SET SUPPORTING ECONOMIC TRANSFORMATION

PLATFORMS IN AGRICULTURAL VALUE CHAINS

Emergence of new business models

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ODI AGRITECH REPORT SERIES

ODI is releasing a series of reports funded by the Enhanced Integrated Framework that aim to explore AgriTech in East African value chains, as detailed in the below table. This current document is Report 2.

ODI AgriTech Report Series

Report	Report brief
Report 1: Disruptive technologies in agricultural value chains: Insights from East Africa	This conceptual paper explains what disruption means within AgriTech, along with who is disrupted and how. It also alludes to how to such disruption can create various pathways to value capture and creation.
Report 2: Platforms in agricultural value chains: Emergence of new business models	**This report aims to explain the various models of Ag-platforms that exist and provide policy-makers with a roadmap that supports the proliferation of sustainable Ag-platforms.**
Report 3: Platforms in agricultural value chains: National and regional policy gaps	This report aims identify the various national and regional policies required to ensure the proliferation of Ag-platforms and consequently ways to use Ag-platforms to bridge national and regional policy gaps.
Report 4: Ag-platforms as disruptors in Ugandan value chains: Pathways to value capture	This report uses survey data to explain the causal factors that have impacts on productivity, value addition, diversification, women's empowerment, youth inclusion and regional trade facilitation in Uganda.
Report 5: 10 policy interventions to implement within the East African Community	This report provides a list of the 10 key interventions that donors can invest in, in order to maximise the value creation and capture the potential of Ag-platforms for the poorest.

ACRONYMS

1AF	OneAcre Fund
3Cs	Costs, Complexity and Capabilities
AfDB	African Development Bank
AFR	Access to Finance Rwanda
AI	Artificial Intelligence
AIC	Agriculture Insurance Consortium
B2B	business-to-business
B2C	business-to-consumer
DAP	Digital Ambassadors Programme
DFID	UK Department for International Development
EAC	East African Community
EAC-BIN	EAC Broadband ICT Network
EACO	East African Communications Organisation
EBA	Enabling the Business of Agriculture
ERP	enterprise resource management
EU	European Union
FAO	Food and Agricultural Organization
GLTN	Global Land Tool Network
GPS	Global Positioning System
ICT	information and communication technology
IP	Internet Protocol
IoT	Internet of Things
ISP	internet service provider
ITC	International Trade Centre
ITU	International Telecommunication Union
IVR	interactive voice response
KfW	German Development Bank
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MCI	Mobile Connectivity Index
MINAGRI	Ministry of Agriculture
MINFIN	Ministry of Finance
MINICOM	Ministry of Commerce
MIS	Management Information System
MNO	mobile network operator
MSEs	Micro and Small Enterprises
MVNO	mobile virtual network operator
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organisation
NDP	National Development Plan
NGO	non-governmental organisation
ONA	One Network Area
Sida	Swedish International Development Cooperation Agency
SMS	Short Message Service
STEM	science, technology, engineering and maths
SWF	Severe Weather Consult
TFP	total factor productivity
TVET	technical and vocational education and training
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
USAID	US Agency for International Development
USSD	Unstructured Supplementary Service Data
VODP	Vegetable Oil Development Project
VoIP	Voice over Internet Protocol
WEF	World Economic Forum

EXECUTIVE SUMMARY

This report aims to develop typologies of business models of the Ag-platforms that exist, identifying the challenges and opportunities of using these business models and the extent to which they can create value capture opportunities for farmers, youth and women in agriculture. These opportunities include Ag-productivity gains; value addition and diversification; creation of more, decent and formal jobs for youth; gender inclusion; knowledge accumulation; and absorptive capacity. Drawing on case study evidence from Uganda and Rwanda, we deep-dive into the business models of Ag-platforms, unpacking the 3Cs of Costs, Complexity and Capabilities, to indicate the potential ways in which platformisation may exacerbate existing inequalities rather than supporting value creation for the poorest. Ultimately, we develop a roadmap for policy-makers to facilitate the development and proliferation of sustainable Ag-platforms.

Section 1 of the report highlights that Ag-platform-related apps offer multiple value creation and capture opportunities as compared with traditional value chains, while at the same time shedding light on possible challenges ensued.

Section 2 compares East African countries in terms of digital and regulatory readiness. Broadly, digital readiness for Ag-platforms refers to the ability of countries to develop, use and navigate digital platforms. This depends on enabling factors including information and communication technology (ICT) infrastructure, rate of technology adoption, human capital, and business and government investment. We find that Kenya ranks ahead of other East African countries on the GSMA Mobile Connectivity Index, followed by Rwanda, Tanzania and Uganda, and also leads on digital readiness of the agriculture sector.

However, there is a significant digital divide across gender and ICT skills in East Africa; only 17% of students pursuing degrees in science and technology subjects in Kenya are women, and 24% in Tanzania and 18% in Uganda (WEF, 2017). Regulatory readiness also varies significantly across these countries, especially in terms of conversion of draft laws into implementable acts/laws or protocols. Each of these aspects – ICT practices and authorities, mandates and competition frameworks – sets the landscape for supporting the development of Ag-platforms within each country. Rwanda is found to rank lower in regulatory readiness but is doing better than other East African countries on e-commerce regulations, having an active legal framework on electronic transactions, data protection, consumer protection and cyber-crime prevention.

Section 3 lays out a typology of Ag-platform models. It presents five models of Ag-platform delivery across a value chain, which consists of a combination of various scopes (breadth of functions and processes) and scales (destination of final product). It is important to note that each Ag-platform model's uptake is linked to the 3Cs and can vary depending on the country context. These models are as follows:

1. The *production and exchange model* consists of three scopes: backward exchange, horizontal offers and information services, whereby farmers gain production-related information, sometimes along with Artificial Intelligence (AI) and big data analytics support, generally at the pre-production and production stage of the value chain.
2. *Output exchange* occurs midstream in the value chain, consisting of three scopes: forward exchange, post-harvest and information services. This is an auction-based model, wherein farmers are provided information on crop prices and on logistic prices to transport products, as well as post-harvest services such as grading and packaging.
3. *Trading and sharing* consists of five scopes: marketplace matching, horizontal offers, information services, complex information services, production and harvest services, and sharing and knowledge exchange. This model covers the full value chain, as it includes services from the pre-production stage to the output sale.
4. *Guarantee purchase and logistics* consists of two scopes; guaranteed purchase and prices, and information services. In this case, Ag-platform firms act as intermediaries and buyers, by

taking the onus of loss onto themselves. They provide farmers with contracts, along with a guarantee of purchase at specific market defined prices.

5. The *single buyer-led (integrated)* model works within a completely vertically integrated value chain, wherein the main off-taker, be it a processor or a retailer, directly controls the entire value chain and there is already a predetermined market.

Section 4 applies this typology to East Africa, drawing on fieldwork in Uganda and Rwanda. Data collection in Uganda involved interviews with over 35 stakeholders conducted in July 2019. Interviewees included representatives of 10 Ag-platform firms, cooperatives, national and sub-national governments, international donors, universities, non-governmental organisations and farmers. Data were collected in Rwanda from over 20 stakeholders and 12 digital Ag-platforms operating in the country.

Findings suggest that, in Uganda, 50% of the apps are *production- and exchange*-related; this is followed by 20% in *trading and sharing* and one for *output exchange* and *single buyer-led*, respectively. None of the apps reviewed (or that were known to government/other app developers) related to *guaranteed logistics and purchase*. Overall, the results suggest that adoption rates increased most in production and exchange models because of relatively low costs and the lower complexity of product and capabilities required. Much of the change in trading and sharing models was driven by significant support from donors, the hands-on approach of the Ag-platform staff and the significant expansion of the app in urban and peri-urban farming. This led to a high rate of adoption despite its higher costs and capabilities. Trading and sharing platforms showed the most improvement in terms of productivity, value addition/diversification, number of jobs created and gender inclusion; it was followed in this by production and exchange, single buyer-led and output exchange.

Productivity appears to have increased for almost all Ag-platform models, in terms of crop yields as well as farm management practices and labour productivity. While the platforms have created only a low number of new jobs, in almost all cases there has been some level of change experienced in relation to the formalisation of jobs, with a large number of new bank accounts opened and written contracts provided to farmers for products, which in turn has provided farmers with better credit/loan facilities for working capital. There is a clear trend of low female participation/gender inclusion on Ag-platforms, because of the lack of mobile phones (e.g. the male member in the family owns and uses the mobile phone).

Unlike Uganda, Rwanda has many more government-supported apps and projects, run by the Ministry of Agriculture and the Ministry of Commerce. A range of value capture opportunities has emerged, which have grown through the use of Ag-platforms. Almost all *production and exchange* platforms reported an increase in crop yields, and a higher number of jobs being created, especially in the app itself (hiring of extension officers, new staff). At the same time, however, research across Africa shows that upskilling and more efficient monitoring and management can reduce the need for human interface, as AI can be used in its place, reducing the overall costs of labour employed. Similar results were shown in the key *trading and sharing* models. Another important improvement to note is the steady change towards gender inclusion in Rwanda

Finally, Section 5 develops a roadmap for developing sustainable Ag-platforms, through an eight-step ‘modular building’ method that enables the piecing-together of a hybrid mix of various platforms to create a new platform that best fits specific contexts, overcomes issues linked to the 3Cs and delivers on the desired value capture opportunity.

1. INTRODUCTION: AG-PLATFORMS AND NEW VALUE PROPOSITIONS

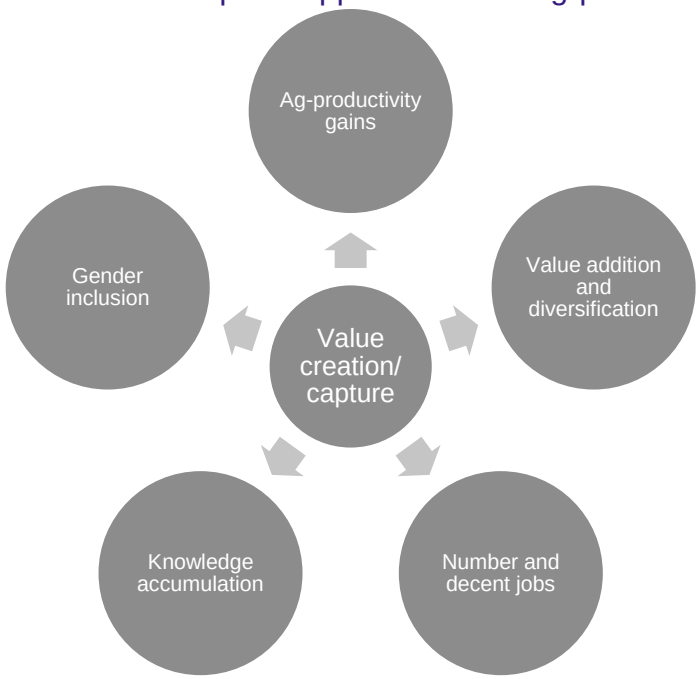
The growth of the platform economy, within agriculture, is increasingly becoming an important pathway to development. In the context of Sub-Saharan Africa, this is critical as, according to Cleland (2017), about 65% of the population relies on farming and about 20% on the non-agricultural informal sector; only around 15% are wage earners working in services and less than 3% are employed in industry. Agricultural digital platforms (such as farming apps) are driving e-commerce and the servicification of agriculture in developing regions. Côte d'Ivoire, Ghana, Kenya, Nigeria, Senegal, South Africa, Uganda and Zimbabwe have been described as hotspots for digital-tech solutions (GSMA, 2018). Of these, Ag-platforms, or farming apps, are some of the most common forms through which farmers have been 'platformised' in agricultural value chains. Our research paper on 'AgriTech Disruptors in East Africa' shows that, of a sample of 70 AgriTech innovative firms (e.g. Ag biotech, Precision Ag and robotics, innovative food and data-connected agriculture) in 2018 in the East African Community (EAC), between 66% and 86% of firms specialised in data-connected agriculture – that is, farming apps or providing enabling services for app development (Krishnan et al., 2020).

Ag-platform-related apps offer multiple value creation and capture opportunities as compared with traditional value chains.[1] Differences exist between 'traditional value chains' and 'platformised value chains'. For instance, in a platformised/digital chain, there is a bundling of information (codification), which potentially reduces the effort expected to search for information compared with a traditional chain. Information ranging from weather information, to land ownership details and financial information, can be used to customise the product to suit farmer-specific needs. While data are collected in a traditional value chain, especially for traceability, much of the supporting data, such as on financial situation, are not collected. This prevents a holistic understanding of the circumstances of the farmer. Furthermore, digital chains offer a facilitative infrastructure, in the sense that they coordinate and offer complementary services such as soil testing, labs, logistics, harvest services, financial management, etc., which were previously not easily accessible, and expensive, for farmers. Significant research also indicates that, as a result of slow payments, high rejection rates, poor contracts, and lack of communication between farmers and buyers, issues of trust and transparency arise (Foster, 2018; Krishnan and Foster, 2018; Barrientos, 2019; Ponte, 2020); however, the use of blockchain and other investments in building e-trust within Ag-platforms highlights the potential to increase trust or at least belief that the trustee's promise can be relied on and that the trustee will act in the spirit of goodwill (Casalo et al., 2011).

Participating in Ag-platforms may create new *value creation and capture opportunities*. Figure 1 illustrates these.

[1] A traditional value chain is defined as an arm's-length structure wherein there are physical interactions with middlemen, brokers, agents and other actors.

Figure 1: Value creation and capture opportunities of Ag-platforms



Source: Authors' construction

Ag-productivity gains: This has economic implications in terms of increased income or asset accumulation, along with improving the efficacy of factors of production. Agricultural productivity increases required to sustain overall economic growth need to be based on increased technical or financial efficiency of use of inputs and factors such as fertiliser, labour and land, or technological progress that makes it possible to produce more with less – or all three. Such productivity enhancement is the definition of total factor productivity (TFP) growth, or the residual extra value created by output growing faster than the growth of all inputs and factors going into production combined (World Bank, 2018).

Value addition and diversification: This creates opportunities for specialisation in agricultural value chain functions, especially by supporting the servicification of agriculture. In diversifying agricultural functions beyond on-farm labour, value-added functions can include downstream activities, such as marketing, branding and/or sophistication and quality improvements through processing. For instance, Twiga Foods has helped revolutionise the way small kiosks stock their inventories, while at the same time providing loans, which have radically disrupted the norm, changing the behaviour and management style of numerous shop-owners across Kenya.

Creation of more, decent and formal jobs for youth: A key value creation opportunity relates to adding more youth into the labour force. Data suggest that Africa needs to create about 12–15 million jobs to absorb the youth entering into the market annually (Gough et al 2013). Estimates by Thurlow (2015) show youth unemployment rates across Africa being consistently between 1.5 and 2.5 times higher than adult rate. The AfDB (2016) and Iriwin et al (2018)) moreover counts fully one third of Africa's nearly 420 million youth (aged 15–35) as 'unemployed and discouraged', another third as 'vulnerably employed' and only one in six as being in wage employment, noting that 'youth face roughly double the unemployment rate of adults, with significant variation by country'. Much of these unemployed, discouraged and vulnerably employed youth often form part of what is referred to as a 'hustlers economy', which is beset with informality and uncertainty and shines a light on unorthodox yet innovative solutions youth have had to use to find some form of employment/income generation capacity (Thieme, 2018).

Ag-platforms can boost youth inclusion in two ways. The first as developers of Ag-platforms; and second through the use of their digital (information and communication technology (ICT) skills) and soft

skills, which thus hones their entrepreneurial skills. We categorise skills based on Banga and te Velde (2018) categories of skills in the digital age: (i) basic to intermediate job-neutral digital skills, such as accessing the internet, digital advertising and data analysis; (ii) job-specific digital skills, such as computer programming and web-app development; and (iii) soft skills such as communication, management and critical thinking.[2] The second relates to encouraging youth to return to agriculture as 'smart farmers' and to use digital technology in farming practices.

Gender inclusion: Ag-platforms have the potential to reduce the gender gap in relation to slimming persistent gender digital divides, through improving access to receiving digital skills, finance/credit and work opportunities, reducing information asymmetries and training gaps, and supporting the creation of a level playing field. Another benefit claimed is increasing efficiency through matching demand to supply, thus enabling women to spend more time on non-work activities (e.g. reproduction, rearing of children). Furthermore, the use of Ag-platforms has often been touted to empower women, through improving bargaining rights, increasing income earned/wages and reducing the potential for gender violence on farms/sexual harassment through reporting mechanisms. However, to boost gender inclusion, there needs to be a slimming-down of persistent gendered digital divides, in terms of basic access to the internet and basic ICT skills.

Knowledge accumulation: Ag-platforms can engender the ability of farmers to harness and mobilise new forms of knowledge. While their adoption can be a complicated process, they have the potential to improve the overall quality of the processing of new knowledge/information and its effective absorption in order to better prevailing work practices (Cohen and Levinthal, 1990; Ernst and Kim, 2002). For example, Krishnan (2018) and Krone and Dannenberg (2018) find that Kenyan horticulture farmers' uptake of ICT led to greater assimilation of good agricultural practices and the following of complex traceability requirements in standards, which was an important contributing factor to increase in incomes.

While Ag-platforms offer multiple sources of value creation, several challenges also emerge. As we point out in our paper on Ag-disruptors in East Africa (Krishnan et al., 2020), Ag-platformisation through the 3Cs of Costs, Complexity and Capabilities may exacerbate or reproduce existing inequalities rather than supporting value creation. For instance, the high costs of running a platform may push costs onto farmers who are unable to pay for services. These costs could be considered sunk costs (incurred costs that cannot be recovered), as they are necessary to upgrade existing processes of doing business. Overall, these costs may inflate both the input costs (e.g. purchasing of specific chemicals) and the running costs (e.g. cost of gaining information, using services) to farmers. In some cases, high costs may compound gender divides by further reducing access and affordability to new technologies (ibid.).

The second and third overarching challenges comprise complexity and the related capabilities needed to adopt Ag-platforms. Complexity occurs if the Ag-platform has a high technological intensity and relate to the extent to which the embedded complex information and knowledge is transmitted to users of the platform. Farmers with lower capabilities – that is, those with low digital skills to use new technology or those who are unable to merge old and new technologies for production, harvesting, quality control, operation and maintenance, and monitoring of productivity – may face significant barriers in the uptake and use of Ag-platforms. This reduces their comparative advantage and further marginalises them from participating in value chains (Krishnan et al., 2020).

There is also significant grey literature on the rapid growth and demise of Ag-platform firms. For instance, over the past 30 years, numerous Ag-platform firms have closed down in Africa (Mann, 2018). This suggests that business models of Ag-platforms may vary significantly, and the value proposition they offer to farmers and users may or may not be sustainable. In order to ensure the attainment of value creation opportunities, there is a need to understand what current types of Ag-platform models

[2] Provision of digital and soft skills requires supply-side policies on formal education, formal and informal technical and vocational education and training (TVET), and employer-led training and demand-side policies on fostering innovation, competition and skill-upgrading, in addition to coordinating mechanism such as online portals to match the supply and demand of skills.

exist, while simultaneously gaining a better understanding of the potential role these models can play in a value chain context. This helps us comprehend whether Ag-platforms are indeed an important digital instrument to improve value creation; and what kinds of models are necessary for long-term sustainability of farmer livelihoods.

This report aims to do the following:

- Develop a typology of existing business models of Ag-platforms, suggesting that multiple varieties and functions are provided by apps within agricultural value chains, and that there is no 'one-size-fits-all' app;
- Identify the challenges and opportunities that affect each Ag-platform business model's ability to maximise the value creation opportunities of increasing Ag-productivity, value addition, increasing the number of youth jobs (formal and decent), supporting gender empowerment and supporting youth entrepreneurial capability. This is executed through case studies of Uganda and Rwanda, in addition to country comparisons with Kenya and Tanzania;[3]
- Develop a roadmap for policy-makers by highlighting the need to use a 'modular' process (adding scope and scale[4] in a progressive manner to create customisable apps) to develop an Ag-platform that fulfils various value creation opportunities. This will make it possible to create win-win sustainable solutions in the transformation of agriculture and in the resilience of livelihoods for the poorest.

The rest of the report is structured as follows. Section 2 presents the enabling environment for Ag-platforms in East African countries. Section 3 develops a typology of Ag-platform business models. Section 4 explores Ag-platform models through case studies of Uganda (65 interviews and a survey of 825 farmers) and Rwanda (20 interviews) in 2019. Information was collected on Tanzania as well; this is provided in Appendix C. Finally, Section 5 summarises the research and provides a roadmap for policy-makers to use to develop context-specific, value-maximising platforms.

[3] The agriculture sector is also a major contributor to gross domestic product in the case of Burundi (34.2%) and South Sudan (34.5%); however, these countries are largely excluded from the analysis in this report owing to limited availability of data on digitalisation of the agriculture sector.

[4] We discuss scope and scale in Section 3.

2. ENABLING ENVIRONMENT FOR AG-PLATFORMS IN EAC COUNTRIES

The building blocks of Ag-platforms are (i) hardware (e.g. ICT infrastructure, sensors, weather stations, irrigation hardware, agronomic diagnostic equipment, technology transfer); (ii) software and applications (e.g. Blockchain, Internet of Things (IoT), Voice over Internet Protocol (VoIP), data analysis, intellectual property source code, Artificial Intelligence (AI)); and (iii) data chains for decision support (e.g. data storage, data collection rules, data capture processes).

In this case, hardware refers to the machines, wiring and other physical components of an electronic and mechanical system, which range from supporting technology transfer in products such as sensors (for mapping to provide spatial and proximate information), to guidance hardware for accurately triangulating GPS and other connected devices or low-cost hyper-local weather stations and weather monitoring devices.

Software refers to applications – the predominant focus of digitalisation – such as improved broadband width; better VoIP for delivery of voice communications and multimedia sessions over IP networks; and technology transfer by IoT, which is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interactions.

The third building block is the collection, storage and processing of data through complex software to support precision agriculture (Krishnan et al., 2020).

Together, these building blocks enable the upgrading of crop and farm practices; management and monitoring; syncing of hardware devices to mobiles; the collation of multiple streams of data related to the growth progress of crops; and the delivery of information on pests, diseases, weather, quality checks and financial and farm labour.

The building blocks require two key enabling factors – ‘digital readiness’ and ‘regulatory readiness’ – which can improve the overall enabling environment for the building blocks to thrive. The strengthening and growth of the building blocks in Ag-platforms will facilitate their proliferation and adoption. This section takes a deeper look at digital and regulatory readiness, at the national and regional (EAC) level, to gain a holistic understanding of the current enabling environment for Ag-platforms.

2.1 Digital readiness for Ag-platforms

Broadly, digital readiness for Ag-platforms refers to the ability of countries to develop, use and navigate digital platforms, which depends on enabling factors that include ICT infrastructure, rate of technology adoption, human capital, and business and government investment. At the regional level, the EAC Development Strategy 2006–2010 captures ‘Information and Communication Technology integrated into regional development initiatives’ as a development objective. In addition to mainstreaming ICT in all its programmes, the EAC has identified regional connectivity issues as a constraint to economic activity, and has therefore defined specific strategic interventions to address this, including implementation of a cross-border connectivity project and coordination and harmonisation of ICT policies (AfDB, 2013). Currently, the majority of the capacity connecting the region to global markets is supplied through submarine cables in Kenya and Tanzania, supplemented by small amounts of international capacity provided through cross-border terrestrial cables, as well as some satellite broadband capacity. The other four landlocked countries access international capacity through cross-border terrestrial cables, facing corresponding mark-ups in pricing. This partly helps explain disparities between existing national connectivity markets.

The EAC Broadband ICT Network (EAC-BIN) aims to address missing links and ensure that landlocked countries have access to the submarine landing stations at the same cost as coastal countries (AfDB, 2013). The EAC’s regulatory harmonisation has been more effective than that of other regions because

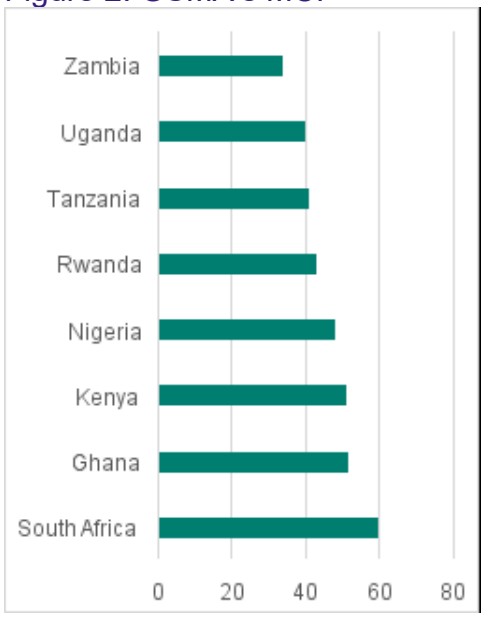
of the small number of countries that participate in the coordinating body – the East African Communications Organisation (EACO). EACO brings operators and regulators together, and has established interconnection guidelines and a model regional interconnect agreement (ibid.).

In 2014, the countries of the EAC also made a joint commitment to fast-track the creation of a One Network Area (ONA) to reduce high roaming charges and interconnection rates, which are significant barriers to cross-border communication (World Bank, 2018). The ONA, currently covering Kenya, Rwanda, Uganda and South Sudan, has introduced harmonised cap rates for cross-border traffic originating and terminating within participating countries, and the elimination of roaming surcharges for users travelling within the region (ibid.). In Uganda, retail roaming rates were cut from $0.93 to $0.10 per minute (based on figures from 2016) following introduction of the ONA; in Kenya and Uganda, cross-border voice traffic has tripled. However, despite the success of this initiative, plans to extend it to data, SMS and mobile money services have been slow to materialise (ibid.). These policies have prompted the growth of Ag-platforms by reducing the challenges of cross-border communication and roaming. Targeted initiatives that lower connectivity prices for consumers, such as the ONA, need to be prioritised and fast-tracked at the regional level. These initiatives also need to be fully extended to cross-border data exchange.

Focusing just on mobile connectivity, Figure 2 finds that Kenya ranks ahead of other EAC countries on the GSMA Mobile Connectivity Index (MCI), followed by Rwanda, Tanzania and Uganda. This index measures the performance of countries against the key enablers of mobile internet adoption: infrastructure, affordability, consumer readiness, and content and services.

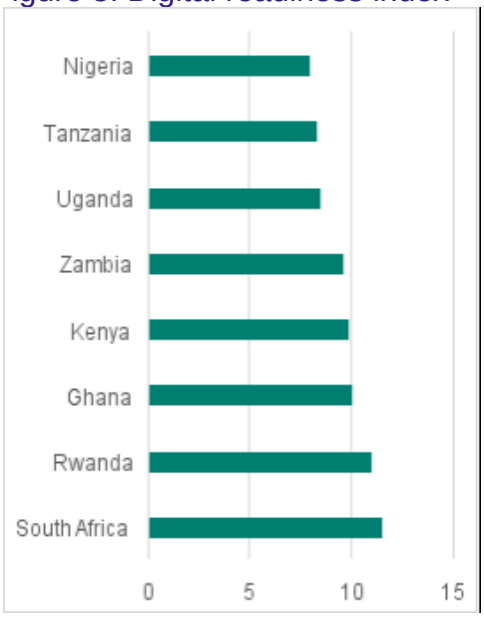
Figure 3 looks more broadly at digital readiness in EAC countries and compares these with other selected African countries on Cisco's country-specific digital readiness scores. This index measures a country's digital readiness along seven components: (i) technology infrastructure (fixed telephone subscriptions, fixed broadband subscriptions, internet services, networking services); (ii) technology adoption (mobile device penetration, internet usage, cloud services); (iii) human capital (quality of maths and science education, adult literacy rate, years of schooling, population aged less than 14 years); (iv) basic needs (life expectancy, mortality rate for those under five years, sanitation, access to electricity); (v) ease of doing business (overall ranking, rule of law, logistics performance, time to get electricity); (vi) business and government investment (foreign direct investment , high-technology exports, government success in ICT promotion); and (vii) start-up (strength of legal rights, time to start a business, availability of venture capital). Within the EAC, Rwanda ranks the highest on digital readiness, followed by Kenya, Uganda and Tanzania.

Figure 2: GSMA's MCI



Source: GSMA MCI 2019

Figure 3: Digital readiness index

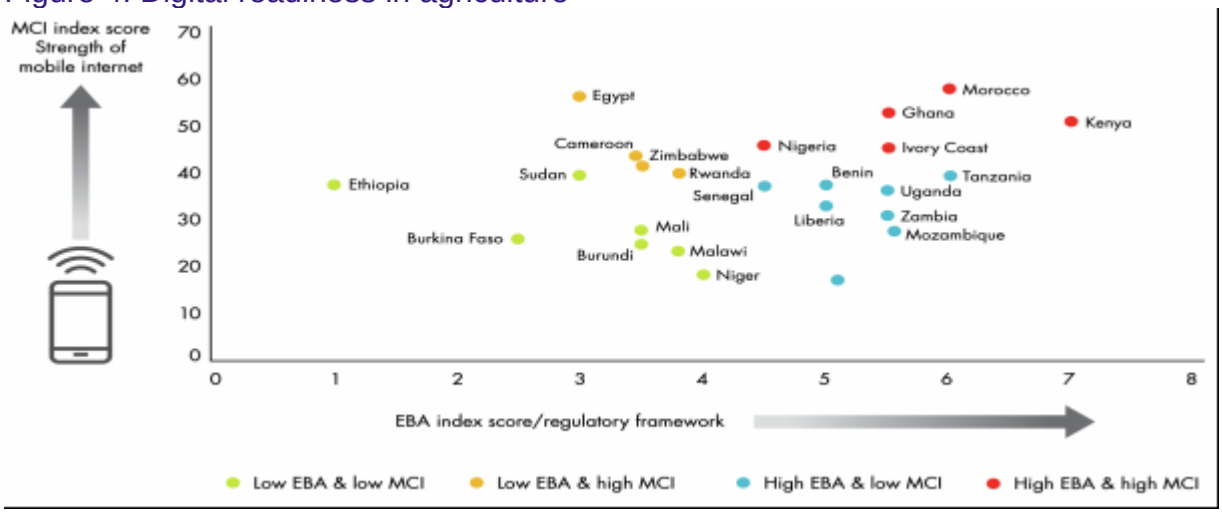


Source: Cisco Digital Readiness Index

While the discussion above captures the overall digital or mobile readiness of the country, Tsan et al (2019) compare countries on the basis of use of technology in the agriculture sector (see Figure 4). Digital readiness of the agriculture sector is mapped using data on overall mobile connectivity (GSMA's MCI) in the country and on Enabling the Business in Agriculture (EBA) (World Bank). Kenya ranks the highest on digital readiness in agriculture: it has high EBA index and MCI scores. Tanzania and Uganda have high EBA but low MCI scores, whereas Rwanda has a low EBA score but a high MCI score. Burundi ranks low on both indices.

Box 1 summarises some lessons from Kenya on leveraging digital technologies for agriculture.

Figure 4: Digital readiness in agriculture

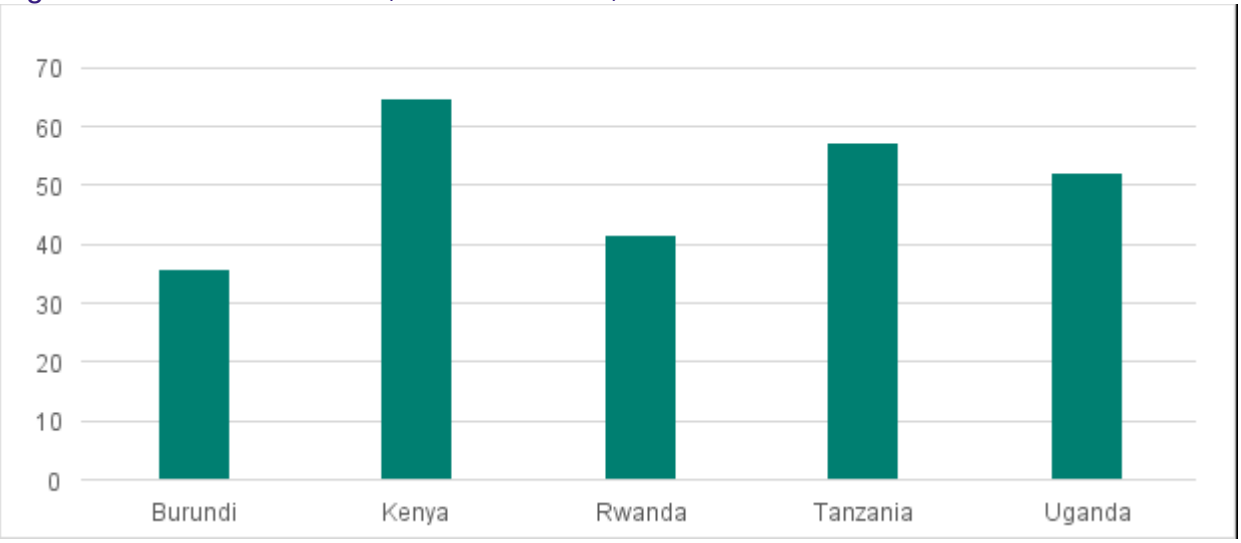


Note: Data are for 2017

Source: Tsan et al. (2019)

EBA data for 2019 show that Kenya continues to rank the highest, followed by Tanzania, Uganda, Rwanda and Burundi (Figure 5). Kenya ranks particularly high on securing water, registering machinery and trading food. The World Bank (2019) notes that digital reforms introduced in Kenya have contributed towards a reduction in time and costs of procedures. For instance, by issuing phytosanitary certificates electronically, Kenya's Health Inspectorate has increased government revenues by 75% and saved exporters an estimated 72,000 km in travel annually (ibid.). Although overall Burundi lags behind other EAC countries on the EBA index, it is one of the most reformed countries since 2017. In addition to improving its phytosanitary measures, it has also improved access to financial services by enacting a comprehensive legal framework on agent banking and electronic money. Moreover, in the seed sector, the government has improved access to information on seed performance by introducing an official variety catalogue.

Figure 5: EBA index scores, EAC countries, 2019



Source: World Bank (2019)

Overall, this section notes that there are varied levels of development when it comes to digital readiness of countries in the EAC, with Kenya the most advanced, followed by Rwanda, Uganda, Tanzania, South Sudan and Burundi.

Box 1: D4Ag lessons from Kenya

D4Ag in Kenya has benefited from its high levels of connectivity, mobile phone usage and data transparency, as well as rise of Safaricom's M-Pesa and of mobile money over the past decade. Around half of venture capital/private equity investment in AgTech in Sub-Saharan Africa occurs in Kenya.

- Donors/non-governmental organisations (NGOs) tend to fill the gaps by supporting those solutions that do not focus on mobile money. For example, the agricultural supply chain, iProcure, is partnering with existing agricultural dealers in Kenya.
- Growth and expansion of platforms such as iKilimo and iCow has been hampered by the lack of strong partnerships among stakeholders and by weak evaluation and monitoring. Intermediaries can play an important role in encouraging partnerships. For example, AgriFin has become an early leader in this effort, hosting networking opportunities for entities active in agriculture finance.
- Policies around data privacy and customer protection are yet to be developed fully but Kenya has a Draft Data Protection Bill (2018).
- Bundled services for farmers are better positioned to capture revenue opportunities.
- Farmers are wary of fully digitalised D4Ag services; human intermediation (agent networks) in D4Ag continues to be important.

Source: Tsan et al. (2019)

2.2 Regulatory readiness for Ag-platforms

In terms of readiness on the legal and regulatory front, it is important to understand how developed the ICT regulatory frameworks are for various countries in East Africa. This points to the possible level to which Ag-platforms can grow and proliferate within national boundaries and across borders.

Table 1 compares progress on ICT regulations using the International Telecommunication Union (ITU) ICT Regulatory Tracker, which identifies trends in ICT legal and regulatory frameworks. While it does not measure the quality or the level of implementation or performance of regulatory frameworks, it helps progress and identify gaps in **national regulatory frameworks** using four dimensions: **regulatory authority, regulatory mandate, regulatory regime and competition framework** (ITU, 2018). The regulatory authority dimension includes indicators measuring, for example, the presence of a separate ICT regulator, autonomy of the regulator in decision-making, accountability, enforcement

power, dispute resolution and the presence of a competition authority. Regulatory mandate examines who has control in the country for regulating the following: licensing, quality of service obligations measures, radio frequency allocation, universal accesses, broadcasting and internet content. In turn, regulatory regime captures the existence of regulations in major areas, including types of licensing, use of VoIP services, mandated infrastructure sharing and co-location, and presence of a national plan that involves broadband. Lastly, competition framework measures the level of competition in the main market segments within the ICT sector – that is, in local and long-distance fixed-line services; 3G, 4G and other services, as well as foreign ownership or participation in facilities-based operators; spectrum-based operators; local service operators/long-distance service operators; international service operators; and internet service providers (ISPs).

Using this ICT Regulatory Tracker, Table 1 compares East African countries with other selected countries across the four different dimensions. Within the EAC, Kenya ranks highest, followed by Uganda and Tanzania. Interestingly, Rwanda ranks at the bottom, lagging particularly on the competition framework aspect.

Table 1: ICT regulatory readiness

Name	Regulatory authority	Regulatory mandate	Regulatory regime	Competition framework	Rank
Ghana	18	21	22	27	42
Kenya	18	21.5	21	27	45
Uganda	17	20	22	27	52
Tanzania	20	21	19	25	62
Rwanda	20	20	18	24.33	73
Nigeria	17	20	20	21.33	91
South Africa	17	17	24	13.33	112

Source: ITU ICT Tracker

Table 2 compares EAC countries on the basis of ICT practices and regulations. Tanzania scores 7 out of 10 on ICT good practices, followed by Kenya (6), Burundi and Uganda (4) and Rwanda (3). All EAC countries except Burundi offer unbundled operating and spectrum licences for mobile operators, with more legally stated renewal criteria in Kenya and Tanzania. In both Uganda and Rwanda, the renewal criteria for licences (operating and spectrum) are not present in the law. Uganda and Tanzania allow both active and passive infrastructure sharing between mobile network operators (MNOs) legally, and mobile virtual network operators (MVNOs) are allowed to operate in the EAC except in Rwanda.

Table 2: ICT practices in the EAC, 2019

Economy	**Burundi**	**Kenya**	**Rwanda**	**Tanzania**	**Uganda**
Count of good ICT practices (0–10)	4	6	3	7	4
Unbundled operating and spectrum licences for MNOs	No	Yes	Yes	Yes	Yes
Presence of operating licence renewal criteria for MNOs in the law?					
a. Structure of renewal fees	No	Yes	No	Yes	No
b. Renewal period	No	No	No	Yes	No
Presence of spectrum licence renewal criteria for MNO in the law?					
a. Structure of renewal fees	N/A	Yes	No	Yes	No
b. Renewal period	N/A	Yes	No	No	No
Is voluntary spectrum trading among MNOs allowed by law?	No	No	No	No	No
Is passive infrastructure sharing between MNOs legally mandated in your country?	Yes	Yes	Yes	Yes	Yes
Is active infrastructure sharing between MNOs legally mandated in your country?	Yes	No	No	Yes	Yes
Is national roaming between MNOs legally mandated in your country?	Yes	No	Yes	No	No
Are MVNOs allowed by law to operate in your country?	Yes	Yes	No	Yes	Yes
What type of operating licence is required for MNOs offering core mobile services (voice, SMS, data) in your country?	Individual	Individual	Individual	Individual	Individual
Is the licensing framework for MNOs offering core mobile services in your country both technology- and service-neutral, by law	No	Both	Tech-neutral	Both	Tech-neutral
What is the validity (in years) of an operating licence for MNOs offering core mobile services?	15	15	15	25	20
Are first-time and annual fees of an operating licence publicly available?	Both	Both	Annual	Both	Both
What is the lowest frequency spectrum (including digital dividend) in megahertz (MHz) ever licensed to mobile operators in your country?	800	800	800	700	900

Source: World Bank (2019), additional data

However, in e-commerce legislation, Rwanda is doing better than other EAC countries (Table 3). The country has an active legal framework across all four dimensions considered: electronic transactions, data protection, consumer protection and cyber-crime prevention. All countries have legislation on e-transactions. In Kenya, for instance, acts on electronic transactions include the Kenya Communications (Amendment) Act 2008 and the Information Communications (Electronic Transactions) Regulations 2016. Kenya, Rwanda and Uganda also have a legal framework for consumer protection online and on cyber-crime; Tanzania has draft legislation. EAC countries are lagging in terms of data protection/privacy: only Rwanda has active legislation.

Table 3: E-commerce regulatory readiness

	Electronic transactions/ e-signature	Data protection/ privacy online?	Consumer protection when purchasing online?	Cyber-crime prevention?
Kenya	Yes	Draft	Yes	Yes
Rwanda	Yes	Yes	Yes	Yes
Uganda	Yes	Draft	Yes	Yes
Tanzania	Yes	Draft	Draft	Draft

Source: UNCTAD e-commerce indicator

Each of these factors is critical to the development of Ag-platforms. For instance, data protection is key when collecting financial and personal data of farmers; electronic signatures are needed on agricultural contracts within the Ag-platforms (e.g. buyers–farmers/platform owners); there needs to be protection of farmers as consumers when purchasing various services and products online through the app; and ensuring data are sent and collected over encrypted logics is necessary to maintain data security.

In sum, regulatory preparedness varies significantly across countries, especially in terms of conversion of draft laws into implementable acts/laws or protocols. Each of these aspects – ICT practices and authorities, mandates and competition frameworks – sets the landscape for supporting the development of Ag-platforms within each country.

2.3 Inclusion of women and youth in Ag-platforms in East Africa

It is critical to note whether there exist gendered digital divides that prevent women from accessing the services that will facilitate use of Ag-platforms. A large proportion of women in East African countries work in the agriculture sector: 96% of women in Burundi, 76% in Kenya, 84% in Rwanda, 71% in Tanzania and 77% in Uganda (UNCTAD, 2017). However, a significant literature suggests that women are still marginalised as a result of socio-cultural norms that curb their basic rights and entitlements (such as land ownership), given lack of access to the internet, basic skills and education (Commonwealth Secretariat, 2020). Only 17% of students pursuing degrees in science and technology subjects in Kenya are women, 24% in Tanzania and 18% in Uganda (WEF, 2018). Women are also less likely to access financial services, and particularly less via mobile technology (Hunt and Samman, 2016). Women are on average 14% less likely to own a mobile phone than men, which translates into 200 million fewer women than men owning mobile phones in low- and middle-income countries. While cost remains the greatest barrier overall to owning and using a mobile phone, security and harassment also emerge as one of the top five barriers, and a key concern for women (Herbert, 2017).

Another important aspect is the increase in youth participation within Ag-platformised value chains, as both developers and users of Ag-platforms. The EAC has a young population, with a large share of the labour force made up of 18–35 year olds. To boost youth inclusion in the future workforce, East African countries will need to design national strategies to develop young people's digital skills and build an enabling environment for innovation, entrepreneurship and job creation in the digital economy.

Beyond increasing access to secondary and tertiary education as well as science, technology, engineering and maths (STEM)-focused technical and vocational education and training TVET, this will require changes in the curricula, effective and quality provision of digital and soft skills training, continuous professional development of TVET trainers, investment in digital infrastructure and linkages with a dynamic private sector to align skills taught with industry needs (Banga and te Velde, 2018a). For out-of-school youth, marginalised sections of society and adult learners, access to digital and soft skills training can be expanded through non-formal TVET.

An excellent example of non-formal TVET delivering future-relevant skills is the Digital Ambassadors Programme (DAP) in Rwanda, a joint initiative by the World Economic Forum (WEF) Internet for All, the Digital Opportunity Trust and Rwanda's Ministry of Youth and ICT. This is mounting a three-pronged push to boost internet access, skills training and jobs in Rwanda. DAP aims to employ 5,000 young Rwandans, with 50% participation of young women and girls, as digital skills trainers. These Young Digital Ambassadors will receive training in essential digital skills and soft skills, which they will then draw on to provide hands-on training across the country (WEF 2017).

3. MODELS OF AG-PLATFORMS: KEY CONCEPTS

This section attempts to breakdown the different models of Ag-platforms that exist. Clearly, based on the discussion in Section 2, countries within the EAC that rank higher on digital readiness and regulatory readiness will tend to have a larger number of Ag-platform firms operating within their national boundaries, as well as those crossing regional borders. Ag-platforms have the potential to transform the *modus operandi* of different nodes of the value chain – that is, they can alter the upstream (pre-production; production; post-production harvest), midstream (logistics and transportation; sale to intermediaries; processing/value addition/ packaging) and downstream (branding; logistics; sale to wholesalers/end buyers/ consumers). This report illustrates five types of Ag-platform delivery business models across a value chain, which consist of a combination of various scopes (breadth of functions and processes) and scales (ultimate destination of final product). It is important to note that each Ag-platform model's uptake is linked to the 3Cs and can vary depending on each country context.

3.1 Scope of Ag-platforms

Scope refers to the breadth of services that substitute for or complement the traditional functions and processes in an agricultural value chain. These can range from 'marketplaces', or virtual intermediaries that match buyers and sellers, like M-Farm in Kenya or M-Lamu in Senegal; to renting platforms that allow business-to-business (B2B) renting of inputs such as hardware (tractors, sprayers), software (e.g. including IoT services); to knowledge-sharing, wherein farmers can post their hardware and software experiences online to share with others on the platform. Another dimension of scope entails horizontal facilities, which include add-ons to extension services such as health services (e.g. ICow) or insurance services (e.g. oneACRE) that provide socioeconomic protection to farmers beyond business-as-usual conditions. Often, such platforms are formally structured right from the start; at times, they can begin as informal networks and may transit into more formalised structures, such as public–private partnerships or cooperatives, with the goal of becoming self-sustaining (Schut et al., 2018). Nine key forms of scope exist:

1. *Backward exchange* refers to the input services (e.g. chemicals, seeds) platforms offer to farmers. Platform firms connect farmers to input suppliers in several ways, either directly linking them to validated input suppliers, who offer quality products often at subsidised prices, or aggregating several input suppliers and providing subsidised 'packages' (e.g. bundles of different input services) that farmers can select from. This occurs upstream in the value chain, at the stage of pre-production. These are frequently explained as B2B transactions, as these are intermediate stages of production.
2. *Forward exchange* refers to a platform's creation of an online output marketplace such as an auction structure, where bids are virtual. Prices are expected to follow current spot market (and futures market if the country has a commodity derivative market) prices and bids are transparent, so farmers selling produce know who is buying the produce and what the trends in market prices are. Forward exchanges can open new market channels for farmers. If the products sold are raw (pre-processing), they occur midstream in the value chain at the stage of selling to processors. They can also occur downstream in the chain when selling to retailers.
3. *Marketplace matching:* This concept is similar to forward exchange but is customised beyond just auction markets. In this case, the platform firm reaches out to various buyers and connects farmers to the aggregated buyers, who can be wholesalers, processors or retailers. This involves significant dis-intermediation, as agents and brokers are no longer pivotal in the picture and it is expected that the value will be captured and distributed between the farmers and the platform firm.
4. *Information services* address information asymmetry and access-related issues for farmers who are growing produce commercially. Complementary services include information on microclimates (weather), real-time market prices, yield, high-quality agricultural extension, such as pest and disease mitigation and prevention, and good agricultural practices that are key to enhancing farmer capability. These services are required across the value chain. Platform firms often coordinate and partner with several organisations, such as weather authorities,

agricultural universities, government entities and NGOs, to gather relevant information, which is then disseminated to farmers who subscribe to the app.

5. *Complex information services* comprise big data decision support through AI, land contour mapping (GPS) and management information, such as enterprise resource management (ERP)[5] to organise farm activities through the use of sensors. These are complex, as they require the capabilities to use smartphones and comprehend sophisticated information. While it is possible to provide some complex services through interactive voice response (IVR), these services require considerable back-end infrastructure to deliver effective last-mile information. Platform firms either develop AI facilities in house through their own big data analytics or coordinate with data providers, private firms and other organisations to provide complex information to farmers. Together, reducing information asymmetry is key to precision agriculture (precision Ag), which aims to use existing resources effectually to maximise yields while minimising environmental degradation and market externalities (e.g. market risk through unpredictability of prices, raw materials, accurate forecasts of yield, quality and quantity of traded crops and accounting for variability and uncertainties within agricultural system – Gebbers and Adamchuk, 2010).
6. *Production and harvest services* cover leasing tractors and other machinery, weeding and spraying, picking and cleaning short-term labour hiring, and subsidised prices for soil and water. These occur upstream in the value chain. Platform firms partner with private sector firms and various testing labs in order to provide high-quality services to farmers.
7. *Horizontal offers* are the complementary services that platform firms offer in order to facilitate the growth of the firm. These include finance for inputs and commercial expansion through loans or working capital – for instance bank-to-bank transfers of loans, as well as in-kind loans to purchase inputs, backed by a credit score and payable direct to the agrodealer (Kioko, 2019). It also includes insurance for crops and climate extremes, provided by banks and private sector agencies, to hedge against uncertain weather changes and crop yield drops. Civil society organisations also provide climate and ICT training and act as conduits for government benefits, such as subsidies on seeds and fertilisers. Platforms often partner with other organisations (e.g. mobile money platforms, universities, NGOs, banks, microfinance institutions) on a commission basis. These occur across all nodes of a value chain.
8. *Guaranteed purchase and prices:* This scope is less common, but occurs in some cases when platform firms act as 'buyers' and proceed to guarantee purchase of the commodity and a contracted price. These offer farmers security of purchase of produce, along with what is expected to be a fair contract price. This fair price is decided in advance, in consultation with farmer group leaders. These often occur midstream in the value chain; from this point, platform firms either sell produce further on to processors or retailers or in some cases process the product themselves.
9. *Sharing and exchange of knowledge* includes chat platforms and free/subsidised calls to other farmers participating on the same platform. This provides an opportunity for learning and for feedback to platform providers and their partners as to the functioning of the various services provided. This often occurs during the production stage or during aftersale of produce.

3.2 Scale of Ag-platforms

Scale, in a value chain context, is the 'global', 'regional' and 'local' dimension. This refers to the territories and the networks that are covered from the stage of production to the sale of the product (Coe and Hess, 2013; Ponte and Sturgeon, 2014).

- A 'global' value chain is a southern supplier selling final or intermediary products to northern end markets.
- A 'south–south' value chain is a southern supplier selling final and intermediary products to southern end markets.

[5] ERP is business process management software that allows an organisation to use a system of integrated applications to manage the business and automate many back-office functions related to technology, services and human resources.

- A ‘regional’ value chain involves suppliers selling final and intermediary products in regional blocs or one-world regions, such as EAC, SADC (Southern African Development Community) or the EU.
- A ‘domestic’ value chain occurs when local suppliers sell products within the national territory of a country, to both formal and informal markets.

Our first paper in the series on disruption in value chains claimed that Ag-platform firms in *Africa most typically seem to occur at a domestic scale*, wherein the key objective is to promote food security and increase resilience in local livelihoods. The proportion of Ag-platform firms that act at the global scale is smaller, because of stringent traceability, sanitary and phytosanitary and rules of origin requirements that make it cumbersome to create services that serve the requirements of northern importers. There is increasing traction for Ag-platform firms to support farmers in south–south and regional value chains, as there is growing trade in this space accompanied by less stringent standards (Krishnan et al., 2020).

3.3 Models of Ag-platforms

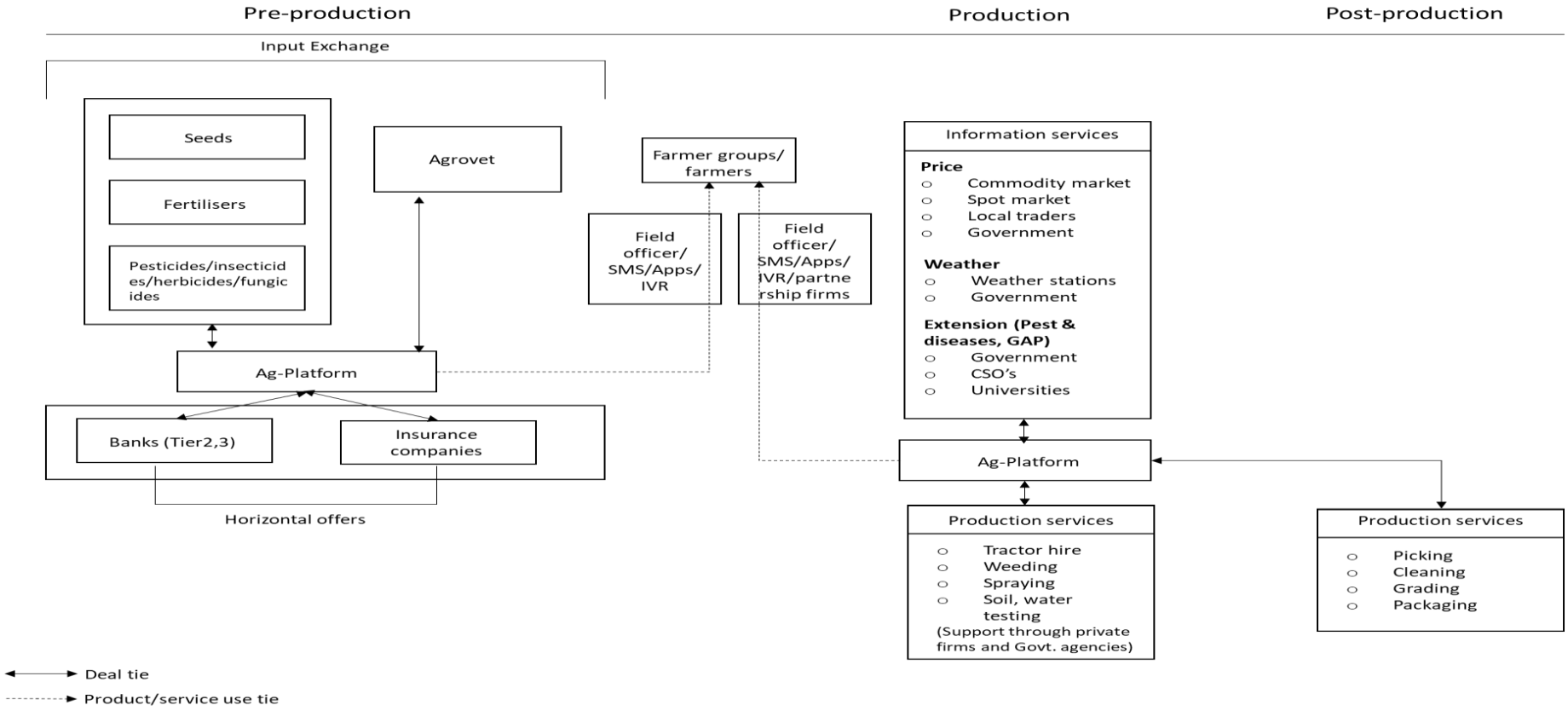
Ag-platform characteristics of scope node and scale described in the section above are integrated into five models, which most commonly occur on the ground. These models are ‘modular’ in nature, in the sense that they are created by combining different types of scope and scale together. Needless to say, several permutations and combinations of the scope and scale may exist; however, the five identified in this study are the most recurring Ag-transaction platforms that are prevalent within Africa.

3.3.1 Production and exchange model

This model (Figure 6) includes three scopes: backward exchange, horizontal offers and information services, generally occurring at the pre-production and production stage of the value chain (upstream). The dotted line in the diagram below illustrates the flow of the service – that is, from the main actor who provides the service to the actor who uses the service – whereas the full line demonstrates the ‘deals’ that the Ag-platform makes with various actors in the value chain to create bundles of services which it in turn hosts on its platform and which are then accessed by farmers. Ag-platforms make deals (i.e. form partnerships on a commission basis) with input suppliers like seed companies and agro-chemical firms within the backward exchange; and with tier 2 and 3 banks, microfinance institutions and insurance providers to provide farmers with horizontal services. They also provide information services by connecting with weather stations, local traders for prices or commodity markets and warehousing corporations. These services are shared with the farmer through SMS, IVR, smartphone dashboard or videos, often with the support of extension/field officers who work for the Ag-platform firm.

Ag-platform firms also aggregate production and harvest services such as tractor hire, trained labour for weeding and picking, and soil and water testing facilities; as well as more value-added services such as grading and packing. Figure 6 shows a simplified diagram of the deals the Ag-platform makes and the services it provides, as well as the various value chain actors participating. The production and exchange model occurs primarily at the domestic scale but is increasing in prevalence south–south and regionally.

Figure 6: Production and exchange



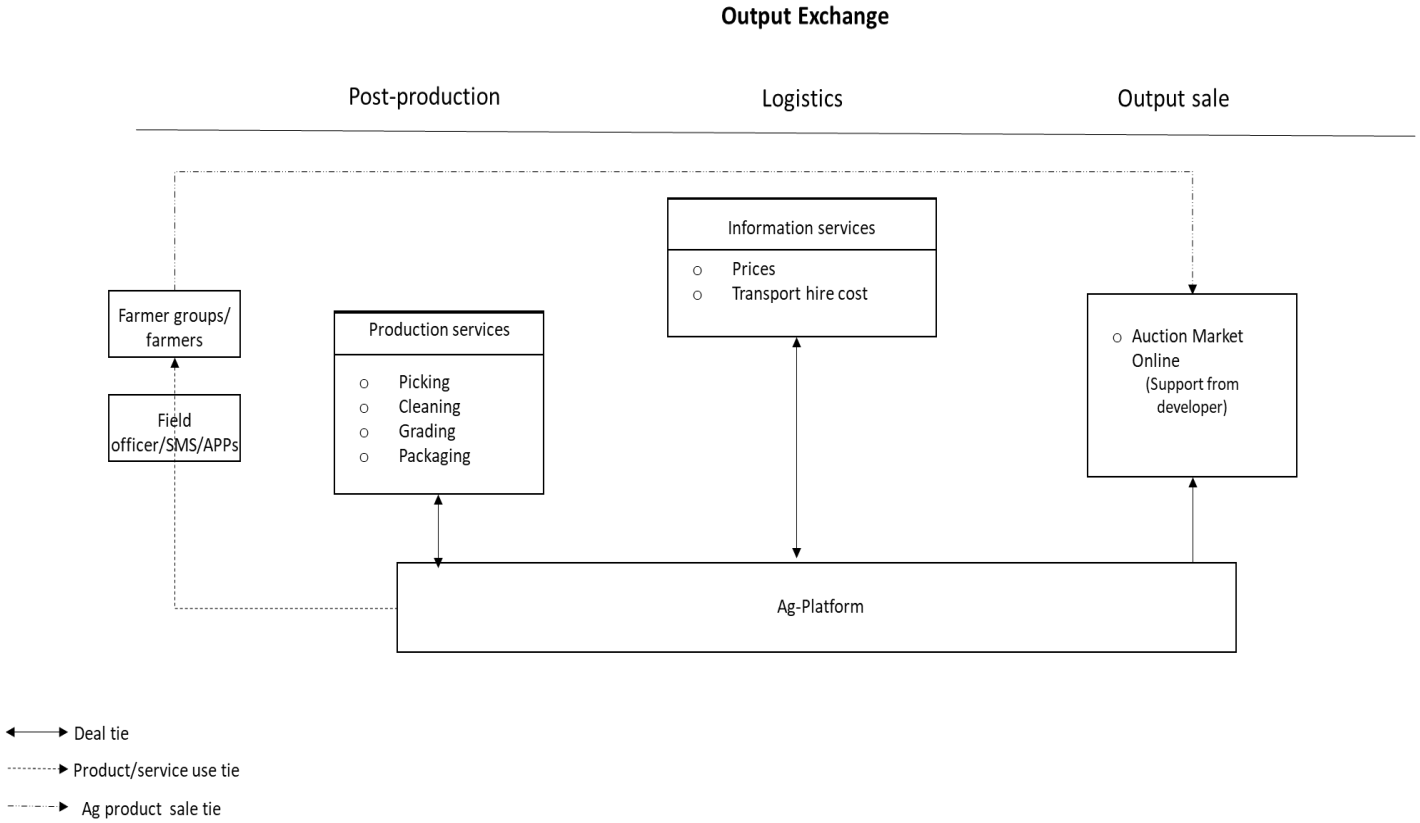
Type of scope				Node	Scale (by order of occurrence)
Backward exchange	Horizontal offers	Information services + complex services	Production and harvest services	Upstream (pre-production, production, post-production)	Local, south–south, regional

Source: Authors' construction

3.3.2 Output exchange model

This model includes three scopes: forward exchange, post-harvest and information services. This is an auction-based model, wherein farmers are provided information on crop prices and logistic prices to transport products, as well as post-harvest services such as grading and packaging. This occurs primarily midstream or downstream in the value chain depending on whether the product is final or intermediate. The Ag-platform firm makes deals with production service providers (e.g. labour firms supplying pickers and cleaners; grading agents; packaging companies) or hires its own team to provide production services. Through its platform with support from developers (either in-house or outsourced), it provides a virtual auction system wherein product details are provided, and buyers bid on these. The Ag-platform firm usually creates several collection points where the produce is stored according to the grades (best to worst quality). The logistics of collection of the product are beyond the remit of this model and are left to the buyer. Figure 7 provides a simplistic illustration of the model.

Figure 7: Output exchange model



Type of scope			Node	Scale (by order of occurrence)
Forward exchange	Horizontal offers	Information services	Downstream, Midstream	Local

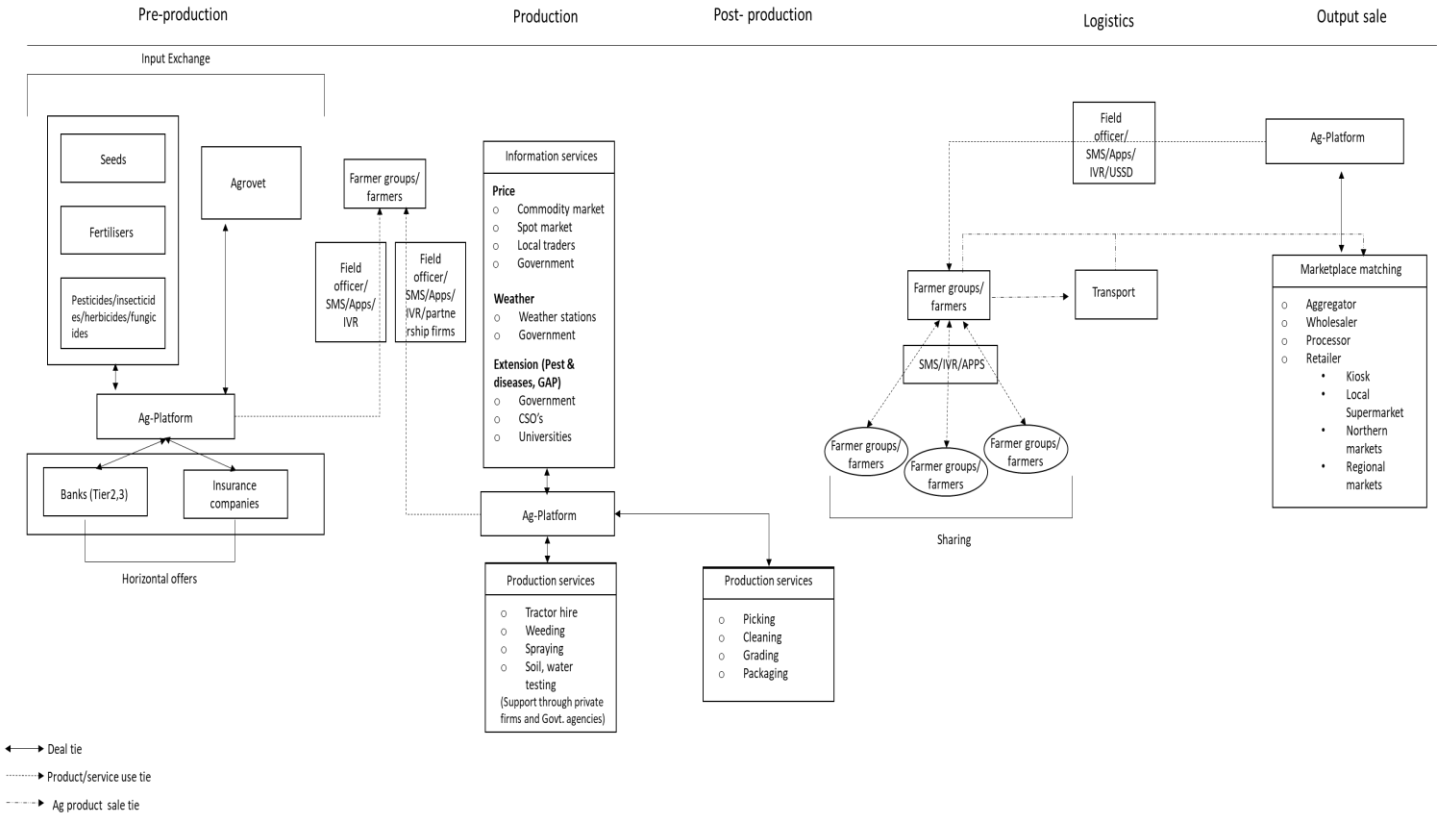
Source: Authors' construction

3.3.3 Trading and sharing model

This model consists of five scopes: marketplace matching, horizontal offers, information services, complex information services, production and harvest services, and sharing and knowledge exchange. This model covers the full value chain, as it includes services from the pre-production stage to output sale. Figure 8 shows that trading and sharing is effectively a combination of production and exchange and output exchange, with two differences. The first is that Ag-platform firms provide a marketplace matching service, which does not have an auction structure but rather advertises the farmer produce on its own accord and gains buyers who also subscribe to the platform. By doing so, the app automatically matches a farmer to a buyer on the platform once all the key descriptors of the product in terms of the quantity, quality and time of requirement is inputted into the system. The sharing aspect of this model allows for intra-app chats between farmers who have subscribed to the app through IVR, SMS or in-app chats.

Ag-platform firms make deals with a range of actors on a commission basis, from input suppliers, to banks and insurance providers, to weather data providers, to universities, to transport providers. This is expected to reduce bottlenecks for farmers considerably and increase transparency of the prices of services. However, monopolistic conditions may arise if there is a compulsion to use only Ag-platform firm-validated services, which can reproduce issues around unfair pricing and increase transaction costs.

Figure 8: Trading and sharing model



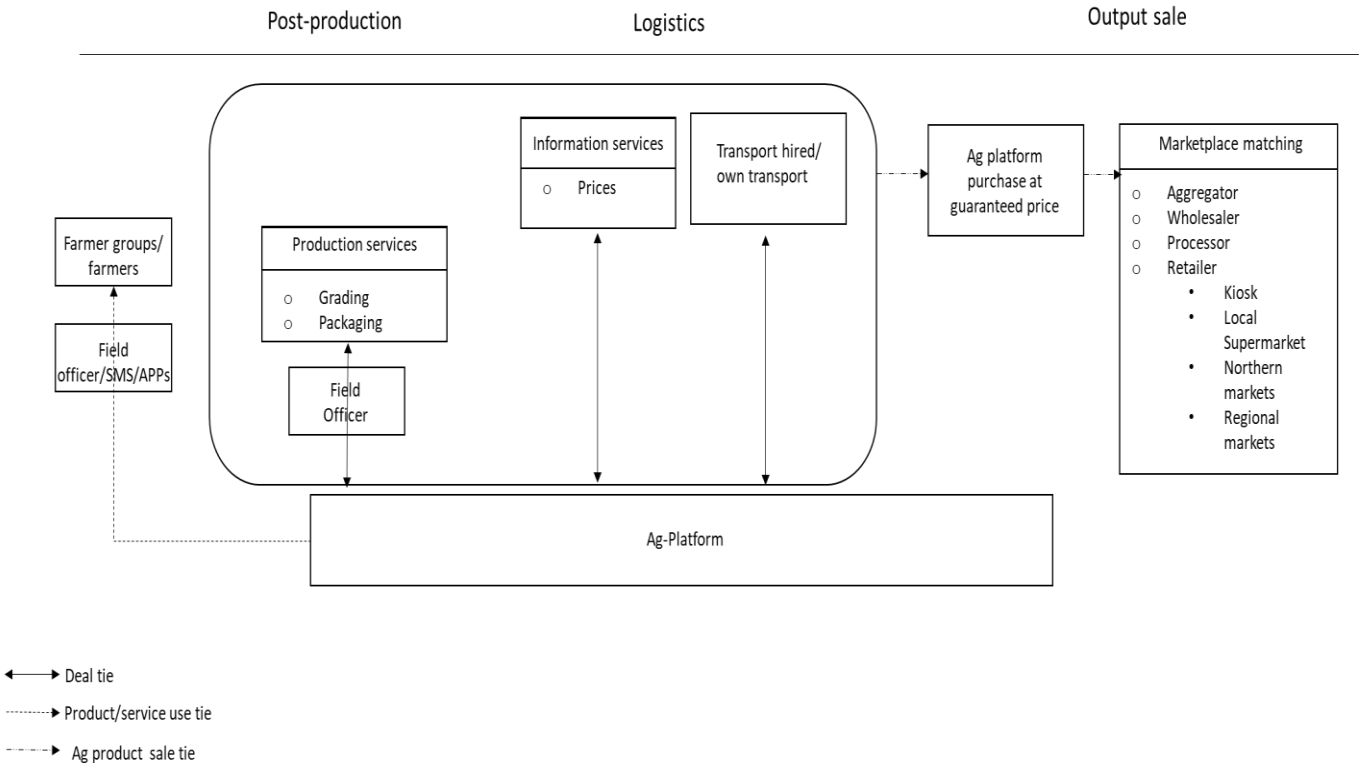
Type of scope				Node	Scale (by order of occurrence)
Marketplace matching	Horizontal offers	Information services, production and harvest services, complex information services	Sharing and exchange of knowledge	Upstream, Midstream and Downstream	Global, local, south–south, regional

Source: Authors' construction

3.3.4 Guarantee purchase and logistics model

This model (Figure 9) consists of two scopes: guaranteed purchase and prices and information services. In this case, Ag-platform firms act as intermediaries and buyers, by taking the onus of loss onto themselves. They provide farmers with contracts, along with a guarantee of purchase at specific market-defined prices. They also act as farmers' guarantors in case farmers require working capital loans for the purposes of production. Simultaneously, Ag-platform firms seek to make deals with processors, and retailers across local, regional, southern and northern end markets, to whom they further sell the produce. Ag-platform firms aggregate farmers' produce and after payment settlement, and spend own funds on the transport and warehousing of the product before they make the final sale. Platform firms frequently make deals with logistic providers and warehousing authorities to store produce prior to sale. This effectively provides farmers with considerable certainty of sale.

Figure 9: Guaranteed purchase and logistics



Type of scope		Node	Scale (by order of occurrence)
Guaranteed purchase and prices	Information services	Midstream, Downstream	Local, regional

Source: Authors' construction

3.3.5 Single buyer-led model

This model is a completely vertically integrated value chain, wherein the main off-taker, be it a processor or a retailer, directly controls the entire value chain and there is already a predetermined market (i.e. prior contract with final buyers already exists). The owner of the platform is usually a lead firm, which makes deals with several other actors, such as developers, banks and extension officers, to support production of a commodity that fits the code of conduct of the lead firm. This cuts out most intermediaries, as employees of the lead firm manage and monitor the performance of contracted farmers who are registered with the app. This isa vertically integrated model that facilitates export to the north, as specialised information can be shared with farmers in relation to production processes that fulfil international traceability requirements. The lead firm provides much of the asset-specific investment in terms of smartphones and ICT towers.

It is important to note that these are the most common models that exist, and they may vary depending on the app, the context in which they are diffused and the uptake. These models are summarised in Table 4.

Table 4: Summary of models of Ag-platforms

Model	Type of scope				Node	Scale (by order of occurrence)
Production exchange	Backward exchange	Horizontal offers	Information services + complex services	Production and harvest services	Upstream (pre-production, production, post-production)	Local, S–S, regional
Output exchange	Forward exchange	Horizontal offers	Information services		Downstream, Midstream	Local
Trading and sharing	Marketplace matching	Horizontal offers	Information services, production and harvest services, complex information services	Sharing and exchange of knowledge	Upstream, Midstream and Downstream	Global, local, S–S, regional
Guarantee purchase and logistics	Guaranteed purchase and prices	Information services			Midstream and Downstream	Local, regional
Single buyer-integrated	All				Upstream, Midstream and Downstream	Global, S–S, regional

Source: Authors' construction

3.4 Ag-platform models and the 3Cs

The models of Ag-platforms do not exist in a vacuum: the 3Cs of Cost, Complexity and Capabilities, along with digital and regulatory readiness (enabling environment), are important factors driving their adoption and proliferation. In terms of costs, interviews with farmers and Ag-platform firms suggested that, in general, the trading and sharing model is the most expensive, as costs mount up in relation to in-app services, costs of maintaining the Ag-platform, data plans and premiums paid for insurance/credit products, while the costs for output exchange models are generally low, as logistic costs are borne by the farmers, and the main costs relate to SMS/voice message costs for matching services. The costs for guaranteed purchase and logistics vary between high and medium depending on the level of risk an Ag-

platform is willing to take to guarantee the products for the farmers. The production exchange model as well as the single buyer model vary between medium and low depending on the amount of subsidy that farmers receive from the donors, the costs to maintain the app (developers, marketing) and the deals/commissions that input suppliers and buyers on the platform are willing to shell out to the platform to participate. This is shown in Table 5. In this case, high, medium and low are heuristic categories measured relative to each other. This means that costs in trading and sharing are usually expected to be higher than those in output exchange.

Table 5: The 3Cs and Ag-platform models

Model	Cost of product	Complexity of product	Capabilities of users
Production exchange	Medium/low	High/medium	High
Output exchange	Low	Medium/low	Medium
Trading and sharing	High	High/medium	High
Guarantee purchase and logistics	High/medium	High/medium	Medium/low
Single buyer-integrated	Medium/low	High/medium	Medium/low

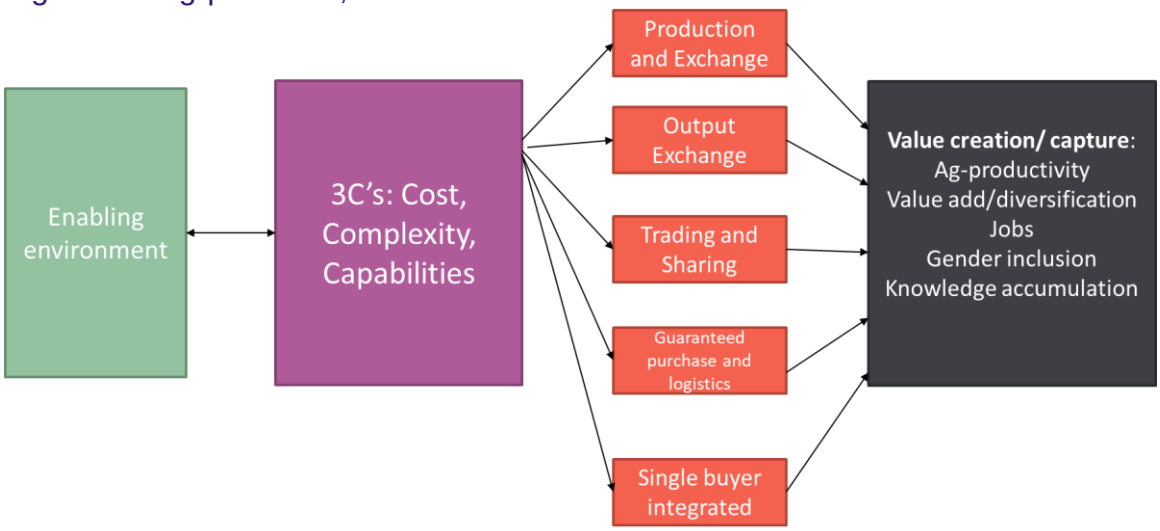
Source: Authors' construction (data collected from interviews)

In terms of complexity of use, most of the apps and AI-related functions were seen as the most complicated; thus, variants of production exchange, trading and sharing, guarantee purchase, and logistics and single buyer were all seen as relatively complex. Directly related to the complexity of the product are the capabilities of users – that is, farmers – in terms of the ICT skills required (e.g. use of internet, innate ability to understand how best to utilise information, ability to use new features, ability to internalise new information efficiently) along with soft/management skills to run a farm (e.g. managing labour and leadership skills, managing relationships with neighbouring farmers). According to interviews, trading and sharing and production exchange require the most knowledge, given the large number of in-app services available, whereas single buyer and guaranteed purchase require fewer capabilities as there is significant support from extension officers. However, without this support, these apps would be almost impossible to run. Therefore, in general it appears that, given the 'scope' of the Ag-platforms in terms of horizontal and information services, backward linkages, etc. provided, all business models (except output exchange) have a high–medium level of complexity in the product. However, the capability of farmers to use the Ag-platform varies considerable: much of the production and exchange and the trading and sharing platforms requires higher capabilities, given their larger 'scope' compared with Ag-platform business models.

In the next section, we attempt to provide examples with regard to each of these from case studies in Uganda and Rwanda.

In sum, we suggest a need to view models of Ag-platforms holistically as depending on the enabling environment and the 3Cs, as well as creating possibilities of value creation and capture, as Figure 10 shows.

Figure 10: Ag-platforms, the 3Cs and value creation



Source: Authors' construction

4. AG-PLATFORM MODELS IN EAST AFRICA: EVIDENCE FROM UGANDA AND RWANDA

This section aims to delve deeper into specific case studies in East Africa and to elicit the main types of Ag-platform models that exist, the 3C challenges that affect adoption/uptake and the potential benefits.

4.1 Ag-platform models in Uganda

Agriculture accounts for 70% of employment in Uganda. This is a critical sector for exports, as approximately 40% of all the country's exports in 2018 were primary Ag-products (ITC, 2019). National agricultural output has grown at only 2% per annum over the past five years, however, compared with agricultural output growth of 3–5% in other EAC members and 3.3% per annum growth in Uganda's population over the same period (World Bank, 2018). Agriculture is considered a leading sector for future economic growth and economic inclusion in Uganda's National Development Plan (NDP). However, despite having conducive natural resource and climate conditions for production of a wide variety of crops and livestock, average TFP growth in Ugandan agriculture has been negative for the past two decades (FAO, 2018).

Uganda's Vision 2040, the NDP II and the new Agriculture Sector Strategic Investment Plan prioritise agriculture as a conduit to economic transformation so that Uganda can graduate into a middle-income status by 2040. Advances are intended through strategic government investments in agriculture that (i) increase on-farm productivity to at least 50% of the yields at research stations; (ii) transform subsistence farmers into enterprise farmers, and smallholder farmers into commercial farmers; (iii) increase food security and food availability in all parts of the country; (iv) increase agriculture exports; and (v) increase efficiency and effectiveness of agricultural services such as research, extension and regulatory bodies.

While there have been strides in the stocks of food and increase in infrastructure spending for agriculture, underlying issues, persist such as the rapidly increasing population and youth unemployment (Evers et al., 2014). Increasing rural population density with continued land and water degradation in the absence of adequate on-farm investments and low quality of agricultural inputs has been exacerbated by low levels of adaptive capacity of communities (World Bank, 2019).

4.1.1 Types of Ag-platforms operating in Uganda: identifying the business models

We interviewed a total of 825 farmers by survey, as well as 6 government officials, 14 Ag-platforms, 5 cooperatives, 4 buyers, 3 brokers, 6 donors, 5 input suppliers, 3 co-working space managers and 1 mobile operator, to gauge a landscape of the types of models prevalent in Uganda (see Appendix A), as well as the key opportunities and challenges facing Ag-platform firms, farmers and women.

The proliferation of Ag-platforms in Uganda has been home-grown: several local entrepreneurs have developed and run successful Ag-platforms. Using the models developed in Section 3 of this report, we identify the key types of Ag-platforms active in Uganda. The data were collected in Uganda in July 2019. The Ag-platform firms were selected through snowball sampling, and cross-validated using lists procured from sub-national government officers and area officers. From the apps interviewed, 50% of the apps are production and exchange-related, followed by 20% trading and sharing and one each for output exchange and single buyer-led. None of the apps (or others known to government/other app developers) provide guaranteed logistics and purchase

Table 6 provides a short summary of the apps, with key information on ownership, farmers registered, types of crops and partners involved. It shows that.

Table 6: Ag-platform model app examples in Uganda

Name of app	**E-Voucher**	**Viral Cassava**	**M-Omulimisa**	**Kudu**	**EzyAgric**	**KOPGT**
Model of Ag-platform	Production and exchange	Production and exchange*	Production and exchange	Output exchange	Trading and sharing	Single buyer-led
Ownership of app	Ugandan: government	Ugandan/ German: Makerere	Ugandan: MSE	Ugandan: MSE	Ugandan: MSE	Bidco: Kenyan MNC
First year of operation	2017	2017	2017	2015	2014	2014
No. of farmers registered	880,000 (expected 450,000)	1,000	13,314	3,067	60,000	1,810
Females (%) registered	30	30	35		40	37
Active users (% of registered)	54	21	45	65	55	60**
Amount spent on app (per month)	Ush 1,000	Ush 0 (subsidised)	Ush 1,200	Ush 0 (subsidised)	Ush 1,600–2,800	Ush 400
Key crops	Coffee, rice, beans, cassava, maize	Cassava	Maize, soybean, sunflower, sorghum	Maize, beans, sorghum, rice, soya	Cereals, cassava, bean	Palm oil
No. of districts served	5 (expected 42)		51	20	40	4
Key partners and funders	NARO, NAADS, Ministry of ICT, Ministry of Science, Technology and Innovation, World Bank	Makerere University, Pulse Lab Uganda, University of Groningen and University of Cambridge, Bill & Melinda Gates foundation	Vision Fund, Opportunity Bank, USAID, Michigan State University	AI and Data Science Makerere, University of British Columbia, University of Chicago, Microsoft Research	USAID: Next Billion, WEF, WFP, ICT Works, Seep	SAP, IFAD, MAAIF, GLTN

Notes: * This includes complex AI services.

** Issues of land grabbing in the area have surfaced (https://www.theguardian.com/global-development/2015/mar/03/ugandan-farmers-take-on-palm-oil-giants-over-land-grab-claims)

Source: Fieldwork interviews 2019, https://m-omulimisa.com/

E-Voucher is a production and exchange model as it allows for backward exchange through B2B purchases of inputs, information services of good practices, weather and prices; and mobile money subsidies through the government. This is a government-run USSD[6] app, housed within the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)'s ICT Division and implemented with help from field agents who work for the National Agricultural Research Organisation (NARO) and the National Agricultural Advisory Services (NAADS). The app was launched as part of the Agriculture Cluster Development Project, which is a six-year partnership with the World Bank, whose key components are Support for Intensification of On-Farm Production; Value Addition and Market Access; Policy, Regulatory and Institutional Support; and Coordination, Management and ICT Platforms.[7]

The app works as a 'subsidy scheme', with farmers given three rounds of input subsidy for every season. In the first round they are given a subsidy of 66% for the inputs, which include seeds and agro-chemicals; the remaining 33% needs to be put forward by the farmer. In the second season, the farmer is given a 50% input subsidy, and this is reduced to 33% by the third season. The expectation is that a cost-sharing model will spread the risks of poor output. The system uses a mobile money payment system to provide credit to the farmer, and information services via SMS. The inputs can be purchased only from government-validated agro-vet dealers, to ensure the quality of the product. Farmers with over 1 acre of land qualify, thus most marginal or small farmers are further marginalised. The app works through cooperative groups, and identified champions who can be trained and further train other farmers in their group.

Viral Cassava android app is also a production and exchange model (which includes complex AI service offerings), which works on automated mobile survey technology and spatial modelling. The primary aim is to detect viral cassava diseases. The smartphone survey system is largely built on ODK Collect and Google App Engine, with significant customised coding for automated diagnosis and mapping. Fieldworkers or extension workers, who are trained in using the app, can capture images and immediately upload them, which in turn is put into AI machine learning techniques to develop a visual diagnosis, which is sent back to the fieldworker to disseminate to farmers. However, farmers are also incentivised to upload photos using a smartphone, and they can receive designated SMS feedback. This app has around 92% accuracy with whitefly counts, Brown Streak Virus and Mosaic Virus in cassava plants.

The AI lab at Makerere performs many of the analytics and carries out maintenance of the app. The larger the dataset received, the easier it is to train the app to perform better. However, several issues were raised during the pilot, such as farmers finding it difficult to understand how to use smartphones (penetration of smartphones in Uganda is less than 8%). Furthermore, the legitimacy of the app was questioned: it is a post-disease counting app rather than a pre-disease mitigating app, which means the AI is trained to count only after the whitefly has attacked the plant and it cannot provide proactive solutions to prevent the attack.

M-Omulimisa is a product and exchange model (without AI)*, which* operates an ICT-powered Village Agent Model that uses a network of village agents to provide a bundle of agriculture-related services, including agriculture insurance; input demand aggregation and distribution; mobile-based extension; soil testing; and micro loans. The network of over 40 village agents works with over 300 farmer groups with a combined membership of over 9,000 members spread across 9 districts in Lango and Acholi sub-regions. The model offers incentives to all actors in the agriculture sector to remain in business: demand is created for input suppliers; farmers are willing to invest in improved technologies since they have access to affordable credit; microfinance institutions have access to a wide market of well-organised farmer groups that present a low risk owing to agriculture insurance; and, thanks to increased demand for agricultural products, village agents earn more commission. Farmers can use their phones to ask questions in languages that they understand and receive understandable feedback from extension

[6] USSD (Unstructured Supplementary Service Data) is a Global System for Mobile communication technology that is used to send texts between mobile phones and an application program in the network. Applications may include prepaid roaming or mobile chatting.

[7] https://agriculture.go.ug/launch-of-the-e-voucher-system-of-the-agriculture-cluster-development-project/

officers in the region via SMS. Inputs are distributed at least 20% cheaper than in input shops in farming communities. The platform earns a commission from supplying these inputs, which is shared with their network agents.

In terms of horizontal offers, M-Omulimisa has partnered with the Agriculture Insurance Consortium (AIC) – to provide highly subsidised agriculture insurance through the field network of agents who work for M-Omulimisa. The service is commission-based, so the more insurance policies the agents sell, the more money they make. The commission helps agents meet their operational costs and provides an incentive for enhancing the service. The service is mobile-based and integrates both USSD for service access and mobile money for premium payments. In partnership with microfinance institutions –Vision Fund and Opportunity Bank – the network of village agents of the platform mobilises farmers into groups and helps them become creditworthy through training in group savings and credit as well as financial literacy. After this, loans are disbursed, with M-Omulimisa acting partly as a guarantor.

Kudu is a USSD and android app that follows an output exchange model (auction system and information services). The main aim is to create a double auction market wherein buyers and sellers separately communicate their preferences and the system matches them up through a customised clearing algorithm designed to be resilient to common forms of market manipulation. When there is a match, each party receives an SMS with the details.[8] The key information provided relates to product weight, price and condition of the crop. There is no mechanism to suss out quality or grading of products, therefore the risk is skewed towards buyers of the product. The SMS interface is provided in four languages –English, Luganda, Acholi and Swahili. Kudu does not employ intermediaries or provide logistic support.

EzyAgric is a trading and sharing android app that offers a range of services: farmer digital profiling; extension; information and complex information services; matching buyers and farmers; and horizontal facilities such as credit vouchers to buy input and services as well as crop insurance. EzyAgric has over 60,000 registered farmers and has created over 480 jobs for youth supporting agriculture and ICT development. The app has considerable appeal for both rural populations and urban and peri-urban agriculture. One of the most popular features is the GPS land mapping system, and access to cheap bundles of inputs and agro-equipment such as irrigation kits and sprayers from a range of input suppliers.

The platform helps farmers manage their finances through a mobile wallet system and provides working capital loans by tying up with tier 2 and 3 banks, where they can purchase bundles of inputs. They work with various agronomists at Makerere, and UN Pulse Lab develops appropriate information packages to share with farmers. Sellers can list their needs in the app's marketplace and, with the help of youth champions hired, farmer transactions are cleaned and listed on the app as well, to increase the attractiveness of supply. Most of EzyAgric's income is amassed through in-app payments by farmers, from commissions from input suppliers and by sharing farmer profiling services with banks and insurance firms. Thus it is in the B2B realm, rather than the business-to-consumer (B2C) realm. The costs of performing downstream activities of marking and advertisement are expensive and reduce overall profit margins. The app uses Google Cloud to store and Analytics for advanced AI solutions on pest and disease damage.

KOPGT is an android-based app that is a single buyer-led model. Over 2,000 farmers are part of a vertically integrated chain selling palm oil to Bidco (a Kenyan conglomerate). Working through the Kalangala Oil Palm Growers Trust, the second Vegetable Oil Development Project (VODP) of MAAIF engaged SAP Rural Sourcing Management software. This digitally records information on producers, farms and communities at every level of the value chain. This provides visibility and allows parties to easily and quickly communicate. The solution is cloud-based, which delivers real cost savings in terms of improved management of finances, according to 50% of farmers interviewed. However, it is highly subsidised, with SAP providing an array of maintenance service.

[8] https://kudu.ug/about/

This is part of VODP and VODP2 in Kalangala, which started in 1998 and 2014, respectively. VODP2 has supported 1,810 smallholder farmers, 652 of them female (37%), to plant 4,424 hectares of oil palm. The government has leased 6,500 hectares to Bidco Uganda Limited for establishment of a nucleus estate, of which 6,440 hectares have been planted with oil palm. The project is being implemented in partnership with the Global Land Tool Network (GLTN) of UN-Habitat: a coalition of 50 international partners focusing on tenure security improvement and development of pro-poor land tools. The database, designed by GLTN, produces reports on each of the key reporting areas from the project, including details on the smallholder farmer, the location of each garden and the farmer's home, tenure information on farmers' gardens and home, the area reserved for food crops, household characteristics, priority farm inputs required by farmers and impact of the VODP according to the oil palm farmer.

In sum, there are several overlaps across the different models of Ag-platforms. The first is that most of them work through farmer groups or cooperatives and frequently hire youth champions, who act as agents. They can either be self-employed and earn commissions, or work as hired employees. At the outset, there seems to be a clear issue with the uptake of Ag-platforms; in general, except in one case, less than 60% of farmers used the services offered to them. This could possibly be because of a significant focus on production and exchange models, rather than models that focus more downstream or midstream, like trading and sharing. The lack of marketplace matching and guarantees seem to have reduced overall trust in the system.

4.1.2 Ugandan Ag-platforms, 3Cs and value capture opportunities

The 3Cs discussed in the above sections highlight key reasons why the adoption of Ag-platforms is limited to a few local products within Uganda. Table 7 gives details of how the 3Cs have affected the adoption rate of Ag-platforms. Overall, the results suggest that adoption rates have increased most in production and exchange models (M-Omulimisa and E-Voucher), because of relatively low costs and the limited nature of the complexity and capabilities required. Much of the change in trading and sharing models (EzyAgric) are due to significant support from donors, hands-on approach of the Ag-platform staff and significant growth of the app in urban and peri-urban farming, led to the high rate of adoption despite the higher costs and capabilities associated. Finally, for the single buyer-led model (KPOGT), the process of qualification was more cumbersome, as it specifically targeted palm oil growers living with specific spatial boundaries, thus it a much more captive form of value chain, with all the production going into a single lead firm (Bidco's) processing plant.

Interviews elicited the key value capture and creation trajectories of each of the Ag-platforms selected in the study. Table 8 shows whether Ag-platforms and farmers interviews mentioned whether there was an increase/decrease or no change in various value capture opportunities. Increase is defined as a situation where a farmer has experienced a significant improvement since using the app; a decrease is defined as a situation where the farmer considers himself/herself worse-off since using the app; and no change is a situation where the farmer has not experienced any change since using the platform. The data collected here represent a combination of perceptive data and the aggregate figures provided by Ag-platform firms.

It is important to note that the sample size is small, with data collected from Ag-platform firms that have some of the largest numbers of farmers registered and those that have been running for at least two years. The results thus need to be studied with caution. Paper 5 in this series, 'Ag-Platforms as disruptors in Ugandan value chains', through a large-scale quantitative survey of 825 farmers, makes looks at whether there has been a true improvement in value creation and capture opportunities.

Overall, the results suggest that trading and sharing platforms have shown the most improvement in terms of productivity, value addition/diversification, number of jobs created and gender inclusion, followed by production and exchange, single buyer-led and output exchange. Productivity appears to have increased for almost all Ag-platform models, in terms of increase in crop yields as well as improvements in farm management practices and labour productivity. Value addition/diversification appears to have improved across trading and sharing and production and exchange Ag-platform models, where farmers have been seen to upgrade by diversifying to new products.

Table 7: 3C's and Ag-platforms in Uganda

Model of Ag-platform	Name of Ag-platform	Cost	Complexity	Capabilities	Adoption rate in 2019 (YOY change %)
Production exchange	E-Voucher	Low/medium: government provides a subsidy in the first season, followed by risk-sharing as season proceed	Low: SMS-driven	Low: need to register on the service, but only farmers with over 1 acre of land allowed to participate	20% (from a base rate of 65,000 in 2018)
Production exchange (with AI)	Viral Cassava android app	High: needs to have smartphones, which are not commonly available. Previously was subsidised with donor funding, which is no longer available	High/medium: needs to be conversant at using smartphones and also use satellite services to upload data	High: requires ICT skills and information processing skills to make decisions on practices to use after counts are informed	2.5% (from a base of 1,500 in 2018) This was primarily because of high costs of hardware required for the app and the low donor funds available
Production exchange	M-Omulimisa	Medium/low: primarily USSD-driven, but also has a mobile app. Farmers pay for bundle of in-app services from product information to insurance	Medium/low: depending on the use through USSD or mobile app, the complexity varies.	High/medium: requires ICT skills to use satellite imagery data and mapping tools; needs management and basic literacy to select from set of bundled options	30% (from a base of 60,000)
Output exchange	Kudu	Low: SMS-based platform that worked with minimal fee to register and use	Low: SMS-based information provided, and USSD option offered	Low: only a matching platform so basic mobile phone skills required (e.g. using SMS, phone calls, voice messages)	No longer functioning, owing to end of project
Trading and sharing	EzyAgric	High: needs to have smartphones, which are not commonly available	Medium/low: depending on the use through USSD or mobile app, the complexity varies	High/medium: requires ICT skills to use satellite imagery data and mapping tools; needs management and basic literacy to select from set options	24% (from a base of 120,000)

Model of Ag-platform	Name of Ag-platform	Cost	Complexity	Capabilities	Adoption rate in 2019 (YOY change %)
Single buyer-integrated	KOPGT	Low: smartphones are required but lead firm and IFAD (donor) contribution significantly reduces the pressure to purchase any assets	High: the complexity of the decision-making product is high but support from SAP significantly reduces pressure on farmers	High/medium: relatively high ICT skills required to use decision-making app, but support from SAP significantly reduces pressure on farmers	18% (from a base of 30,000)

Source: Authors' construction from interview data

Table 8: Ag-platform models and value creation opportunities in Uganda

Model of Ag-platform	Name of Ag-platform	Productivity	Value addition/ diversification	Number of jobs	Formalisation of jobs	Gender inclusion
Production exchange	E-Voucher	Marginal increase in crop yield and more efficient use of natural resources	No change	No change	Increased formalisation: more written contracts provided and bank accounts opened (better access to credit)	No change
Production exchange (with AI)	Viral Cassava android app	Increase in crop yields owing to early detection of pests	No change	No change	No change	Increase
Production exchange	M-Omulimisa	Increase in yields and	Increase, new products	Marginal Increase	Increase	Marginal increase
Output exchange	Kudu	No change	Increase, new products	No change	No change	No change
Trading and sharing	EzyAgric	Increase	Increase, to new products	Increase	Increase, in those registered on government rosters, new bank accounts and credit facilities	Marginal increase
Single buyer-integrated	KOPGT	Increase	No change	Marginal increase	Marginal increase	No change

Source: Authors' construction from interview data

An important feature is the low number of jobs created, in all cases but EzyAgric (trading and sharing model). This latter Ag-platform has been able to tap into a new customer base of urban and peri-urban professionals who also farm as a side-business. They are located in and around Kampala and address a growing demand for urban agriculture. Additionally, it is important to note that most of the new jobs are taken up by youth, who are now interested in returning to farming. While there have been relatively minor changes in the number of jobs, in almost all cases there has been some level of change in the formalisation of jobs, with a large number of new bank accounts opened and written contracts provided to farmers for products, which in turn have provided farmers with better credit/loan facilities for working capital. However, formalisation increase occurs within only a narrow set of parameters, rather including reduced work precariousness, dignity at work, better working conditions and working hours, etc.[9]

There is a clear trend of low female participation/gender inclusion in Ag-platforms, through lack of mobile phones (e.g. the male member in the family owns and uses the mobile phone). However, in the case of Viral Cassava, more females were using their partner's phones to diligently upload photos.

[9] Paper 5 in this disruptive AgriTech series on Ag-platforms and value creation in Uganda provides further details on formalisation.

4.2 Ag-platform models operating in Rwanda

Rwanda has many examples of agricultural technology – especially Ag-platforms – aimed at connecting smallholder farmers to markets or sharing know-how with them. This owes in part to the structure of Rwanda's agriculture sector, which is characterised by many millions of smallholder farmers with plots that are often less than a hectare in size. As part of the post-genocide peace and reconciliation process, the Land Tenure Reform Programme, completed in 2018, cemented the individualisation of land rights by demarcating 11.4 million parcels and issuing over 8 million titles. While there is already evidence of increased land transactions and land aggregation that will continue in the coming years, Rwanda's agriculture sector will remain dominated by smallholders for some time to come. This also means that Ag-platforms will have an important potential role to play as the country seeks to become a net exporter of agricultural products. Nonetheless, challenges remain. All but a few existing platforms have 'taken off', and the digital technology industry is marred by difficulties related to a lack of capacity (on the side of developers and that of users), as well as limited mobile phone coverage in rural areas and high fees for software licences.

A total of 12 interviews were conducted among 15 participants in country, with two follow-up interviews over telephone. Interviews were semi-structured and based on a survey of 10 essential questions. Despite a background list of almost 30 different apps in Rwanda, the non-response rate was very high. Many of these initiatives – including applications such as AgriGo, ehaho, YEAN, Zirakamwa, MCC, Aruduino and Inyungu – have not been sustainable and have effectively suspended operations for the time being owing to lack of funding, capacity and a sustainable business model. The only applications that remain in operation are donor- or government-funded. Almost all of these remaining apps are categorised either as production and exchange or as trading and sharing. Unlike Uganda, which is dominated primarily by donors, Rwanda has many more government-supported apps and projects, run by the Ministry of Agriculture (MINAGRI) and the Ministry of Commerce (MINICOM).

The major projects are funded by Access to Finance Rwanda (AFR), an initiative aimed at removing barriers to finance with support from various donors, including the UK Department for International Development, the Swedish International Development Cooperation Agency (Sida), the US Agency for International Development (USAID), the MasterCard Foundation and the German Development Bank (KfW). All three of these projects have involved three-year pilots, which are either finished (TechnoServe Coffee Digitalisation) or are in their final stages.

The Rwandan government has run several Ag-Platform initiatives across different departments, including the Ministry of Finance (MINFIN), MINAGRI and MINICOM. While MINAGRI has spearheaded most digitalisation efforts in the Rwandan government, MINICOM's commodity-specific Ag-platforms for Irish potato, maize, rice, milk/dairy and cassava are the most developed. MINFIN has ambitions to develop Ag-platforms as well.

There are several independent initiatives, many of which have struggled with financial sustainability and have either hibernated or wound down operations altogether. An exception is the OneAcre Fund (1AF), which has continuously expanded its operations in Rwanda and other sub-Saharan African countries in a financially sustainable way.

There is limited evaluation and monitoring data of these initiatives, although some work in this regard is in the process of being completed. Interviews yielded some anecdotal evidence, as presented in Table 9, which identifies six apps in Rwanda that have been gaining importance over the past two years.

Table 9: Ag-platform model app examples in Rwanda

Name of app/project	**SPARK IPoVaF**	**Heifer International**	**TechnoServe SMS Bookkeeping Credit Monitoring System**	**MINAGRI MIS**	**1AF**	**SWC (formerly SFR)**
Model of Ag-platform	Trading and sharing	Trading and sharing	Production and exchange	Trading and sharing	Production and exchange	Production and exchange
Ownership of app	Dutch NGO	US NGO	US NGO	Rwandan government	US NGO	Rwandan
First year of operation	2017	2017	2012	2016	2013	2014
No. farmers registered	7,000	17,000	32,923 (2015)	600	No information	8,000
Females (%) registered	Forthcoming	Forthcoming	42% (2015)	No information	No information	No information
Active users (% of registered)	Forthcoming	Forthcoming	Forthcoming	No information	No information	No information
Amount spent on app (per month)	Rwf 0	Rwf 0	Rwf 0	Rwf 0	Rwf 0	Rwf 10/SMS
Key crops	Irish Potato	Dairy	Coffee	Cassava, dairy, Irish potato, maize, rice	Inputs (all commodities)	Weather information (Irish potato)
No. of districts served	4 (Burera, Musanze, Nyabihu, Rubavu)			Country-wide	Country-wide	Northern province (Musanze)

Name of app/project	**SPARK IPoVaF**	**Heifer International**	**TechnoServe SMS Bookkeeping Credit Monitoring System**	**MINAGRI MIS**	**1AF**	**SWC (formerly SFR)**
Key partners and funders	AFR, Rwandan government, USAID, UKAid, Mastercard Foundation, Sida, Netherlands government	AFR, Rwandan government, USAID, UKAid, Mastercard Foundation, Sida	AFR, Rwandan government, USAID, UKAid, Mastercard Foundation, Sida, TechnoServe	Government	Independent	Independent

Source: Authors' construction from interview data

IPoVaF is a mobile platform developed by SPARK in cooperation with the AFR fund. It is aimed at bridging the gap between farmers and access to information and financial services. The platform has developed an integrated mobile technology, based on USSD messaging that does not require the use of a smartphone, or even access to internet data. It is specifically designed for the simple mobile phones that the majority of rural farmers use. The app does not charge any fees. The tool provides agricultural information about the Irish potato value chain as well as weather forecasts. Farmers can keep track of their harvest and sales records using a personalised dashboard. This information is used by financial institutions to predict harvests (and therefore collateral) and approve loans, which enables farmers to borrow money without having to step foot inside a bank. The platform also provides group chat facilities for farmers, cooperatives and other members of the supply chain.

The app is aimed at increasing transparency, group solidarity and cohesion. Access to information and finance ultimately aims to increase productivity among farmers. The initiative has primarily reached out to cooperatives and had achieved over 7,000 subscribers in 92 cooperatives by 2019.

Heifer is coming to the end of a three-year pilot project on digitising farmer financing, aimed at helping support supply chains and the market environment for dairy farmers. The pilot works with 20 cooperatives from all over the country, including up to 17,000 farmers. Similar to IPoVaF, the software captures farmers' transactions (e.g. production and sales records), which users can use to apply for advance payments from financial institutions. Heifer's activities build on previous experience in Rwanda, mainly around a Bill and Melinda Gates Foundation grant dating back to 2008 that aims to provide every farmer in the country with a milk cow.

Unlike in other projects, the technical and capacity requirements of the Heifer project are relatively high. Heifer provides smartphones, routers (for internet access) and training to rural farmers. The charity also works with a network of financial institutions and credit providers. While costs have been high as a result of an underestimation of the capacity of rural farmers, there have been noticeable impacts in terms of increased productivity, mainly through the availability of financial resources at times of need and the ability of farmers to purchase inputs (e.g. feed) for their cows. Five cooperatives have also taken up communal health care insurance using the additional income generated by increases in productivity, as well as diversifying production into other crops. There is further financing in place by MINAGRI to fund scale-up, initially among 10 additional cooperatives but aiming for more. An impact assessment is underway and will provide further details in due course.

TechnoServe SMS Bookkeeping Credit Monitoring System is an extension of TechnoServe's successful SMS Bookkeeping Platform, a credit monitoring system that was launched in 2014 under a previous project. This phase of the project aimed to scale up and improve finance flows within the coffee value chain. The project drew in various financial service providers in the region, including the Development Bank of Rwanda and Kenya Commercial Bank, and aimed to see at least Rwf 10 billion ($12.3 million) of total working capital monitored by the SMS Bookkeeping Credit Monitoring System within two years.

This project intended, among other outcomes, to improve working capital lending through the SMS Bookkeeping Platform, which provided key financial information to key stakeholders. The system allowed users to transmit financial and coffee-cherry stock information to a digital platform via text message, which banks and other lenders could monitor in real time. The increased transparency gave lenders more confidence to extend working capital. Between 2008 and 2015, the platform raised over $4.6 million in working capital among participating cooperatives. Furthering this project, according to the AFR report (2017), the SMS Bookkeeping System was combined with the online web portal coffeetransparency.com, allowing working capital lenders to mitigate their risks, with the new project running between 2017 and 2019. A major achievement of the project was the development of the Cashless Wet Mill Tool with support from private sector exporters: Dormans, Rwacof and Rwanda Trading Company; furthermore, new banks BPR, Bank of Kigali and Urwego Opportunity agreed to use the SMS system, which translated into an increased number of farmers availing of these services. Major successes were achieved by training coffee-washing station leaders in bookkeeping and reporting on their green sales data, which increased transparency. However, there were a few challenges along the

way; for instance, it was complicated to create partnerships with telecom providers and create well-functioning, easy-to-use Cashless Wet Mills, and the costs of monitoring were high and buy-in from banks was slow (as many continue to be risk-averse in lending).

MINAGRI's Agricultural Management Information System was established to support implementation of the Strategic Plan for the Transformation of Agriculture. It is a management tool that helps decision-makers monitor the sector's performance and improve transparency. The system is hosted by the National Data Centre and receives technical support from Agri-TAF; it is based on the DHIS2 open source platform, which is web-based but allows offline use. Data can be recorded by computer or through Android mobile phones or tablets. The system is fully operational and is used to monitor cassava, rice, dairy, Irish potato and maize supply chains. However, capacity constraints have meant that parts of the system have been left neglected for some time, although there is willingness to improve these and extend the system's functionality beyond monitoring purposes towards information-sharing (e.g. of minimum prices).

1AF primarily uses field officers to distribute inputs and solar lights to smallholder farmers, provide training and collect loan repayments. However, the NGO has successfully digitised loan repayments for farmers in a bid to boost transparency and efficiency, enabling farmers to easily make loan repayments via mobile money instead of cash. An SMS-based platform is used where possible to improve speed and efficiency of loan repayments. Farmers can make payment on their loans using the platform without having to visit the field officer. This increases participant satisfaction, through greater transparency and convenience. For 1AF, the technology improves reliability and reduces instances of repayment fraud, as well as the time spent on repayment. Overall, the time staff worked on collecting payments reduced by about a half when the technology was piloted in Kenya.

Severe Weather Consult (SWC) shares weather forecasts, including warnings of extreme weather (to which Rwanda is prone) to farmers and fishers. Information gathered from weather stations and the company's own lightning stations can be distributed by SMS, USSD and a smartphone application. The platform is aimed not just at farmers but also at banks and insurance companies wishing to reduce the risks of their loans or to validate insurance claims based on bad weather.

4.2.1 Rwandan Ag-platforms, 3Cs and value capture opportunities

Table 10 summarises how the 3Cs of the six Ag-platforms in Rwanda compare. Given the similarity of the different platforms, the results do not differ greatly across the board. Most platforms are essentially SMS- or USSD-based knowledge exchange systems that work either way, by providing farmers with information on weather, prices or know-how or providing app developers with information on farm-level transactions (in order to provide advance payments). The only initiative that has faced issues related to higher costs, complexities and capabilities is the Heifer International project, which involves smartphones. Given the nature of Rwanda's agriculture sector, which is heavily smallholder-based, and the deep poverty that persists in rural areas, the gap effort required to improve capacity among some farmers in order to use such technology is substantial (as the project staff themselves have acknowledged).

Table 10: 3C's and Ag-platforms in Rwanda

Name of Ag-platform	Models of Ag-platform	Cost	Complexity	Capabilities
IPoVaF	Trading and sharing	Low: basic USSD technology and no costs. Just requires a mobile device	Medium: some issues with foreign software developer and need to simplify steps in USSD step-by-step process	Low/medium: step-by-step process a challenge for some users, especially in rural areas. However, information-sharing service is very simple
Heifer International	Trading and sharing	High: requires smartphones, licensed software and network infrastructure (routers, etc.), provided by the charity at this stage but unlikely to be a sustainable solution	Medium: requires users to enter transactions and other information (e.g. yield calculations)	High: requires substantial training from a very low starting level on how to use smartphones, apply for credit, etc.
SMS Bookkeeping Credit Monitoring System	Production and exchange	Low: SMS-based, no cost for users	Low: simply requires farmers to enter transactions	Low: essentially a messaging app
MINAGRI MIS	Trading and sharing	Low: essentially a USSD-based messaging system for farmers	Low	Medium: primarily faces problems on MINAGRI side owing to lack of integration, finance. On farmer side, a straightforward information-sharing system for prices, subsidies, weather, trade opportunities, etc.
1AF	Production and exchange	Low: farmers can use SMS-/USSD-based service or contact field officer	Low: uses mobile payment technology that is widespread in sub-Saharan Africa	Low: requires basic mobile phone skills; if these are not present, farmer can fall back on field officer
SWC	Production and exchange	Low/medium: uses combination of USSD and SMS, but also smartphone app if needed	Medium: some issues understanding weather forecasts, especially in deeply rural areas	Low: essentially a messaging app

Source: Authors' construction from interview data

Impact evaluations for the three AFR-funded projects are still underway or have not yet been released. Table 11 presents some preliminary results based on interviews, as well as some information from the predecessor of TechnoServe's Coffee Digitalisation project. The impact of Rwanda's Ag-platforms has mainly taken the form of productivity increases. These have been achieved through knowledge-sharing and/or the provision of upfront finance. In the case of Heifer, providing credit at times when dairy farmers need to provide their cattle with good-quality feed has had enormous impacts on raw milk yields. Yield increases have also been reported for the IPoVaF and Coffee Digitalisation projects. SWC reported a significant reduction of fertiliser use, as farmers were able to more reliably predict weather associated with decreased fertiliser efficiency. The impact of Ag-platforms on jobs (both number and formalisation) as well as gender inclusion has been very limited in Rwanda.

Table 11: Ag-platform models and value creation opportunities in Rwanda

Model of Ag-platforms	Name of Ag-platform	Productivity	Value addition	Number of jobs	Formalisation of jobs	Gender inclusion
Trading and sharing	IPoVaF	Improved yields owing to credit uptake and information-sharing on best practice planting/harvesting techniques	Identifying markets for individual farmers, including volumes required and prices offered, that farmers can bid on	No change	No change	Women, with young people, particularly interested in new technology
Production and exchange	Heifer International	Increase in production linked to availability of feed at times of need owing to presence of finance	Improved living conditions, adoption of communal healthcare insurance (5/20 cooperatives)	Diversification has led to new jobs in feed and milk processing capacity (e.g. cheese, yoghurt, etc.)	These new jobs have been formalised	No change
Trading and sharing	SMS Bookkeeping Credit Monitoring System	62% coffee income increase (2015)	Raised $4,631,668 of working capital for cooperatives, as well as $203,580 of capex (2015)	No change	No change	38% of trained farmers were female (2015)
Trading and sharing	MINAGRI MIS	No change	Improved efficiency within government	No change	No change	No change
Production and exchange	1AF	On average, yield increases for farmers are 40–50%	Improves business processes – cheaper and less administrative for 1AF. Also reduces fraud. For farmer, commercialisation can lead to life away from subsistence farming	No change	No change	No change
Production and exchange	SWC	No change	Improved application of fertilisers for potato production, and therefore cost savings	No change	No change	No change

Source: Authors' construction from interview data

5. AG-PLATFORM ROADMAP: THE WAY FORWARD

This section provides two key takeaways and presents policy-makers with an Ag-platform roadmap, which attempts to combine the win/win strategies to create customised and targeted Ag-platform models that create value creation and capture opportunities.

5.1 Two key takeaways

Takeaway 1: Five business models of Ag-platforms

Combining the scope (that is, the breadth of services that substitute for or complement traditional functions and processes in an agricultural value chain) and scale (different end markets) leads to creation of the five most common Ag-platform forms:

1. *Production and exchange model**:*** Three scopes – backward exchange, horizontal offers and information services – where farmers gain production-related information, sometimes along with AI and big data analytics support. Generally, occurring at the pre-production and production stage of the value chain.
2. *Output exchange:* Midstream in the value chain, with three scopes – forward exchange, post-harvest and information services. This is an auction-based model, wherein farmers are provided information on crop prices and logistic prices to transport products, as well as post-harvest services such as grading and packaging.
3. *Trading and sharing:* Five scopes – marketplace matching, horizontal offers, information services and complex information services, production and harvest services, and sharing and knowledge exchange. This model covers the full value chain, as it includes services from the pre-production stage to the output sale.
4. *Guarantee purchase and logistics:* Two scopes – guaranteed purchase and prices and information services. In this case, Ag-platform firms act as intermediaries and buyers, by taking the onus of loss onto themselves. They provide farmers with contracts, along with a guarantee of purchase at specific market defined prices.
5. *Single buyer-integrated**:*** A completely vertically integrated value chain, wherein the main off-taker, be it a processor or a retailer, directly controls the entire value chain and there is already a predetermined market (i.e. prior contract with final buyers already exists).

Takeaway 2: Value creation and capture of opportunities

Opportunities include Ag-productivity gains, value addition and diversification, creation of more, decent and formal jobs for youth, gender inclusion and knowledge accumulation and absorptive capacity. In the case of Uganda, trading and sharing platforms showed the most improvement in terms of productivity, value addition/diversification, number of jobs created and gender inclusion; these were followed by production and exchange, single buyer-led and output exchange. Productivity appears to have increased for almost all Ag-platform models, in terms of crop yields as well as improvements in farm management practices and labour productivity. Value addition/diversification appears to have improved across trading and sharing and production and exchange Ag-platform models, with farmers seen to upgrade by diversifying to new products. An important feature identified is the low number of jobs created, except in the case of one trading and sharing app, which tapped into a new customer base of urban and peri-urban professionals who also farm as a side-business. Additionally, it is important to note that most of the new jobs are taken up by youth, who are now interested in returning to farming. There is a clear trend of low female participation/gender inclusion on Ag-platforms, owing to lack of mobile phones (e.g. the male member in the family owns and uses the phone).

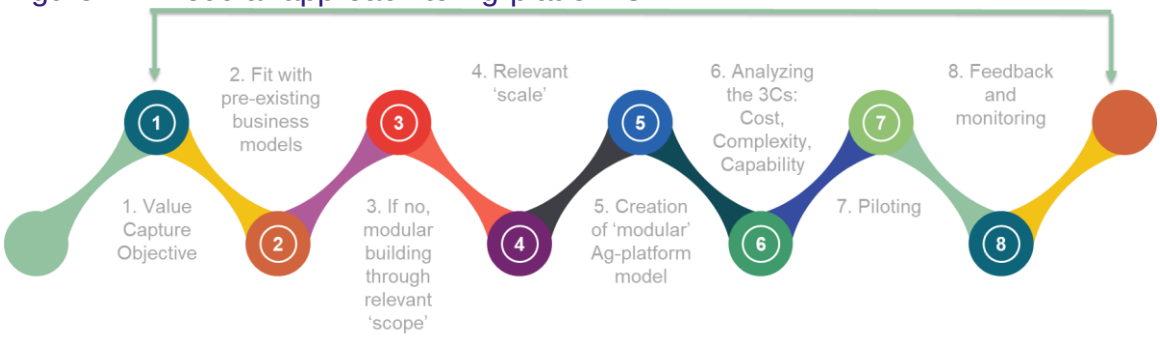
5.2 Designing win/win Ag-platforms through the five business models: Roadmap

This report encapsulates the various contexts in which different models of Ag-platforms thrive or perish. As indicated in the previous sub-section, when accounting for value capture opportunities, productivity increase is most common in trading and sharing and production and exchange platforms, whereas gender inclusion occurs more commonly in trading and sharing models. This suggests there is a need to create a set of questions to provide policy-makers with a roadmap:

- What are the target value creation opportunities that need to be addressed?
- How to design a business model best positioned to maximise value creation opportunities?
- What are the costs, complexities and capabilities associated with the selected Ag-platform?
- What feedback and monitoring mechanisms dynamically iterate the targeted Ag-platform?

It is important to consider the large number of platform firms that have failed to take off or have had to close after their pilot. This has been because many firms use technocratic approaches to design the platform, trying to use a one-size-fits-all blueprint. But, as this report has shown, the implications for Ag-platforms and created by Ag-platforms vary significantly in different contexts. Figure 11 presents an eight-step procedure to begin creation of a customised Ag-platform that suits specific needs in specific contexts to ensure the probability of success and long-term sustainability.

Figure 11: Modular approach to Ag-platforms



Source: Authors' construction

Step 1: Selecting the priority value creation objective or objectives that the Ag-platform intends to tackle. For instance, these could be linked to increases in agricultural productivity, or in the number of jobs, in value addition and in diversification opportunities, and so on.

Step 2: Fitting in with the five types of business models – identifying which types perform better for which specific types of value creation opportunity. For instance, production and exchange models seem to fare better on average in Uganda than output exchange when it comes to value addition or formalisation of jobs. Thus, the focus can be more on production and exchange models than others.

Step 3: Modular building through relevant scope. In many cases, pre-existing production and exchange or trading and sharing models may not fit the context. Thus, matching the scope can create a hybrid form of existing business models that works best. This is called a 'modular building' process, which entails adding each scope as a 'module' until an Ag-platform product is developed.

Steps 4 and 5: Selecting the relevant scale of the model – that is, is it meant for local sale, exports, regional trading – and finalising the 'modular' Ag-platform that directly helps achieve the value capture objective. ***In sum, policy-makers can mix and match different 'scales', 'scopes' or even existing business models of Ag-platforms, to create unique platforms for serve specific purposes***. This suggests that finding an Ag-platform model that works for specific policy priorities occurs in a 'modular' way – that is, by adding each module separately (each scope separately) to form a new model. This can ensure that Ag-platform models are sustainable over a longer term.

Step 6: Analysing the 3Cs. After creating a modular Ag-platform, there is a need to analyse the relevant costs associated with it, the complexity of the product and its capabilities. For instance, if the costs and the complexity of the Ag-platform are high, while the overall capabilities of the target audience are 'low', then the platform will not be adopted efficiently. There is a need to match the 3Cs.

Steps 7 and 8: Piloting the Ag-platform and then setting up monitoring and feedback mechanisms to be able to collect data to further improve its functioning.

5.3 Internal dynamics affecting Ag-platform sustainability: Important considerations

Most of the discussion here focuses on the modus operand of different forms of Ag-platforms and how 'users' (e.g. farmers, women and youth in agriculture) adopt these. However, for an Ag-platform to be sustainable, we need also to consider a range of issues internal to the Ag-platform itself. These are related to the capabilities of entrepreneurs and micro and small enterprises (MSEs) themselves, including in financial sustainability and ability to constantly innovate. We briefly highlight here some important capabilities but this is not our focus and further research will be required in this regard.

These are inherent characteristics of Ag-Platforms that are critical to the formation of the business model itself. We highlight four sustainability issues that need to be considered in order to facilitate successful investment in Ag-platforms and their long-term sustainability:

1. *Management capabilities* refer to the leadership and soft skills involved in managing a team/suppliers/developers, engendering trust and respect and garnering social capital.
2. *Production capabilities* refer to the skills necessary for the efficient operation of a farm/factory with new technologies.
3. *Linkage capabilities* refer to the deals and networks that entrepreneurs/MSEs create and the strength of the relationships with suppliers (e.g. input providers, horizontal service providers, etc.).
4. *Development and innovation capabilities* refer to the skills needed to decode transmitted information from other organisations, allowing diffusion of technology and the delivery of the product to the final consumers.
5. *Financial accounting capabilities* link to two aspects: the financial management and accounting ability of the MSE/entrepreneur and their ability to attract series funding (i.e. venture capital funding of a class of preferred stock). These include seed funding (angel investors) and series A, B, C, D funding[10] (venture capital) (i.e. provide outside investors the opportunity to invest cash in a growing company in exchange for equity, or partial ownership of that company.

Thus the sustainability of the Ag-platform determines the efficacy of the business model employed and the acumen necessary to ensure that the business model can create value capture opportunities and be resilient in the long term.

[10] Opportunities may be taken to scale the product across different markets.

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APPENDIX A: LIST OF INTERVIEWS IN UGANDA

Organisation	**Type of stakeholder**
EzyAgric/Akoiron	Ag-platform, private sector
Uganda Cooperative Alliance	Civil society
Ministry of Science, Technology and Innovation	National government
Ministry of Trade	National government
Ministry of Agriculture, Animal Husbandry and Fisheries	National government
AGRA	Civil society
Makerere University	University
Oil Palm Association	NGO and quasi-governmental
Uganda Warehousing Receipt System Authority	Government organisation
Akello Banker	Ag-platform, private sector
Makerere University	Ag-platform, private sector
M-Omulimisa	Ag-platform, private sector
Technoserve	Civil society
CTA, Netherlands	International organisation
MUUIS	Ag-platform, private sector
DFID	International organisation
OutBox	Co-working space
MTN	Private sector
Syngenta	Private sector
USAID	International organisation
SNV	International organisation
UNEP	International organisation
EAC	Regional government
GIZ	International organisation
IFAD	International organisation

APPENDIX B: LIST OF INTERVIEWS IN RWANDA

Organisation	**Type of stakeholder**
Ministry of Finance	National government
Ministry of Agriculture	National government
Rwanda Land Management and Use Authority	National government
DFID	International organisation
Heifer International	Foundation
IGC	Think tank
1AF	Private firm
Kumwe	Private firm
GIZ	International organisation
SWC, formerly Smart Farming Rwanda (SFR)	Private firm
Spark – IPoVaF	Private firm
Ministry of Commerce	National government
Agri Pro Focus	Private firm
Baza Farms	Private firm
AgriGo or Go	Private firm
FAO Rwanda	International organisation
SMAgri	Private firm
Kiza Agri	Private firm

APPENDIX C: AG-PLATFORM MODELS IN TANZANIA AND VALUE CAPTURE OPPORTUNITIES

Agriculture is the backbone of the economy, contributing over 27% of GDP and employing 78% of the labour force in Tanzania. This is not an exhaustive list; we primarily study four major apps prevalent within Tanzania: Tigo Kilimo, Kilimo Smart, Yara Image and Farmster.

Tigo Kilimo is an agricultural value added service provided by MNO Tigo in Tanzania. The service offers information for farmers via mobile phone and can be accessed via four mobile channels: USSD, push SMS subscription, IVR and a helpline. Tigo Kilimo provides agronomic tips on 10 major crops (maize, rice, Irish potato, cassava, onions, banana, citrus, sweet potato, tomato and cashew). The app provides market prices and weather forecast information (GSMA, 2015). While it reported a high number of registered users, the IVR channel remains underused, with an average of less than 250 accesses per month (GSMA, 2018), owing to the high costs (at TZS 50 ($0.03) per access). This is categorised as a *production and exchange* model, as explained in Table C1.

Kilimo Smart provides smart farming techniques and financial support to youth and small-scale farmers, children, youth and women. More broadly, it uses ICT methods to address issues relating to hunger in Tanzania. This app is one of the first to support offline reading of agriculture content with the aim of improving farmers' productivity through provision of good agricultural practices. Such practices relate to animal husbandry, farming, pest and disease, agri-marketing and agrochemicals. The app is integrated with social media and in-app customisation. The app also has an incubator farm (ShambaDarasa) that enables farmers the opportunity to learn these new practices through demonstrations and observations. Furthermore, this app also provides market opportunity for farmers by matching sellers and buyers on the app. This is classified as a trading and sharing model platform.

Yara Image is a precision agriculture app that provides information on nitrogen uptake plants. Using a smartphone app, farmers are incentivised to take a picture of the leaf and upload onto the app. In return, the app will provide details on the nitrogen uptake based on leaf cover, leaf green colour and the estimated fraction of the brown leaf. The app will advise on the fertilisers needed for crops, based on the image analysis. This is a production and exchange model platform, with AI technology. Yara is a Norwegian company, which provides a full spectrum of digital support to farmers in fertiliser for coffee, maize, potato and rice.[11]

Farmster is an output exchange model, as it is an e-marketplace to link farmers and buyers. This is a USSD-based model that enables buyers to search for products of a specific quality to be delivered at specific times. The app allows peer-to-peer network connections to facilitate the growing of business by both farmers and buyers. Farmster has developed a two-way SMS Chatbot for farmers to publish their crops well before harvest time. This information is then published on the Farmster app, where buyers can see crops available organised by crop, harvest date, location and quantity. Buyers can then browse this marketplace and, on finding a listing of interest, receive the farmer's contact. This enables farmers and buyers to connect with each other before harvest time and expand their networks (see Figure C1 for the Farmster application process).[12] The unique feature of Farmster is that it can work without internet. However, Farmster does have a smartphone version.

[11] https://www.yara.co.tz/about-yara/yara-tanzania/

[12] https://www.globalinnovationexchange.org/innovation/farmster

Figure C1: Farmster

Source: http://pubdocs.worldbank.org/en/117871556637556264/Farmster.pdf

Table C1: Ag-platform models in Tanzania

Name of app/ project	**Tigo Kilimo**	**Kilimo Smart**	**Yara Image**	**Farmster**
Model of Ag-platform	Production and exchange	Trading and sharing	Production and exchange	Output exchange
Launch year	2012	2012	2005	2015
Registered users	400,000*	NA	NA	3,000
Operation area in Tanzania	26 regions	NA	NA	NA
Dissemination by mobile phones	SMS, IVR, USSD, smartphone app	SMS, USSD and smartphone app	Smart phone app	SMS, USSD and smartphone app
Key partners and funders	GSMA	Mzumbe University, Sokoine University of Agriculture, MATI Mlingano Collage, Catholic University of Eastern Africa –Nairobi, Sunway University Malaysia	Fully owned subsidiary of Yara International ASA	8,200 Social Accelerator, Tel-Aviv

*Note: *Data from 2015*

Source: Authors' construction from secondary data

In terms of opportunities for value capture (Table C2), in Tigo Kilimo, for instance, most of the users are men (63%) and the majority are aged under 25 years old (69%), and women were likely to become the most frequent users of the app (GSMA, 2015). Tigo Kilimo service users were shown to be 30% more likely to be growing new crops, using new seeds or new agricultural practices and consequently 39% more likely to report increased income in a given year than those who do not use the service (ibid.). Repeat users who have changed farming practices are more likely to share Tigo Kilimo advice with other farmers than those who have not changed behaviour. This expands the impact of the service as well as bringing new users. Farmster app (output exchange) suggests a fall in post-harvest losses and generally reports a 20% improvement in earnings, but the current costs per farmers of $15, will be expensive without a substantial subsidy. In order for Farmster to make profits, costs must drop to $4 per farmer.

Table C2: Ag-platform models and value creation opportunities in Tanzania

Model of Ag-platform	Name of Ag-platform	Productivity	Value addition	Number of jobs	Formalisation of jobs	Gender inclusion
Production exchange	Yara Image, Tigo Kilimo	Increase	Increase	Marginal increase	No change	No change
Trading and sharing	Kilimo Smart	Increase	Increase	Marginal increase	No change	No change
Output exchange	Farmster	Increase (reduce post-harvest loss)	NA	NA	NA	NA