscribers at agricultural shows.

5.1.6 Literacy and computer literacy of farmers: Services based on text are not accessible by farmers who cannot read, unless they have a family member or friend who can read the message to them. Limited competency in operating smartphones or even basic and feature phones is also a constraint: services need to be as simple to use as possible.

5.1.7 Penetration of smartphones: Not all farmers in Tanzania have access to smartphones. FARM Africa have an interesting approach to overcome this limitation, albeit a model dependent on on-going donor funding. Smartphones are made available on credit to farmers who participate in their sesame project. The phones are preloaded with training modules on sesame. If the farmers use their phone to train another farmer who does not have their own smartphone they have TSH 2,000 (USD 0.90) deducted from their loan and also receive TSH 500 (about USD 0.20) in cash via mobile money. Significantly, the training modules are not disseminated over the mobile phone networks but preloaded prior to distribution of the phones.

5.2 Lessons from the UPTAKE case study

5.2.1 Building on previous initiatives: It is a great advantage to build on the outcomes and knowledge of previous initiatives, in this case technologies previously promoted by the Scaling Seeds and Technologies Partnership (SSTP).

5.2.2 Need for flexibility and rapid response: The Southern Highlands maize case study clearly demonstrated the need for the teams behind agricultural SMS campaigns to be able to react quickly to changing circumstances and emerging situations. In this case, it would clearly have been pointless to send out the messages on maize production timed for when the rains should have occurred. Team members needed to be constantly monitoring the actual situation on the ground and also available forecasts, and needed to be able to adjust the messages and their schedule for sending the SMS in real-time.

5.2.3 Importance of involving stakeholders in the campaign: The UPTAKE case study demonstrated the importance of involving a wide range of stakeholders, including local officials, experts, farmers and input suppliers, in the design and execution of the campaign. The participatory approach is vital for promoting consensus-building amongst stakeholders with diverse views, interests, technical know-how and experience. The approach meant that the messages were ratified by the zonal authority and also that the input suppliers, especially the seed companies, were aware that demand in that growing season would likely be different from the norm, allowing them to respond as best they could. Because it takes time to bulk up and produce certified seed, within a season the companies can only sell the seed stocks that are available, so there are significant limits on how fast they can respond to increased demand.

5.2.4 Trade-offs needed between numbers of messages and farmers reached: Campaigns will usually have a fixed budget, so there is a trade-off between the number of message sent to each farmer and the number of farmers who can be reached: using the example from above, it costs USD 1 to profile a farmer and USD 0.5 to send them a series of 25 SMS. Knowledge partners tend to believe that there is a lot of information that is important for farmers and they also believe that farmers are keen to access this information. Farmers, however, may prefer to receive fewer SMS. Further study is planned by CABI to understand better how to minimize numbers of messages and focus on those that best support decision making at farm level. Useful approaches here include ensuring farmers are represented and listened to when SMS campaigns are being developed, pre-testing messages with focus groups before scaling up and systematically collecting farmer feedback after a campaign has been delivered.

5.2.5 Farmers share information: Feedback from the field indicated that farmers share information within their communities, including information that is delivered via SMS. Active profiling of farmers represents a high proportion of service costs – particularly at start-up. In order to maximize benefits for communities, it may be better to profile fewer farmers and cover more communities, although this may not be optimal in terms of developing a sustainable business model where farmers are expected to pay. Further studies will be undertaken by CABI to consider this question further.

5.3 Opportunities for knowledge organizations which provide small-scale farmers with information

All the MNOs and Agri VAS providers interviewed expressed interest in principle in receiving quality-assured agricultural information which they could then share with farmer subscribers. It appears to be possible to do this on a revenue-sharing basis, although the sharing model sees 65-70% of revenue going to the MNO. Also, it is not yet proven that small-scale farmers in Tanzania will pay for such information. Nonetheless, there is undoubtedly the potential for organizations to increase dissemination of their content via mobile-based initiatives.

5.3.1 Piggy-backing on existing services: Since there are already a number of Agri VAS initiatives established which are struggling to be sustained and are as yet unprofitable, it could make sense for knowledge organizations to partner with one or more of these. For example, Vodacom's Kilimo Klub has 200,000 active members and a further 300,000 inactive subscribers; Tigo Kilimo has 100,000 active subscribers and 1 million total subscribers; and Airtel has 100,000 active subscribers out of a total of 200,000 for its Linda Mbegu service.

By partnering with an existing service, the knowledge partners could benefit by having access to their subscriber base of farmers who are interested in receiving agricultural information, and the MNOs and other Agri VAS providers could benefit from having access to high-quality content. The latter could generate more traffic and help push these struggling services to become profitable and therefore sustainable in the long term. The knowledge partner could also share in the revenue generated while better achieving their public good purpose. The motivation for the MNOs is to increase awareness and number of subscribers in rural areas and to add value to existing services, all with a view to increasing revenue from rural areas.

By providing content to existing services, knowledge partners would also avoid financial risk that they would be exposed to if they launched their own Agri VAS: for example, penalty fees payable if a service fails to meet the MNO's minimum monthly revenue target.

Knowledge organizations have the option to partner with MNOs which have their own Agri VAS initiatives, or with specialist Agri VAS providers. Advantages to partnering directly with MNOs include that they own the infrastructure needed to disseminate information, whereas Agri VAS providers need to link up with one or more MNO; also, the opportunity for revenue sharing is greater with an MNO; the revenue split between an MNO and content-provider partnership would be 65-70:35-40 in favour of the MNO, whereas if organizations partner with an Agri VAS they could only share the 35-40% of the revenue with the Agri VAS provider.

One potential niche for knowledge organizations is to partner with financial institutions providing loans to smallholder farmers. It would be in the interest of both the farmer-borrower and the lending institution to ensure that the farmer was as productive and profitable as possible. One option for achieving this could be to make it a condition of granting a loan that the farmer subscribes to an Agri VAS that provides appropriate, timely and well-targeted information designed to improve yields through use of quality inputs and good agronomic practices, and to avoid problems, such as those related to weather or pest and disease outbreaks.

MNOs reported that currently they tend to prioritize health and nutrition content over agricultural content because the former is relevant to all subscribers while the latter is only of interest to farmers. There is, perhaps, an opportunity to initially develop and deliver nutrition-based content with a follow-up option to subscribe to information on growing your own nutritional crops. This could provide an entry point to farming households.

5.3.2 Partnering with new and existing initiatives: Agriculture is a high priority sector in Tanzania for the government and development partners alike. An increasing proportion of the projects and programmes initiated by these actors are likely to want to include an Agri VAS component and will be seeking partners to develop and deliver these. Knowledge organizations therefore need to constantly scan the horizon to remain aware of upcoming opportunities and to be able to rapidly respond to them. Developing a clear understanding of what the organization can and cannot do, and its modus operandi in this regard, is an important first step: this could take the form of a strategic plan or a simple statement of competence.

5.3.3 Prioritizing and targeting content: Given the huge amount of content available to agricultural knowledge organizations covering a wide range of crops, pests and diseases, and other agronomic information, careful consideration needs to be given to deciding what sort of content should be prioritized, including which crops, and what would trigger the sending of a specific piece of information. Ideally information would need to be tailored to the prevailing conditions and cropping calendar and the farmers' priority crops. In addition, subscribers should be made aware of where they can access additional information, bearing in mind the limitations of a 160-character SMS in conveying complex information. The campaign approach being piloted by CABI's Africa Soil Health Consortium (ASHC) project, in which a combination of different media and approaches are used to deliver information to different members of farming families, may provide useful lessons in this context.
It may be advisable for knowledge organizations to start by providing content to support just one or two crops and extend the range of crops as more experience is gained.

5.3.4 Need to build in flexibility: The UPTAKE case study clearly showed the importance of being flexible and able to respond quickly to changing situations and contexts. This has budgetary implications: teams of stakeholders and experts may need to be brought together at short notice to review the changing circumstances, agree on the most appropriate response and develop the appropriate SMSs to convey these messages. The revised messages also need to go through the necessary validation and approval processes quickly. Input providers need to be alerted to potential increased demand for key inputs. Messages appropriate to the situation in the farmers' fields must be disseminated in time for these to be acted upon. This is all challenging but the UPTAKE example shows it is possible and can generate meaningful impact.

5.3.5 Delivery option: USSD menus can be used to enable farmers to select the information they need, which can then be sent via SMS but data literacy is an issue and the system needs to be as simple as possible. Similarly, reading literacy is an issue: the poorest farmers will tend to be the least literate and although IVR systems are an option, they are usually more expensive to access and more limited in content than USSD and SMS.

5.3.6 Unintended consequences: Care also needs to be taken to avoid creating demand for inputs that cannot be met, or are available only in limited areas, or to encourage production of crops for which there is no market. In some cases, such as outbreaks of pests and diseases, information is needed urgently but, because such outbreaks have trade implications, permission may be needed from the relevant government agency before any announcements can be made. This may cause tensions and introduce delays.

5.3.7 Knowledge organizations' capacities and policies: The opportunities outlined above raise important questions about organizations' capacities to provide factually correct, relevant information in formats that have been tested and found to be farmer friendly, which do not create any unforeseen consequences and which can be delivered promptly, such that subscribing farmers can act on the information within their cropping cycle. Ideally such information needs to be coordinated with input suppliers, extension services and other actors. Would the organizations' share of the revenue generated cover its costs – at the outset or in the longer term? Is it desirable for them to extract revenue directly from poor farmers or should the costs be covered by grants, at least in the short- to medium-term?
The issue of how to inform farmers about pesticides needs careful consideration. Should locally available products be referred to by trade name? How can safe and efficacious use instructions be adequately covered in an SMS?

5.3.8 Data protection and other regulatory matters: Databases which contain profiles of farmers and their mobile phone numbers are potentially valuable assets. However, to avoid any data protection issues, or contravening any other regulations, organizations which own or use such databases must ensure that the way they plan to use the database is lawful.

5.3.9 Towards sustainability: None of the farmer-focused information services covered in the survey were sustainable and the UPTAKE campaign was dependent on donor funding. The fact that the seed companies involved are asking for a second campaign and have indicated they are willing to make financial contributions towards this is encouraging. Although the companies' contributions will only represent a small proportion of the total cost, this suggests that it may be possible to run future campaigns mainly or wholly financed by input providers, as long as the return on their investment is sufficiently large. At the same time, the public good represented by helping small-scale farmers to avoid making costly mistakes – such as planting at the wrong time or planting inappropriate varieties, which may have serious implications for livelihoods and food security – probably justifies ongoing subsidies from funds provided by the national and global taxpayer, foundations and others.

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