20 Going digital

Harnessing the power of emerging technologies for the transformation of Southern African agriculture

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Introduction

The story of the impressive expansion of mobile phones across the developing world has often been told. Southern Africa is no exception to this trend. The region has been digitalizing fast, albeit unevenly. The average mobile penetration rate across the SADC (Southern African Development Community) region has reached 88 per 100 people in 2018 and 30% of the population has access to the web primarily through mobile phones.¹ However, these numbers hide significant differences between countries. Looking at the statistics by income quartile, we find that the share of mobile phone, internet and social media users is considerably higher in higher-income countries than in the lowest-income countries (Figure 20.1). Whereas mobile phones are the dominant means to access the web across the region, users in higher income countries also use computers for much of their web surfing, and more of them benefit from faster internet connectivity through broadband (Figure 20.2). We are also seeing a continued rural-urban divide in particular with regard to internet access and network speeds (Mothobi et al., 2017).

These discrepancies may go some way towards explaining why digitalization has not yet led to the transformation of Southern African agriculture that it promises. Although there are numerous digital services available for smallholder farmers, they are often disjointed, short-lived, lacking in scale or financially unsustainable. Farmers have proven difficult to reach because of low levels of digital literacy, technological sophistication and purchasing power. Information and communication technologies (ICT) can undoubtedly play a role in the toolbox of measures to assist smallholder farmers. However, the transformative power of digital technologies will in the short- to medium-term show itself in segments higher up in the value chain and among larger producers and industry players, including in areas such as production planning, processing, supply chain management, quality control and financial services.

Opportunities for advanced digital technologies in African agriculture

We recognize four digital technology trends that could help to revolutionize agriculture in Southern Africa. What these trends have in common is that

Figure 20.1 Internet use and mobile connections in Southern Africa

Source: Digital in Africa 2018, Hootsuite and We Are Social, www.slideshare.net/wearesocial (accessed 10 Feb 2019)

Note: Countries categorized by GDP/capita: 1 – Seychelles, Mauritius, Botswana, South Africa; 2 – Namibia, Swaziland, Angola, Zambia; 3 – Lesotho, Tanzania, Zimbabwe; 4 – Comoros, Madagascar, Mozambique, Malawi, Democratic Republic of the Congo

Figure 20.2 How Southern Africans are accessing the internet

Data source: Digital in Africa 2018, Hootsuite and we are social, www.slideshare.net/wearesocial (accessed 10 Feb 2019)

Note: Countries categorized by GDP/capita: 1 – Seychelles, Mauritius, Botswana, South Africa; 2 – Namibia, Swaziland, Angola, Zambia; 3 – Lesotho, Tanzania, Zimbabwe; 4 – Comoros, Madagascar, Mozambique, Malawi, Democratic Republic of the Congo

they often make use of mobile phones but also incorporate other advanced digital technologies and backend solutions. These trends should not be seen in isolation, however. Rather, their true value will come from their integration.

Data for decision making

Diverse devices that are interconnected through the so-called “Internet of Things”, such as radio-frequency identification (RFID) tags, sensors, drones, satellites or meters, are making it possible to collect a wide range of data. At the backend, sophisticated analytical tools can integrate, analyze and visualize the data, including through data mining, artificial intelligence, machine learning and smart algorithms. This could be a leapfrogging technology in Africa where access to data for decision making remains a challenge. Automating a larger part of the data collection can reduce data collection costs, increase accuracy and enable the integration and joint analysis of larger data sets. Areas of application include, for instance, smart water and farmland management, pest and disease monitoring, recording and tracking of goods and animals, credit scoring or automated processing. Among the technology trends presented here, these are the areas where most progress has been made in Africa.

Examples of related applications can be found across the continent, often developed by local start-ups. Many applications focus on data collection at the farm level, using a range of tools to gather data, such as drones, satellites, sensors or mobile phones. For instance, the Nigerian company BeatDrone² employs drones for crop supervision and farmland mapping, while the South African company DroneScan³ uses them for inventory management in warehouses. Also, in South Africa, the company Aerobotics⁴ uses satellite and drone images for pest and disease detection on farms. Data analytics are also assisting in the provision of financial services, including credit⁵ and insurance⁶.

Platforms for goods, services and people

Digital technologies are offering new opportunities to set up networks of users to exchange goods, services, labour, money or knowledge. Platforms such as Facebook, WhatsApp and Uber are prominent examples of this trend, which has also been described as platform economy, gig economy, microtask platforms, sharing economy or uberization. Areas of application in food and agriculture include hiring labour, home food delivery, sharing machinery (with or without operator), trading agricultural products, sharing knowledge among farmers⁷ or accessing finance through crowdfunding⁸.

In the so-called gig economy, “paid work [is] allocated and delivered by way of internet platforms without an explicit or implicit contract for long-term employment” (Graham et al., 2017, p. 2). This could offer new employment opportunities for the self-employed even in remote areas as long as they are well-connected to the internet, thereby removing constraints of local labour

markets (ibid). Such platforms already exist in Africa, albeit not in the agriculture sector. The taxi platform Uber is probably the most well-known example. Another model is being applied to the sharing of machinery, such as Hello Tractor in Nigeria.⁹ A study of seven African countries has shown that most of the services provided through such platforms are manual or physical labour e.g., laundry, driving (Onkokame et al., 2017).

Such networks can also be used to set up virtual trading platforms for food and agriculture products. They would lend themselves in particular to the sale of goods where the quality is consistent and subject to certain standards that can be easily certified or verified, such as seeds, agro-inputs or processed food products. Trade in fresh products would require additional quality control mechanisms. ICTs can be used to ensure quality and reliability of such virtual trading, for instance GPS for tracking the goods or animals, cameras to take pictures or videos or sensors to measure moisture content. QualiTrace¹⁰ in Ghana, for instance, allows farmers to check the authenticity of agro-inputs by entering the serial number on their mobile phone. Digital payment systems make such platforms possible and can also assist in trust building, where the payments are held by the platform providers until the quality has been verified.

Blockchain technologies for traceability, transparency and security

Blockchain technologies have attracted much attention even though commercial applications in Africa are still limited (Pollock, 2018). The first and most well-known application is the cryptocurrency Bitcoins launched in 2008. However, the utility of blockchains in the agri-food industry goes far beyond Bitcoins (Tripoli and Schmidhuber, 2018). Also referred to as Distributed Ledger Technology, blockchains promise to revolutionize record keeping, product tracing and contracting. Simply put, a blockchain allows users to move from centralized to distributed storage and verification of data on multiple computers, which makes verification cheaper and faster, transactions traceable and transparent, and records immutable (ibid). Areas of application include, for instance, smart contracts, management of registries, supply chain management and financial services.

Only a few examples of blockchain applications in food and agriculture can be found in Africa, but they already give an indication of the technology's potential. The provision of financial services beyond crypto-currencies, such as loans or insurance, is one of the promising areas of application. For instance, the Kenyan company Twiga Foods,¹¹ which links farmers and vendors through supply chain management, partnered with IBM to use a blockchain to manage micro-lending to small food kiosks in Kenya (Kinai, 2018). Insurance providers can also take advantage of blockchain-enabled smart contracts which are used to automate the contracting process by auto-executing certain actions when specific conditions are met, such as insurance pay-outs. Such contracts have the potential to simplify dealing with a large number of dispersed customers in rural areas. They could also reduce the need for litigation and courts, which can be useful in countries with weak judicial systems (Shadab, 2014).

Some companies are experimenting with distributed ledgers to trace products from African farmers to the end consumer. The German software company SAP is piloting its SAP Cloud Platform Blockchain¹² to manage the entire supply chain in collaboration with various food companies (Milano, 2018). Another example is AgriLedger,¹³ which has piloted its blockchain-based traceability system with Kenyan wheat farmers to assist them with record-keeping on their own farm and tracking the produce along the value chain. Land registries are another promising area of application. For instance, the Rwandan government is collaborating with Medici Land Governance¹⁴ to set up a blockchain-based land management and property rights platform (Overstock.com, 2018).

Autonomous systems for greater efficiency in production and processing

The use of autonomous machines for automation in food and agriculture also holds great promise, for instance to assist in farming operations, logistics and processing. The widespread use of such machines may still be some way off in Southern Africa, but a few examples can give a glimpse of what is possible. Drones and robots, for instance, can be used for seeding, weeding¹⁵ or the application of fertilizer or pesticides¹⁶. These machines can also store information for future decision making, for instance to apply fertilizer at the specific location where the seed was planted. Automation can also assist in the operation of farm machinery. Automated tractor steering, for example, reduces the need for experienced machine operators and mitigates the risk of equipment damage.

The food industry offers many more opportunities for digital automation, also referred to as Industry 4.0. It can help to increase efficiency, reduce waste, ensure consistent quality and meet safety standards. Automation in the industrial sector is of course not new, but the arrival of digital technologies is opening up new opportunities by offering access to a wider range of data and analytical tools for machine learning that can facilitate autonomous cyber-physical systems of connected devices (Siemens, 2017). Realistically, simpler automation will be the first step for the African food industry. Even in industrialized countries advanced digital manufacturing technologies are still in their early days and the drivers that incentivize their application, such as increasing labour costs, a sizeable middle class, well-developed internet infrastructure and high-tech skills, are less pronounced in Africa than in other global regions (Dinham, 2017).

Creating an enabling environment for digitalization

Many of these ICTs may seem far out of reach for Southern Africa now, but as the technologies improve, simplify and become cheaper, they will become increasingly applicable in the region. To assist adoption of transformative digital technologies in the food and agriculture sector, it is essential that Southern African countries provide the necessary framework including policies, infrastructure, skills development and start-up support.

Policies are required to enable the provision of digital services in the first place. At the regional level, the SADC countries put ICTs high on the political agenda already in 2001 by adopting the Declaration on Information and Communication Technology, which committed member states to work towards bridging the digital divide in the region. However, as the numbers provided have shown, the divide continues to exist. Implementation of relevant regulations at the country level are needed to move the digital agenda forward, for instance in areas such as taxation, licensing, spectrum management, rules to govern network access and universal access funds.¹⁷ Conducive competition policies are also essential. The Mobile Network (MNO) market in SADC is still concentrated and dominated by a few big players such as Airtel, MTN and Vodacom (Mothobi et al., 2017). More competition could help to reduce prices and improve service quality and diversity.

At the same time, policies to ensure access to digital technologies and services will need to be accompanied by policies that govern their use. An area that has not received enough attention in Africa is regulating the collection and protection of data. There is also a need to mitigate any downsides of digitalization. For instance, potential job losses that may result from automation require contingency plans to offer alternative employment. At the same time, policies will need to ensure that ICTs narrow rather than widen the existing digital divides (e.g., rural/urban, men/women). A survey conducted in seven African countries has shown that only 17% of respondents in rural areas had used the internet compared to 43% in urban areas (RIA et al., 2018). Usage was considerably lower among women.¹⁸

Policies need to be accompanied by investments in infrastructure to ensure connectivity, including sea cables, fibre optic cables, internet exchange points and last mile infrastructure. Not only the reach of mobile networks is important but also their speed and usage costs. Mobile data prices vary widely across Southern Africa ranging from US\$2.3 per 1 GB in Tanzania to US\$35.3 in Swaziland in 2017 (Mothobi et al., 2017). In particular, the last mile infrastructure to reach end users requires attention. Decentralized solutions could prove particularly useful, such as WLAN, WiMAX and WiBack. Equally important is the expansion of electricity access. Appropriate and sustainable alternative energy sources, especially solar energy, will be a key to the adoption of emerging technologies in “smarting” Africa’s agriculture.

As emerging digital technologies are rolled out, African countries need to ensure they have adequate human capacities to operate and maintain these technologies. This, undoubtedly, will require radical shifts in policy, mind-sets and awareness, as well as continuous investment to provide the appropriate learning infrastructure for smart-farming and agri-tech entrepreneurship. It will need to include early interventions in the education ecosystem as well as intensive and comprehensive extension and advisory services. Here, there is an opportunity to attract young people to work in the food and agriculture sector and create much needed jobs for Africa’s growing youth population. The establishment of agri-tech learning and entrepreneurship hubs may help to reorient

young Africans towards agriculture and build the requisite “smart agri-talent pool” to drive smart agriculture in Africa.

The right policies, investments and skills will help to build a conducive innovation environment for local start-ups to thrive. Private sector engagement is essential to promote digitalization in food and agriculture since companies possess the necessary technical know-how and can keep up to date with the fast-developing ICT sector. Other supportive measures can include innovation hubs that offer a space to meet mentors and investors, incubation centres to develop ideas into full-fledged businesses, access to start-up funding through competitions or investors and, importantly, access to mid-level funding that allows start-ups to scale. Such initiatives have been shown to have driven the emergence of a local ICT sector in Kenya (Baumüller, 2016).

Frugal ICT innovation to cover the “last mile”

It is widely established in the literature that the ever-evolving nature of digital technologies makes it easy to get caught up in the excitement of new innovations. It is important that we do not overlook the value of simple, pragmatic and appropriate ICTs in African agriculture, especially when reaching out to farmers. After all, basic mobile phones were technically sophisticated enough to spark the mobile revolution in Africa. Thus, the development of agricultural services that can be delivered through simpler phones is far more useful for most farmers than more advanced technology that is dependent on the internet.

Simple phones lend themselves to diverse types of services. They can be used, for instance, to collect information, such as customer details when registering for a service or crowdsourcing information about crop disease outbreaks. They can also be used for the dissemination of standardized information such as weather forecasts, price information or specific instructions for crop management and postharvest handling. In particular, ICT-enabled financial technology (FinTech) for smallholder farmers can be key in reforming the financing of the agriculture value chain and ecosystem in Southern Africa. Using the previously mentioned emerging technologies, FinTech can increase efficiency and create new financial models for smallholder farmers, for instance to allow for better and simpler ways for payments and to facilitate access to investments, financing or insurance.

Smallholder farmers will not need to understand the sophisticated technologies under the hood of digital services to adopt, access and benefit from their power. The growth of cloud computing, also in Africa (Goldstuck, 2018), is making it possible to run sophisticated systems on centralized computers while using simple phones as interfaces to access the services (Baumüller, 2017). Intermediaries can also play an important role in facilitating access, such as village kiosks, agro-dealers or mobile money agents. Even the data that is incidentally collected by mobile phones can assist in the provision of services. For instance, the U.S. company Branch¹⁹ uses artificial intelligence to analyze digital data, including handset details, SMS logs, repayment history, GPS data, call logs

and contact lists, to make lending decisions in Kenya, Nigeria and Tanzania. However, such services should only be rolled out once adequate data protection laws are in place.

Conclusions

It may still be early days for the digital revolution in Southern Africa's food and agriculture sector, but it is essential that policymakers adopt a forward-looking vision to create an innovation environment that supports the use of tomorrow's digital solutions, not only today's. The emerging technologies presented here, when combined with quality data, talent, Africa's youth and their creativity, have the potential to unleash unprecedented advances in the transformation of Africa's agricultural ecosystems and value chains. They can help to establish a modern food sector in Africa that can produce a wide range of food products using a reliable supply of locally available, high quality agricultural products.

With this shift in focus towards the entire value chain and food sector, we do not want to leave smallholder farmers behind in the digitalization age. Dedicated apps for smallholders will continue to have their place in the portfolio of digital solutions. Any improvements in the innovation environment will also benefit providers of such services. At the same time, many of the advanced technologies applied higher up in the value chain can benefit farmers, even if at times indirectly, for instance through better market linkages, data availability or access to financial services. In the longer run, more sophisticated digital solutions will also trickle down to farmers as their digital skills and technologies improve.

Notes

- 1 Digital in Africa 2018, Hootsuite and we are social, www.slideshare.net/wearesocial (accessed 10 Feb 2019). SADC countries include Angola, Botswana, Comoros, Democratic Republic of the Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Swaziland, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe.
- 2 <http://beatdrone.co>
- 3 www.dronescan.co/
- 4 www.aerobotics.com/
- 5 e.g., FarmDrive in Kenya, <https://farmdrive.co.ke/credit-scoring>
- 6 e.g., ACRE operational in Kenya, Rwanda and Tanzania, <http://acreafrica.com/>
- 7 e.g., the farmer-to-farmer network WeFarm, <https://wefarm.org/>
- 8 e.g., Farmcrowdy in Nigeria, www.farmcrowdy.com/
- 9 www.hellotractor.com
- 10 <http://qualitracegh.com>
- 11 <https://twiga.ke/>
- 12 www.sap.com/products/leonardo/blockchain.html
- 13 www.agriledger.io/
- 14 www.mediciland.com
- 15 e.g., the weeding robot Dino by Naïo Technologies which mechanically weeds vegetable rows, www.naio-technologies.com/en/category/dino-robot/
- 16 e.g., BeatDrone which uses drones to spray on the farms,

- 17 www.ictregulationtoolkit.org/
- 18 The gender gap can be attributed, e.g., to lower education levels and income among women as well as cultural and social norms. It is interesting to note that internet access by urban women was higher than that of rural men. This shows that gender is only one aspect influencing internet adoption along e.g. with access to electricity or mobile coverage (RIA et al. 2018).
- 19 <https://branch.co>

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