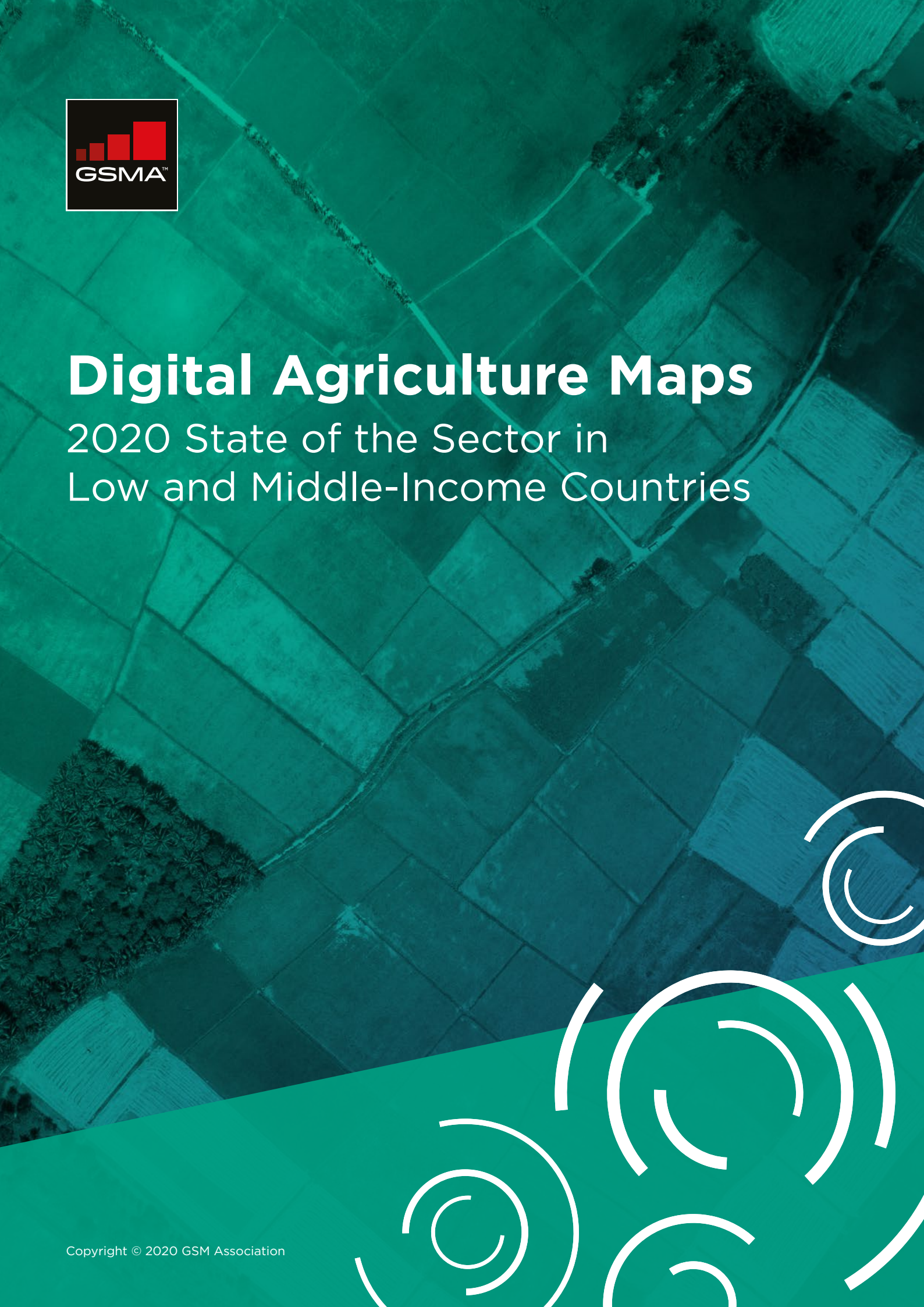

Digital Agriculture Maps

2020 State of the Sector in Low and Middle-Income Countries

GSMA AgriTech Programme

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with nearly 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

For more information, please visit the GSMA corporate website at www.gsma.com

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We bring together and support the mobile industry, agricultural sector stakeholders, innovators and investors in the agritech space to launch, improve and scale impactful and commercially viable digital solutions for smallholder farmers in the developing world.

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IDH Farmfit supports companies in making service delivery to smallholder farmers profitable – for farmers and companies alike. Based on the experience of supporting and systematically analysing 70+ companies across sectors and geographies, IDH Farmfit provides strategic advice, technical assistance and de-risking finance to companies to improve and scale their service delivery to smallholders. Digitisation of value chains represents a key opportunity to reduce costs and increase the scale of service delivery. IDH Farmfit's digital transformation advisory is providing tailored recommendations on how digital technology can add value to businesses and the farmers they serve.

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Executive summary

Agriculture is the backbone of most developing economies and a major source of food, income and employment for 500 million smallholder households globally. However, smallholder farmers face significant challenges that limit their agricultural productivity and earning potential.

These challenges include poor access to agronomic, market and weather information; lack of access to finance for agricultural inputs and capital investments; poor access to infrastructure and modern equipment; fragmented or inadequate access to markets; and more frequent and extreme weather events resulting from climate change.

Over the last decade, a number of digital agriculture solutions have reached sufficient scale to become commercially attractive to investors and have a positive socio-economic impact on smallholder farmers. From agronomic advisory to e-commerce platforms, these solutions are improving agricultural knowledge, enhancing productivity and boosting incomes. However, the digital agriculture sector is still young and evolving — donor financing remains critical to the development of the sector, and agritech investors will need both commercial patience and a long-term vision for growth and expansion. There is a broad range of digital tools in agriculture, from low-tech solutions disseminating agronomic advisory to high-tech holistic tools involving satellites, sensors and big data analytics. Together, they deliver an array of benefits to smallholder farmers, providing a pathway to the formal economy and helping them become more resilient to the effects of climate change and other challenges, like the COVID-19 pandemic.

Despite the adoption of digital agriculture tools to address the challenges facing the sector, smallholder farmers have yet to experience the widespread benefits of this digital transformation. Realising the full potential of digital agriculture solutions will require sharing and implementing best practices. Several attempts have been made to provide a complete picture of the digital agriculture services available to smallholder farmers in LMICs (low and middle-income countries), but building and maintaining a live inventory of solutions in this constantly evolving space has been a challenge for the industry.[1] **The GSMA AgriTech's Digital Agriculture Maps (DAMs), produced in collaboration with IDH Farmfit provides a window into the digital agriculture landscape to help industry practitioners and potential investors understand key trends and emerging opportunities.**

At the core of DAMs is the AgriTech programme's dataset of over **700 active digital agriculture services tracked as of January 2020, which has grown rapidly from 53 services in 2009. The services are divided into five use cases: digital advisory and agri digital financial services (access to services), agri e-commerce and digital procurement (access to markets) and smart farming (access to assets).** These are further divided into **24 sub-use cases that address five key challenges: the agricultural knowledge**

1 Examples of online platforms tracking digital agriculture innovations in LMICs are the Global Innovation Exchange (GIE, 2020) and the CGIAR Evidence Clearinghouse (CGIAR, 2020). In high-income countries, organisations such as AgFunder, Traxcn and Crunchbase track technology products and start-ups, including those with some presence in LMICs, for investors and industry partners.

gap, network and internet connectivity, financial exclusion, poor access to markets and climate change. The digital agriculture services included in this report are offered both directly to smallholder farmers through a business-to-consumer (B2C) model, and indirectly as enterprise solutions targeting agricultural value chain actors such as agribusinesses and cooperatives under a business-to-business-to-consumer (B2B2C) model.

The imperative of this work is increased by the ongoing **COVID-19 pandemic, which has magnified systemic challenges in the agriculture sector** faced by smallholder farmers and value chain actors. Major disruptions to food and input supply chains have put the finances and food security of smallholder farmers at risk, and limited their ability to plan and invest in the next growing season. **Digital agriculture tools offer ways for both commercial and subsistence farmers to become more agile and efficient in adapting to the pandemic.** There is growing evidence that value chain actors that already use digital solutions in their operations are finding ways to repurpose them to address the new challenges of COVID-19.

Throughout this report, we highlight specific use cases to encourage innovation and adoption of best practices. Global trends are broken down by region and use case to help practitioners understand the specific conditions needed for digital agriculture solutions to scale. The report concludes with an outlook section that looks at the current trajectories of digital agriculture in different business models, user needs, the uptake of new technologies, and opportunities for donors, commercial and impact investors to help shape the agritech sector.

Global trends in key use cases

- Digital advisory services first emerged in LMICs in the late 1990s to address the knowledge gaps among smallholder farmers, and they remain **the most prevalent use case, providing agricultural knowledge, weather predictions and information on market prices.** While rich media services delivered via apps are expanding, basic 2G channels (text and voice) remain vital to delivering advisory to smallholder farmers. Digital advisory services are becoming more intelligent, providing highly localised, granular information to support farmers in decision making. They are also becoming more complex, with new services providing specialised services on demand.
- New sources of data, technology and relationships with farmers are being leveraged to increase financial inclusion among smallholder farmers. **Although digital credit products are becoming widely available, very few address the long-term financing needs of smallholder farmers**, for example, investments in machinery, farming tools and irrigation systems. Meanwhile, digital credit scoring and crowdfunding tools have grown significantly in the last five years, opening access to digital financial services for farmers by providing alternative ways to aggregate and analyse financial data.
- The shift from indemnity-based to index-based insurance, combined with the **growing use of mobile phones as a low-cost way to scale traditional insurance, is unlocking new opportunities for insurance providers to serve smallholder farmers.** Digitally-enabled agricultural insurance is gaining traction, but lack of awareness among smallholder farmers and challenging business models are limiting its reach.
- Digital procurement tools are bringing visibility and efficiencies to agribusinesses, cooperatives and smallholder farmers in the last mile of agricultural value chains. **The digitisation of paper records is the foundation of all procurement tools, but holistic solutions that integrate both payments and product tracing are emerging to support more sustainable farming**, from the ability to secure long-term supply to smallholder farmers earning a living income.
- **Agricultural produce is growing in popularity on e-commerce platforms in LMICs, presenting an opportunity for consumers and smallholder farmers to forge closer connections.** The proliferation of agri e-commerce in any market depends on several enabling factors, including important infrastructure like telecommunications, logistics networks and financial services. Mobile money providers, including mobile network operators (MNOs), have valuable assets that can remove some of the barriers to e-commerce and address the pain points of buyers and sellers.
- **Smart farming is the latest use case to take hold in LMICs. While the mobile Internet of Things (IoT) is a key enabler for smart farming solutions, IoT deployments in the agriculture sector in LMICs can still be expensive and difficult to roll out.** Equipment monitoring was the first use case to emerge, but smart shared assets now account for over 60 per cent of the smart farming tools we are tracking globally. While smart shared asset solutions facilitate access to capital-intensive agricultural assets, most are not economically viable for farmers due to the small size of their farms and low incomes.

Regional trends

- **As of January 2020, the GSMA AgriTech programme has tracked 437 services in Sub-Saharan Africa, 105 in South Asia, 99 in Southeast Asia and 59 in Latin America and the Caribbean. Sub-Saharan Africa has seen the most growth in the uptake of digital agriculture tools.** Digital advisory is the most established use case in all regions, except in Latin America and the Caribbean where agri e-commerce has seen the most significant growth.
- **In Sub-Saharan Africa, digital financial services have experienced considerable growth, driven by the prevalence of mobile money across many markets.** Mobile money has made it viable to provide financial services via mobile phones and extend the reach of services to segments of the population like farmers, which financial service providers have traditionally considered too difficult and expensive to serve. However, this growth has been concentrated largely in East Africa, where mobile money adoption is more widespread.

Nearly half of all digital financial services tracked in Sub-Saharan Africa are available in five countries: Kenya, Uganda, Tanzania, Burundi and Rwanda.

- **In South Asia, some of the most well-established digital advisory services are in operation, with regional providers among the first to launch and scale these solutions.** South Asian MNOs played a leading role in the development of the agricultural value-added services (Agri VAS) model, delivering information services to farmers through large-scale digital agricultural advisories in India, Pakistan, Sri Lanka and Bangladesh. South Asia also has some of the most successful agri e-commerce services in LMICs, especially in India. Agri e-commerce in the region has also benefited from the presence of a few well-established companies and a larger banked population, which is boosting demand for agricultural produce in urban areas via digital platforms.
- **In Southeast Asia, digital agriculture has benefited from the relative prevalence of structured commercial value chains and dynamic technology hubs in countries such as Indonesia, Vietnam and the Philippines.** Digital procurement is now as established as digital advisory despite appearing much later, and similar but slower trends are emerging in other regions. Smart farming is also growing significantly due to wider adoption of IoT. After a slow start, digital financial services are growing rapidly, particularly in the last four years. Mobile money solutions are not widespread in the region, but innovations in using digital agriculture data to enable financial services are emerging.
- **In Latin American and Caribbean countries, agri e-commerce is the most established use case, driven by demand from urban centres, comparatively better logistics networks and a few well-established companies operating in multiple countries in the region.** Considering the potential to scale digital procurement solutions due to the presence of many cash crop value chains, the region lags behind in this area, presenting an opportunity for local agritech start-ups and international companies to enter this space. Digital financial services have also experienced staggered growth, but recent growth in credit scoring and crowdfunding solutions indicates some progress is being made.

Target audience

This report is aimed primarily at **investors** and **donors** to support their global and regional strategies and investments for social and commercial impact.

Agritech companies and **MNOs** actively serving the rural sector will also find valuable information to position themselves more competitively in their markets.

Value chain actors, such as **agribusinesses** and **cooperatives**, will gain insights into opportunities to launch digitisation initiatives in their operations and the solutions available in their markets.

The report is also a tool for **mobile money providers (MMPs)** and **financial service providers (FSPs)** seeking partnerships to provide financial services to the rural sector.

Finally, **institutional actors,** such as government, multilateral agencies and NGOs, will find useful information on using digital solutions to improve their agriculture sector programmes.

1 Introduction

According to the United Nations Food and Agriculture Organization (FAO), **smallholder farmers manage about 80 per cent of the world's cropland and produce about 60 per cent of global agricultural output.**[2] **In low and middle-income countries (LMICs), smallholder farmers face significant challenges that limit their productivity and earning potential.** These challenges include poor access to agronomic, market and weather information; lack of access to finance for agricultural inputs and capital investments; poor access to infrastructure and modern equipment; fragmented or inadequate access to markets; and more frequent and extreme weather events due to climate change.

Over the next few decades, the world will confront the challenge of feeding a growing population that is predicted to reach almost 10 billion by 2050. Combined with the effects of climate change, population growth will place even more pressure on already strained global food supply systems.

Digital solutions have emerged to mitigate the challenges faced by smallholder farmers and the value chain stakeholders they interact with throughout the agricultural cycle. However, significant investment in digital solutions is required to advance the scale and impact of digital agriculture. Growing investment in agritech as a proportion of total investment in agriculture is highlighting opportunities to deploy commercial digital agriculture solutions that address the pain points of the agriculture sector. Donors, innovation hubs and angel and social impact investors have supported a variety of agritech companies in the early funding stage, and the funding landscape has become more complex as agritech companies seek to expand. However, the sector needs to attract significantly more investment. In Sub-Saharan Africa, where investor capital is becoming more available, funding remains a major challenge for agritech companies, primarily due to the high perceived risk of investing in the agriculture sector and the knowledge gap investors face in agricultural value chains.[3] In 2019, of all the funds raised by African technology start-ups over USD 1 million, just four per cent (around USD 38 million) was raised by agritechs.

The GSMA's Digital Agriculture Maps (DAMs), produced in collaboration with IDH Farmfit, highlights key trends and opportunities in the digital agriculture sector in LMICs for agritech investors, donors, practitioners and value chain stakeholders. The GSMA AgriTech programme is tracking over 700 active digital agriculture services, up from 53 in 2009 that support and deliver services to smallholder farmers. These include digital tools offered directly to

2 FAO (2017), The future of food and agriculture: Trends and challenges. FAO, Rome.
3 GSMA AgriTech (2020), *Agritech in Nigeria: Investment Opportunities and Challenges*.

smallholder farmers through a business-to-consumer (B2C) model, as well as enterprise solutions targeting agricultural value chain actors, such as agribusinesses and cooperatives, under a business-to-business-to-consumer (B2B2C) model. DAMs features the range of digital agriculture use cases that have emerged globally and at a regional level, and provides evidence-based analysis of the forces driving their growth.

Several attempts have been made to provide a complete picture of digital agriculture in LMICs, but building and maintaining a live inventory of digital solutions in this constantly evolving space has been a challenge for the industry.[4] Practitioners have needed a resource to understand emerging opportunities in digital agriculture and prioritise digital interventions aimed at smallholder farmers. For example, IDH Farmfit has developed a Digital Transformation Analysis (DTA) methodology based on its own digital solutions database that provides tailored recommendations to agribusiness, off-takers, end buyers, input providers, financial service providers (FSPs) and advisory providers seeking to embrace digital technologies to improve efficiency and scale.

This report is aimed primarily at agritech investors and donors in LMICs to help them prioritise interventions and inform investment and partnership decisions. Agritech companies and mobile network operators (MNOs) actively targeting the rural sector will also find valuable information to position themselves more competitively in their markets. A secondary but key audience for this report are value chain stakeholders (agribusinesses and cooperatives) planning to digitise their operations and seeking insights into emerging opportunities for digitisation and available solutions in their markets. In addition, this report can serve as a useful tool for a range of actors pursuing partnerships with agritech companies. These include MMPs and FSPs seeking partnerships to offer financial services to the rural sector, as well as institutional actors, such as government and multilateral agencies and NGOs, seeking digital solutions to improve their agriculture sector programmes.

The chapters that follow explore the significance of agriculture in different regions and the challenges smallholder farmers face. We will look at how digital agriculture solutions are addressing the pain points of smallholder farmers and value chain actors through a variety of use cases, and provide a snapshot of how they have developed in different regions. The next chapter will delve into each of the use cases in detail, shining a light on key trends and opportunities. In the final two chapters, we look at how the digital agriculture sector is building resilience to the impacts of COVID-19 and conclude with an outlook on the future of digital agriculture.

4 Examples of online platforms tracking digital agriculture innovations in LMICs are Global Innovation Exchange (GIE, 2020) and CGIAR Evidence Clearinghouse (CGIAR, 2020). In high-income countries, organisations such as AgFunder, Traxcn and Crunchbase track technology products and start-ups, including those with some presence in LMICs, for investors and industry partners.

2 Agriculture in LMICs and the role of digital tools

Although the first digital agriculture solutions appeared in the late 1990s, smallholder farmers in LMICs have yet to experience the full benefits of this digital transformation. In the last decade, a variety of digital solutions have been trialled and some have reached sufficient scale to attract commercial investment. Several of these services are having a positive socio-economic impact on the lives of smallholder farmers, whose agricultural knowledge and improved farming practices have led to greater productivity and higher incomes.

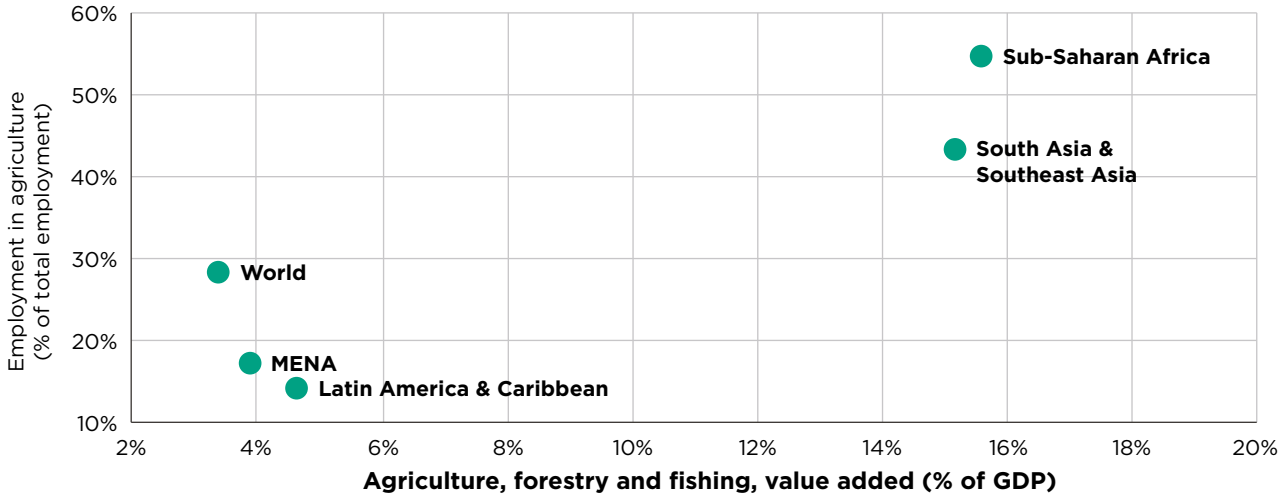
2.1 The relevance of agriculture across regions

Agriculture is the backbone of most economies in LMICs and the main source of food, income and employment for rural populations. This is most evident in Sub-Saharan Africa and in South and Southeast Asia where 54 per cent and 43 per cent of the labour force, respectively, are active in agriculture and depend on the sector for their livelihoods, and where the sector accounts for about 15 per cent of regional GDP (Figure 1, 2).[5]

5 The World Bank (2018), "Agriculture, forestry, and fishing, value added (% of GDP)".

Figure 1

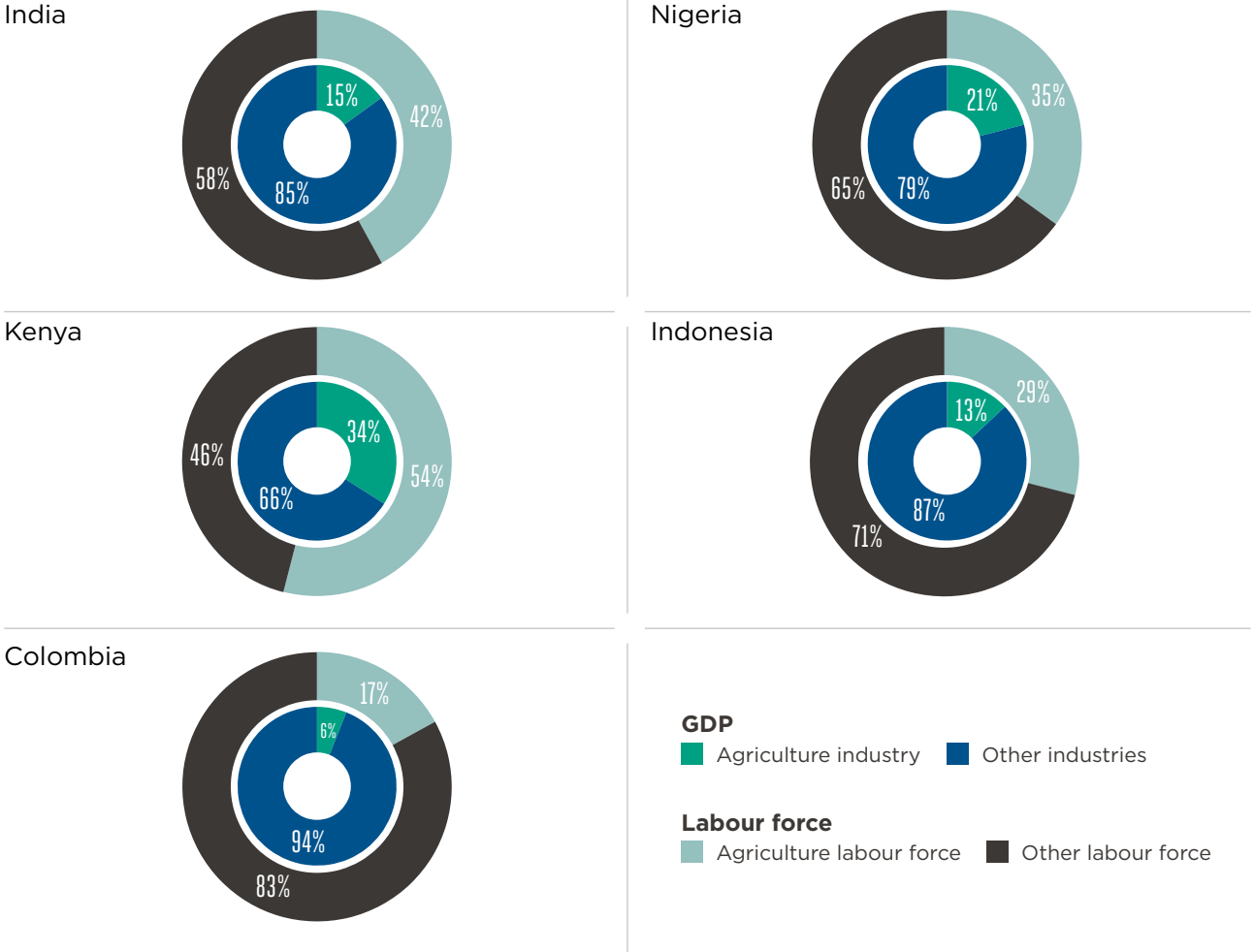
Relevance of agriculture by region, 2018[6]



Source: World Bank, 2018

Figure 2

Agriculture's contribution to GDP and labour force by country, 2018[7,8]



Source: World Bank, 2018

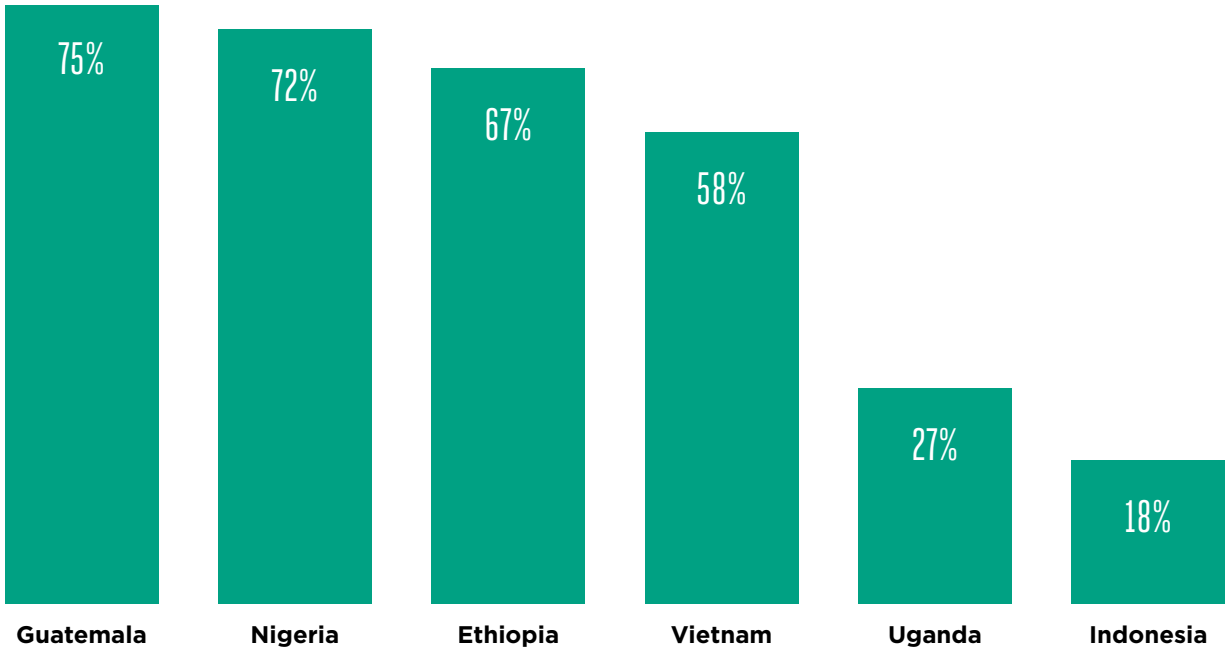
6 The World Bank (2018), "Agriculture, forestry, and fishing, value added (% of GDP)".
7 Ibid.
8 The World Bank (2018), "Employment in agriculture (% of total employment) (modelled ILO estimate)".

Poverty among smallholder farmers in LMICs is generally high, but varies significantly between and within countries. In Guatemala, where smallholder farmers make up 31 per cent of the labour force, 75 per cent live below the poverty line on less than $1.90 a day. In Indonesia, where smallholders make up 29 per cent of the labour force, 18 per cent live below the poverty line (Figure 3).

Smallholder farmers are not a homogeneous group. While smallholder farmers in LMICs typically produce crops or livestock on two-hectare plots of land or less,[9] average plots are smaller than two hectares in Sub-Saharan Africa, South Asia and Southeast Asia. In Latin America, average farms are well over 10 hectares, but when the more affluent Southern Cone of Argentina, Chile and Uruguay are excluded (areas where vast amounts of land are dedicated to cattle production), average farm sizes are around 2.5 hectares. Of the nearly 500 million smallholder farmer households in LMICs, most of which are in South and Southeast Asia (208 million) and Sub-Saharan Africa (48 million), only seven per cent are commercial farmers operating in tight value chains with established relationships with agribusiness buyers.[10] Another 33 per cent are commercial farmers in loose value chains with fragmented access to markets and high dependence on intermediaries. The vast majority of smallholders are non-commercial subsistence farmers who have little or no surplus produce to sell and depend on intermediaries who often undercut them on price.[11]

Figure 3

Percentage of smallholder farmers living below the poverty line ($1.90/day), 2018/2019[12]



Source: FAO, multiple sources (adapted by GSMA)

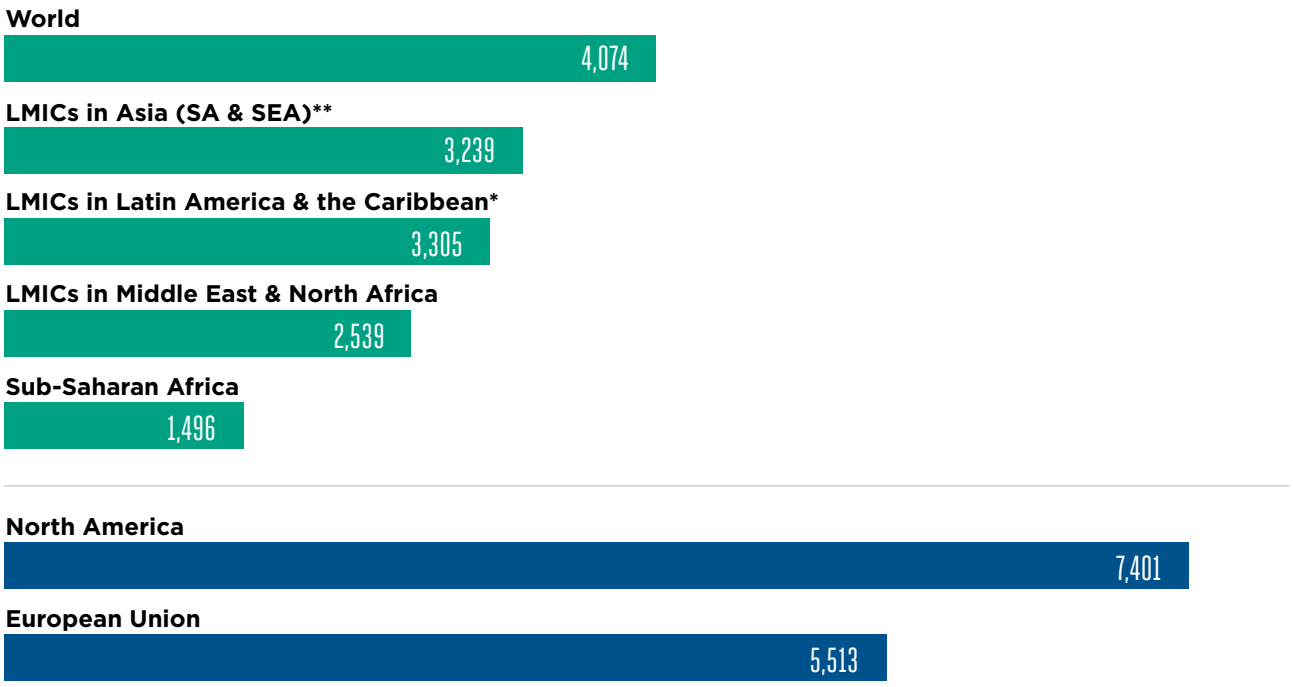
9 International Finance Corporation (2019), *Working with Smallholders: A Handbook for Firms Building Sustainable Supply Chains*.
10 Mastercard Foundation Rural and Agricultural Finance Learning Lab (2016), Inflection Point: Unlocking Growth in the Era of Farmer Finance.
11 Ibid.
12 Data from multiple FAO publications: *Smallholders data portrait*; and *Family Farming in Latin America and the Caribbean: looking for new paths of rural development and food security*.

2.2 Challenges for smallholder farmers and the role of digital agriculture

Despite their differences, smallholder farmers around the world suffer disproportionately from a lack of infrastructure and resources in rural areas, and confront similar challenges that limit their productivity and income. When output per hectare is compared across regions, agricultural productivity in LMICs emerges as a clear challenge. Globally, cereal yield is around 4,074 kg/hectare compared to 3,239 kg/hectare in South Asia and Southeast Asia, and just 1,496 kg/hectare in Sub-Saharan Africa (Figure 4).

Figure 4

Cereal yield (kg/hectare) globally, 2017[13]



Source: World Bank, 2017 * Excluding St. Vincent and the Grenadines where yields averaged 26,110 kg/hectare in 2017. ** SA = South Asia; SEA = Southeast Asia

Smallholder farmers' low productivity is due to several key factors that also affect their income levels: the agricultural knowledge gap, lack of access to finance, lack of access to markets and climate change. The agricultural knowledge gap prevents farmers from improving their practices. Financial exclusion leaves farmers without access to short-term capital for agricultural needs (i.e. inputs such as seeds and fertilisers) and long-term capital for expanding their operations (i.e. mechanised equipment, transport solutions and warehousing). Access to markets is a challenge due to the complexity of agricultural value chains and the strong role of intermediaries, leaving many farmers highly dependent on them and often with little or no choice of buyers. All these challenges are exacerbated by climate change, which is making agriculture an increasingly risky business.

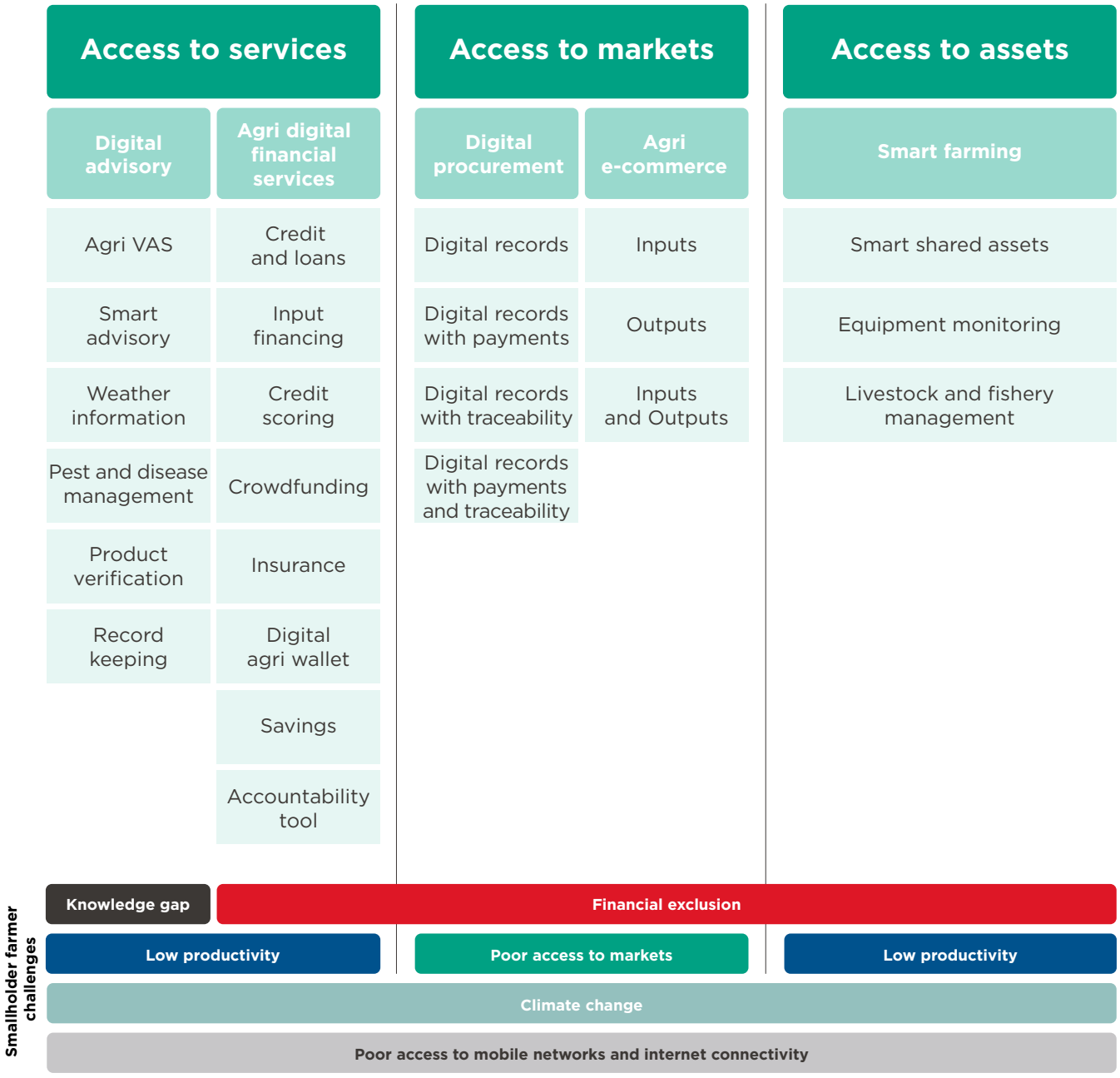
13 The World Bank (2017), "Cereal yield (kg per hectare)".

The use of digital technologies and data in the agricultural sector is transforming the way various value chain stakeholders interact with smallholder farmers. These technologies are mitigating the challenges farmers face and addressing the pain points of value chain actors in the agricultural last mile. The range of digital tools in agriculture is broad, from low-tech solutions disseminating voice and text-based advisory on feature phones, to high-tech holistic tools involving satellites, sensors and big data analytics. They offer an array of benefits to smallholder farmers, including participation in the formal economy and greater resilience to climate change.

The GSMA has segmented digital agriculture solutions into three broad categories of access that further break down into five use cases and 24 sub-use cases (Figure 5).

Figure 5

Digital agriculture use cases and sub-use cases



The agricultural knowledge gap

Smallholder farmers lack access to critical information, including reliable weather and climate information, that can help them plan their farming activities, improve on-farm practices, reduce inefficiencies and increase per-hectare yields, all of which boost income. Agriculture extension services offered by governments, NGOs and value chain actors aim to fill this knowledge gap by providing information on best practices, market prices and training and education on certification standards.

Despite these efforts, traditional face-to-face extension services are costly and challenging to provide at the scale required. The ratio of extension agents to farmers in LMICs remains low. In Africa, it is estimated there is one extension provider for every 4,000 farmers, compared to one per 200 in developed countries and lower than the FAO recommendation of one for every 400 farmers.[14] Many farmers still depend on traditional agricultural knowledge and methods passed down from the previous generation, which may no longer be reliable or relevant.

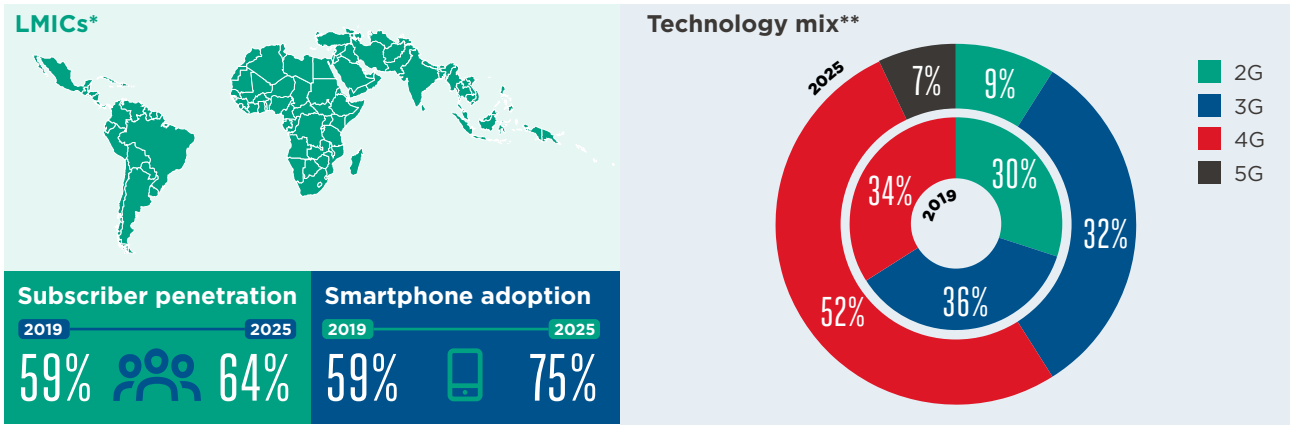
Mobile-based advisory services can provide much-needed information on agricultural best practices, market prices and weather forecasts. Smartphone penetration is on the rise in emerging markets, presenting an opportunity to deliver digital agriculture advisory through mobile internet. However, 2G networks and feature phones still play a prominent role in service delivery. Voice channels such as IVR (interactive voice response), OBD (outbound voice dialling), helplines and text channels, such as SMS (short message service) and USSD (unstructured supplementary service data), are vital to reaching users in rural areas where connectivity remains a challenge and basic, technical and digital literacy levels are all lower. By transforming a mobile phone into a productivity tool, smallholder farmers can enhance their knowledge and skills and improve yields and income. Mobile advisory services, especially ones that include localised, granular weather forecasts and extreme weather advisories, can help farmers make better-informed decisions and minimise their risks.

Poor access to mobile network and internet connectivity

While mobile data has become more affordable across all regions, the cost of devices remains a significant barrier to mobile internet access in LMICs, particularly for the poorest 20 per cent of the population.[15] According to GSMA Intelligence data, 2G channels make up just under a third of mobile connections in LMICs, while 3G and 4G connections account for 36 per cent and 34 per cent, respectively. Significant changes in the technology mix are expected in 2025, as shown in Figure 6.[16]

Figure 6

Mobile connections in LMICs, 2019 vs 2025[17]



Source: GSMA Intelligence, 2020. *excludes licensed cellular IoT **Figures include Australia

14 For more information on agricultural extension, benefits and limitations, see: https://ag4impact.org/sid/socio-economic-intensification/building-human-capital/agricultural-extension/.
15 GSMA Intelligence analysis of Tarifica data.
16 GSMA Intelligence (2020), *The Mobile Economy*.
17 Ibid.

Table 1

Percentage of mobile connections in LMICs, by technology, by region[18]

Region	Technology	2019	2025
Sub-Saharan Africa	2G	45%	12%
	3G	46%	58%
	4G	10%	27%
	5G	0%	3%
Asia Pacific (South and Southeast Asia)*	2G	27%	7%
	3G	25%	14%
	4G	48%	68%
	5G	0%	11%
Latin America and the Caribbean	2G	17%	5%
	3G	35%	21%
	4G	47%	67%
	5G	1%	7%
Middle East and North Africa	2G	31%	10%
	3G	40%	36%
	4G	29%	48%
	5G	0%	6%

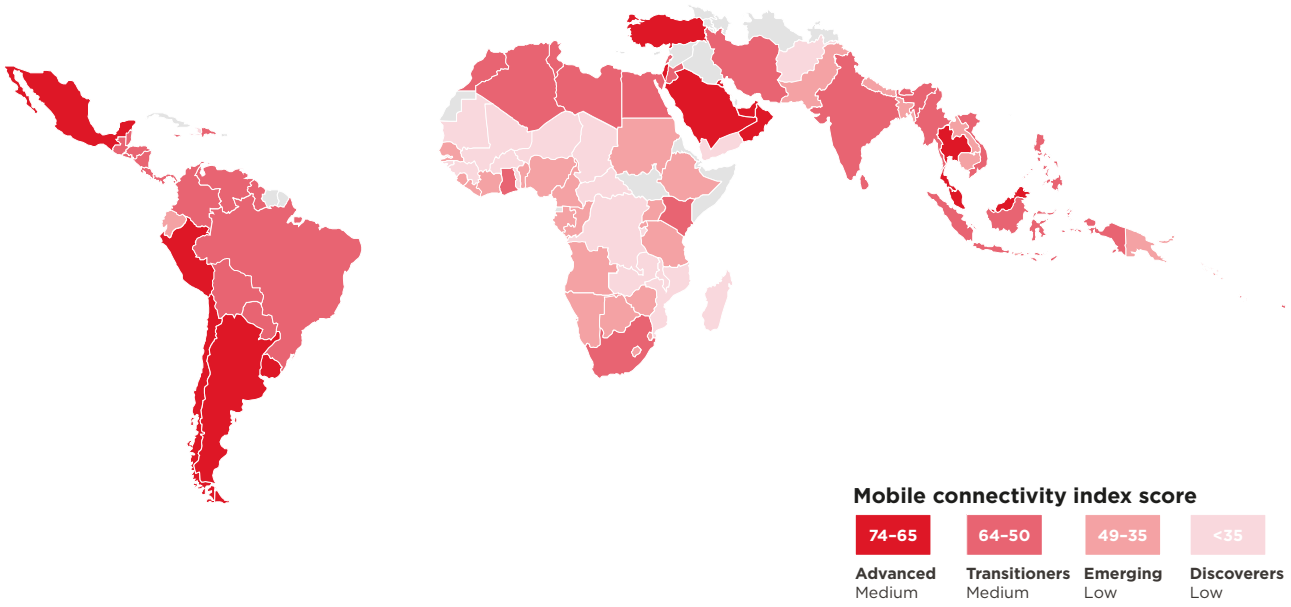
Source: GSMA Intelligence, 2020. *Figure includes Australia. Note: totals may not add up due to rounding

18 GSMA Intelligence (2020), *The Mobile Economy*.

While mobile is the primary way people in LMICs access the internet, roughly 60 per cent remain unconnected and those in rural areas are disproportionately affected (Figure 7). Rural populations are 40 per cent less likely to use mobile internet than urban populations,[19] which exacerbates existing inequalities. There is also a persistent gender gap in LMICs: women are 20 per cent less likely to use mobile internet than men.[20] These disparities are more pronounced in Sub-Saharan Africa and South Asia, where women are 37 per cent and 51 per cent less likely to use mobile internet, respectively.[21] The gender gap is also evident at the level of basic mobile phone ownership, limiting the extent to which women can access and use mobile services. Across LMICs, women are eight per cent less likely to own a mobile phone than men, which translates into 165 million fewer women owning a mobile.[22]

Figure 7

Mobile connections in LMICs, 2018*[23]



Source: GSMA, 2018 * Grey indicates no data is available for the country

19 GSMA Connected Society (2019), *The State of Mobile Internet Connectivity 2019*.
20 GSMA Connected Women (2020), *The Mobile Gender Gap Report 2020*.
21 GSMA Connected Society (2019), *The State of Mobile Internet Connectivity 2019*.
22 GSMA Connected Women (2020), *The Mobile Gender Gap Report 2020*.
23 GSMA Connected Society (2018), *The GSMA Mobile Connectivity Index*.

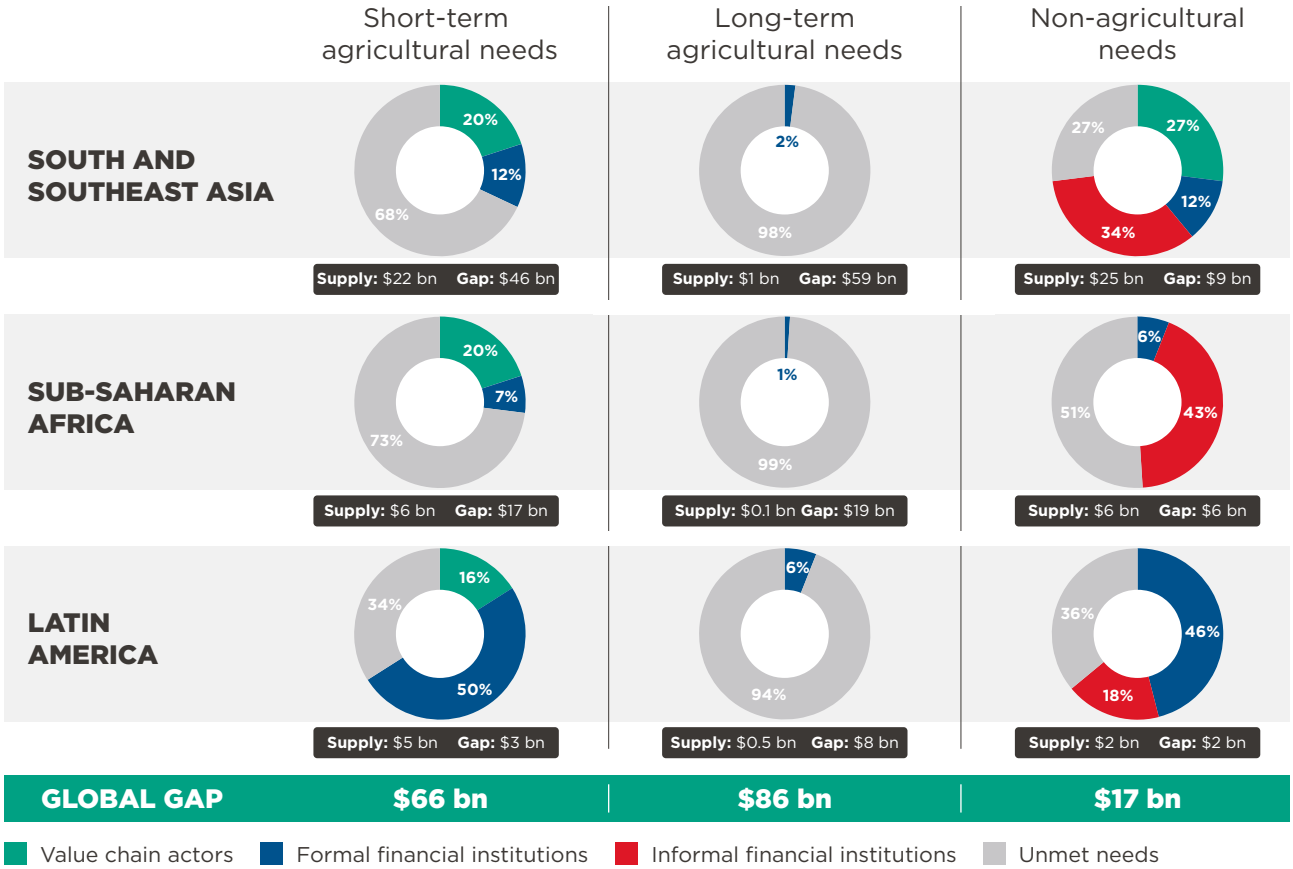
Financial exclusion

Financial services are key to enhancing productivity, increasing incomes and building climate resilience. In addition to the knowledge gap, smallholder farmers also lack the collateral and financial history they need to access formal financial services like credit, loans, savings and insurance. Farmers' financial needs are complex and varied. They need short-term financing for high-quality inputs, such as climate-resistant seeds and fertiliser, and long-term financing (longer than a season) for assets like water pumps and drip irrigation systems, crop storage and processing equipment to boost productivity and income. For example, access to a drip irrigation system gives farmers the opportunity to plant off season and increase their number of yearly harvests. Farmers also have non-agricultural financial needs for a range of household expenses, from medical emergencies to weddings and funerals, which can have a sudden and severe impact on cash flow and often plunge families deeper into poverty.[24] However, **the main agricultural financing gap is capital for long-term agricultural needs** (Figure 8).

Access to short-term finance for inputs and to long-term finance for assets can also provide the financial stability farmers need to be more resilient to climate change. The ability to access appropriate financial services allows farmers to plan ahead, absorb financial shocks and manage risks more effectively. They are also better able to invest in weather and crop insurance to protect against crop failure resulting from severe weather.

Figure 8

Smallholder finance gap by region and type of financing need, 2019[25]



Source: Mastercard Foundation Rural and Agricultural Finance Learning Lab and ISF Advisors, 2019

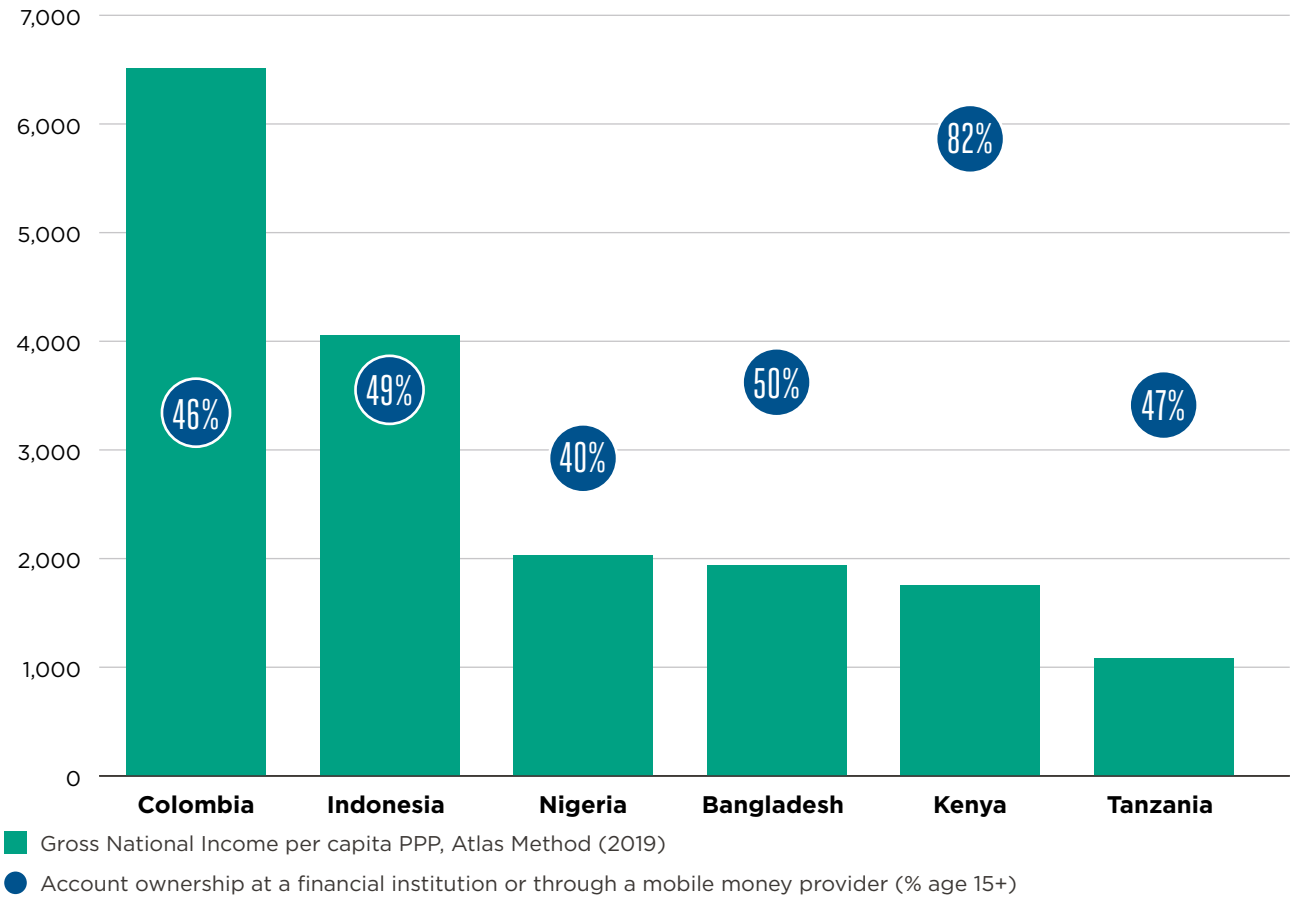
24 Mastercard Foundation Rural and Agricultural Finance Learning Lab and ISF Advisors (2019), *Pathways to Prosperity: 2019 Rural and Agricultural Finance State of the Sector Report*.
25 Ibid.

The growth of mobile money services in LMICs is providing an alternative and more accessible platform for financial services than traditional banking. In low-income countries, penetration of traditional banking services at financial institutions can be as low as 24 per cent, while in middle-income countries it can be up to 64 per cent.[26] According to the GSMA's *State of the Industry Report on Mobile Money 2019*, there were 290 live mobile money services in 95 countries serving over 372 million active customers. Sub-Saharan Africa is home to 144 of these services, which serve 181 million active customers.[27]

Mobile money has become an important tool for expanding financial inclusion. In countries with comparatively high gross national income (GNI) per capita, but low or no availability of mobile money (e.g. Colombia, Indonesia, Nigeria), account ownership at formal financial institutions is also lower (Figure 9). In 2014, 12 per cent of people aged 15 and over in Sub-Saharan Africa had mobile money accounts, and by 2019 this figure had more than doubled to 29 per cent. However, in Latin America and the Caribbean, this figure only grew from two to three per cent during the same period.[28]

Figure 9

Financial inclusion and gross national income (GNI) per capita across regions, 2019[29]



Source: Mastercard Foundation Rural and Agricultural Finance Learning Lab and ISF Advisors, 2019

Mobile money is also reducing the financial inclusion gender gap. While the gender gap in financial inclusion has narrowed only marginally in LMICs from 36 per cent in 2014 to 33 per cent in 2017, this aggregated figure masks significant variations in mobile adoption and use across countries and regions. In mature mobile money markets such as Senegal, Uganda and Zimbabwe, over 20 per cent of adults have only mobile money accounts, and women are either as likely or more likely than men to own only a mobile money account.[30]

26 Demirgüç-Kunt, A., et al. (2018), *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution*. The World Bank.
27 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.
28 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.
29 Demirgüç-Kunt, A., et al. (2018), *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution*. The World Bank.
30 Delaporte, A. and Naghavi, N. (21 October 2019), "*The promise of mobile money for further advancing women's financial inclusion*", *GSMA Mobile for Development Blog*.

Digital tools are unlocking new ways for smallholder farmers to access financial products and services such as credit, loans, savings, insurance and input financing. Digital financial services (DFS) for the agriculture sector that are powered by mobile money, such as digitised payments for crops, create vital transactional data and digital footprints for farmers. A range of other data is generated by mobile-enabled digital agriculture tools, such as farmer and farm records collected at registration. All these data points combine to create economic identities for farmers and enable financial institutions to assess creditworthiness.

Digital tools are also spurring the development of innovative products like credit-scoring algorithms, crowdfunding platforms and digital agri wallets, which enable smallholders to access finance from a range of sources, including through data-sharing partnerships with FSPs. Back-end technologies like artificial intelligence (AI), IoT and big data and analytics, are powering multiple use cases, such as smart farming and DFS, and making advisory services more intelligent.

Poor access to markets

Most smallholder farmers operate in informal value chains with inadequate access to markets and buyers. In the absence of strong value chains, institutional buyers, transport, storage infrastructure and formal financing mechanisms, intermediaries serve as both off-takers and providers of short-term, informal financing for farmers. Intermediaries aggregate produce from farmers, often buying it at below market prices and selling it to large-scale buyers at much higher prices, taking a disproportionately large share of the profits. Without access to viable financing options, many farmers are left with no choice but to borrow money from intermediaries to purchase inputs or hire machinery and tools at high interest rates. This then compels farmers to sell their produce to the intermediary to recover the loan, trapping them in a vicious cycle of debt.

Enabling better access to formal markets reduces farmers' dependence on intermediaries and allows them to sell their produce at more competitive prices. Agriculture e-commerce platforms provide a vital opportunity for farmers in informal value chains to access new buyers and formal markets, bypass multiple intermediaries and reshape the power dynamics. This, in turn, saves time and costs, potentially giving them a wider choice of buyers and a higher margin of what consumers pay.[31]

Enabling better access to markets is also important for farmers already operating in formal value chains. **Commercial farmers are increasingly benefiting from digital procurement tools that enable them to transition from paper to digital. From improving transparency and traceability in the agricultural last mile to reducing inefficiencies in crop procurement for both agribusinesses and farmers, digitising processes and systems has far-reaching effects.** Some digital procurement tools may integrate mobile money to enable payments to farmers and the collection of transactional records, such as digital receipts. Alternatively, value chain actors like agribusiness field agents can use digital procurement solutions to generate digital footprints of farm and farmer data, from transactions to identification and geolocation data. In partnership with FSPs, this data can inform the assessment of farmer creditworthiness for financial services.[32]

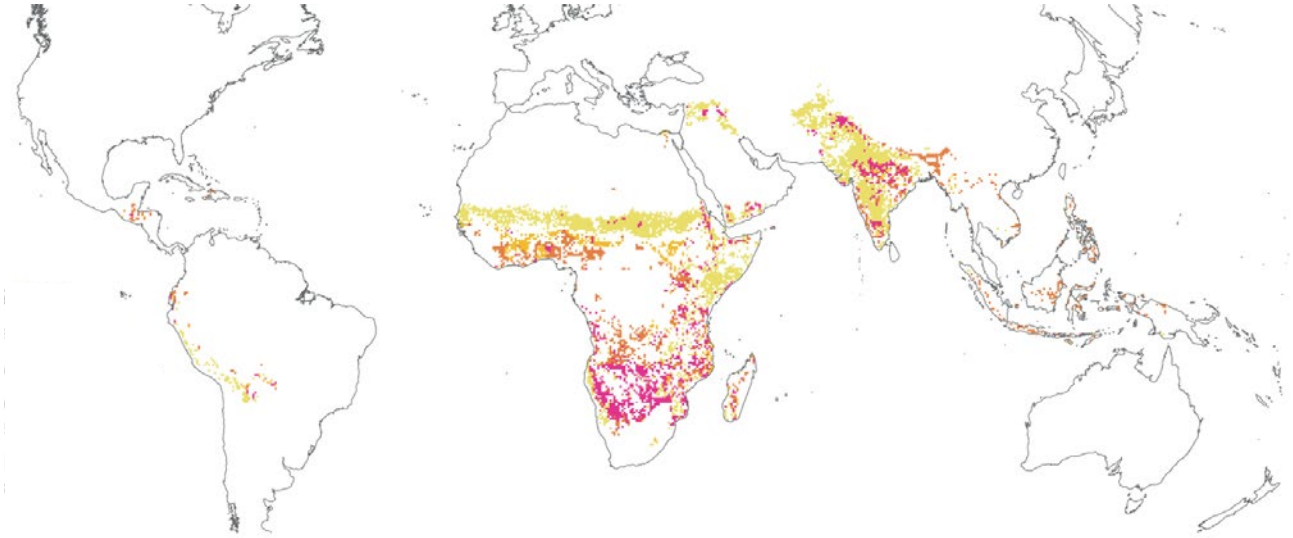
Climate change

Agriculture is highly dependent on regional climates. Variations in regional climate due to climate change, including changing rainfall patterns, drought, flooding and the geographical distribution of pests and diseases, will therefore ultimately affect agriculture. **Smallholder farmers in LMICs are particularly vulnerable given their reliance on natural resources and exclusion from social protection schemes** (Figure 10).

31 GSMA AgriTech (2019), *E-commerce in agriculture: new business models for smallholders' inclusion in the formal economy*.
32 GSMA AgriTech (2020), "Digital footprints and economic identities for farmers", *The GSMA AgriTech Toolkit for the Digitisation of Agricultural Value Chains*.

Figure 10

Areas of high agricultural risk for different climate hazards in vulnerable areas[33]



Climate hazards

High climate variability | Growing season reductions | High temperatures during growing season | Combination of two or more climate hazards

Source: Global Commission on Adaptation, 2019

Access to information, such as localised weather forecasts and agro-climatic advisory, combined with access to financial services, like weather and crop insurance, can enable smallholder farmers to build climate resilience and withstand the effects of climate change. There is an opportunity for smart advisory providers to expand existing services and offer insurance services or vice versa, either directly or through partnerships. For example, Agri VAS provider EcoNet's existing weather indexed insurance product (EcoFarmer) could incorporate localised agro-climatic advisory and weather information to strengthen its value proposition for farmers.

To build climate resilience, boost productivity and increase incomes, it is important for farmers to have access to physical assets, such as specialised farming equipment, irrigation systems and tillage equipment. These assets are becoming increasingly accessible to smallholder farmers as part of the digitally enabled shared economy, or pay-as-you-go (PAYG) models. The sharing economy for smart farming equipment and assets is rapidly gaining momentum in LMICs. Since first appearing in 2013, there are now over 20 asset-sharing platforms providing smallholder farmers access to a range of mechanised farm equipment and drones for various activities, such as crop spraying.

PAYG models allow farmers to request, schedule and prepay for services via a mobile phone. The platforms provide equipment owners enhanced security through remote asset tracking and virtual monitoring. Drones for crop mapping, crop monitoring and crop spraying are becoming more accessible through the shared economy. Examples of companies offering drone services are **Poladrone** in Indonesia, Thailand, Vietnam and Malaysia, **AcquahMeyer** in Ghana and **BeatDrone** in Nigeria. Agritech companies like **SunCulture** in Kenya are offering farmers access to PAYG solar-powered irrigation systems, making them more affordable. The proliferation of mobile money makes it possible for companies to provide the equipment to farmers and collect variable payments over time rather than a lump sum purchase.

Digital agriculture solutions have the potential to transform the agriculture sector in LMICs by closing the knowledge gap, expanding financial inclusion, improving access to markets and strengthening climate resilience. By enabling access to a range of services, markets and assets, digital solutions can unlock opportunities for smallholder farmers to boost productivity and income. In the sections that follow, we discuss key trends emerging at the global level within each of the five digital agriculture use cases and 24 sub-use cases.

33 Global Commission on Adaptation (2019), *Adapt Now: A Global Call For Leadership On Climate Resilience*.

DEEP DIVE
The importance of inclusive service design

Human Centred Design (HCD), or user-centred design, is an approach to product and service development that can ensure digital agriculture tools address the specific pain points of different users. HCD involves designing products and services around user needs and preferences, identifying the most suitable technology to deliver them and implementing a viable marketing and pricing strategy to target different users. By putting users and their experience at the centre of the design process, HCD ensures continuous and structured interactions with the service features. Users are engaged at every step in product development, from early stages of identifying opportunities and generating concepts, to advanced stages of product realisation, execution and scaling.[34]

HCD is critical to ensure that digital agriculture services are inclusive. Users of digital agriculture tools are diverse — women and men, young and old, physically able and disabled, tech savvy and non-tech savvy, literate and illiterate. It is therefore critical to design digital agriculture products and services with multiple users in mind and recognise that their needs vary. For example, rural women often have lower levels of education and digital literacy, limited mobility and less access to technology (including using and owning mobile phones), resources (financial and other) and land ownership. It is important to identify these gender inequalities and address them with products and services that are more inclusive, without putting the onus on women to overcome usage barriers like travel or gender norms.

For digital advisories, the style of content delivery is as important as the quality of the information itself. Inclusive design for this type of digital agriculture service requires special attention to content stylisation,[35] or conveying scientific information in a way that is understandable, engaging and actionable. Adapting the content to the local population's culture, communication style and traditions enhances user engagement and, in turn, drives uptake and produces the desired impact on farmer behaviour.[36]

34 GSMA mAgri and frog design (2015), *The mAgri Design Toolkit: User-centered design for mobile agriculture*.
35 GSMA mAgri (2016), *Agricultural Value-added Services (Agri VAS) Toolkit 2.0*.
36 To convey agronomic information through its IVR-based M'chikumbe 212 service in a way that engaged the target audience and was more easily understood, Airtel Malawi created short stories set in a typical Malawian smallholder community (dialogue with background music). A similar approach has been taken by Telenor Pakistan with its Khushaal Zamindar service.

3 Digital agriculture: Global and regional trends

Digital advisory services first appeared in the late 1990s in response to the need to overcome the knowledge gaps limiting farmers' productivity. Since then, the range of solutions in the digital agriculture landscape has evolved rapidly and become increasingly sophisticated (Figure 11).

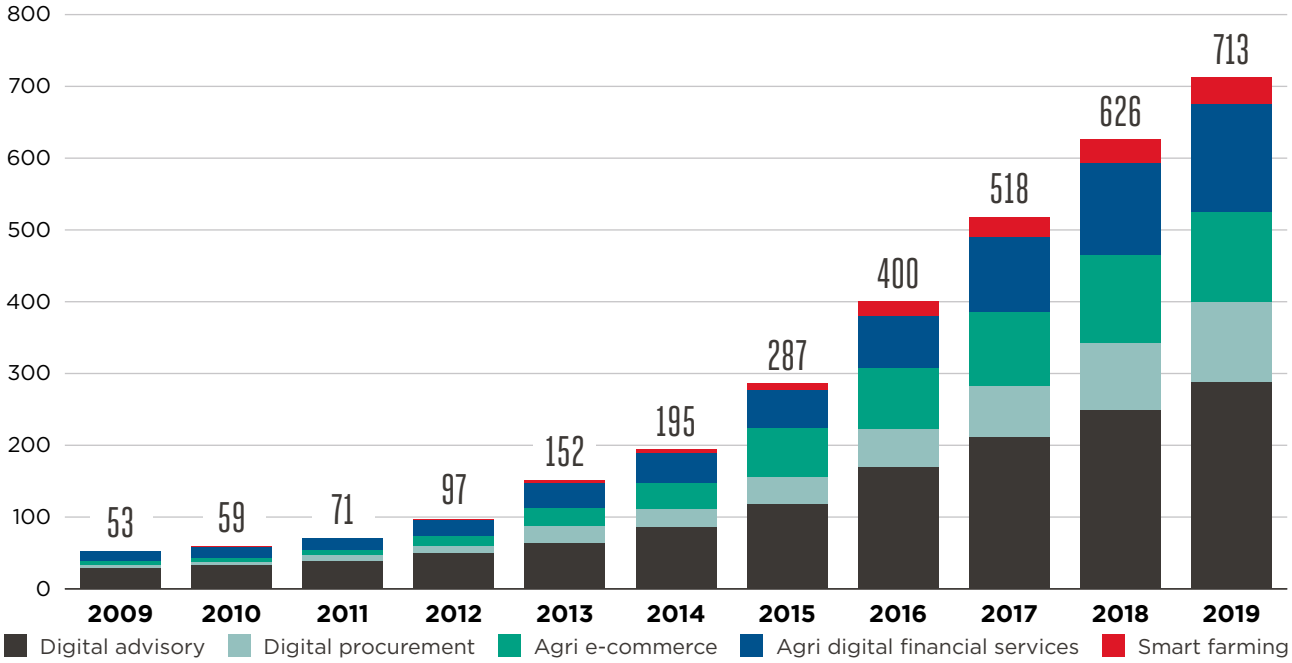
The uptake of mobile money in the last decade has enabled opportunities for MMPs, including MNOs, to work on use cases tailored to the rural sector. According to the GSMA's 2019 Mobile Money Global Adoption Survey, "around 10 per cent of mobile money providers globally have partnerships with companies in the agricultural sector, such as agribusinesses and cooperatives, to digitise value chain payments to smallholder farmers." [37]

A greater focus on enabling access to markets, rather than simply providing market prices, has boosted both digital procurement and agri e-commerce solutions. The availability of digital payment solutions like mobile money, as well as those provided by fintech companies in non-mobile money markets, have made it easier for these solutions to proliferate. Tech enablers, such as application programming interfaces (APIs) have also opened a range of new possibilities, for example, mobile money integration that also supports solutions like smart farming PAYG services.

37 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.

Figure 11

Number of active digital agriculture services by use case, 2009–2019



The emergence of new use cases over time has created a fragmented digital agriculture space in which the pattern and pace of change has varied across regions. This reflects the predominant types of value chains in a region or specific country and its enabling environment. The factors shaping a country's enabling environment include the level of tech innovation, the extent to which these innovations have reached the agricultural sector, the regulatory environment and the investment and partnership opportunities to test and scale services.

The push to deploy digital tools in the last mile is strongest in structured value chains for cash crops, such as coffee, tea, cocoa and dairy. It is in formal value chains like these that agribusinesses have established relationships with smallholder farmers and have a keen interest in making both production and procurement activities more visible and reducing the cost of operating in cash by digitising payments to farmers. Formal value chains also have strong connections to international markets where demand is growing for "farm-to-fork" traceability in food chains and, in turn, drives the need to digitise value chains. Informal value chains, in which staple crops like maize, rice, fruit and vegetables are more widely grown and sold, have different challenges, such as fragmentation in the last mile and inconsistent demand. These challenges are increasingly being addressed by e-commerce platforms.

The presence of a vibrant tech sector creates a conducive environment for tech innovation in the agriculture sector, provided there is a focus on addressing the needs of smallholder farmers and value chain actors. Back-end tech innovations, such as big data, analytics and AI, power different digital agriculture use cases. Regional innovation hubs that have a strong focus on smallholder agriculture because of the importance of the sector to the country's GDP and/or labour force, such as India, Nigeria and Kenya, have seen innovation spin off to the agriculture sector. Nigeria, for example, has over 85 tech hubs around the country[38] that have supported the emergence of over 80 agritech companies in the last 10 years.[39] However, in countries with otherwise high levels of tech innovation, such as Egypt and Tunisia, there is limited focus on smallholder agriculture, causing the agritech sector to lag behind.

An enabling regulatory environment for transformational technologies like mobile money facilitates high levels of innovation in digital financial services. It also helps use cases become more viable given the availability of digital payment solutions, such as e-commerce and smart farming. In the case of IoT, favourable regulatory frameworks are supporting innovation in smart advisory and smart farming solutions as the technology becomes more readily available to start-ups. Progressive regulations like

38 Giuliani, D. and Ajadi, S. (10 July 2019), "618 active tech hubs: The backbone of Africa's tech ecosystem", *GSMA Mobile for Development Blog*.
39 GSMA AgriTech (2020), *AgriTech in Nigeria: Investment opportunities and challenges.*

Tunisia's Start-up Act[40] can also boost socio-economic development and expand technological infrastructure by making it easier to access funding and simplifying the process of creating and liquidating a company, which encourages entrepreneurship.

MNOs such as Safaricom in Kenya and EcoNet in Zimbabwe, which have been serving the agriculture sector with the **DigiFarm** platform and **EcoFarmer** portfolio of services respectively, are creating an enabling environment by providing agritech companies a significant opportunity to scale services through mobile money API integrations and/or partnerships. This allows agritechs to leverage key MNO assets like an established user base and distribution network, reputable brand, local market knowledge, established relationships with local banks and governments, and customer and transaction data.

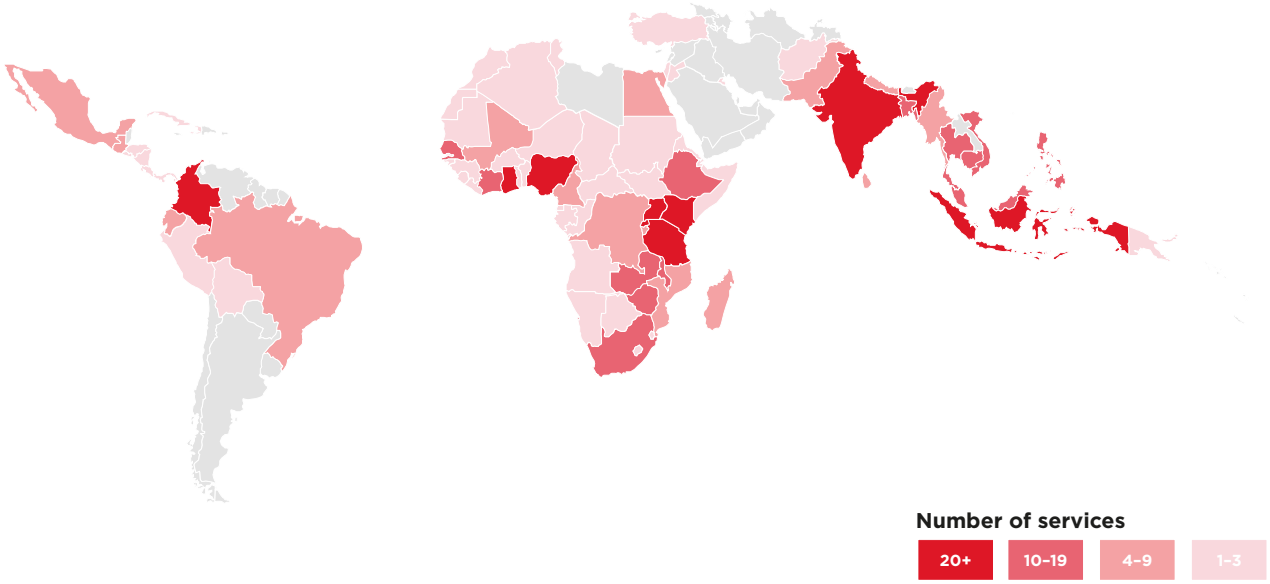
In the absence of MNO involvement in a mobile money ecosystem, as in Nigeria, the potential for agritech companies to scale is extremely limited. For example, **TROTRO tractor**, an asset-sharing company that gives farmers on-demand access to tractors using a PAYG model, offers a standalone service in Ghana while in Zimbabwe it operates through a partnership with EcoNet as part of the EcoFarmer portfolio. Since launching in Ghana in 2016, the company has onboarded 400 tractor owners and 21,000 farmers. In Zimbabwe, however, the partnership with EcoNet opened access to mobile money and 2,000 tractor owners and 70,000 farmers were onboarded in less than a year. The mobile money asset is therefore vital to making the PAYG model work for service providers.

The need to test commercially sustainable business models and scale services is another important enabling factor for digital agriculture solutions. Donor and investor funding is also crucial, however, as investing in agritech requires commercial patience and a long-term vision for growth and expansion. Successful agritech companies have developed significant expertise in the agriculture sector and are often very involved in on-the-ground activities (e.g. onboarding, education and mobilisation of farmer and value chain actors), making them resemble agriculture sector companies more than a technology venture. Regions such as East Africa have benefited from donor and investor attention, which has contributed to the widespread growth of services in the region.

The map in Figure 12 uses GSMA AgriTech data to show the global prevalence of active digital agriculture services in LMICs across all use cases in January 2020. There is significant variation in the number of active services in countries that are experiencing more traction (20+ services). Kenya has the highest number of deployments with 95 active services, followed by India with 68, Nigeria with 47 and Ghana with 45. The lowest in that category is Colombia, which has 21 services.

Figure 12

Global map of active digital agriculture services, January 2020*

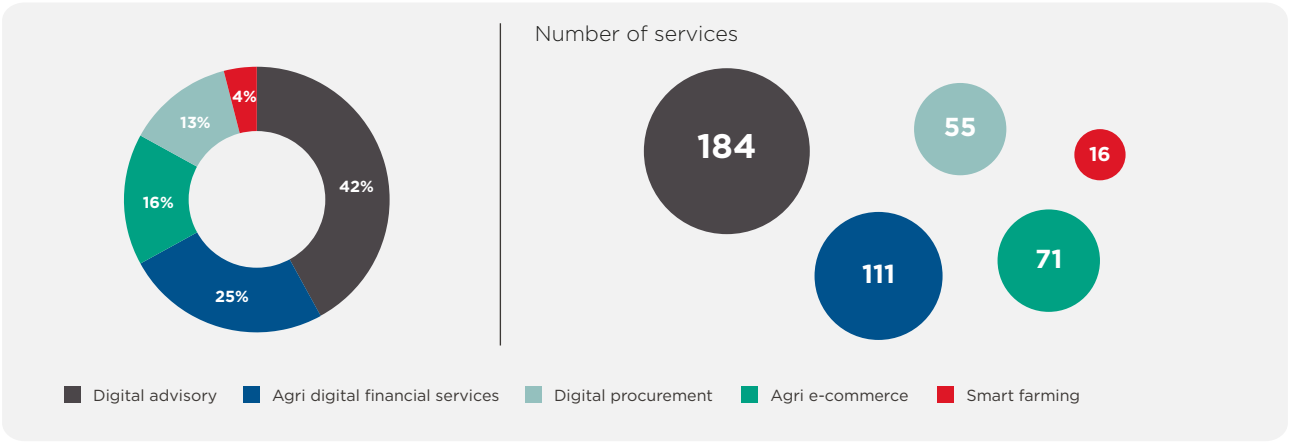


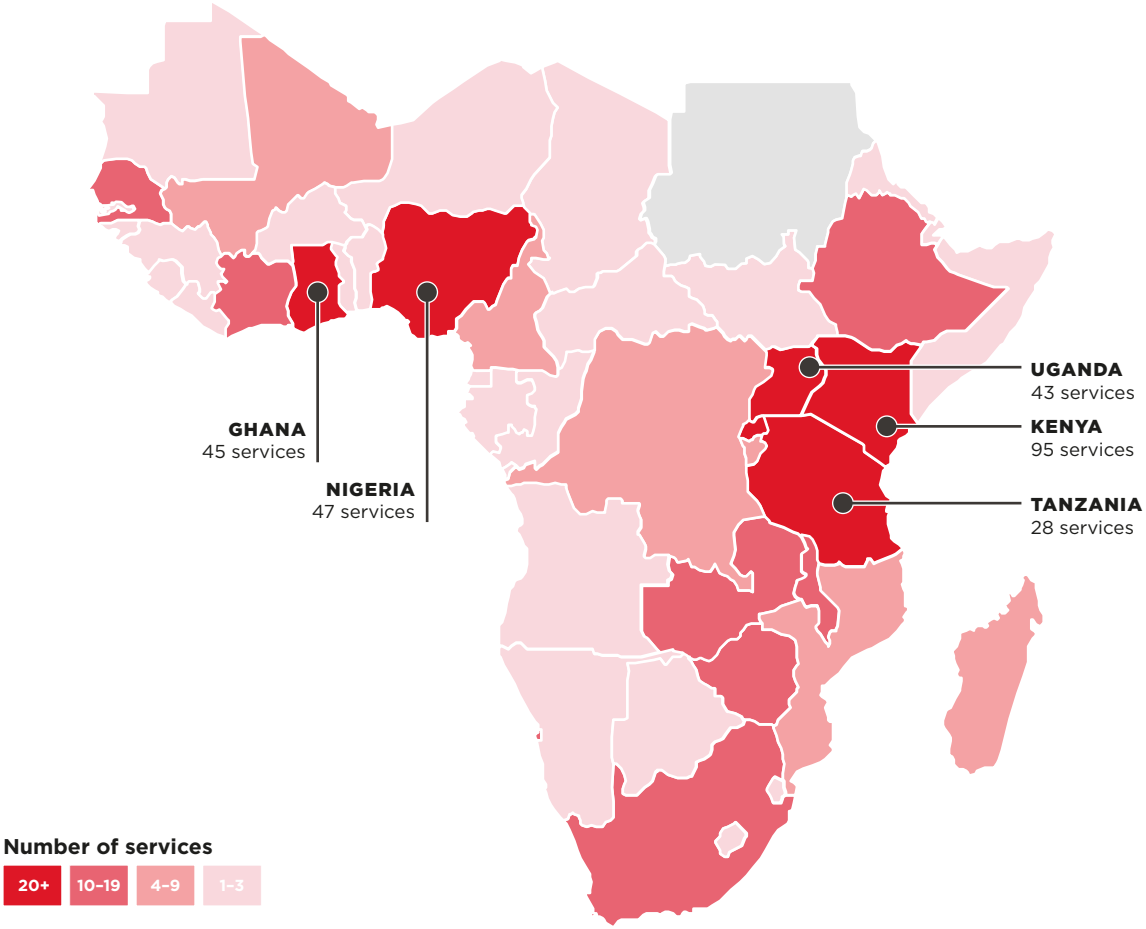
* Grey indicates either no data is available for the country or the country is not a LMIC

40 The Tunisian Start-up Act: https://carnegieendowment.org/sada/76685

Figure 13

Regional map of active digital agriculture services by use case, Sub-Saharan Africa, January 2020





Digital advisory	Agri digital financial services	Digital procurement	Agri e-commerce	Smart farming
ThirdEye – Mozambique, Kenya	**Agri360** – Zambia	**TaroWorks** – Kenya, Nigeria	**eMiska** – Zambia	**AcquahMeyer Agricultural Drone Services** – Ghana
Vodacom 4502 (3-2-1) – Democratic of Congo	**Agri PME** – Togo	**mFarmer** – Uganda, Rwanda	**FarmFresh** – The Gambia	**Kóbiri** – Guinea Conakary
CowTribe – Ghana	**CashCard** – Nigeria	**WeightCapture** – Côte D'Ivoire, Kenya, Nigeria, Tanzania	**IzyShop** – Mozambique	**HelloTractor** – Nigeria
EzyAgric – Uganda	**FarmDrive** – Kenya	**AgroMall** – Nigeria	**Jinukun** – Benin	**WeFlyAgri** – Côte D'Ivoire
mAgri – Botswana	**Bayseddo** – Senegal	**Metajua** – Uganda, Tanzania, Rwanda, Burundi, DRC, Madagascar	**HeheMart** – Rwanda	**EcoFarmer Vaya Tractor** – Zimbabwe

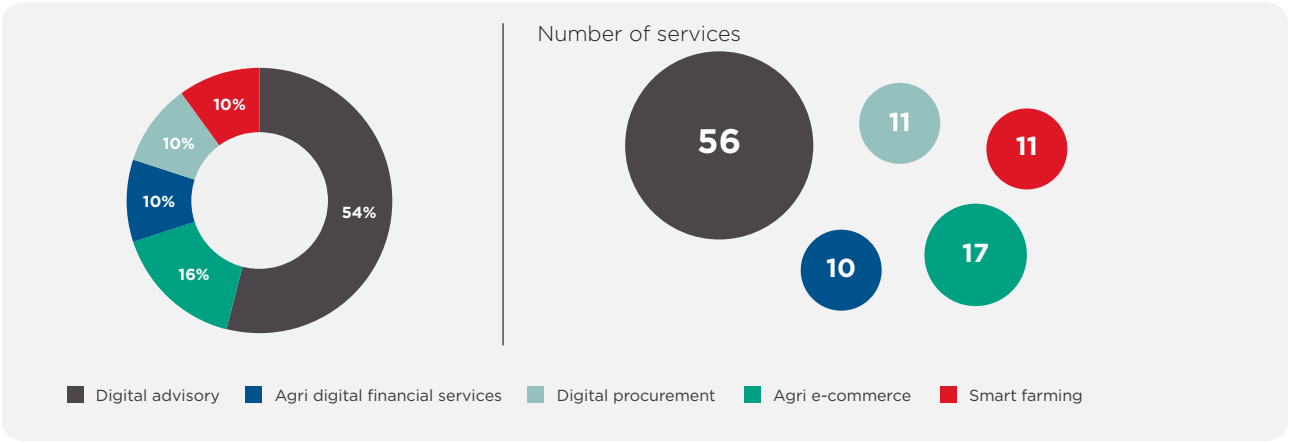
In Sub-Saharan Africa, digital advisory remains the most dominant digital agriculture use case, although agri digital financial services have experienced considerable growth, from 52 services in 2015 to 150 in 2019 (Figure 13)**. This growth has been driven by the prevalence of mobile money across many markets**. Mobile money has made it viable to provide financial services via mobile phones and extend the reach of services to farmers, a customer segment once considered too difficult and expensive to serve by traditional FSPs. However, this growth has been largely concentrated in East Africa where mobile money adoption is more widespread. Of the 111 digital financial services targeted at the agriculture sector in Sub-Saharan Africa, 49 are in just five countries: Kenya, Uganda, Tanzania, Burundi and Rwanda.

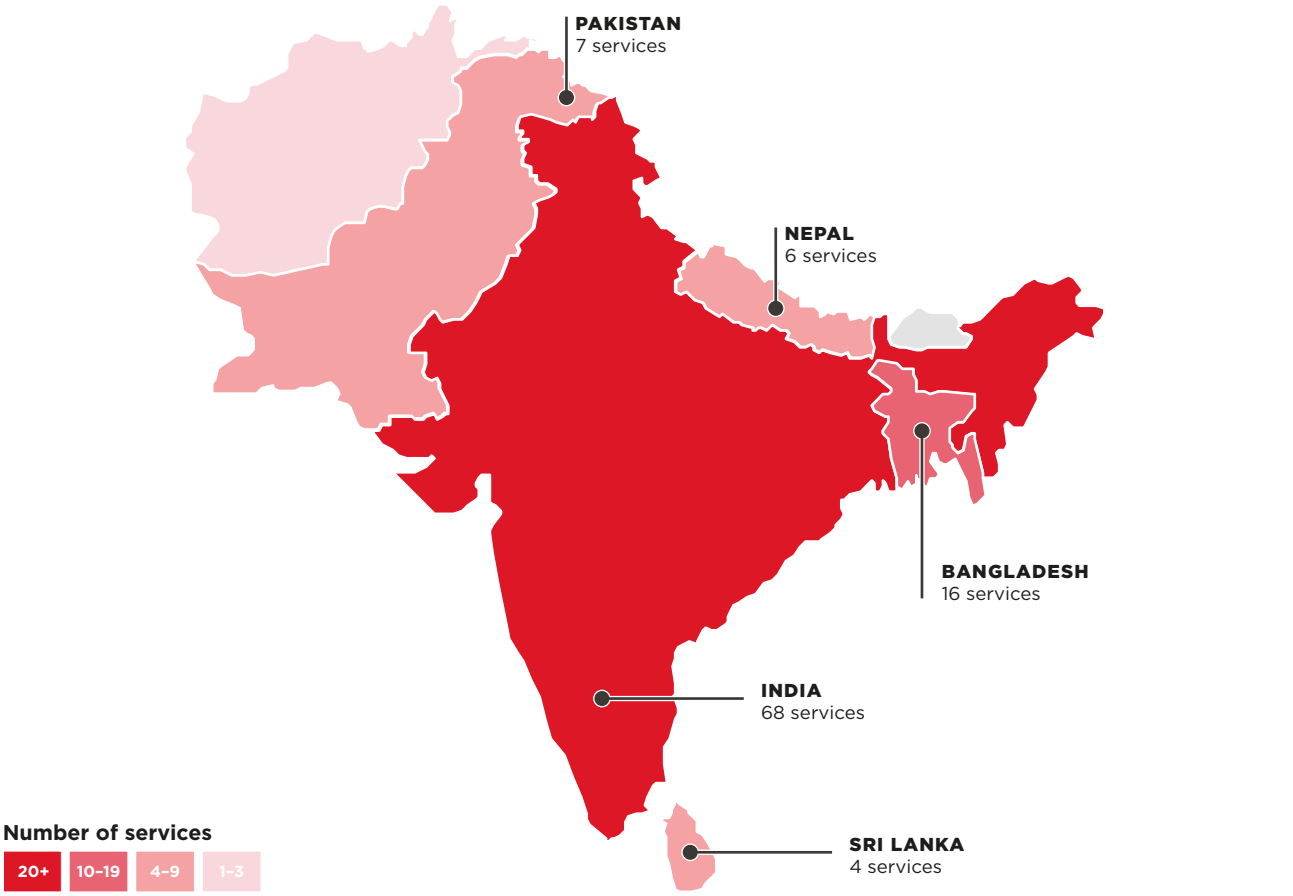
The number of agri e-commerce services has grown rapidly across Sub-Saharan Africa, from three in 2009 to over 70 in January 2020. This growth has been more evenly distributed than mobile money adoption and use. Driven by the dynamics of supply and demand, the growth in agri e-commerce demonstrates the need to build more agile value chains that connect farmers directly with growing local consumer and urban markets.

Digital procurement has also grown significantly where there are strong formal value chains — 44 of the 55 solutions are concentrated in a handful of countries in East and West Africa. While smart farming has taken off in Sub-Saharan Africa, most of the services enable smart shared assets, with a few examples of equipment monitoring solutions, such as **SunCulture**'s solar irrigation system and **Illuminum Greenhouses**' automated solar-powered greenhouse solution. The region has suffered from a lack of scalable IoT networks and the challenge of developing business models for IoT services with smallholder farmers as the main customer. As a result, livestock and aquaculture management solutions have lagged significantly behind (see section 4.5 for more detail).

Figure 14

Regional map of active digital agriculture services by use case, South Asia, January 2020





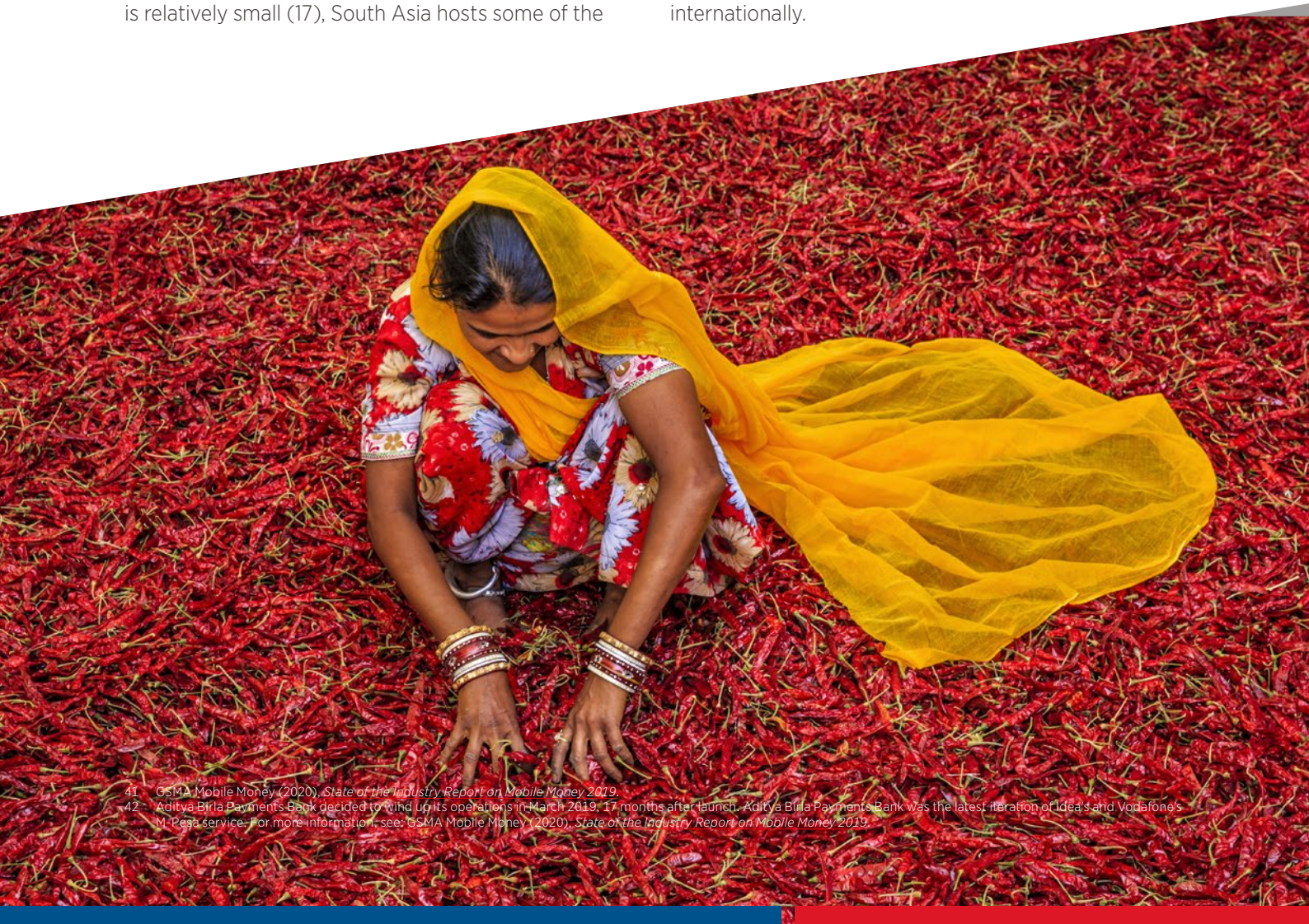
Digital advisory	Agri digital financial services	Digital procurement	Agri e-commerce	Smart farming
Khushaal Zamindar – Pakistan	**The LenddoScore** – India	**Agri-Gate** – Sri Lanka	**Ricult** – Pakistan	**Cowlar** – Pakistan
GeoKrishi – Nepal	**Green Delta's Weather Index Based Agriculture Insurance** – Bangladesh	**NeoInt** – India	**Chadal** – Bangladesh	**Nano Ganesh** – India
Krishi Sheba – Bangladesh	**iFarm app** – Sri Lanka	**SmartMoo** – India	**Ninjacart** – India	**SmartFarm** – Bangladesh
Govi Mithuru – Sri Lanka	**iFarmer** – Bangladesh	**Datagreen solutions** – India, Bangladesh	**Go4Fresh** – India	**Cowdy** – Bangladesh
Malomat m-agriculture service – Afghanistan	**farMart's agricultural loans** – India	**AgriBuddy** – India	**Farm to Home** – Pakistan	**Hello Tractor** – Pakistan

South Asia was one of the first regions to launch and scale digital advisory solutions, and is therefore home to some of the most established services. While other use cases are growing rapidly, agri digital financial services have been slower to take hold due to low mobile money adoption (Figure 14). MNOs in the region have played a leading role in the establishment of the Agri VAS model and delivering information services to farmers. However, other service providers are deploying services successfully, too. Telenor Pakistan's **Khushaal Zamindar** service over 10 million registered users, of which 7.5 million are active 30-day users, Tata Consultancy Services' InteGra service in India has over two million users and Grameenphone's **Krishi Sheba** service has nearly one million users.

Innovations from across the region have crossed over into other use cases. Smart farming services for livestock care and management have emerged in the last few years, driven by the importance of livestock farming to South Asian economies. One example is Stellapps' **MooOn** solution, which uses a collar placed around a cow's neck to detect and predict when a cow goes into oestrus, as well as various disorders based on their activities and resting behaviour. While the number of agri e-commerce services in the region is relatively small (17), South Asia hosts some of the largest agri e-commerce platforms in LMICs. Growth in agri e-commerce has been driven by a few well-established companies that have benefited from larger banked populations that boost demand in urban areas. Improvements in logistics and road networks are also contributing to the uptake of e-commerce overall (see section 4.4).

Agri digital financial services have grown relatively slowly, with only 10 active services across the region. One reason has been the slower proliferation and lower adoption of mobile money services, which grew by just 3.9 per cent in 2019, compared to Sub-Saharan Africa and Southeast Asia, which registered growth rates of 11.9 per cent and 23.8 per cent, respectively.[41] The challenging regulatory and operating environment in India — a big potential market — has also limited the growth of mobile money services and several players have closed operations altogether.[42]

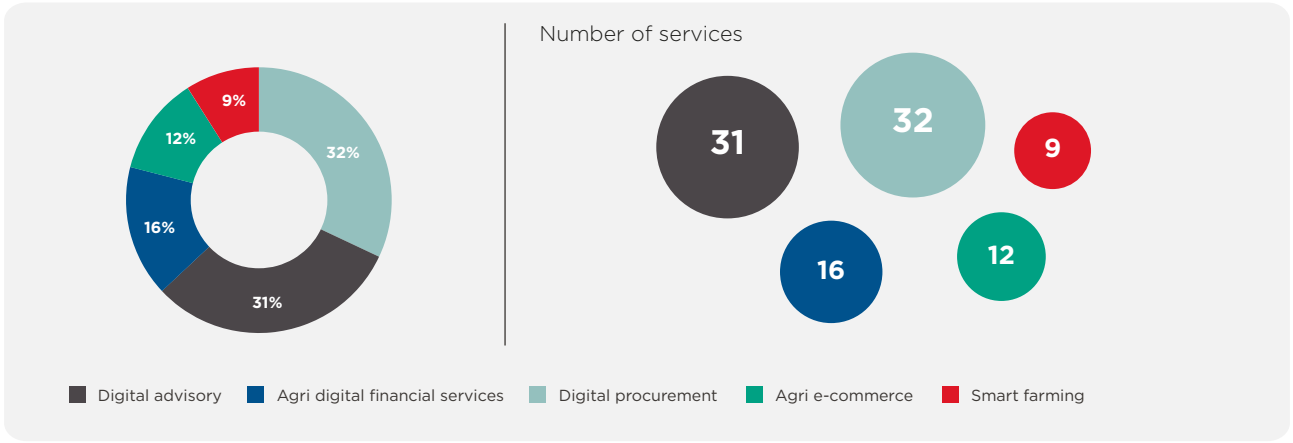
Digital procurement has seen a smaller increase in the number of services, with 11 active services in South Asia in 2019 compared to other regions. However, several providers based in the region, such as **CropIn** and **SourceTrace**, are among the most established and provide multiple services domestically and internationally.

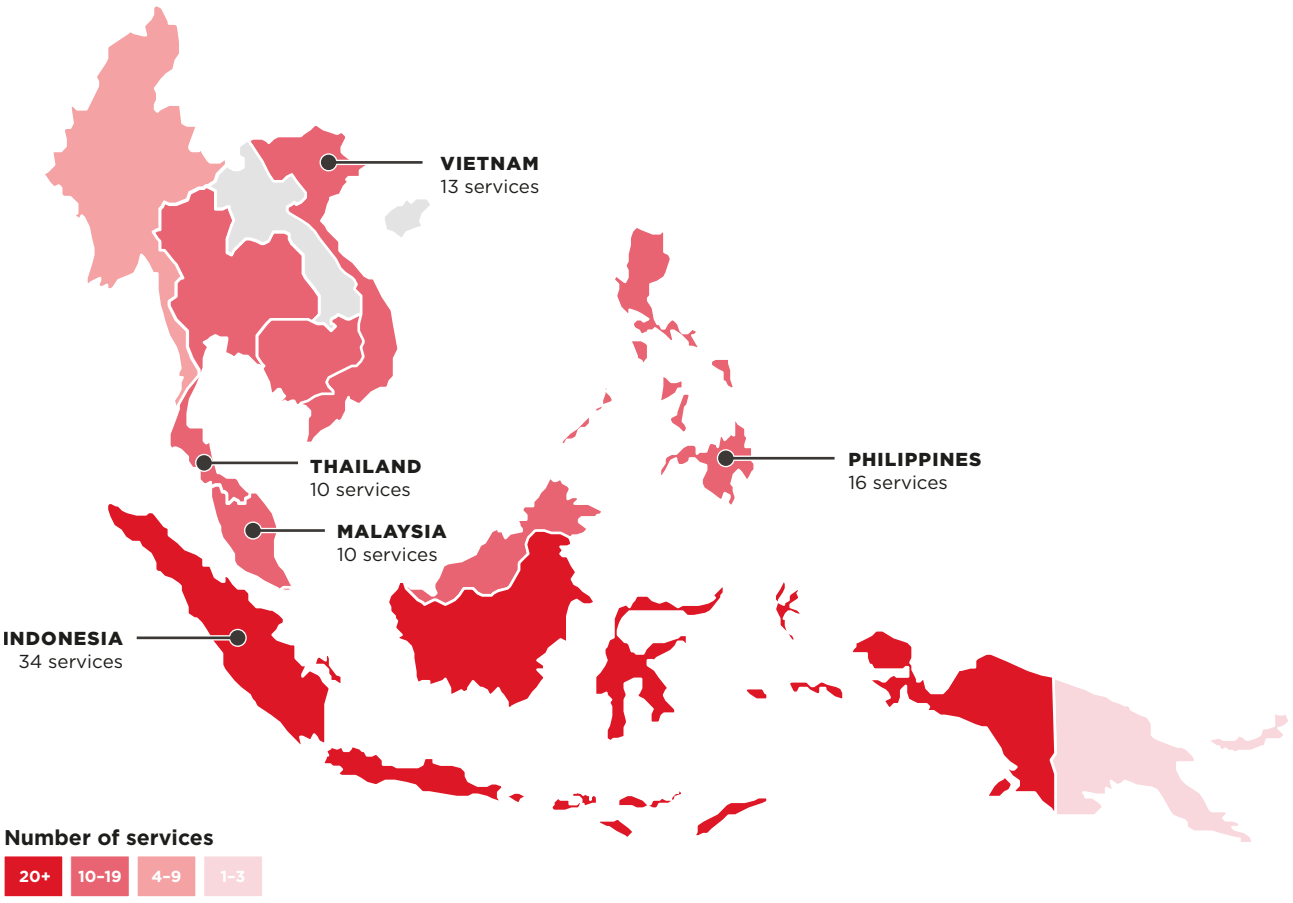


41 GSMA Mobile Money (2020). *State of the Industry Report on Mobile Money 2019*.
42 Aditya Birla Payments Bank decided to wind up its operations in March 2019, 17 months after launch. Aditya Birla Payments Bank was the latest iteration of Idea's and Vodafone's M-Pesa service. For more information, see: GSMA Mobile Money (2020). *State of the Industry Report on Mobile Money 2019*.

Figure 15

Regional map of active digital agriculture services by use case, Southeast Asia, January 2020





Digital advisory	Agri digital financial services	Digital procurement	Agri e-commerce	Smart farming
Agrimedia – Vietnam	**FarmTrek** – Myanmar	**SimpleAgri** – Indonesia, Malaysia, Thailand, Philippnes	**B2BPriceNow** – Philippines	**Jala** – Indonesia
FarmerLink – Philippines	**Binhi Crop Insurance** – Philippnes	**NeoInt** – Indonesia, Philippines, Malaysia	**FreshKet** – Thailand	**Tun Yat** – Myanmar
MyCrop – Indonesia	**FarmCloud** – Indonesia, Philippnes, Cambodia	**AgUnity** – Papua New Guinea, Indonesia, Solomon Islands, Vietnam	**FarmRetail** – Philippines, Cambodia	**MimosaTek** – Vietnam
GoldenPaddy – Myanmar	**Crowde** – Indonesia	**Olam's digital Solutions** – Vietnam, Indonesia	**TaniHub** – Indonesia	**PolarDrone** – Indonesia, Thailand, Vietnam, Malaysia
CropBASE – Malaysia	**The Lenddo Score** – Thailand, Philippines, Vietnam, Indonesia, Malaysia	**ScanTrust Knorr app** – Vietnam	**Talad** – Thailand	**Smarternak** – Indonesia

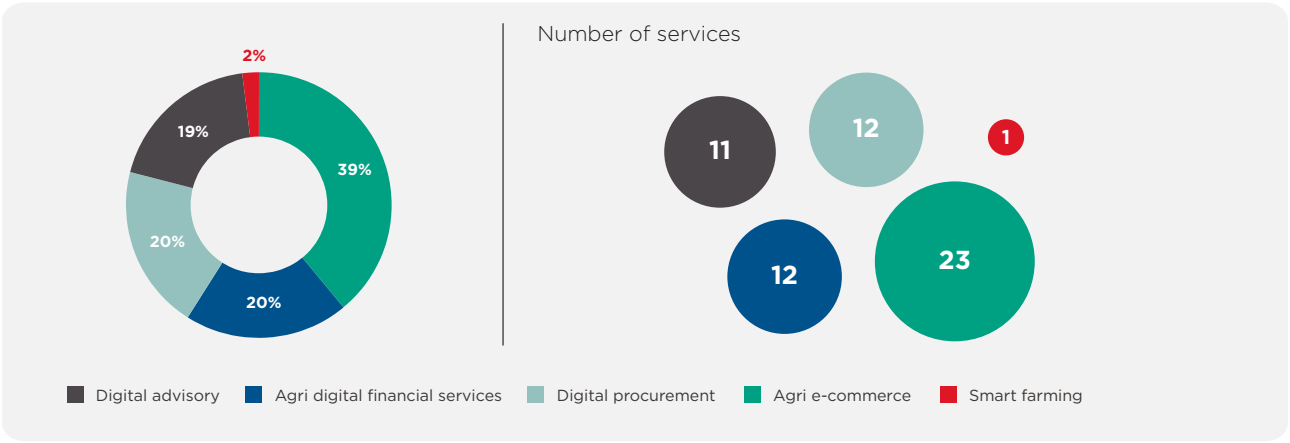
Compared to other regions, digital procurement is well established in Southeast Asia, second only to digital advisory by number of active services. This trend is driven by the relative prevalence of strong commercial value chains in the region (Figure 15). Smart farming is also growing significantly, from three services in 2015 to nine in 2019, due to the wider adoption of IoT as mobile IoT networks have expanded. This has enabled a range of highly specialised services to develop, such as **MimosaTek**'s smart irrigation solution for crops, **e-Fishery**'s automated fishpond monitoring and automated feeding solution, **Dycodex**'s **Smarternak**, a cattle care and management solution and **Tun Yat**'s smart shared asset solution that enables access to farming equipment. The region also has some of the most advanced economies in emerging markets, such as Indonesia, Thailand and Malaysia, accompanied by comparatively high levels of smartphone adoption and digital literacy, which make such services more easily accepted.

After a slow start compared to other use cases, agri digital financial services are growing rapidly, especially in the last four years. The number of services has more than doubled from six in 2015 to 16 in 2019. Although mobile money solutions are not yet widespread, Southeast Asia recorded the highest regional growth in 2019 in both registered and active accounts.[43] Innovative use of digital agriculture data generated from digital procurement tools is also taking hold, enabling financial inclusion in countries such as Indonesia[44] and Myanmar,[45] with credit-scoring solutions seeing the most uptake.

43 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.
44 GSMA AgriTech (2019), *Agtech Innovation Unlocks Economic Identities for Smallholder Farmers in Indonesia*.
45 GSMA AgriTech (2020), *Digital credit scoring for farmers: Opportunities for agritech companies in Myanmar*.

Figure 16

Regional map of active digital agriculture services by use case, Latin America and the Caribbean, January 2020



Digital advisory	Agri digital financial services	Digital procurement	Agri e-commerce	Smart farming
Arable Mark 2 – Mexico, Colombia, Brazil, Uruguay	**Yapu Smart Finance** – Bolivia, Ecuador, Colombia, Costa Rica	**Farmforce** - Haiti, Guatemala, Ecuador	**Smattcom** – Mexico, Colombia, Ecuador, Guatemala, Brazil, Panama, Bolivia, Cuba, Costa Rica, Honduras, Nicaragua	**UmitronCELL** – Peru
MasAgro Móvil – Mexico	**Coffee Growers' Smart ID Card** – Colombia	**TaroWorks** – Colombia	**Frubana** – Colombia, Mexico, Brazil	
Sustainable Coffee Verification – Guatemala, Honduras, Nicaragua, Costa Rica, Colombia	**EthicHub** – Mexico	**Olam's digital Solutions** – Guatemala, Nicarauga, Brazil, Colombia	**Mucho** – Colombia	
e-kakashi Smart Rice – Colombia	**Faces Microfinanzas** – Ecuador	**AgUnity** – Guatemala	**SiembraViva** – Colombia	
Farmapp – Colombia, Ecuador	**IncluirTec** – Colombia	**SimpleAgri** – Colombia	**Accesso** – Haiti, El Salvador, Colombia	

In Latin America and the Caribbean, agritech innovation is focused largely on smart farming and tackling challenges faced by large farmers and agribusinesses in agricultural powerhouses such as Brazil and Argentina (Figure 16). However, a growing number of services are aimed at smallholder farmers in countries where agriculture accounts for a greater share of GDP and a greater share of the labour force is active in agriculture, such as Guatemala, Peru and Bolivia. Colombia, a regional tech hub and a country where smallholder farmers have a strong presence,[46] particularly in the coffee value chain, is also gaining traction in the digital agriculture space.

E-commerce is currently the dominant use case in the region, driven primarily by larger banked populations that create demand in urban centres; comparatively better logistics and road networks; and the expansion of a few established agri e-commerce companies, such as **Smattcom**, which operates in multiple markets providing services that connect farmers and buyers. **Despite the potential to scale digital procurement solutions in cash crop value chains, the region lags behind in this area, presenting an opportunity for local agritech start-ups and international companies to enter this space.** Digital financial services designed for and aimed primarily at farmers have experienced staggering growth in the region in the last decade. The number of agri digital financial services providers has doubled from six in 2016 to 12 in 2019. Much of this growth has come from fintech companies, indicating there has been some progress in making digital financial services more widely available in the agricultural sector. A significant proportion of this growth has been in credit-scoring and crowdfunding solutions.

46 Levin, M. (7 June 2019), "Crisis Forces Colombia's Coffee Farmers Fight for Living Wage", *Fresh Cup Magazine*.

4 Digital agriculture: A closer look at the use cases

This section takes a detailed look at each of the digital agriculture use cases and sub-use cases in LMICs, and analyses the key trends and opportunities in the sector (Figure 17). Deployment heat maps show the prominence of use cases in different regions and highlight some of the most established service providers in specific countries. We also track the evolution of different sub-use cases over time. Each use case section concludes with a case study on an established digital agriculture service.

Figure 17

Global overview of active digital agriculture services by use case, January 2020

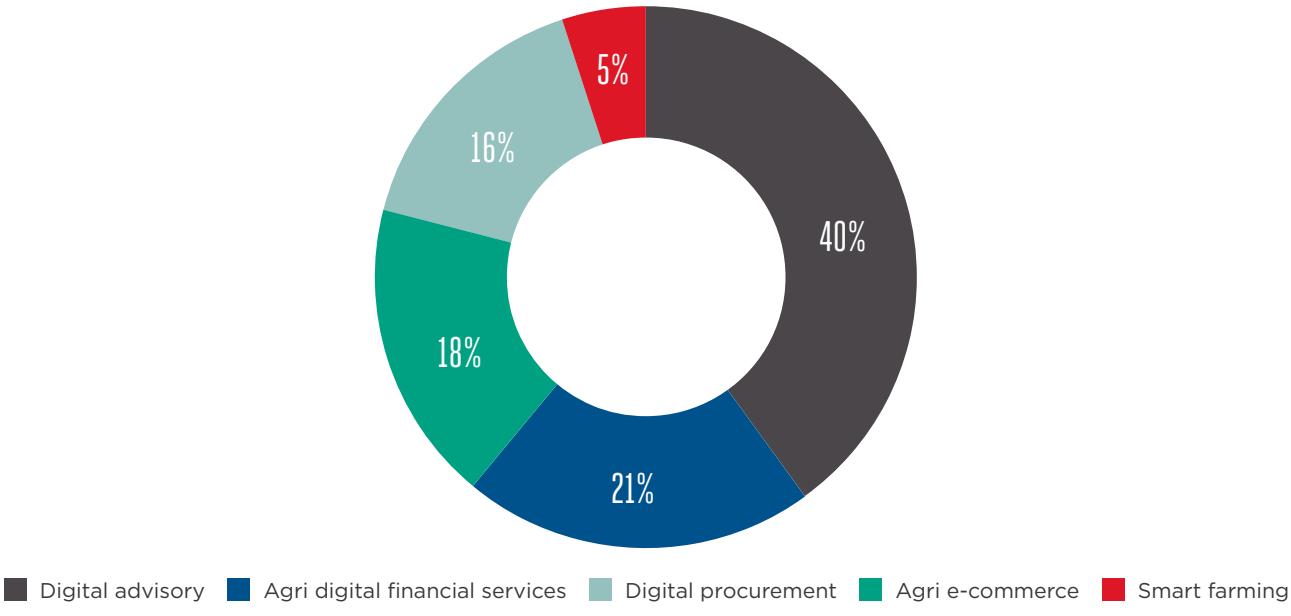


Figure 18

Global map of active digital advisory services, January 2020

1 KENYA
36 services

including:
Digifarm, Arifu, Wefarm

2 INDIA
34 services

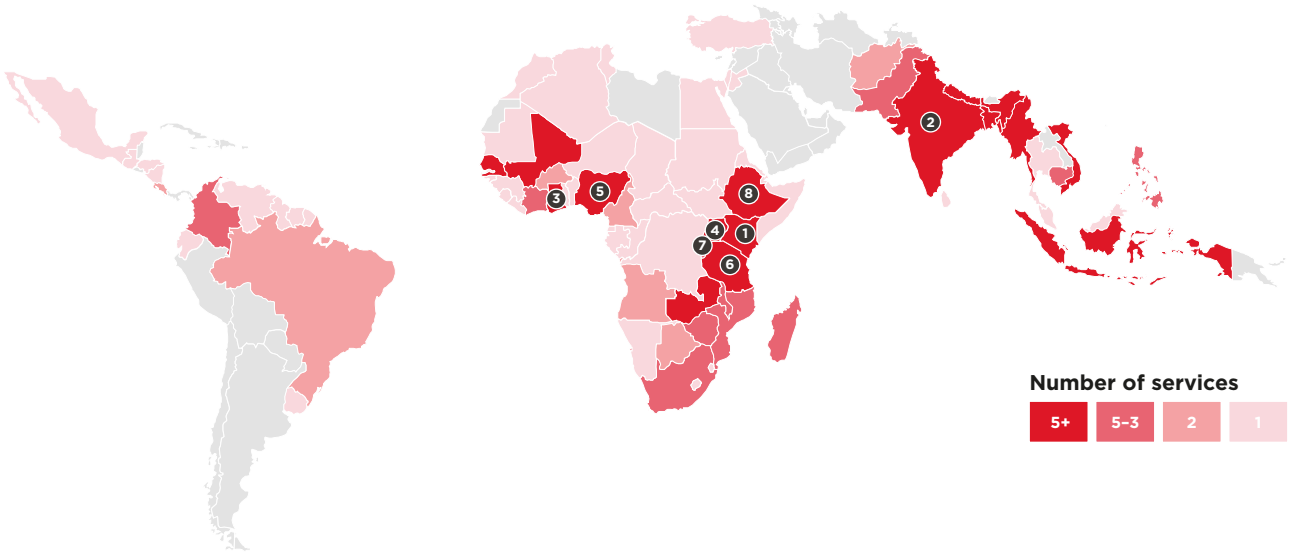
including:
IFFCO Kisan Green SIM, AgroStar, mKRISHI

3 GHANA
21 services

including:
Esoko, Iska, GeoFarmer

4 UGANDA
17 services

including:
Airtel 3-2-1, Wefarm, GeoFarmer



5 NIGERIA
16 services

including:
Airtel 3-2-1, Iska, Zenvus

6 TANZANIA
12 services

including:
Wefarm, Vodacom 3-2-1, Harnessing Agriculture Know How for inputs (HAKIKI)

7 RWANDA
11 services

including:
MTN 3-2-1, Precision Agriculture for Development (PAD), nFrnds mAgri platform

8 ETHIOPIA
11 services

including:
iCow Kalenda, 8028 Farmer Hotline, Precision Agriculture for Development (PAD)

4.1 Digital advisory

While advisory services are still the most prevalent digital agriculture use case, new technologies supporting other types of services are gaining traction.

Digital advisory services first emerged in the late 1990s to address knowledge gaps faced by smallholder farmers. National extension agencies in LMICs have traditionally provided agricultural advisory to farmers, but with a lack of capacity and the challenges of deploying extension officers to remote rural areas, mobile technology has emerged as a cost-efficient way to reach farmers with much-needed agricultural information. The number of advisory services providing farmers with agronomic knowledge, weather predictions and information on market prices has grown from 33 active services in 2010 to 288 in January 2020.

Advisory services are delivered by a range of service providers, including MNOs, Agri VAS providers, NGOs and, in some cases, technology vendors, governments and regulatory agencies, often in partnership with MNOs (Figure 19). Most digital advisory services are still delivered through basic technology channels — SMS, USSD, IVR or OBD — and given the persistent digital literacy challenges in LMICs, voice is still the most popular delivery channel in 2020, followed by SMS.[47] However, rich media, including online content and apps, is growing in popularity, driven by greater mobile internet connectivity and smartphone adoption.[48] A growing number of digital advisory services are now delivered via mobile apps, including some of the early weather information services, while some providers are moving towards app-only solutions.

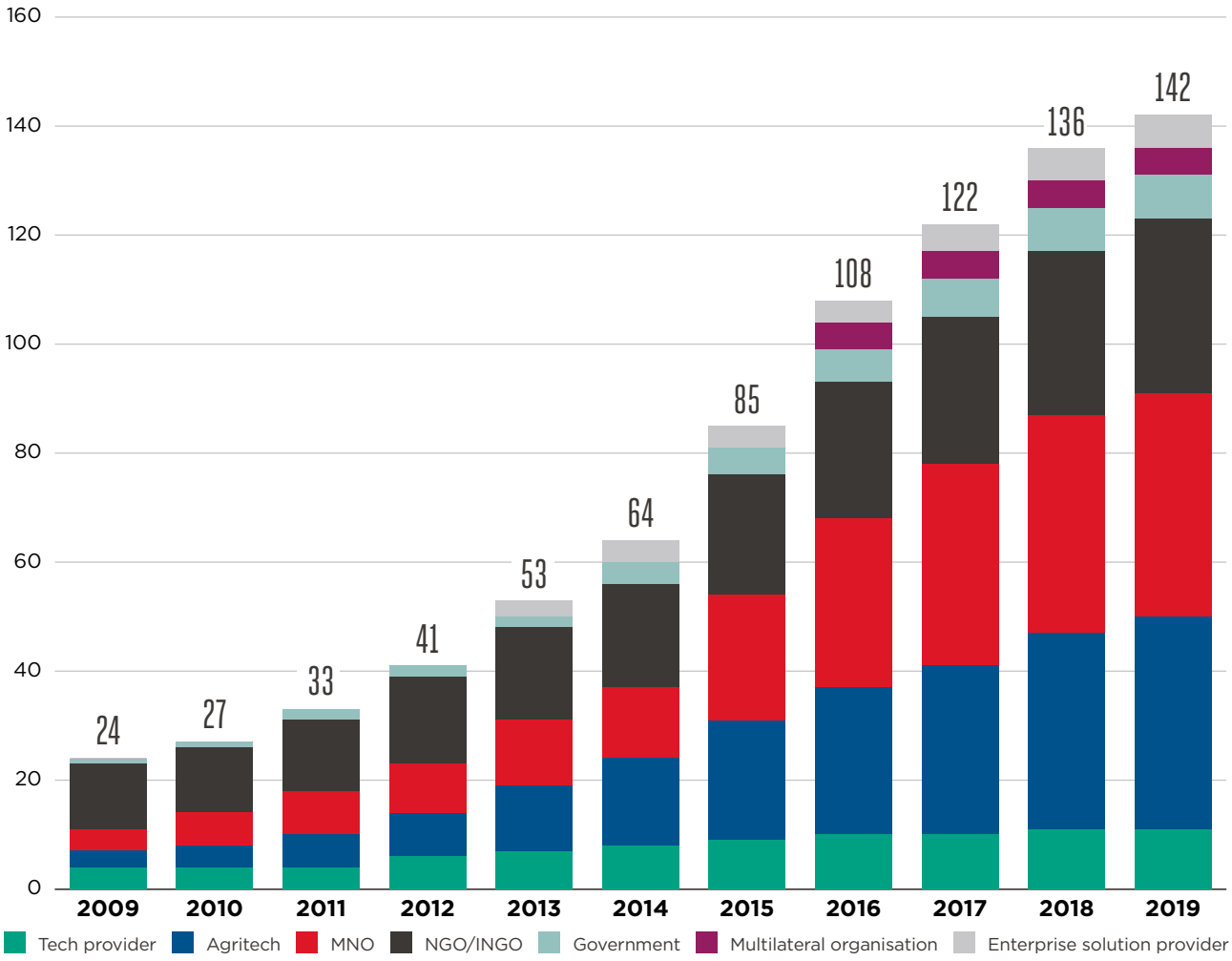
The first wave of digital advisory services, often referred to as agricultural value-added services (Agri VAS)[49] or farmer information systems,[50] typically focused on delivering best-practice information directly to farmers based on general crop types via basic channels or through intermediaries such as government extension officers, agribusiness field agents, lead farmers and NGO staff.

Examples of long-running Agri VAS are InfoTrade Uganda's **Agricultural Market Information Service (AGMIS)**, Esoko's **Digital Farmer Services** in Ghana, Dialog's **Govi Mithuru** in Sri Lanka, Econet's **EcoFarmer** in Zimbabwe, and **iCow** in Kenya, Tanzania and Ethiopia. In India, several long-running services are **IFFCO Kisan,**[51] **AgroStar**, RML Ag Tech's **RML Farmer (Krishi Mitr)** and Tata Consultancy Services' **mKRISHI**. Telenor Pakistan's **Khusaal Zamindar** with over 10 million registered users as of January 2020 (see the case study later in this section), is one of the most notable mobile information services at scale. Another service provider that has reached significant scale is Viamo, a digital behaviour change communications and content provider serving millions of farmers in 17 countries through its **3-2-1** service delivered in partnership with multiple MNOs. These services are being provided either under a direct revenue model or an indirect benefits model, depending on the provider and the key drivers launching the service.

47 GSMA mAgri (2016), *Agricultural Value-added Services (Agri VAS) Toolkit 2.0.*
48 GSMA Intelligence (2020), *The Mobile Economy*.
49 GSMA mAgri (2016), Agricultural Value-added Services (Agri VAS) Toolkit 2.0.
50 Tsan, M., et al. (2019), *The Digitalisation of African Agriculture Report 2018–2019*. The Technical Center for Agricultural and Rural Cooperation (CTA).
51 GSMA mAgri (2016), IFFCO Kisan Agricultural App: Evolution to Data Driven Services in Agriculture.

Figure 19

Number of active digital advisory services by type of service provider, 2009–2019



There are three types of direct business models for digital advisory services: business-to-consumer (B2C), business-to-business (B2B) and a hybrid of the two. In addition, business-to-government (B2G) models have emerged where national or regional governments pay for services on behalf of farmers. For example, **Precision Agriculture for Development (PAD)**, an international NGO with deployments in South Asia and East Africa, uses funds from governments or government donor partners to collaborate with in-country partners to provide digital advisory services to farmers in eight countries.

Under a direct business model, Agri VAS generate cash revenue by charging farmers or third-party organisations like agribusinesses or cooperatives that are willing to pay on behalf of farmers to access the service or a specific function of the service (e.g. certain type of content, advertisements from input suppliers and surveys with customers). Examples include Esoko and Viamo, which, in addition to disseminating agricultural information, use digital tools for data collection and farmer surveys. The valuable insights gleaned from these tools are used to inform interventions by NGOs, agribusinesses or governments. The indirect business model has so far applied mainly to MNOs, which can derive non-cash benefits. These include greater market share and rural acquisitions; higher usage of SIM cards for core services, data or other VAS; customer loyalty; and related churn reduction and brand awareness. In some cases, Agri VAS are subsidised by NGOs, government agencies or private companies that sustain services for smallholder farmers by taking on the delivery costs.

Digital agriculture services are becoming more holistic, supporting multiple use cases in which agricultural advisory is a component of a bundle. Zimbabwe's EcoNet Wireless, for example, initially offered two standalone advisory products, a subscription-based SMS advisory service for various crops and animals (**EcoFarmer SMS Advisory Tips**) and a service

connecting farmers to livestock, tobacco or crop production and marketing specialists via a call centre (**Dial-a-Mudhumeni**). The MNO now also provides these services as part of a service bundle called **ZFU EcoFarmer Combo**, which provides advisory tips, membership to the Zimbabwe Farmers Union, weather index insurance and funeral cover.

Currently, 40 per cent of all digital agriculture services are focused on providing information services to smallholders, but we expect to see this percentage drop in the near future as other use cases like DFS gain a greater share of the market. As new technologies become more available, services are being created to address other pain points in agricultural value chains. For example, mobile money, which first appeared in Sub-Saharan Africa to solve the problem of sending money to rural areas, has made it possible for agribusinesses to pay farmers digitally for their crops.

Advisory services are becoming more data driven and intelligent, providing highly localised, granular information that helps farmers make better decisions.

The growing availability of data and new technologies to make sense of the data, such as AI, machine learning and big data analytics, are making it possible to provide farmers with customised information based on field-level conditions, for example, linking climate indicators to on-farm activities. The latest advisory services are providing intelligent, actionable advice that considers a range of agro-climatic factors by collecting and analysing data from multiple sources.[52] These include remote-sensing data from satellites and images from drones, field measurements logged by farmers or via sensors and granular weather data. Smart advisory services help farmers optimise agricultural production by providing advice on the types of crops to grow in a specific field and the most appropriate inputs and the precise amounts of inputs. These services also enable more intelligent irrigation and offer guidance to farmers on optimal harvesting times, as well as information on crop performance and yield estimates.

Smart advisory has experienced considerable growth in LMICs in the last decade, with six active services in 2010 growing to 85 active services in 2019. Until recently, these types of services have been inaccessible to smallholder farmers in emerging markets. Deploying and maintaining technologies such as sensors in remote locations is both an economic and operational challenge as the initial investment required is high, and connectivity in rural areas can be patchy. This limits the effectiveness of real-time communication and makes it difficult for the business model to work and to offer an affordable product to smallholder farmers.

International NGOs were early pioneers in making data-driven advisory widely available to farmers, using donor funding to test ideas. **Precision Agriculture for Development (PAD)** analyses satellite imagery together with soil data and a weather prediction model to provide customised advisory to farmers. While new market entrants provide most of the smart advisory services, some of the established first-wave Agri VAS are incorporating elements of smart advisory, such as location data to provide highly localised agronomic and weather information. This shift is particularly evident in South Asia. Agri VAS provider Telenor Pakistan, through a partnership with LMKT, an IBM partner, has improved its weather forecasting to provide farmers with location-based advisory. This has helped farmers make informed decisions based on the latest weather conditions and ultimately improve crop yields.

Peer-to-peer and participatory advisory services are another way to tailor advice to farmers' needs. **Wefarm**, currently operating in Kenya, Tanzania and Uganda, has built a farmer-to-farmer digital network powered by big data, AI and machine learning to enable peer-to-peer, crowdsourced knowledge. Farmers receive advice via SMS on a range of questions, from farming techniques and pest and disease management to organic farming. They can also share business ideas or information on how to diversify their livelihoods.

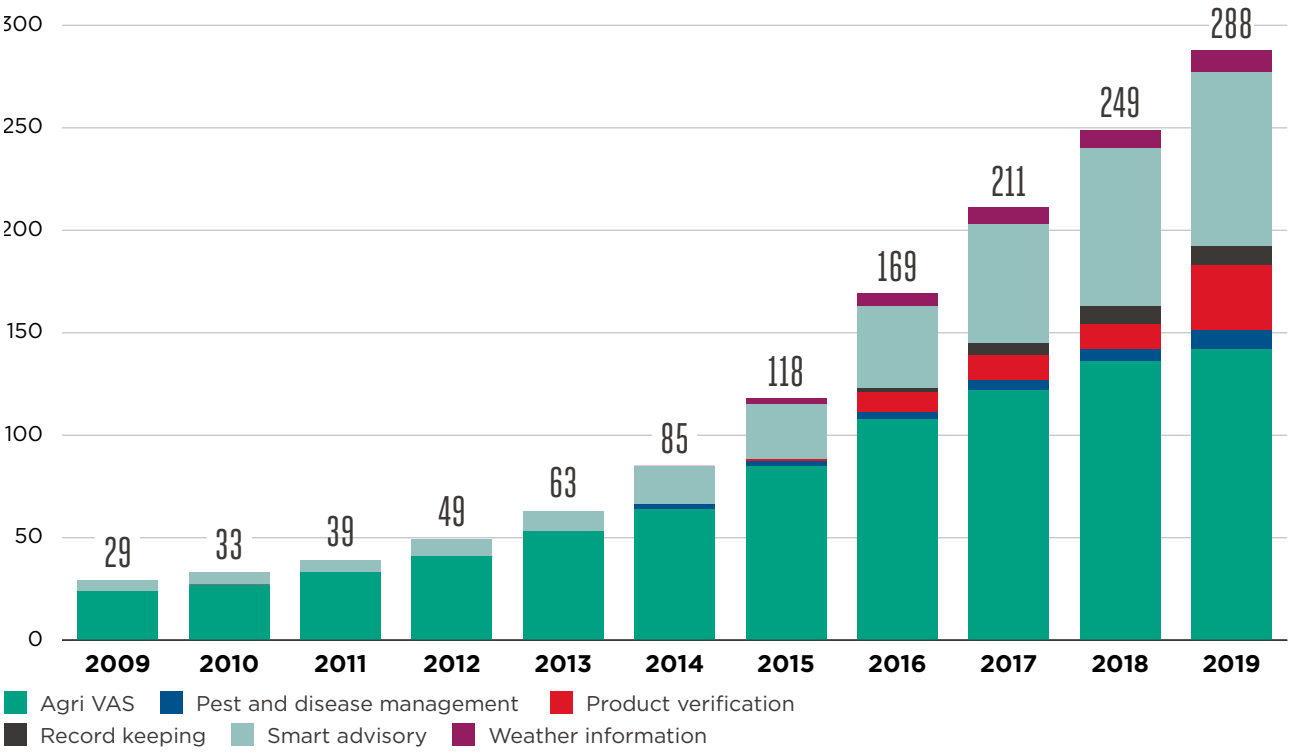
52 IDH Farmfit's report, *A practical guide for integrating data into farmers' decision making – Lesson from Asia* (2020) offers a comprehensive view of how to support farmers' transitions to data-backed agriculture through the use of Farm Management Information Systems (FMIS). It provides a summary of choices, considerations and best practices for FMIS service providers to improve their business models and service offerings.

Another example of peer-to-peer knowledge sharing is **Farm.ink**, also in Kenya. Leveraging the marginal but growing use of social media platforms like Facebook and WhatsApp by farmers in LMICs, Farm.ink built an online forum and chatbot information service called **Africa Farmers Club** to turn unstructured social feeds into actionable insights using machine learning. Through the chatbot, farmers can search farmer-generated questions and answers and get notifications delivered to their phones. By combining the insights generated from the platform with content and data from the International Livestock Research Institute (ILRI), Farm.ink delivers weekly information to dairy farmers on animal health issues, local milk prices and local cows for sale. The start-up has also developed a Fall Armyworm chatbot service to train farmers in identifying and protecting their crops from this harmful pest.[53]

Digital advisories are becoming more complex as new services provide specialised information on demand.

Figure 20

Number of active digital advisory services by sub-use case, 2009–2019



While digital agricultural advisory services have become more intelligent, they have also become more complex, providing solutions to a wider range of challenges farmers face (Figure 20). Pest and disease outbreaks are a growing threat due in part to climate change, and as they have increased in frequency and intensity, new digital solutions have emerged to help farmers manage them more effectively. Since 2016, following the Fall Armyworm outbreak, numerous app-based solutions have emerged to diagnose plant disease and provide recommendations on the best course of treatment and preventive methods. Most of these apps require farmers to take and upload a photo of the affected plant and some, like the Cameroon-based **Agrix Tech** app, can provide recommendations in local languages using voice recognition technology.

53 CGIAR (7 February 2019), *Up close and personal with Farm.ink founders, transforming how African farmers receive information*.

Product verification services to reduce the proliferation of counterfeit products have grown significantly in the last five years in response to farmer concerns about the authenticity of inputs. Ghana-based **QualiTrace**, through its QualiCheck service, empowers farmers to verify agro-inputs using track and trace technology. The Kenya Plant Health Inspectorate Service (KEPHIS) and the Uganda National Bureau of Standards have both deployed services that enable farmers to check the authenticity of inputs by sending a code scratched from the product's package to a specified number via SMS or USSD. Similarly, the Common Market for Eastern and Southern Africa (COMESA) launched an online seed label verification system in 2019 to address the problem of fake agro inputs, such as seeds, fertilisers and crop protection products, and to boost trade in quality and improved certified seeds.

Growing demand from livestock farmers to reduce losses from disease or a missed conception have given rise to digital record-keeping tools for livestock management. Solutions such as **CowTribe** in Ghana, **Sen Ngunu** in Senegal and **myfugo** in Kenya allow farmers to capture key metrics on each animal, such as biometrics, health records, including vaccination, illness and medication, and feeding and milk production information. Using the information logged by the farmer, these solutions make it possible to monitor the health of an animal against different parameters, provide tailored care schedules with reminders, advise when to observe for oestrus and connect farmers to nearby veterinary services. These solutions also allow farmers to maintain good financial records on their animals.

While smart advisory services incorporate hyperlocal weather information to provide customised agronomic advice to farmers, there are also specialist standalone localised weather information tools aimed at farmers. Climate change is disrupting agricultural ecosystems, leading to changes in agro-climatic elements, such as temperature, precipitation and sunlight, and leaving farmers unable to rely on traditional methods of predicting the weather to manage their activities. Granular weather information delivered to farmers' phones offers a significant opportunity to support farming decisions. It is also possible to support climate adaptation through improved agricultural extension and advisory services that can lead farmers to adopt climate-smart technologies and practices.

Examples of such services include Ignitia's flagship product, **Iska**, a 48-hour forecast message delivered daily via SMS. The forecasts also feature monthly and seasonal predictions and detail the likelihood, timing and intensity of the weather. The service is currently available in Mali, Burkina Faso, Ghana and Nigeria. Orange Mali also offers, in partnership with Ignitia, weather forecasts to support farming decisions via the **Sandji** service. The Technical Centre for Agricultural and Rural Co-operation's (CTA) **CLIMARK (Climate Livestock and Markets)** projects, in collaboration with aWhere & Amfratech Ltd, deploy a blended agri-weather information system to inform pastoralist communities in northern Kenya and southern Ethiopia of short-term and long-term weather patterns and make actionable recommendations to safeguard their livelihoods.

CASE STUDY

Telenor Pakistan's Khushaal Zamindar: Delivering localised digital agronomic advisory to smallholder farmers at scale

Launch date: December 2015 **Users:** 10 million **Country of operation:** Pakistan

Khushaal Zamindar, meaning "Prosperous Landholder" in Urdu, is a well-established agricultural advisory service with over two million daily active users and 7.5 million monthly active users. Users of Khushaal Zamindar receive one daily outbound robocall (OBD) with customised agricultural and livestock advisory and weather information each morning. Messages for the agricultural and livestock advisory are pre-recorded and delivered based on the farming cycle. In addition to the OBDs, farmers can use the IVR channel to access advisory content across multiple value chains and connect to weekly live shows with local crop experts and vets who answer their questions on air.

Value proposition

The service empowers farmers to increase their productivity and yields with information tailored to their farm, based on location, type of crop and stage of the farming cycle. The live shows provide an opportunity for farmers to learn about relevant issues faced by other farmers at a specific point in time. The service also offers direct access to crop and livestock experts and medical advice via paid add-on features such as veterinary and personal health advisories.

Business model

Incubated by Telenor with support from GSMA (under the mNutrition Initiative funded by UK aid), Khushaal Zamindar is a commercially viable service, offered to farmers through a freemium model. In the early stages, the service generated revenue through targeted advertising via OBD or SMS. The platform now allows farmers free access to pre-recorded advisory and weather content as well as weekly live shows while providing paid "add-ons" through a variety of partnerships. These include a TeleVet service that connects farmers with agriculture and livestock expert services for urgent queries, a TeleDoctor service to provide farmers with personal health advice and a paid health insurance add-on. Telenor also runs occasional small advertising campaigns for agri-related businesses.

Milestones

Khushaal Zamindar's content is refreshed annually and there are plans to increase this to six months. The content is available in multiple languages. Since establishing a partnership with IBM in 2018, the service provides localised weather forecasts, which has enabled customised advisory for farmers based on their location. Since relaunching in 2016 following iterative product development, the service reached 45 per cent of its identified target market within one year and as of January 2020 reaches over 10 million users.

Future roadmap

Telenor plans to scale the current services and add more service components, such as infotainment and agri-tainment tailored to the preferences of rural customers, crop insurance and microloan services. Telenor is also working to make these services MNO-agnostic and accessible to a larger audience, thereby offering it to subscribers of all MNOs in Pakistan. Telenor has also launched the Khushaal Watan smartphone app, which it plans to develop alongside its current IVR service offering.

CASE STUDY

Wefarm: Crowdsourcing advisory to connect farmers to local knowledge from experienced peers

Launch date: 2015 **Users:** 2 million **Countries of operation:** Kenya, Uganda and Tanzania

Wefarm connects the smallholder farming community by enabling members to ask questions, share knowledge and access quality products via its platform. Services are available in English, Swahili, Luganda and Runyankole. Wefarm is accessible via SMS allowing farmers to access the platform without relying on the internet.

Value proposition

Wefarm helps farmers increase their productivity by enabling them to ask and answer questions from other members and, by leveraging the size of the community, offer better prices for quality agricultural products. Wefarm has also created Natural Language Processing (NLP) libraries that enable SMS services to process millions of messages from farmers in multiple languages and dialects. The service uses machine learning and custom NLP to understand the messages that farmers send, making it more efficient to share knowledge and disseminate information widely.

Business model

As a free service, Wefarm operates under a B2B business model. The company creates demand from farmers and retailers for products such as seeds and fertilisers, and then uses data generated on the platform and qualitative insights they have gathered to work with manufacturers or distributors that supply their products to farmers via authorised retailers. Revenue is generated by charging partners a variable and category-dependent fee for products sold.

Milestones

Wefarm has reached over two million registered members across three countries, with members sharing nearly 20 million questions and answers on farming-related topics. The median response time is currently six minutes, which has decreased over time. To date, over $5 million has been transacted on Wefarm with estimated savings for farmers of over $350,000. The platform has onboarded over 90 retailers in three countries, which have made over 650 products available since launch.

Future roadmap

Wefarm continues to grow and strives to reach 100 million members by expanding its services and product offering in existing and new markets.

Figure 21

Global map of active agri digital financial services, January 2020

1 KENYA
23 services

including:
Pula, AgriWallet, Kwara

2 UGANDA
13 services

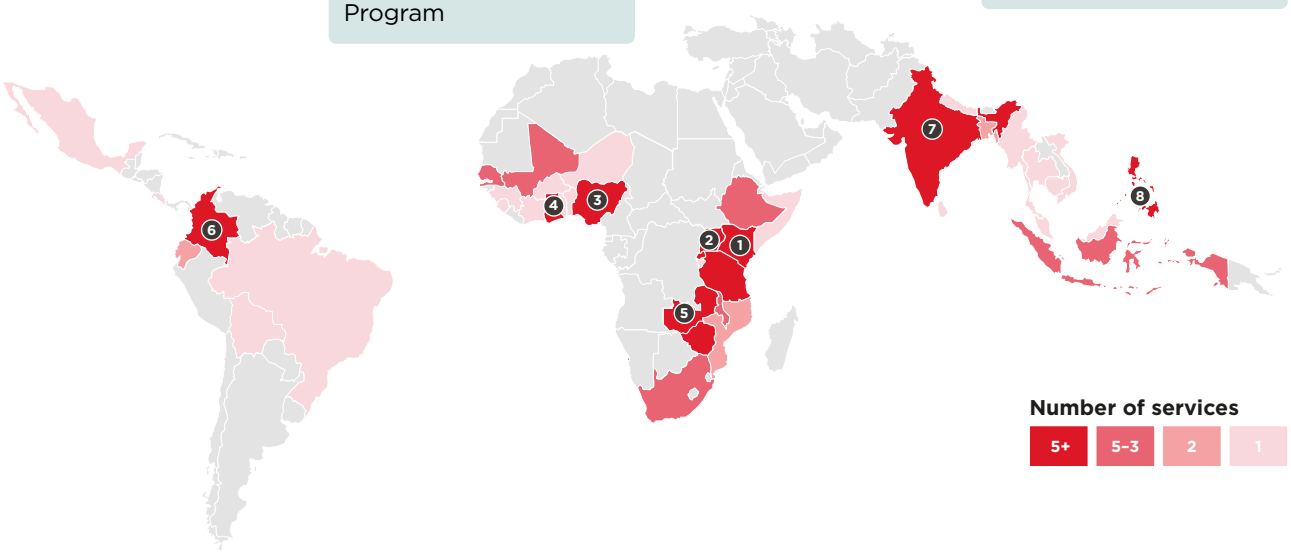
including:
Pula, Mobile Banking and Information System (MOBIS), Opportunity International's Agricultural Finance Program

3 NIGERIA
11 services

including:
BabbanGona, Farmcrowdy, ThriveAgric

4 GHANA
9 services

including:
World Cover, Kwidex, Opportunity International's Agricultural Finance Program



5 ZAMBIA
7 services

including:
The Zambia Integrated Agricultural Management Information System (ZIAMIS), NWK Agri-Services, AgriPay

6 COLOMBIA
6 services

including:
IncluriTec, AgriCapital, Agrapp

7 INDIA
6 services

including:
Pula, The LenddoScore, farMart

8 PHILIPPINES
6 services

including:
The LenddoScore, Cropital, FarmOn

4.2 Agri digital financial services (DFS)

Digital financial services, or DFS, refers to a range of financial services accessed and delivered through digital channels, including payments, credit, savings, remittances and insurance. As a concept, DFS includes mobile financial services (MFS), which involves using a mobile phone to access financial services and execute financial transactions. These include transferring funds to make a mobile payment via mobile money, as well as non-transactional services, such as viewing financial information.[54]

Agricultural DFS[55] are a subcategory of DFS that includes services provided directly to smallholder farmers, such as digital agricultural payments, as well as derivative services supporting agricultural credit (e.g. input financing), agricultural savings (e.g. digital wallets designed to support specific agriculture sector activities) and agricultural insurance. Agri DFS also include solutions that enable access to derivative services through data analytics, such as credit-scoring solutions provided by third-party companies, as well as those provided by agribusinesses that have developed in-house solutions to extend financing to the farmers they procure from.

A range of providers, including traditional FSPs like banks and microfinance institutions (MFIs), MMPs and fintech companies, provide agri DFS to farmers. FSPs have integrated digital technology to optimise their operating models and launch new products aimed at the rural sector. Governments and NGOs are also using agri DFS to deliver financial services to farmers, such as input subsidies. Much work is underway to identify innovative models for data-sharing partnerships between different actors, including agribusinesses, FSPs and tech providers (MMPs, fintech and agritech providers) that enable financing to be provided to smallholder farmers. For example, the Agriculture Finance Working Group convened by the UN Secretary-General's Special Advocate for Inclusive Finance for Development (UNSGSA) is supporting a pilot in Kenya to develop a data-sharing platform with the Mastercard Farmer Network. The objective of the pilot is to eventually enable banks and agribusinesses to use the platform to offer affordable input financing to smallholder farmers.[56]

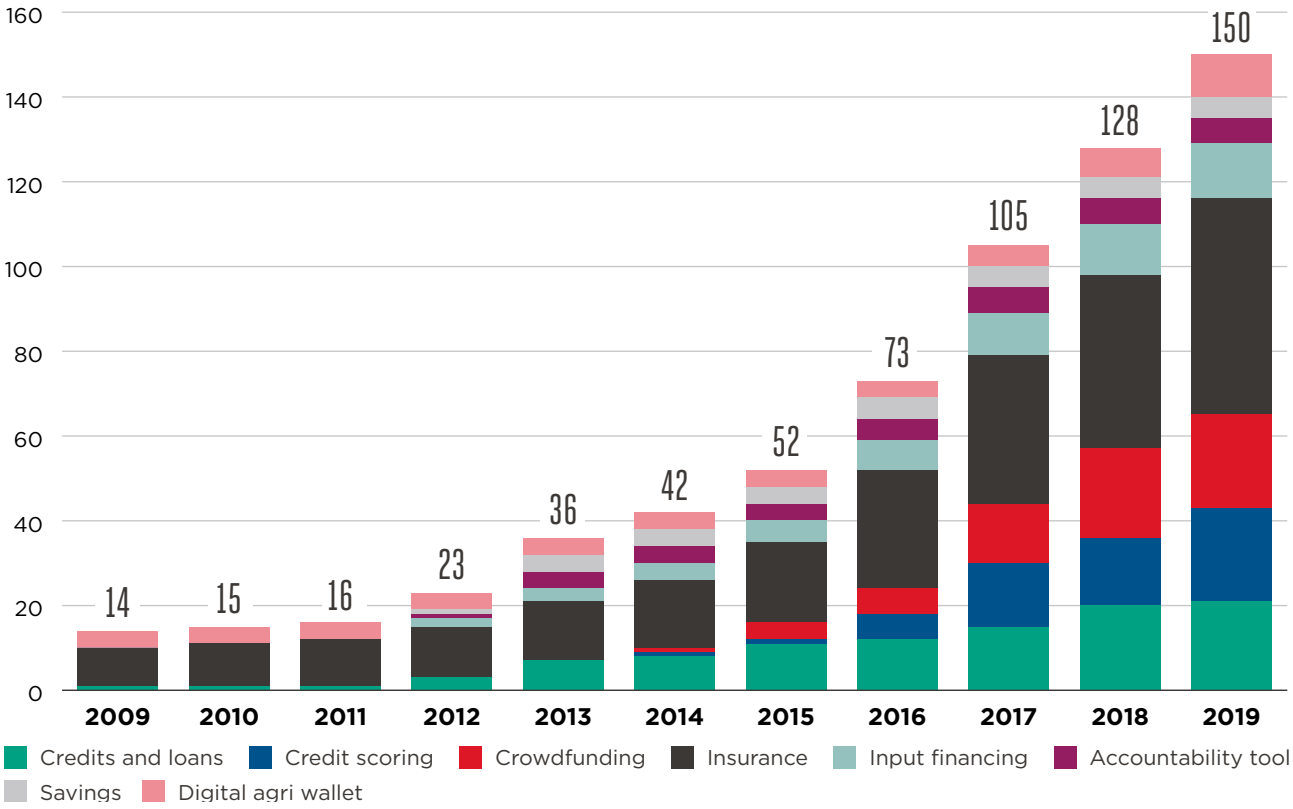
The GSMA AgriTech programme has analysed data from 150 agri DFS, 111 of which are in Sub-Saharan Africa where growth is far more pronounced due to the wider availability of mobile money. Sixteen of the services are in Southeast Asia, 12 are in Latin American and the Caribbean and 10 are in South Asia. Figure 22 shows the number of live agri DFS over the last decade.

54 Alliance for Financial Inclusion (2016), *Digital Financial Services. Basic Terminology*.
55 For the purposes of this report, DFS refers to services provided specifically for the agricultural sector, tailored to the needs of smallholder farmers. By smallholder farmers, we are referring to farmers in LMICs whose average plots are typically two hectares or less.
56 The members of the UNSGSA-convened Agriculture Finance Working Group are CGAP, ECOM Trading, ETG Farmers Foundation, GSMA, IDH, IFAD, IFC, Mastercard, Rabo Foundation, and Royal Friesland Campina NV. For key findings, see the report: *Sowing the Seeds of Innovation for Smallholder Finance*.

The agri DFS ecosystem is evolving rapidly and becoming more sophisticated as a variety of actors use their data, technologies and relationships with farmers to facilitate financial inclusion.

Figure 22

Number of active agri digital financial services by sub-use case, 2009–2019



The agri DFS space is becoming increasingly complex as a growing number of solution providers leverage their data, technologies and relationships with farmers to open access to financial services. In the last decade, the emergence of digital tools supporting market access, such as digital procurement and e-commerce solutions, have allowed rich data sets to generate financial footprints for smallholder farmers, such as transactional data from the sale of crops, and made it more viable to extend financial services to them.

The agri DFS landscape varies widely across regions. In Sub-Saharan Africa, MMPs (led by large MNOs) have played a central role in the ecosystem, while in South and Southeast Asia, fintechs and tech giants play a greater role. In Latin America and the Caribbean, there is comparatively little fintech intervention in smallholder financing, with initiatives led by traditional FSPs and a nascent fintech sector.[57] There are also major variations within regions in DFS access and adoption by smallholder farmers. For instance, the widespread use of mobile money in Kenya and relatively high digital savviness of its rural population, including farmers, make it possible for new DFS aimed at the agricultural sector to emerge and scale more rapidly than in some markets in West Africa where mobile money is more nascent.

According to GSMA AgriTech data, solutions that use their data to open access to DFS have seen strong growth. Cumulatively, digital credit scoring and crowdfunding tools have grown from just two services in 2014 to 44 services in 2019. Examples span Sub-Saharan Africa, Southeast Asia and Latin America and the Caribbean. Fintech companies, such as **FarmDrive** in Kenya and **Harvesting** with operations in Uganda, Turkey and Brazil, are collaborating with FSPs to use the farm and farmer data they collect to assess farmers' creditworthiness, enabling them to serve farmers at scale and at a lower cost.

57 GSMA mAgri and Mobile Money (14 December 2018), "Reinventing rural financial inclusion in Latin America: Highlights from Foromic", *GSMA Mobile for Development Blog*.

In Colombia, start-up **IncluirTec** helps financial institutions assess a farmer's creditworthiness by collecting mobile demographic information, crop production data and expected sales prices for their crops via a mobile app. The solution generates a user profile with projected cash flow, which the financial institution can use to grant and define terms of credit. Similarly, IDH **Farmfit** has a proprietary digital transformation tool that digitises a range of value chain data made available from agribusinesses to offer technical assistance for FSPs and agribusinesses seeking to lend to smallholder farmers.

Crowdfunding platforms in Nigeria (**Farmcrowdy**), Senegal (**Beyseddo**) and Indonesia (**Crowde**, **TaniHub**) are supporting investment in smallholder farmers by sourcing funds from individuals, called investors or sponsors. In Indonesia, TaniFund leverages its relationship with smallholder farmers via its TaniHub e-commerce service to access transactional data from farmers and enable peer-to-peer lending.

Innovative digital tools have emerged that use transactional data to enable the provision of savings products. In Uganda, **Ensibuuko** works with Airtel and MTN Mobile Money to provide a software as a service (SaaS) platform to Village Savings and Loan Associations (VSLAs) and Savings and Credit Cooperative Organisations (SACCOs) to digitise their data, processes and payments, enabling them to better serve groups of farmers.[58] Accountability tools like **Budget Mkononi** in Kenya is designed to help farmers view farming as a business by allowing them to track farming expenses and revenues and prove their creditworthiness — the first step in accessing DFS.

Despite the opportunity to use digital channels for savings, agriculture-specific savings products have gained little traction.

Smallholder farmers typically receive the bulk of their earnings from farming activities in one or two lump sum payments a year, depending on the crops they grow and the number of rainy seasons in their region. There is often very little separation between personal or household finances and finances for agricultural expenses and investments, making saving money for agriculture-specific activities a daunting challenge. Savings products can play a critical role in helping farmers even out their cash flow throughout the year, set money aside for the next season's inputs and build a financial safety net for family emergencies or to weather external shocks, such as pest and diseases. However, there are still very few agriculture-specific digital savings products, and most are locked-in solutions designed to address short-term input requirements. **We have not found any digital savings solutions that enable long-term saving for capital assets.**

One notable example of a short-term input savings product is **MyAgro**, a mobile layaway product for farmers in Mali, Senegal and Tanzania that allows farmers to save money for seeds and fertilisers by purchasing scratch cards and loading the value onto a mobile account, similar to prepaid credit for a mobile phone. MyAgro then delivers the inputs to partner grocery shops in rural areas at the start of the planting season for farmers to redeem. Another example is Dodore Kenya's **AgriWallet**,[59] which allows farmers to store funds from the sale of crops in M-PESA or tokens in the wallet specifically for buying inputs from vetted suppliers. Using the service also gives farmers access to short-term loans offered via a partnership with Rabobank.

There are many reasons why so few agriculture-specific digital savings products are available. First, traditional savings methods, such as Rotating Savings and Credit Associations (ROSCAs), VSLAs and SACCOs are customary among women in most rural settings. There have been a variety of efforts by MMPs and fintechs to digitise savings groups. **EcoCash Savings Club** in Zimbabwe, **Ezypesa** in Tanzania, **M-PESA Chama** in Kenya and **M-Koba** in Tanzania all allow group members to contribute remotely, with group managers able to track payments and manage payouts securely and transparently. While these services are not designed specifically for the agriculture sector, they are relevant for farming communities. For example, **Zantel** has partnered with the Zanzibar Association of Seaweed Farmers to reach seaweed farmers, who are predominantly women, to encourage the use of the Ezypesa platform to pay suppliers, accept money from customers and manage their finances.[60]

58 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.
59 Bolt, J. (8 February 2019), "Agri-wallet, a wallet for smallholder farmers", CTA Blog.
60 Lindsey, D. and Wilson, A. (27 April 2020), "'Relevance': How mobile operators can improve the relevance of their services for women to help close the mobile gender gap", GSMA *Mobile for Development Blog*.

For women in LMICs, digital savings and payment services can provide a vital link to the formal economy and a gateway to greater economic security and personal empowerment.[61] A 2016 study of women-headed households in Kenya found that the adoption of mobile money accounts led to a drop in poverty and an increase in savings.[62] However, there is still a wide gender gap in mobile money account ownership due to fundamental differences between men's and women's mobile phone ownership. *GSMA Connected Women's Mobile Gender Gap Report 2020* shows that once women acquire a smartphone, many of the other mobile gender gaps are corrected for, including awareness and use of mobile internet and mobile money.[63] While the gender gap in mobile money account ownership has narrowed slightly in recent years, according to the latest Global Findex data from 2017, women across LMICs are still 33 per cent less likely than men to own a mobile money account (compared to 36 per cent in 2014).

Among traditional methods of saving, there is also an option to invest in livestock and, for more affluent farmers, provide credit to others as a form of savings. In more established mobile money markets, unbanked farmers value the safety and convenience of receiving and storing funds in mobile money accounts due to the risk of keeping cash at home.[64] In some markets, the option to earn interest from mobile money accounts makes them more valuable as savings mechanisms, even though high inflation rates may outpace interest rates.[65]

Interest-bearing e-wallets provided in combination with national subsidy schemes are also attractive savings alternatives.[66] In Zambia, farmers with **Zoona** e-wallet accounts created under the Farmer Input Support Programme (FISP) electronic voucher system earn interest on funds saved in their e-wallets through a partnership with FINCA Zambia, an MFI.[67] In Rwanda, **IKOFI**, a USSD-accessible digital wallet built on the back of the **Smart Nkunganire System** (SNS), a payments and supply chain management tool for Rwanda's national agro-input subsidy programme, allows farmers to access savings accounts through the Bank of Kigali and create a digital financial record of all transactions.[68]

Digital credit products are becoming widely available, but very few address the long-term agricultural and non-agricultural needs of smallholder farmers.

Alongside the generic microcredit products increasingly available in mobile money markets, several new digital tools address smallholder farmers' specific need for agricultural credit have emerged. However, these products focus largely on the provision of short-term credit, mostly for inputs or cash advances. With the highest concentration of digital credit services overall, Kenya offers many examples. Musoni Microfinance's **Kilimo Booster** is a flexible loan product with a customised grace period based on a farmer's seasonal cash flow; **Apollo Agriculture** offers a customised package of farm inputs, farming advice and credit using satellite data and machine learning to enable credit decisions; **Tulaa**'s input-on-credit product is bundled with advisory and market linkage services; and Kenya Commercial Bank's **MobiGrow** product is bundled with training and other financial solutions, including savings and insurance, and is also available in Rwanda. In Myanmar, Mandalay Capital's **FarmTrek** provides livestock-backed loans and insurance products. In India, **farMart** provides farmers access to credit for inputs by enabling the purchase of farming inputs from a network of retailers signed onto their platform. The service also provides farmers access to shared farming equipment. Although these services are not strictly DFS, they offer credit facilities as part of a bundle of services to strengthen their value proposition to farmers.

While short-term financing tools play an important role, farmers also need long-term financing for assets that enable them to grow and invest in their farms, such as farm machinery, tools and irrigation systems. As mentioned earlier, farmers also have non-

61 Bill & Melinda Gates Foundation (2019), *A G7 partnership for Women's Digital Financial Inclusion in Africa*.
62 Tavneet S. and Jack, W. (December 2016), "The long-run poverty and gender impacts of mobile money," Science 354 (6317), pp. 1288–1292.
63 GSMA Connected Women (2020), *The Mobile Gender Gap Report 2020*.
64 Tricarico, D. (4 March 2019), *Learning first-hand how farmers experience last mile digitisation: Ghana Field Focus Week lessons, part one*. *GSMA Mobile for Development Blog*.
65 MTN Ghana offers seven per cent interest on their Y'ello Save Account. Similarly, Econet wireless in Zimbabwe offers EcoCashSave customers four per cent interest on account balances and Safaricom offers mShwari customers in Kenya 7.35 per cent interest.
66 Tsan, M. et al. (2019), The Digitalisation of African Agriculture Report 2018–2019. The Technical Center for Agricultural and Rural Cooperation (CTA).
67 The Technical Center for Agricultural and Rural Cooperation (CTA) (8 June 2017), "Zoona – innovative mobile finance", *Spore*.
68 Sabiiti, D. (16 May 2019), "Bank of Kigali Launches "Ikofi" to Boost Agriculture Financing", KT Press.

agricultural needs not addressed by existing lending products, such as emergency expenses to recover from extreme climate events or unexpected medical issues, school fees and other education expenses or repayment of a loan.[69]

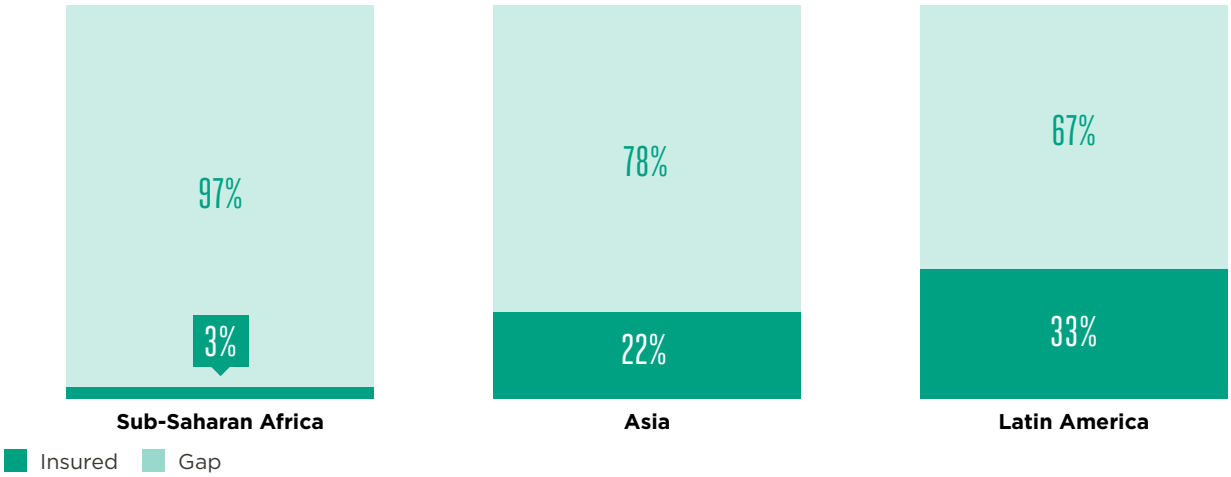
Given the lack of traditional and fintech tools for smallholder financing, global agribusinesses have developed their own in-house solutions and are enabling financial services through a value chain approach. In 2017, Ibero Uganda Ltd, part of global coffee buyer Neumann Kaffee Gruppe, set up a Farmer Financing Unit under the **NKG Bloom** programme[70] to provide farmers with input advances in the form of fertilisers and seasonal cash advances for household consumption needs via mobile money. At the end of the 2019 coffee season, Ibero reported a successful repayment rate of 99 per cent. Based on this positive result, Ibero is securing a microfinance licence in Uganda and plans to launch a long-term financing product.[71]

Digital insurance has become a widespread and low-cost way to scale traditional insurance, but among farmers, understanding and awareness of insurance is a barrier.

Agricultural insurance is designed to protect smallholder farmers from a range of external shocks that adversely affect their livelihoods, including pest and disease outbreaks, volatile market prices and non-agriculture-related expenses, such as family emergencies. Changing weather patterns and the frequency and intensity of extreme climate events exacerbate these risks, leaving them unprotected and unprepared when disaster strikes. Globally, less than 20 per cent of smallholder farmers are insured. This figure is even lower in Sub-Saharan Africa where less than three per cent of farmers have agriculture insurance coverage (Figure 23).

Figure 23

Gaps in smallholder insurance coverage across regions, 2018[72]



Source: ISF Advisors, 2018

Low penetration of traditional agricultural insurance is due to low awareness among smallholder farmers, the high cost of premiums and lack of trust in financial institutions. In order to opt-in or purchase insurance, farmers need to understand the importance of insurance, perceive it as valuable and trust the provider.[73] For providers, insurance for farmers is a difficult product to design and offer profitably due

69 GSMA AgriTech (2020), *The GSMA AgriTech Toolkit for the Digitisation of Agricultural Value Chains*.
70 NKG BLOOM Uganda: https://uganda.nkgbloom.coffee/
71 Learning Lab and Fund for Rural Prosperity (10 February 2020), *Strengthening agricultural supply chains through the delivery of financial services*.
72 ISF Advisors (2018), *Protecting growing prosperity: Agricultural insurance in the developing world*.
73 Barooah, B. et al. (2017), *Understanding financial agricultural risk for smallholder farmers in developing countries. What do we know and not know?* The International Initiative for Impact Evaluation (3ie).

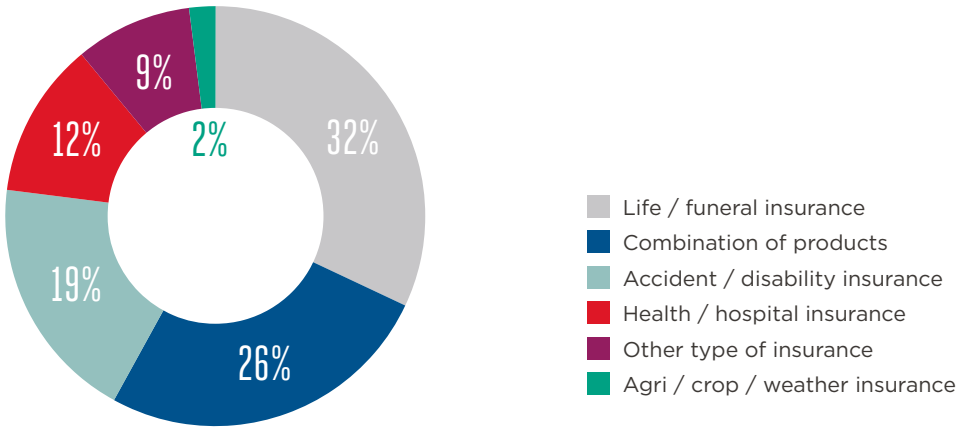
to the high cost of customer acquisition and service delivery and the low value of premiums.[74]

The shift from indemnity-based to index-based insurance, and the growing use of mobile phones to deliver services to smallholder farmers, have unlocked new opportunities to provide digital insurance products. Index-based insurance pays out benefits based on a predetermined index (e.g. rainfall levels) rather than on-farm visits to quantify losses, as with indemnity-based insurance. New sources of weather data from satellites are also breaking down barriers with agricultural insurance, for instance, by enabling the prediction of risk and triggering automatic payouts of claims based on remote-sensing data.[75]

Digitally enabled agricultural insurance is gaining traction, but with many providers still relying on traditional non-digital channels, it is not yet widely available.[76] The agriculture sector lags behind other sectors that have embraced mobile as a channel to deliver insurance products in emerging markets. In 2019, only two per cent of mobile-enabled insurance products were agricultural or weather insurance products (Figure 24).

Figure 24

Share of active mobile-enabled insurance products, 2019[77]



Source: GSMA, 2020

Digital agricultural insurance products make up 39 per cent of all agri DFS globally, and Sub-Saharan Africa has seen the most adoption at 84 per cent, accounting for 43 of the 51 digital insurance services we are tracking. One of the main factors driving this is that traditional offline insurance schemes are less established in the region (compared to, for example, South Asia and Latin America and the Caribbean), which has left more room for experimentation with digitally-enabled insurance models. **OKO** in Mali and Uganda (see case study at the end of this section), **Pula** in Kenya and **Worldcover** in Ghana are among a handful of companies providing digital end-to-end agricultural insurance products, with registration and payouts conducted via mobile phones. However, all these digital insurance providers maintain some level of human interaction to onboard farmers and deliver customer service.

To address the lack of awareness and understanding of agricultural insurance in emerging markets, digital insurance providers must carefully curate the messaging, farmer education and product packaging. **ACRE Africa** has embraced this challenge with a solution that sells insurance with the sale of every bag of seeds from selected suppliers. By placing a registration card with a code inside the bag, a farmer sends a scratch-off code via SMS to a short code, which registers their location. Through satellite imagery, ACRE monitors the rainfall for that location, and if germination fails after 21 days without rain, farmers are sent compensation for the bag of seeds via mobile money, enabling them to purchase more seeds and replant their crop within the same season.[78] EcoNet's EcoFarmer uses a different mechanism to achieve a similar result. To address the challenge of selling weather insurance as a standalone product, EcoFarmer offers a weather index insurance product as a bundled service with funeral cover (a more widely understood product) and agronomic advisory.

74 ISF Advisors (2018), *Protecting growing prosperity: Agricultural insurance in the developing world*.
75 Tsan, M. et al. (2019), *The Digitalisation of African Agriculture Report 2018–2019*. The Technical Center for Agricultural and Rural Cooperation (CTA).
76 GSMA AgriTech (2020). Agricultural insurance for smallholder farmers: Digital innovations for scale.
77 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*.
78 ACRE Africa: https://acreafrica.com/

CASE STUDY

OKO crop insurance: Strengthening farmers' climate resilience with agricultural insurance via mobile phones

Launch date: 2015 **Users:** Mali: 1,800 paying, 5,000 registered. Uganda: 1,500 registered

Countries of operation: Mali and Uganda

OKO's digital agricultural insurance targets maize farmers in Mali and barley farmers in Uganda. OKO uses index insurance to overcome the time and cost burdens of traditional insurance services and the need for farm-level loss assessment. Orange SIM card users can register for the service by providing their location, name phone number, field sizes and the crops they grow. Farmers receive quotes on insurable land by hectare. Payouts are determined by satellite-based rainfall monitoring data, which tracks both excess and insufficient rainfall.

Value proposition

The service covers farmers for both drought and flood. Users register via a network of agents and cooperatives that raise awareness of the service and educate new users. Once farmers are registered on the service, notifications on payouts are sent via SMS or robocall. The service is integrated in Orange Mobile Money's USSD menu, allowing users to access specific policy information and information on existing and outstanding payments. In addition, OKO offers a call-back request option that allows farmers to ask questions on the service in local languages. Through a partnership with Baobab, an MFI, OKO also offers microloans with insurance used as collateral.

Business model

The business model centres around partnerships. With the exception of underwriting, which is done by Allianz Insurance Group, OKO carries out most functions, including content generation, call centre assistance and marketing. OKO's call centre responds to farmers' questions and ensures they understand the service. In Mali, OKO partners with Orange to provide access to the service through its Mobile Money menu. Orange also generates robocalls and shares statistics on the number of people picking up the calls. Under a B2B2C model, the cost of insurance is taken up by agribusinesses. In Uganda, Nile Brewery, the local affiliate of AB InBev, covers the upfront cost of insurance and deducts the fee from farmers' crop payments at the end of the season. OKO plans to eventually enable a direct-to-consumer model by integrating mobile money payments to and from farmers.

Milestones

OKO launched its service in Mali in January 2020. By April 2020, the number of registered farmers had reached 4,200. The addition of OKO to Orange's Mobile Money menu has been instrumental in expanding outreach. OKO's call-back request option began with a capacity of 10 calls a day, but this has since increased to 600 a day, prompting scale up of the call centre. So far, 20,000 requests have been made for more information about the service. Building on its success in Mali, OKO has expanded into Uganda, registering 1,500 users.

Future roadmap

OKO plans to make its service easier to access for illiterate users through voice-based interfaces (IVR) and interactive messaging systems (USSD). The company is also seeking to provide insurance for additional crops, pests and diseases, and to expand into more markets.

Figure 25

Global map of active digital procurement services, January 2020

1 INDONESIA
12 services

including:
Koltiva Commodity Management Platforms, GeoTraceability, Simple Agri

2 KENYA
10 services

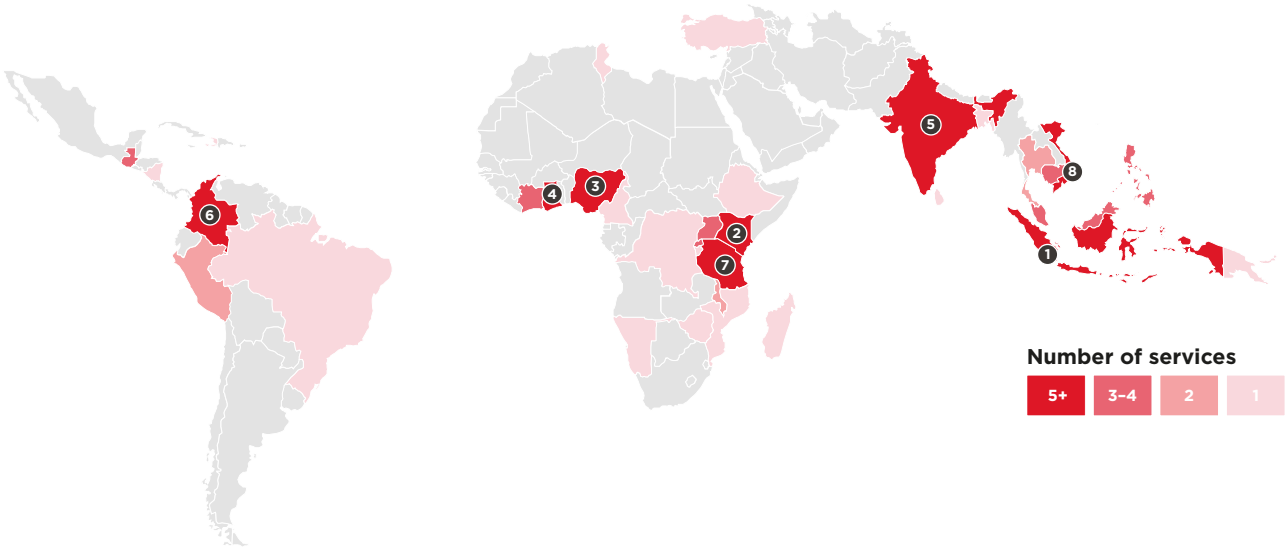
including:
Connected Farmer, FarmForce, iProcure

3 NIGERIA
9 services

including:
TaroWorks, Supply Base, TradeBuza

4 GHANA
8 services

including:
mAgric, Mergdata platform, Rural Sourcing Management



5 INDIA
8 services

including:
Datagreen solutions, FarmERP, AgriBuddy

6 COLOMBIA
5 services

including:
Datagreen solutions, FarmForce, SimpleAgri

7 TANZANIA
5 services

including:
GreenFingersMobile, iProcure, Digital Mobile Africa

8 VIETNAM
5 services

including:
ScanTrust Knoor app, GeoTraceability, AgUnity

4.3 Digital procurement

Digital procurement tools play an intrinsic role in global food supply chains, bringing efficiencies to agribusinesses, cooperatives and smallholder farmers that work closely in the last mile of agricultural value chains.

The "last mile" refers to the web of relationships and transactions between farmers, crop buyers and input suppliers. Such solutions create a digital record of the interactions between farmers and the agribusinesses or cooperatives. **At the most basic level, digital procurement solutions generate digital transaction records, but a growing number of solutions integrate other sub-use cases, including payments or traceability, or a combination of the two** (Figure 26).

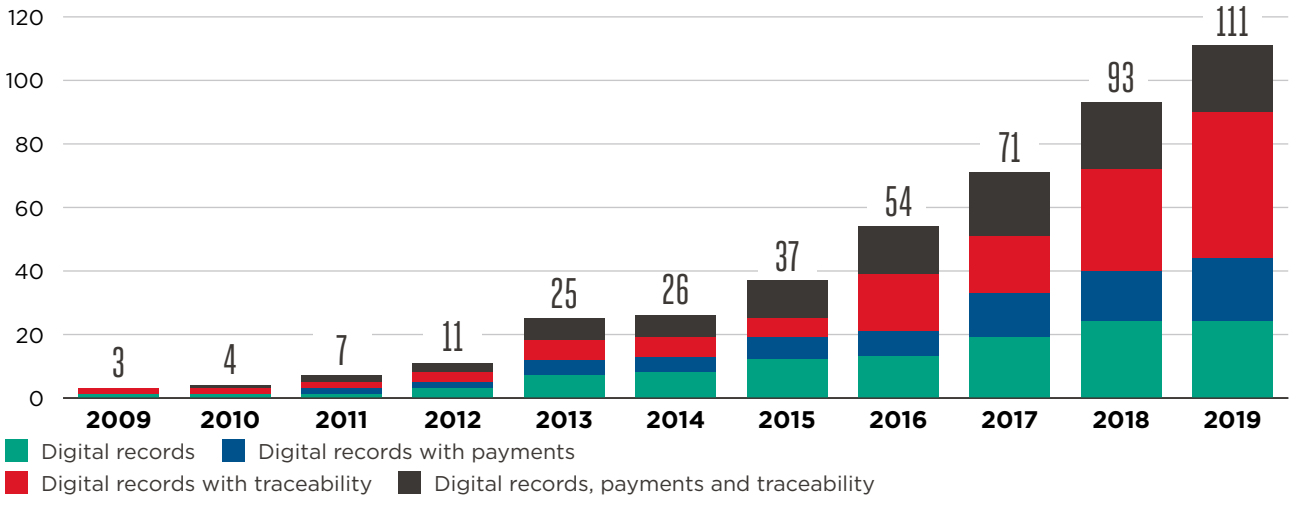
Global food supply chains are evolving rapidly and integrating a multitude of actors that source from smallholder farmers in remote areas and geographies. The agricultural last mile is complex and fragmented, but digitising value chain activities can make operations more efficient and transparent, and reduce costs for agribusinesses and cooperatives. This, in turn, helps them to meet customer demand and transition to more sustainable models of food sourcing.

For agribusinesses and cooperatives, **digital procurement tools offer more control over activities in their value chain.** Armed with data on cost contributors, their supply base and operational risks and quality, they can adapt more easily to new value chains or suppliers, build an "early-warning system" into their supply chain to deploy timely corrective measures and potentially offer better prices to farmers, especially in competitive value chains. For farmers, digital procurement provides insight into production trends, allowing agribusinesses or cooperatives to offer tailored support to help them improve productivity and quality and, in turn, earn more money for their crop.

As of January 2020, the GSMA AgriTech programme is tracking 111 digital procurement services globally that are linking smallholder farmers with agribusinesses. This is a significant increase from the five active services we originally tracked in 2010. Of the 111[79] services, Sub-Saharan Africa has the highest concentration with 55, while 31 are in Southeast Asia and 11 in South Asia. We are also tracking 12 services in Latin America and the Caribbean and two in the Middle East and North Africa (MENA) region.

Figure 26

Number of active digital procurement services by sub-use case, 2009–2019



79 Limited to one deployment per country per service provider. Providers of digital procurement solutions often have multiple enterprises using their services in one country, but it can be challenging to keep track of them on an ongoing basis.

Digital procurement solutions are mostly available as SaaS due to their complex functions, but some large agribusinesses are developing in-house solutions.

In the vast majority of cases, digital procurement tools are available as SaaS by specialised solutions providers. This is largely due to the complexity and cost of building and maintaining such solutions. Customisable solutions provided by specialist companies operating in multiple markets, such as SourceTrace (see case study at the end of this section), make it possible for agribusinesses and cooperatives to opt for off-the-shelf solutions that can be tailored to their needs. As food systems around the globe undergo fundamental shifts in reaction to climate change and urbanisation, there is growing demand to monitor and ensure food safety and origination. However, given that the pace of this shift varies from one region to another, different use cases for digital procurement are emerging to address specific needs. SaaS solutions are providing agile ways to digitise procurement and offer value-added functionalities, such as traceability and payments.

TaroWorks, incubated by Grameen Foundation, is a SaaS solution that has been widely adopted. The platform enables agribusiness and extension service providers to connect with farmers in hard-to-reach, rural or poorly connected areas.[80] Through offline customer relationship management (CRM) and a mobile app, TaroWorks provides mobile forms to log progress in the field and creates a feedback loop between the extension office and field agents' on-farm data, crop yields and training materials. This information ultimately helps agribusinesses manage the challenges of delivering goods and services in the field.

Increasingly, large commodity traders and processors are building in-house procurement solutions, such as Olam International's proprietary suite of digital solutions to optimise business processes, which include **Olam Direct**, **Olam Inside** and **Olam Forward**.

An integrated supplier of both raw and processed agricultural commodities, Olam International has a direct presence in over 60 countries. Its crop procurement network includes 4.8 million farmers, making it the largest in the world. Olam Direct offers digital procurement functionality, digital warehousing, bag barcode traceability, digital origination and an app, **Olam Farmer Information System (OFIS)**. Over 430,000 farmers in 20 countries have been registered on the OFIS platform, allowing the company to collect farm-level data such as transaction records; map their supply base using GPS; upload training and farm visits and manage first-mile transactions, such as crop purchases, input distribution and financing. Among other functions, the platform provides farmers with information such as pricing, weather, agronomic advisory and safety guidance, and supports digital payments to farmers.

Similarly, Halcyon Agri, an integrated supplier of natural rubber, has developed a portfolio of digital tools to support its growing, sourcing, processing and distribution activities. These include **Heveaconnect**, a digital trading marketplace for sustainably processed natural rubber; **Heveagrow**, a programme to ensure agronomical standards are applied to the sustainable production of natural rubber for plantations and smallholder farms; and **Heaveatrace**, which uses digital trace technology to map the raw material source used in the production of the HeveaPro brand of natural rubber.[81] Barry Callebaut, one of the world's largest cocoa processors and chocolate manufacturers, uses the **Katchilé** app, a cloud-based last-mile digital tool for tracing cocoa beans and managing sustainability data. Using technology solutions from SAP, it combines desktop and mobile access and can digitally record information on farmers, their farms and communities at every level of the supply chain.[82]

80 Social enterprises are organisations that address a basic unmet need or solve a social or environmental problem through a market-driven approach.
81 Heveatrace: www.heveaconnect.com/industrial-standards/
82 GSMA AgriTech (2020), *GSMA AgriTech Toolkit for the Digitisation of Agricultural Value Chains*.

The digitisation of farmer and farm records is the foundation of all digital procurement tools. While solutions with payment functions are growing, they are largely concentrated in regions where mobile money is available.

Digital records enable agribusinesses to build and maintain transparency in their transactions with smallholder farmers, which over time can improve loyalty and trust and improve operational efficiency. For farmers, digital payments reduce the time and cost of travelling to collect cash payments, as well as the associated security risks. For agribusinesses, managing payments digitally can help minimise the risks of theft and fraud and other costs of dealing in cash. **Kyagalanyi Coffee Limited** (KCL), a Ugandan company involved in the procurement, processing and export of coffee, has piloted digital payments to coffee farmers and traders. A cost comparison revealed that digital payments enabled a 27 per cent cost saving. Digital payments also led to indirect cost savings, such as 17 per cent higher productivity due to farmers not queuing to receive cash payments and KCL staff processing payments more quickly.[83]

With payments integration, agribusinesses can build more reliable value chains and introduce value-added financial services, such as credit products for inputs or long-term asset financing, directly or in partnership with financial institutions. **Ibero Uganda** has seen early success with this model (see section 4.2). Digital procurement solutions integrated with payments help promote financial inclusion by enabling the creation of digital financial footprints that, over time, can open access to financial services from formal institutions.

Sub-Saharan Africa is leading the implementation of digital procurement solutions with payments thanks to the widespread availability of mobile money services. In the region, close to 10 per cent of GDP in transactions occur through mobile money. Led by Kenya, there are roughly 144 mobile money services supporting over 181 million active accounts in Sub-Saharan Africa.[84] Connected Farmer is a digital procurement tool that integrates with Safaricom's M-Pesa mobile money solution. Operational in East Africa, primarily in Kenya, it is a multifunctional, mobile- and web-based supply chain management system that allows farmers to build a transaction history, helping buyers and suppliers better understand a farm's day-to-day operations. Since its launch in September 2012, eight agribusinesses have tested Connected Farmer's mobile solution and four have transitioned to full or partial commercial adoption.[85]

83 Additional cost savings from the payments digitisation project included a 15 per cent time saving for traders, who were able to spend the additional time procuring more crops rather than waiting for payments, and an eight per cent increase in crops procured as more farmers trading with KCL were paid on time. See: CGAP (2018), *Digitizing Agricultural Payments Lessons from Uganda's Coffee Value Chain*.
84 GSMA (2020), *State of the Industry Report on Mobile Money 2019*.
85 Technoserve (2016), *Connected Farmer Alliance: Assessing the impact of a commercial mobile agriculture (mAgri) solution*.

DEEP DIVE

Designing for multiple users in the last mile

A digital procurement tool is likely to address the pain points of different actors in agricultural value chains, not only farmers, but field and extension agents, truck drivers, purchasing clerks and agribusiness or cooperative office staff.

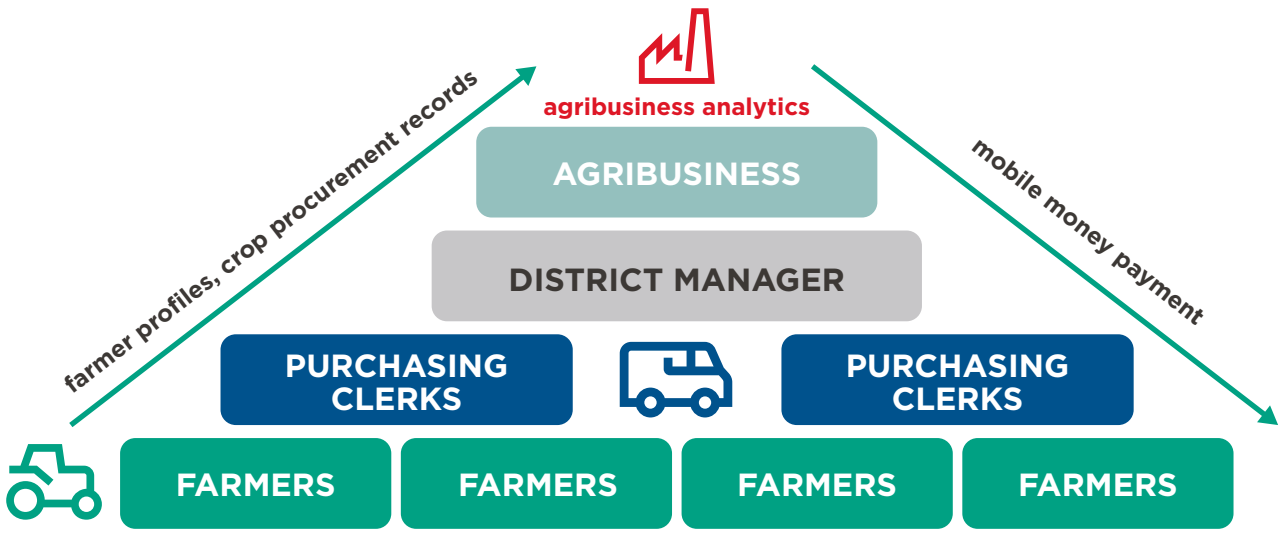
A human-centred design (HCD) approach involves designing for multiple users at the same time. A well-designed digital procurement tool requires understanding the complexity of the agricultural last mile and the various touchpoints between different actors as produce and transactions flow through it. It also ensures that digital tools are inclusive and equitable, and avoids amplifying existing bad practices based on unfair relationships. Designing with all users in mind should provide incentives for all value chain actors to use and support the tool over time. If just one key actor does not derive sufficient value from the digital tool, the last mile digitisation initiative is likely to fail.

MTN Ghana's **mAgric** digitises the entire procurement process in the last mile of the cocoa value chain. mAgric supports farmer registration and mobile money payments from agribusinesses to farmers, as well as data analytics and monitoring for agribusinesses. Purchasing clerks at the agribusiness are central to the procurement of cocoa. The mAgric app is designed to help them plan their cocoa collections by allowing them to see what produce is available in their catchment areas. The tool would not be viable, however, if other actors involved in the procurement process did not have sufficient incentives to justify uptake.

For district managers and agribusiness office staff, the mAgric dashboard's integrated analytics functions adds efficiency to monitoring (e.g. availability of funds to pay farmers) and planning last-mile operations (e.g. logistics, warehousing). Crucially, farmers benefit from the option to receive payments from purchasing clerks via mobile money. Our field research revealed that farmers recognise the benefits of digital wallets as more efficient cash management tools and the greater security they offer through less cash handling. This is also an incentive for purchasing clerks who no longer need to travel long distances with large amounts of cash. Similarly, the agribusiness benefits from eliminating the costs associated with transporting cash long distances and liability for staff security.

Figure 27

MTN Mobile Money, mAgric service flow



Increased mobile internet penetration and growing demand for "farm-to-fork" visibility in agricultural supply chains, particularly in Southeast Asia, is driving the growth of digital procurement solutions that offer traceability.

Southeast Asia has experienced a surge in solutions providing digital records and traceability. These solutions enable produce to be monitored from "farm to fork", providing full visibility into food chains not only for consumers, but also for agribusinesses and processors to ensure greater food safety and sustainable production. Since traceability solutions rely on smartphones, tablets and readers to record and relay information on commodities via RFID,[86] high-quality mobile internet coverage is critical.

Mobile internet penetration stands at 45 per cent in South and Southeast Asia[87] compared to 23 per cent in Sub-Saharan Africa.[88] Reliable internet connectivity is especially important in Asian countries where a growing middle class is demanding healthier, safer and ethically sourced food with traceable ingredients and origins. These changing consumption behaviours are evident across the globe (Figure 28), driving demand for digital procurement solutions with traceability.

Figure 28

Food preferences and choices by region, 2018[89]

	Africa	Developed Asia Pacific	Emerging Asia	Developed Europe	Emerging Europe	Latin America	Middle East	North America
Food preferences & choices								
Health and belief driven								
Simple, real, natural	Low	High	High	High	High	Medium	Low	High
Low in sugar, fats, lactose, etc	Low	Medium	High	High	Insignificant	Medium	Low	High
Ethical	Insignificant	Low	Low	Medium	Insignificant	Low	Insignificant	Medium
Flexitarian	Insignificant	Medium	High	Medium	Low	Low	Insignificant	Medium
Small portions	Insignificant	Insignificant	Insignificant	Low	Insignificant	Low	Low	Insignificant
Barriers								
Availability	High	Insignificant	Low	Insignificant	High	Low	High	Insignificant
Affordability	High	Insignificant	Medium	Insignificant	Low	Low	Insignificant	Insignificant
Food safety	High	Insignificant	Medium	Insignificant	Low	Low	Medium	Insignificant
Influencers								
Friends, family, etc	High	Low	High	High	High	High	Medium	Medium
Educational system	Low	Low	Insignificant	Low	Medium	Insignificant	Low	Low
Social media	Low	Medium	Medium	High	Low	High	High	High
Traditional media	High	Medium	Low	Low	Medium	Medium	Low	Low
Regulatory	Insignificant	Low	Low	Medium	Medium	Medium	Medium	Low
Trends								
Tradition	Medium	Medium	Medium	Low	Low	Medium	Low	Low
Adventure	Insignificant	Insignificant	Medium	High	Medium	High	Insignificant	High
Hyper convenience	Insignificant	Medium	Medium	Medium	Medium	Medium	Medium	High
Health awareness increase	Insignificant	High	Low	High	Medium	High	Low	High
Plant based	Insignificant	Medium	High	Medium	Insignificant	Medium	Insignificant	Medium
Food waste elimination	Insignificant	Insignificant	Insignificant	Low	Insignificant	Insignificant	Insignificant	Low
Accessible nutrition	High	Medium	Medium	Low	Insignificant	Medium	Insignificant	Low

High relevance · Medium relevance · Low relevance · Insignificant

Source: World Business Council for Sustainable Development, 2018

86 Radio-Frequency Identification (RFID) is the use of radio waves to read and capture information stored on a tag attached to an object.
87 GSMA (2019), *The Mobile Economy Asia Pacific*.
88 GSMA (2019), *The Mobile Economy Sub Saharan Africa*.
89 World Business Council for Sustainable Development (2018), *FReSH insight report – Consumption Behavior and Trends: Understanding the shift required towards healthy, sustainable and enjoyable diets*.

In South and Southeast Asia, agritech companies such as **Koltiva** in Indonesia are helping businesses trace their supply chains, verify and analyse their data and generate evidence to support sustainability claims. Established in 2013, Koltiva provides solutions to enable 100 per cent traceability across multiple value chains, including cocoa, rubber, seaweed and natural ingredients. Demand from international buyers is another key driver for traceability-based solutions in Southeast Asia where fisheries comprise the majority of food supply chains in the region. The aquaculture sector is the second largest export earner in the region.

Of the top 10 fish producing countries in the world, four are in Southeast Asia, with Indonesia the second-largest producer. [90] As global demand for seafood and fish grows, producers are increasingly dependent on international markets and international guidelines for food safety and quality. The EU and United States, major importers from the region, rely on traceability programmes to enforce regulations on combating illegal, unreported and unregulated (IUU) fishing and seafood fraud. There are a variety of monitoring, control and surveillance (MCS) measures that address IUU fishing, including vessel monitoring, genetic analysis, licensing systems and landing and dockside reports. Singapore-based **Fishcoin** uses blockchain technology to improve traceability in the seafood industry. The company provides farmers with tokens to top up their mobile phone data plans as an incentive to collect and submit information on their catch.

Holistic solutions that integrate payments and product traceability support sustainable farming and secure long-term supply while also moving farmers towards a living income.

Since first appearing in 2010, the number of digital procurement solutions enabling both payments and traceability has risen steadily. While interest in the origin of food has grown on a global level, countries in the EU are leading the shift. In Germany, 85 per cent of consumers want to be able to trace their food. [91] In addition to consumer demand, a government emphasis on food quality standards and certifications are the primary drivers for traceability in high-income European countries. The European Commission has established the EU TRACES network, which notifies, certifies, and monitors imports, exports, and trade in animals and animal products. [92]

Traceability requirements have also become prevalent for certain crops like cocoa and coffee, due to the high consumption rates in high-income countries and concern for farmer welfare among consumers. In Belgium, the government-led **Beyond Chocolate partnership** [93] for a sustainable chocolate industry comprises chocolate manufacturers, civil society organisations and investors. As one of the world's largest importers of cocoa beans, the partnership aims to end deforestation, promote education for future generations and provide a living income for cocoa growers. Demand for single-origin cocoa in Europe is driving this initiative. [94]

On a national level, several governments are committed to reforming production and pricing in the farmers' interest, making a strong case for digital procurement. In 2019, the governments of Côte d'Ivoire and Ghana [95] announced a living income differential (LID) to be paid for every tonne of cocoa procured. Other cocoa-producing countries are following suit, and LID will be integrated in the procurement of more crops. Such efforts should stimulate demand for digital tools that provide traceability records and support payments by agribusinesses. In response to growing demand, **Farmforce**, a cloud-based mobile platform for the agricultural last mile, is used by agribusinesses in different regions of the world to provide traceability at the field level, increase efficiency in the management of information and transparency, streamline compliance with food and sustainability standards (FairTrade, Rainforest Alliance) [96] and simplify audits.

Globally, agribusinesses are also using digital platforms to incentivise sustainable practices. Indigo Ag's **Terraton Initiative** encourages farmers to register on Indigo's digital platform, **Indigo Carbon**, a market that provides growers with a financial incentive to implement regenerative farming practices and remove carbon from the atmosphere. Growers who join Indigo Carbon within the first 12 months are eligible to receive a minimum of $15 per metric tonne of carbon dioxide sequestered. Demand for these solutions is coming from companies looking to offer environmentally sustainable products and from businesses aiming to become carbon neutral.

90 OECD/FAO (2017), "Southeast Asia: Prospects and Challenges", *OECD-FAO Agricultural Outlook 2017–2026*.
91 Fraunhofer ISI (2019), *50 trends influencing Europe's food sector by 2035*.
92 Charlebois, S., et al. (2014), "Comparison of Global Food Traceability Regulations and Requirements", *Comprehensive Reviews in Food Science and Food Safety, Vol. 13, pp. 1104–1123.*
93 Beyond Chocolate Partnership (2019), *Beyond Chocolate Partnership for Sustainable Belgian Chocolate*.
94 Centre for the Promotion of Imports from Developing Countries: www.cbi.eu
95 Ghana and Côte d'Ivoire are the world's two largest cocoa-producing nations, accounting for 60 per cent of global supply. In both countries, cocoa contributes significantly to their economies and provides livelihoods for about a quarter of the population (World Cocoa Foundation, 2017).
96 Fairtrade International works to share the benefits of trade more equally through standards, certification, producer support, programmes and advocacy. The Rainforest Alliance is an international non-profit organisation working to build an alliance to protect forests, improve the livelihoods of farmers and forest communities, promote their human rights and help them mitigate and adapt to the climate crisis.

CASE STUDY

GreenFingers Mobile: Transitioning from paper to digital to deliver efficiencies and transparency in the last mile

Launch date: 2015 **Users:** 12,000 farmers

Countries of operation: South Africa, Malawi, Nigeria, Tanzania and Zimbabwe

GreenFingers Mobile's (GFM) SaaS platform replaces paper-and-pen farming and agroforestry management systems, enabling agribusinesses and cooperatives to manage and finance large groups of smallholder farmers and gain real-time visibility of their activities in the last mile. At its core, the platform's functionality allows field officers to collect farmer, household and farm data, including geolocation. GFM's latest reforestation tracking tool, TreeTracker, uses a blockchain platform that allows funders to invest directly in outcomes-based reforestation projects managed by smallholder farmers in Africa. Funding is disbursed once validated impact data is loaded onto the blockchain. Farmers can also diversify their incomes by growing and maintaining fruit tree agroforestry projects, thereby sustainably restoring and protecting land destroyed by deforestation.

Value proposition

For agricultural enterprises, GFM enables customised digital management of smallholder farmers, with access to back-end data analytics for performance assessment, reporting and the provision of additional services to farmers, such as warehousing, logistics, financial management and forecasting and credit scores. By replacing inefficient paper systems with a browser-based, offline web app solution, agribusinesses and cooperatives can instil confidence in supply chains and increase operational efficiency and transparency. GFM's platform enables enterprises to manage yield forecasting, track commercial transactions, monitor the effectiveness of training and technical assistance and help smallholder farmers build a digital record of their economic activities.

Business model

A B2B2C model, GFM is available to agribusinesses and cooperatives under a per user licence fee on a subscription basis, while farmers are registered on the platform by their affiliated enterprise free of charge. Additionally, GFM offers technical, operational and training support to clients on a prepaid basis. For its blockchain-enabled outcome funding initiatives, GFM earns a margin on total funding volume. All impact events (data) are validated and payments are triggered to farmers and partners.

Milestones

GFM was initially piloted in 2013–2014 with international food corporation Nando's, which wanted to diversify its supply chain by including smallholder farmers growing ABE chili in Mozambique, Zimbabwe and Malawi. The GFM solution spun out of Impact Amplifier, a social innovation accelerator, and was fully established in 2015. GFM currently has over 12,000 farmers registered on the platform and has processed over 65,000 commercial transactions. In late 2019, GFM launched its reforestation tracking tool. GFM has clients in Malawi, Nigeria, South Africa, Tanzania and Zimbabwe. The company has received seed funding from Hivos Food and Lifestyle Fund, Google Impact Challenge and a KIVA interest-free loan.

Future roadmap

GFM aims to run large-scale outcomes-based reforestation projects across Africa through its network of smallholder farmers. GFM is diversifying its core system as a last-mile digital distribution platform for agro dealers in Africa. The company wants to enable farmers to take advantage of various third-party products and services, such as crop insurance, credit, digital remittances, mobile money, and weather, climate and market information through the integration of APIs. It aims to reach 50,000 farmers on its platform by 2021 and facilitate at least $100,000 in funding through its blockchain reforestation token.

CASE STUDY

SourceTrace: Supporting traceability in agricultural value chains and strengthening smallholder farmer relationships

Launch date: 2013 **Users:** 140 companies **Countries of operation:** 28 countries across four continents

SourceTrace is a SaaS company that develops customisable software solutions for a range of value chain activities. SourceTrace's DATAGREEN platform includes multiple modules, including farm and farmer management, agronomic advisory services, certification, traceability, supply chain management, financial services management, monitoring and evaluation tools and market linkages. The solution works in remote areas with low bandwidth and connectivity, making it possible to capture and geolocate interactions with smallholder farmers in real time.

Value proposition

SourceTrace helps agribusinesses streamline their operations, increase operational efficiency and bring transparency to the entire value chain. The platform also enables businesses to provide complete traceability of their production and supply chain systems. Smallholder farmers working with these businesses gain access to essential agronomic information, such as pest and disease information, yield estimates, weather forecasts and market linkages. The platform also provides farmers with a digital record of their transactions and can enable payments.

Business model

SourceTrace is a SaaS company operating under a B2C2B model. A broad range of agriculture sector actors, including cooperatives, agribusinesses, FSPs, governments and development organisations, use SourceTrace's suite of applications. The pricing includes a one-time onboarding cost, followed by a monthly subscription, which is dependent on the number of farmers registered. In some cases, pricing is based on the number of acres under management. In traceability solutions, pricing depends on the number of commodity ecosystems tracked.

Milestones

SourceTrace began working in digital agriculture and sustainability programmes in 2013, and since then has worked with governments, donor organisations and large agribusinesses. SourceTrace has contributed to Cargill's Cocoa Promise, which has reached about 240,000 smallholder cocoa producers in Africa. In 2019, the company integrated enhanced traceability solutions in its platform, making it a holistic tool supporting both sustainable agriculture and food safety. SourceTrace has reached over a million farmers and is currently being implemented in 28 countries.

Future roadmap

SourceTrace has developed an integrated solution with potential to streamline the operations of agricultural and food businesses. Plans to develop the platform include adding remote sensing technology, quality testing and blockchain-based traceability. The company aims to bring sustainability to both food production and consumption systems, and reach 10 million farmers over the next three years.

Figure 29

Global map of active agri e-commerce services, January 2020

1 KENYA
18 services

including:
Twiga Foods, TruTrade Africa, MasterCard Farmer Network

2 INDIA
14 services

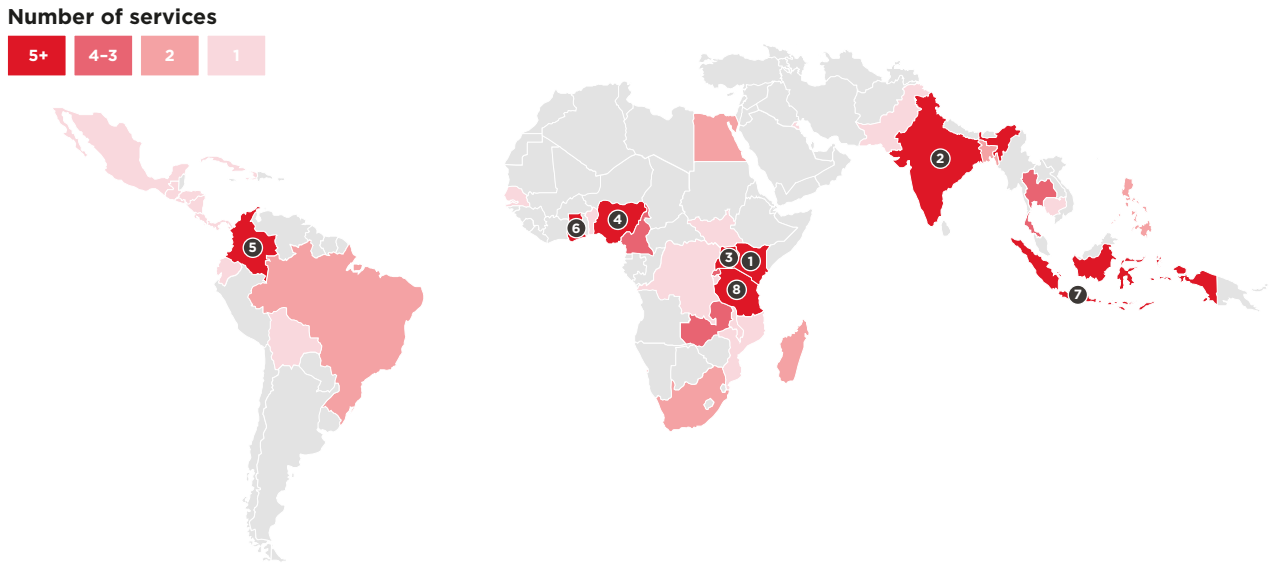
including:
NinjaCart, Milkbasket, AgriBazaar

3 UGANDA
10 services

including:
Famunera, AgroMarketDay, TruTrade Africa

4 NIGERIA
9 services

including:
Afrimash, Agirkore, AFEX Commodities Exchange



5 COLOMBIA
6 services

including:
Frubana, Mucho, Smattcom

6 GHANA
5 services

including:
AgroTrade, Organic Trade and Investments, AkokoMarket

7 INDONESIA
5 services

including:
TaniHub, Regospantes, Syurbox

8 TANZANIA
5 services

including:
Ninanyo, AgriMark, Mastercard Farmer Network

4.4 Agri e-commerce

Agricultural produce is growing in popularity on e-commerce platforms, providing an opportunity for consumers and smallholder farmers to build closer connections. In LMICs, agri e-commerce platforms facilitate the movement of agricultural produce from farmers to urban consumers.

For example, **Vitak Farm Fresh** in South Africa delivers fresh fruit and vegetables sourced directly from smallholder farmers to individuals and businesses across the province of Gauteng, home to two of the country's largest cities, Johannesburg and Pretoria. Agri e-commerce also enables the sale of agricultural input to farmers in rural areas. For instance, **Lima Links** in Zambia works with cooperatives, NGOs and outgrower schemes to connect farmers with buyers of agricultural produce and to enable groups of farmers to place bulk orders via a USSD-based platform.

On the output side, agri e-commerce companies adopt either a direct-to-consumer B2C model or a strictly B2B model in which the company sells to the catering industry (e.g. hotels, restaurants) and market retailers, or a hybrid of the two. On the input side, agri e-commerce companies are connecting farmers to input suppliers via a B2C model. A few e-commerce companies, such as **Famunera** in Uganda, offer both B2C and B2B solutions. The company allows farmers to list their produce and contact buyers (corporate or individual) on the web and via a mobile app.

Agri e-commerce is an opportunity to reshape and formalise the power dynamics in fragmented value chains. By enabling the buying and selling of agricultural produce online, farmers can bypass intermediaries and gain access to new markets, giving them more choice and a higher margin of what consumers pay (Figure 31).

Figure 30

Number of active agri e-commerce services by region, 2009–2019

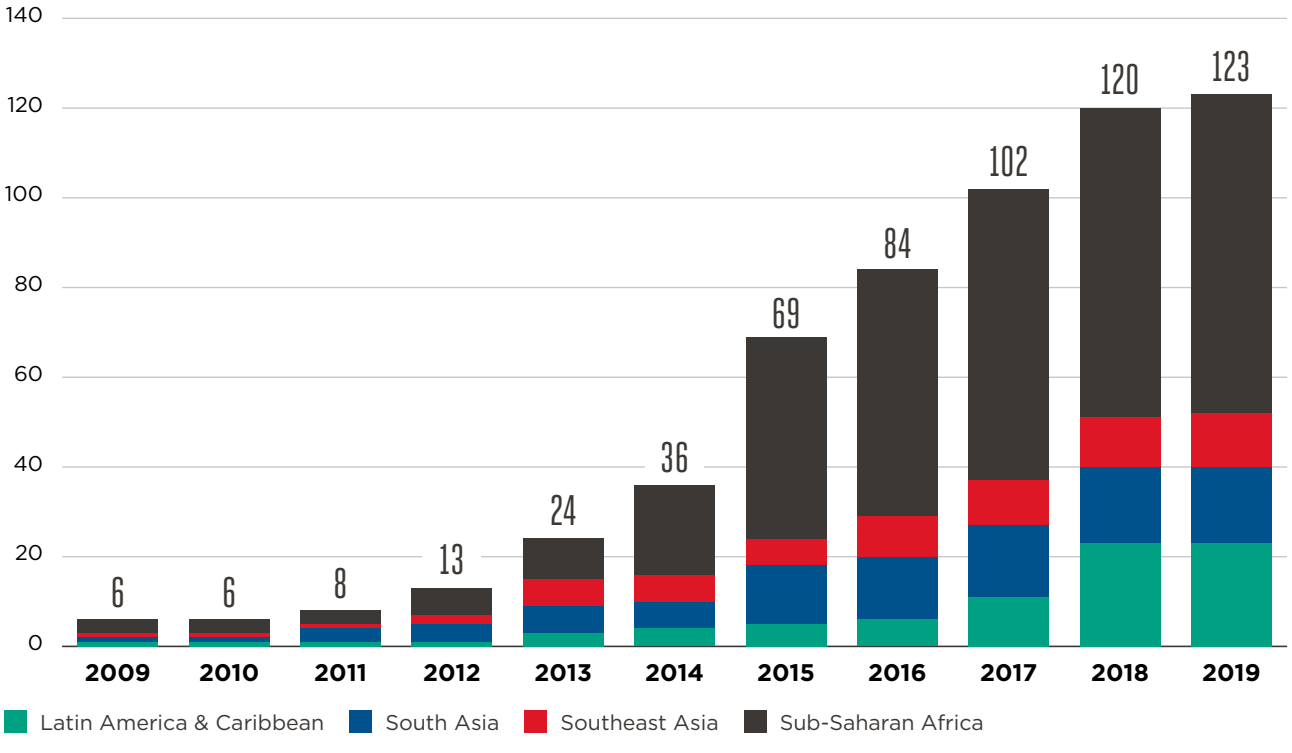
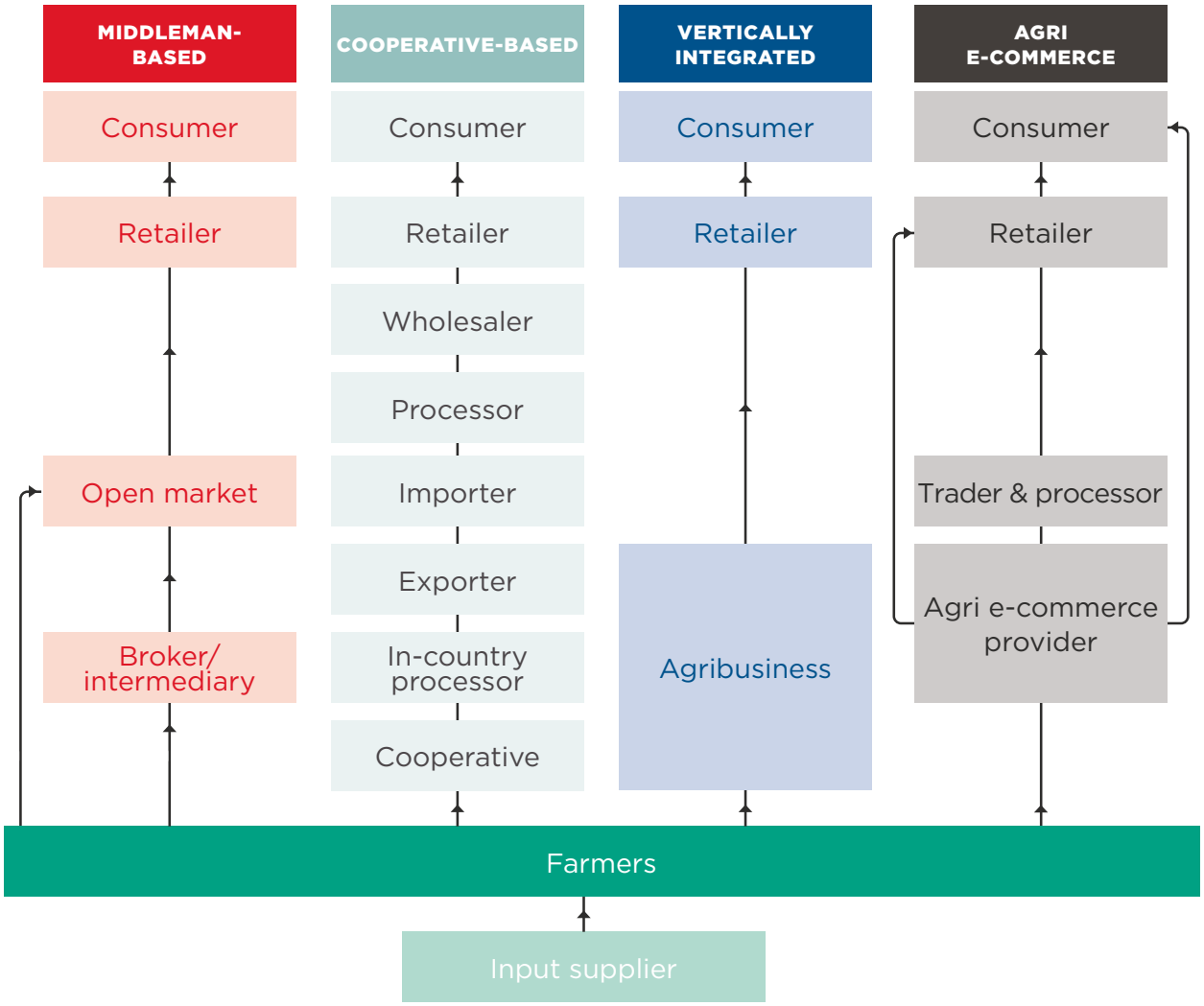


Figure 31

Generic structure of agricultural value chains[97]



Source: : Adapted from GSMA Intelligence, 2019

Agri e-commerce is growing in every region. While South and Southeast Asian companies have scaled due to strong and growing consumer demand for online agricultural produce, Sub-Saharan African companies are limited by poor logistics networks.

The number of agri e-commerce platforms in LMICs has grown exponentially, from six in 2009 to 126 in 2019, 71 of which are in Sub-Saharan Africa (Figure 30). While Sub-Saharan Africa has seen the most traction in the agri e-commerce space, the region lacks examples of services that have achieved significant scale (20,000+ farmers registered). With the exception of a few services, such as **Twiga Foods** in Kenya, which connects fruit and vegetable farmers to urban retailers, and AgroCenta's **AgroTrade** in Ghana, which connects farmers in the staple food value chain to large off-takers, most e-commerce start-ups in Sub-Saharan Africa are still small scale, dependent on donor funding and in the pilot stage. The growth of e-commerce platforms in recent years is largely due to growing interest in fixing the "middleman

97 GSMA Intelligence (2019), *E-commerce in agriculture: new business models for smallholders' inclusion into the formal economy*.

problem" in the region. E-commerce solutions provide an opportunity to aggregate products and gain direct access to markets. Despite increased mobile internet penetration[98] and large numbers of mobile money accounts,[99] the most significant challenge to scaling agri e-commerce is the region's poor logistics networks and infrastructure.[100]

South and Southeast Asia have seen fewer examples of agri e-commerce, but services have scaled more successfully. Strong and growing consumer demand for online agricultural produce has driven growth in these regions, and India has some of the most established agri e-commerce services. For example, **Ninjacart** works with nearly 37,000 farmers across the country (see case study at the end of this section). **Ricult**, a service operating in Thailand and Pakistan, has a network of close to 100,000 farmers.

Compared to Sub-Saharan Africa, the region has better logistics networks and more reliable and accessible internet connectivity. The banked population is also growing and there are more widely available banking options, such as digital wallets and mobile money services. This makes countries such as Indonesia, Malaysia and India well suited to agri e-commerce services. As countries like Thailand and Vietnam become increasingly connected to the internet[101] and e-commerce continues to grow considerably,[102] the prospects for agri e-commerce in the region look even more promising.

In Latin America and the Caribbean, agri e-commerce has also grown significantly, from five services in 2015 to 23 in 2019, with growth driven by established companies with operations in multiple countries, such as **Frubana**, **Mucho**, **Accesso** and **Smattcom**.

In any market, the proliferation of agri e-commerce depends on a number of enabling factors, including mobile internet penetration and connectivity, a well-established logistics network and accessible digital payment solutions where traditional banking service penetration is relatively low.

The sustainability and scalability of an agri e-commerce service depend on a country's infrastructure, including telecommunications, logistics networks and financial services. A recent GSMA AgriTech study on emerging business models in agri e-commerce[103] identified seven key market enablers. The three most important are **mobile internet penetration and connectivity** to enable buyers to access online services; a **well-established logistics network**, including national infrastructure such as roads, address systems and delivery services to move produce from one place to another; and **accessible digital payment solutions**, such as mobile money and payment banks where traditional banking service penetration is relatively low.

Other enabling factors include **agriculture sector readiness**, which requires being technically equipped for e-commerce with access to relevant devices and digital skills. **Familiarity with other, non-agriculture specific e-commerce services** also increases the likelihood that consumers will use agri e-commerce. **The rate of urbanisation** in South and Southeast Asia, which currently outpaces Sub-Saharan Africa, is a catalyst for consumers with busy urban lifestyles to shift to agri e-commerce. Over the last decade, some countries in South and Southeast Asia have seen **growing income levels**, leading to changing food consumption and lifestyle patterns. E-commerce is therefore becoming a particularly appealing way to cater to growing middle-class interest in ethically sourced local produce, as well as fresh and organic food.

98 Mobile internet penetration in Sub-Saharan Africa increased from 35 per cent in 2014 to 53 per cent in 2018. See GSMA Intelligence (2019), *E-commerce in agriculture: new business models for smallholders' inclusion into the formal economy*.
99 Globally, Sub-Saharan Africa has over 45.1 per cent of total registered accounts as of December 2019. See: GSMA Mobile Money (2020), State of the Industry Report on Mobile Money 2019.
100 McKinsey & Company (2019), How e-commerce supports African business growth.
101 GSMA Mobile Internet Connectivity Index scores for 2018, Thailand=68.3 and Vietnam=65.0. See: *GSMA Connected Society (2018), The GSMA Mobile Connectivity Index*.
102 The e-commerce sector in the six top ASEAN countries (Indonesia, Vietnam, Philippines, Thailand, Malaysia and Singapore) is valued at USD 38 billion today, seven times more than the USD 5.5 billion it was valued at in 2015. See: Thomas, J. (8 October 2019), "Southeast Asia's internet economy booming", *The Asean Post*.
103 GSMA Intelligence (2019), *E-commerce in agriculture: new business models for smallholders' inclusion into the formal economy*.

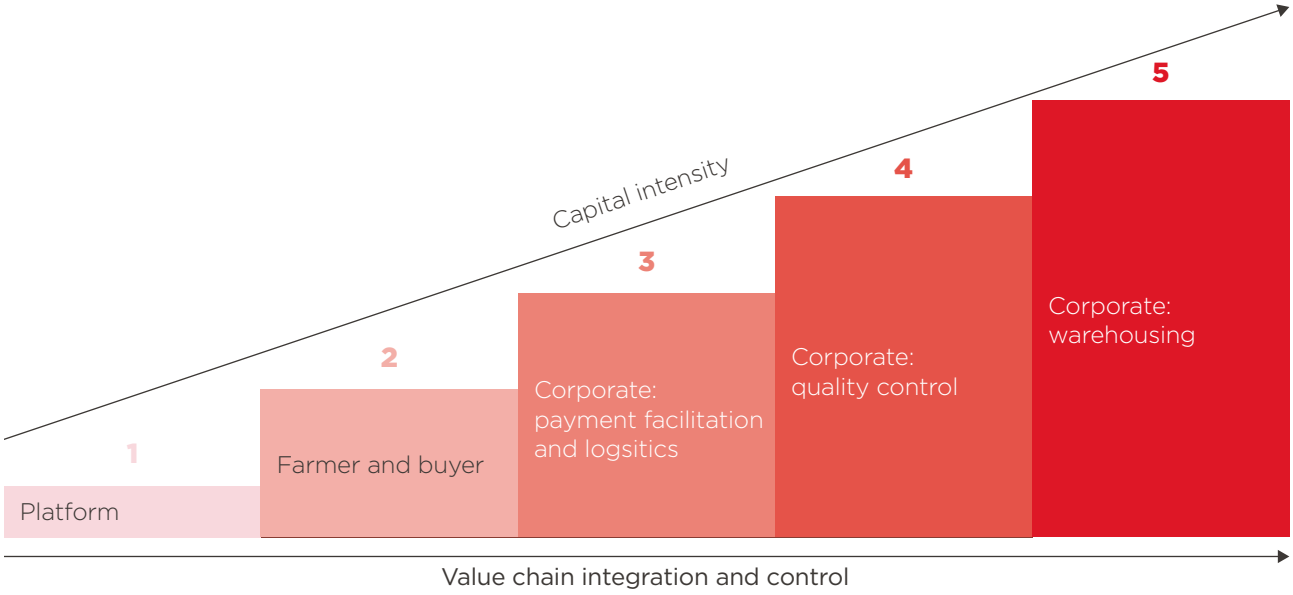
The most successful agri e-commerce businesses invest in more than a platform. They provide additional functions, such as farmer and buyer engagement, payments and logistics, quality control and warehousing.

Research shows that the most successful agri e-commerce companies take on many core functions typically the remit of agribusinesses, including farmer acquisition, education and pre-financing. An agri e-commerce business can also take on buyer's side functions, such as marketing, customer service and returns. On the corporate side, an agri e-commerce platform may also take on logistics, warehousing, quality control, platform provision, payment facilitation and regulation. The functions undertaken by an agri e-commerce platform depend on the level of formality in the relationship between farmers and buyers, the geographic location of farms and buyers and the perishability and seasonality of produce. Agri e-commerce businesses must therefore balance their online and offline assets to enable some of the key functions, which require presence on the ground.[104]

The more functions an e-commerce business undertakes, the more control it will have over key elements of the service and the more capital expenditure (CAPEX) and operational expenditure (OPEX) it will require. As e-commerce businesses take on more functions, the capital intensity and complexity of their operations increase and they move into higher level business models (Figure 32).

Figure 32

Evolution of the agri e-commerce business model[105]



Source: GSMA Intelligence, 2019

Companies with the highest level of involvement in their value chains, such as the Indonesian e-commerce platform **TaniHub**,[106] manage complex warehousing and cold storage functions. TaniHub also raises awareness for farmer acquisition and provides a platform for marketing and customer care, arranging logistics, facilitating digital payments and performing quality control at farms. This allows the company to ensure that produce is appropriately stored, packaged and distributed, which introduces efficiencies and reduces the risk of post-harvest waste. Companies such as **Tulaa** in Kenya and **IzyShop** in Mozambique provide similar services, but in the absence of purpose-built warehousing facilities, quality control and packaging take place at the farm.

104 GSMA Intelligence (2019), *E-commerce in agriculture: new business models for smallholders' inclusion into the formal economy*.
105 Ibid.
106 Part of the TaniGroup.

Mobile money providers have valuable assets that can help agri e-commerce businesses scale.

MMPs have several key assets to offer agri e-commerce platforms. These include an extensive agent distribution network, established customer base, reputable and trusted brand, local market knowledge, existing relationships with local banks and governments, and customer and transaction data to identify fraudulent transactions. In Kenya, **Twiga Foods** and **Safaricom** are an example of an effective partnership between an agri e-commerce platform and an MMP. Twiga Foods, Sub-Saharan Africa's largest agri e-commerce service operating in Kenya, is a B2B food supply platform that sources fresh horticultural produce from farmers and delivers it to vendors, retailers and kiosks in urban areas. By collaborating with Safaricom, the company has created an entirely cashless operation, enabling Twiga Foods to send money from M-PESA to bank accounts and make high-value payments to farmers. Limits on mobile money wallet ticket sizes would not have made this possible.

CASE STUDY

Ninjacart: Connecting urban consumers and rural producers to boost farmers' incomes

Launch date: 2015 **Farmers engaged:** 40,000–50,000 farmers **Country of operation:** India

Ninjacart is an agriculture e-commerce B2B platform connecting smallholder farmers with retailers, restaurants and service providers across seven cities in India. The company currently sources about 1,600 tonnes of fresh produce from over 150 villages, and supplies to about 60,000 businesses across the country every week. To launch operations in a village, Ninjacart onboards at least 10 farmers through procurement field agents and establishes collection centres within a maximum of 15 to 20 kilometres from each farmer, where they do sorting, basic grading and conduct quality control assessments of the produce before sending them out to their customers.

Value proposition

By removing multiple intermediaries from the supply chain, Ninjacart's service allows farmers to get better prices and consistent demand for their produce. Farmers onboarded by procurement field agents are given IDs with which to identify themselves and receive communications from Ninjacart either via SMS or an app. Farmers are also paid directly into their bank accounts using the ID. The proximity of collection centres enables even the most marginal farmers to gain access to buyers beyond the farm gate, making it possible to sell their produce at a higher value than if they sold at markets. For businesses in urban areas, Ninjacart ensures a consistent supply of high-quality fresh produce at competitive prices with full traceability, while also freeing up time for retailers whose produce procurement activities previously involved daily visits to local markets in the early hours of the morning.

Business model

As a B2B service, Ninjacart generates its revenue by taking a commission from the businesses that order supplies using its platform. The service is free for farmers to use. Ninjacart's operational process involves hiring up to 800 trucks daily, renting the space for collection centres and hiring people to load deliveries into crates on a contractual basis, which together make up the major operational costs of running the supply chain business. The company has developed a sophisticated supply chain algorithm to predict customer demand and translate them to farmers on a weekly basis to secure the required supply.

Milestones

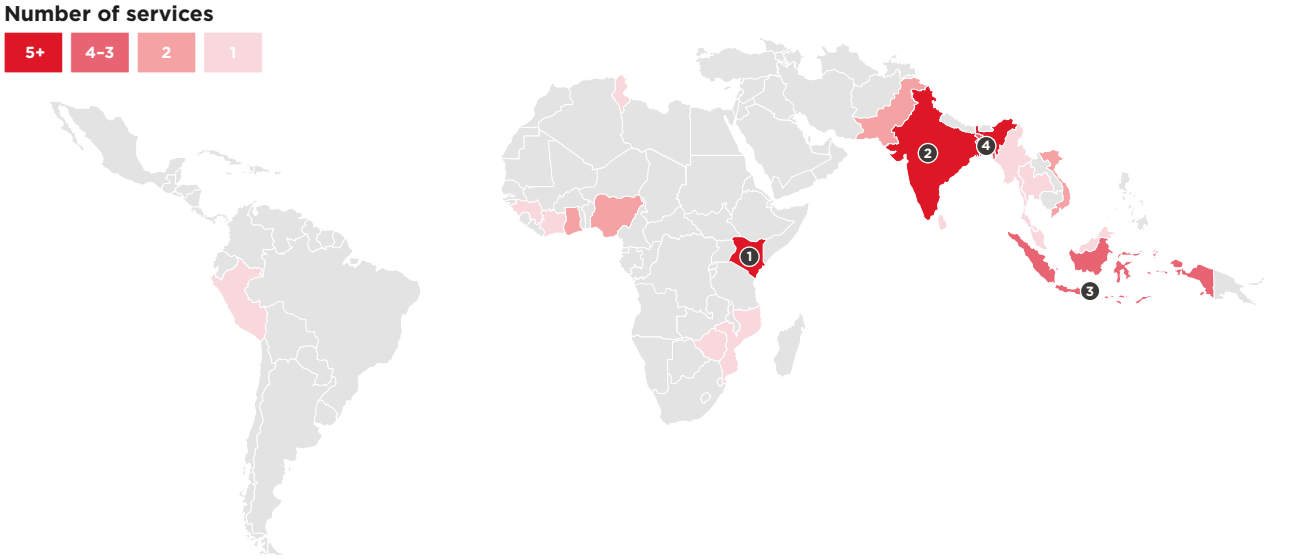
Ninjacart started out as a grocery delivery tool, serving consumers via a B2C model. However, the company's founders adopted a B2B model in response to concerns about low margins, profitability and the long-term viability of the B2C model. By evolving its business model, Ninjacart has gained more control of the value chain and created a seamless link between farmers and businesses. The company handled 100 tonnes of fresh produce a day in 2018 for delivery in the Bangalore area. In 2020, it is handling 1,600 tonnes per day across seven major cities and continues to grow.

Future roadmap

Ninjacart is looking at continual expansion into other cities in India, and providing value-added services to farmers, including facilitating access to cheaper inputs by aggregating demand.

Figure 33

Global map of active smart farming services, January 2020



❶ KENYA 8 services	❷ INDIA 6 services	❸ INDONESIA 4 services	❹ BANGLADESH 3 services
including: Illuminum Greenhouses, SunCulture, Astral Ariel	including: TRRINGO, MooOn, farMart	including: e-fishery, Polardrone, Smarternak	including: Smart Farm, Hello Tractor, Cowdy

4.5 Smart farming

Smart farming is the newest digital agriculture use case to take hold in emerging markets, first appearing in the late 2000s.

Smart farming refers to the use of sensors, drones, satellites and other farm assets to generate and transmit data about a specific crop, animal or practice to support agricultural activities. Smart farming solutions rely on connectivity between IoT-enabled devices to optimise production processes and growth conditions while minimising costs and saving resources.

In emerging markets, smart farming involves three main types of solutions:

- Remote equipment and operations monitoring solutions, such as irrigation systems and smart greenhouses.
- Livestock and aquaculture management solutions that include components such as smart collars for cattle that track and transmit data on the animal's health and movement, or sensors in fish ponds that detect the movement of fish, determine the amount of feed required and enable automation of feeding processes.
- Smart shared assets solutions that enable farmers to access agricultural equipment via digital booking systems. The equipment is fitted with IoT-enabled tracking devices to allow remote monitoring. Such services are primarily provided via mobile money for PAYG billing.

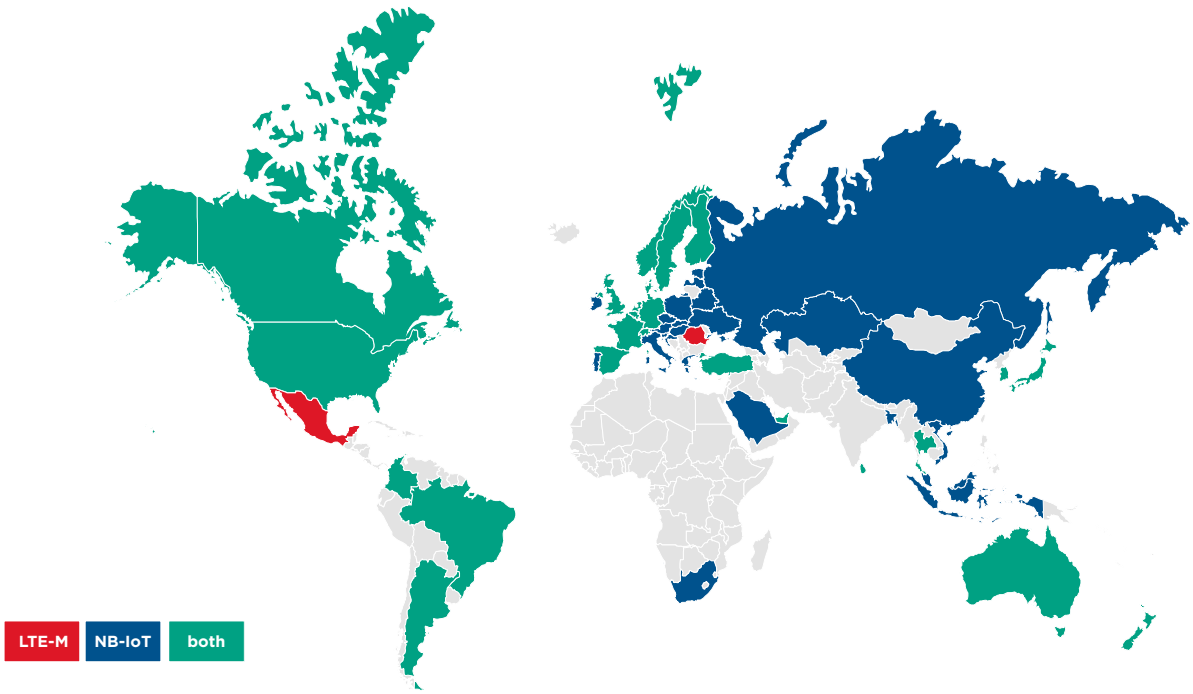
In addition to enabling better field monitoring and management, smart farming tools generate critical agricultural data to support farmers with decision making. The GSMA AgriTech programme is tracking 38 smart farming services globally, 16 of which are in Sub-Saharan Africa, 11 in South Asia and nine in Southeast Asia.

Mobile IoT is key to smart farming solutions, but IoT deployments in the agricultural sector can be expensive and challenging to roll out.

In the agricultural sector, IoT technology introduces efficiency, precision and automation at various stages of the crop, livestock or aquaculture production cycle. In emerging markets, connectivity and the cost of hardware (e.g. sensors) are major challenges inhibiting deployments, particularly in rural areas. According to GSMA Intelligence data, most of Sub-Saharan Africa does not have licensed mobile IoT networks deployed by MNOs (Figure 34). Through licensed NB-IoT and LTE-M networks using mobile connectivity, it is possible to cover large farming areas with smaller data requirements, potentially lowering the cost of deployment. Other advantages of licensed networks are security and scalability due to the application of international standards, and the potential to bundle with other mobile offerings.

Figure 34

Licensed mobile IoT deployments globally, 2020[107]



Source: GSMA Intelligence 2020

Service providers of smart farming solutions have the option to use IoT modules that rely on connectivity from unlicensed IoT networks through standards such as LoRa, SigFox and RPMA.[108] In LMICs, unlicensed IoT networks are the main source of connectivity,[109] but they lack the capacity for scale and are less reliable. It is therefore critical that MNOs identify use cases and business models that justify investments in NB-IoT and LTE-M networks.

A handful of MNOs in emerging markets are piloting, or have already launched, agri IoT solutions on the back of their IoT network deployments. In Latin America, for example, **Telefónica** has partnered with the FAO to pilot an integrated monitoring, control and prediction system that uses sensors installed in fields to measure agronomic variables. The data is then analysed and farmers receive alerts via their mobile phones that help them make decisions about optimising irrigation.[110] **Orange** is working with Dacom, an agricultural yield

107 GSMAi Mobile IoT (LPWA) Deployment Map: www.gsma.com/iot/deployment-map/.
108 i-SCOOP, "LPWA network technologies and standards: LPWAN wireless IoT guide".
109 Unlicensed IoT networks used in many emerging markets include SigFox, LoRa and RPMA.
110 María José Lanuza (17 October 2019), "Smart Agro: Institutional alliances for a sustainable agriculture", *Telefónica Public Policy Blog*.

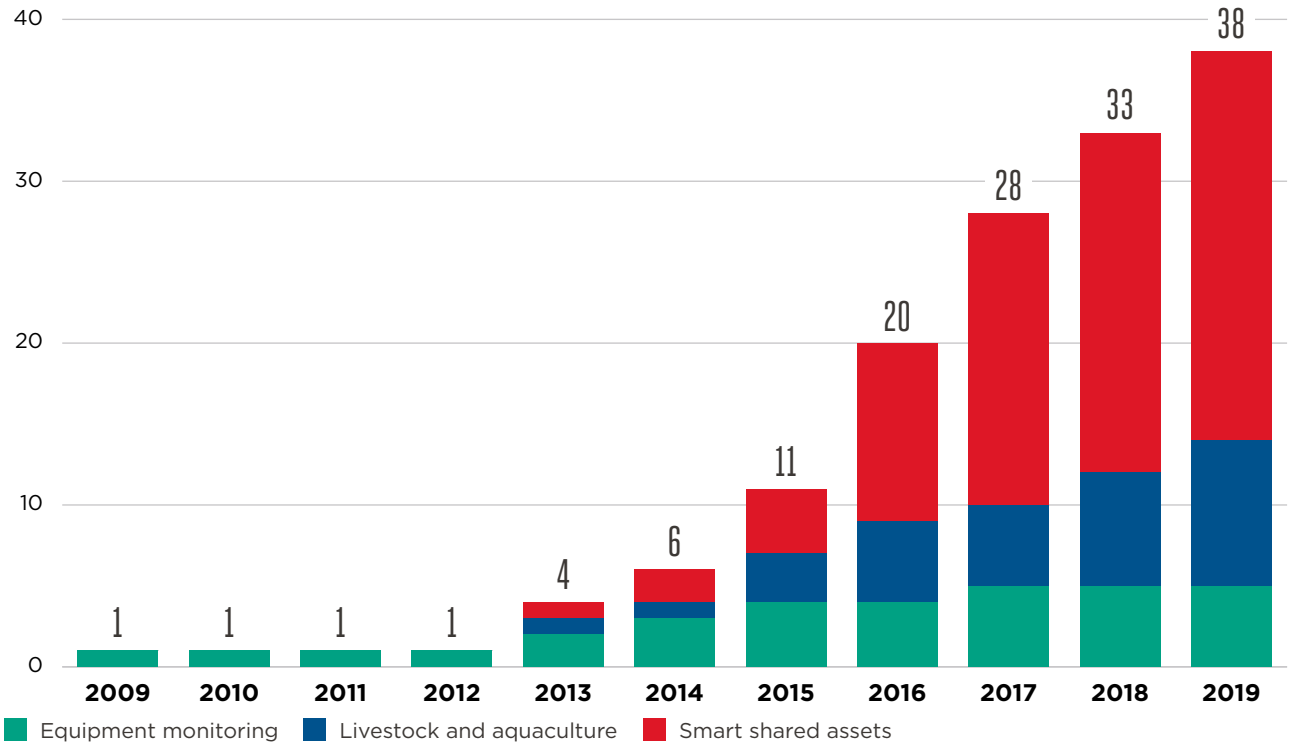
management solutions provider, to develop IoT-based solutions for several markets in parts of the Middle East and Africa. These solutions will help farmers with activities such as monitoring water levels and quality, identifying optimum harvest dates and detecting crop diseases.[111] In South Asia, **Dialog Sri Lanka**[112] has partnered with two national universities to develop a smart greenhouse system for agriculture powered by its NB-IoT network. Using low-cost IoT-enabled sensors and actuators, the system provides real-time data to support decision making and allow farmers to monitor growth and control activities remotely via any smart device.[113] In Bangladesh, Grameenphone has launched **Smart Farm**, a cattle care solution using IoT (see below for more information).

One of the key barriers to the adoption of agri IoT solutions is the cost of the equipment. Sensors can range widely in price, from $120 for a pack of three greenhouse humidity sensors to $4,450 for an onboard drone sensor from Slantrange, a company developing sensing and analytics technologies. Sensors for agri IoT uses are more complex to manufacture and connect than those for smart home applications. As a result, they have not been able to take advantage of economies of scale even in developed countries, although prices are likely to fall as deployments increase and equipment becomes less complex.

To reduce the upfront cost burden of IoT sensors, service providers could switch to a contractual financing model, similar to how MNOs provide smartphones to consumers. This option could make it easier for progressive farmers and agribusinesses to deploy connected equipment and change the equipment they use depending on the mix of crops and/or livestock. For service providers, the advantage is the ability to predict regular revenue in the form of instalment payments over the duration of the contract and increase overall unit sales with a more affordable consumer product. This model also offers the possibility to bundle a certain amount of information or analysis depending on how many devices the farmer has, making it easier to target them with more insights or analysis.

Figure 35

Number of active smart farming services by sub-use case, 2009–2019



111 Orange Business Services (no date), "Dacom raises sustainable arable crop production and profits".
112 Javed, A. and Gunawardena, D. (16 Juley 2020), Local partnerships to drive affordable smart farming with Dialog Sri Lanka. *GSMA Mobile for Development blog.*
113 Daily FT (30 October 2018), *Dialog and Universities of Ruhuna and Moratuwa spearhead next-gen solutions for smallholder farmers*.

Smart shared asset solutions, such as those enabling access to tractors, drones and other farm equipment, account for most of the growth in smart farming globally.

Smart shared assets account for 24 of the 38 active smart farming solutions we are tracking in LMICs globally (Figure 35). For smallholder farmers who lack access to capital for mechanised equipment, smart shared assets provide an alternative way to access farming assets, which are not economically viable for most due to the small size of their farms and low income. Also, the growth in DFS enabling access to credit has not yet translated into greater availability of long-term asset finance, leaving smallholder farmers to turn to the sharing economy or PAYG solutions.

Tractors and other farm equipment enable the mechanisation of fieldwork, such as ploughing, harrowing and harvesting, which increase productivity considerably by reducing the amount of manual labour and time required. According to the FAO, Sub-Saharan Africa is the least mechanised agricultural region in the world with less than two tractors per 1,000 hectares of cropland, compared with 10 tractors per 1,000 hectares in South Asia and Latin America.[114] In response to the need for greater mechanisation, smart shared asset solutions in Sub-Saharan Africa have registered the strongest growth. Thirteen of the 24 solutions we are tracking originate in Sub-Saharan Africa, while Southeast Asia accounts for five services and South Asia for six. By connecting farmers to equipment owners, smart shared asset solutions are also providing opportunities for owners to earn money and maximise the use of their equipment, which would otherwise have been left idle for long periods.

One of the most established smart shared asset solutions is **Hello Tractor**, which operates in multiple markets across Sub-Saharan Africa and South Asia. The Nigeria-based company connects a monitoring device fitted on tractors to the cloud for data analytics and virtual monitoring, which tractor owners can access via a mobile app. Each device has GPRS and SMS capabilities, allowing it to transmit data in areas of low connectivity. Farmers can request tractor services via an app or through trained booking agents in rural communities who aggregate demand from farmers, capture relevant farm and farmer data and make payments on the platform. Other examples of services connecting farmers to owners of farm assets include **Kóbiri** in Guinea Conakry, **TRRINGO** and **FarMart** in India and **Tun Yat** in Myanmar.

Other shared economy and PAYG solutions provide drones. Drones are playing an increasingly important role in making tasks like crop spraying, mapping and health monitoring more efficient, precise and affordable, while also providing invaluable data to inform decision making on farming practices and inputs.[115] **BeatDrone** in Nigeria provides drones-as-a-service to smallholder farmers through a value chain approach via cooperatives, farmer associations or agribusinesses that aggregate demand, request and pay for services through the company's digital platform. Unlike tractors, which are used specifically in agriculture, the use of drones spans numerous sectors, including energy, construction and infrastructure. While drones-as-a-service companies, such as **AcquahMeyer** in Ghana, **Poladrone** in Indonesia and **AUS-Aarav Unmanned Systems** in India, also provide services to the agriculture sector, their business models are geared towards large farm owners rather than smallholder farmers due to the complexity of serving this fragmented segment.

Equipment monitoring solutions were the first smart farming use case to emerge and remain present in every region.

Equipment monitoring solutions were the first smart farming solutions to emerge. As simple applications that can automate operations by switching a pump on and off, they enable better management of natural resources (water), which is critical for rainfed agriculture and even more so with climate change. One of the first equipment monitoring solutions to appear in LMICs was Nano Ganesh, an irrigation automation system developed by India-based Ossian Agro Automation in 2004. **Nano Ganesh** is an electronic device installed in the starter panel of an irrigation pump that allows farmers to remotely control and

114 UN, *Africa Renewal* (April–July 2019).
115 TechnoServe (19 August 2019), *Can Drones Change Africa's Agricultural Future?*

monitor pumps via mobile phones, reducing the time and energy required to travel to the farm and manually operate the equipment. The system uses a simple interface enabled by a phone call or SMS.

Other notable examples of resource optimisation solutions are tools provided by **SunCulture** in Kenya, **MimosaTek** in Vietnam and **Seabex** in Tunisia. SunCulture's products are sold to smallholder farmers as a PAYG solution enabled by mobile money, payable over 18 to 36 months. The company's main product is the RainMaker2 solar-powered irrigation system sold with or without a climate-smart battery. SunCulture also offers a drip irrigation system that can be installed as an add-on to the RainMaker to improve efficiency. In addition, SunCulture offers the Shakti Pump solution for community or large-scale solar irrigation projects, which provides community centres, schools and office buildings with a steady supply of water and clean off-grid electricity.

Established in 2014 in Kenya, **Illuminum Greenhouses** constructs and sells a comprehensive greenhouse solution installed with solar-powered sensors that monitor environmental parameters and regulate the water supply, which is channelled through drip irrigation lines. Farmers can monitor conditions in the greenhouse via their mobile phones and receive text messages that alert them to any changes they need to make and allows them to turn the irrigation system on or off via SMS. Illuminum Greenhouses offers a flexible payment plan that gives farmers the option to acquire a unit after making a 50 per cent deposit, with subsequent payments made via mobile money or in cash to the company's field agents.

South and Southeast Asia lead growth in smart farming, with specialised solutions geared to the needs of major regional value chains.

Most of the growth in agricultural IoT solutions has been in South and Southeast Asia. Of the six livestock management solutions for smallholder farmers we are tracking, four are in South Asia — two in Bangladesh and one each in India and Pakistan. This is a reflection of the important role the livestock and dairy industry play in the South Asian economy. In Southeast Asia, however, aquaculture plays a bigger role, and Indonesia is one of the largest regional aquaculture farming countries, with smallholder farmers involved in fish and shrimp farming. **eFishery** has developed an NB-IoT smart feeding solution (supported by MNO Telkomsel) that uses sensors installed in ponds to monitor fish movement. The technology enables farmers to manage their ponds remotely via a smartphone, allowing them to automate optimal feeding levels. The data generated from the sensors can predict production outputs, allowing farmers to connect with buyers before arriving at the market. Also in Indonesia, IoT company **Jala** offers a water quality monitoring device that allows shrimp farmers to measure key variables and relays sudden changes via SMS, allowing them to make decisions about their ponds remotely.

In Bangladesh, Grameenphone has recently launched **Smart Farm**, a cattle care IoT-enabled solution comprised of a base station solution and a smart tag fitted on cows. The tag transmits data about the health of the cow to detect its hormonal oestrus period and ensure it is inseminated at the right time (a costly mistake if farmers miss the window of opportunity), and to detect health abnormalities to ensure the right treatment is sought promptly. Other companies, such as **StellaApps** in India, **MisFit** in Bangladesh, **Cowlar** in Pakistan and **Dycodex** in Indonesia, provide similar solutions to help dairy farmers make their operations more precise, efficient and profitable.

As smart farming solutions and business models become more innovative, they are also becoming more accessible to many smallholder farmers for whom access to assets and services was previously out of reach. However, most solutions are still serving small groups of farmers. To make services more affordable, the costs of connecting to licensed IoT networks and producing sensors must come down significantly. To circumvent the high costs of importing sensors from developed markets, some solution providers have invested in emerging market companies to support the development and testing of low-cost sensors manufactured using locally available materials. Companies serving the agricultural sector should also develop targeted business models to make it possible to serve smallholder farmers profitably by leveraging economies of scale. Greater investment in agritech start-ups in LMICs will also allow them to scale up operations and reduce the cost of serving individual farmers, enabling them to reach a larger number of smallholders.

CASE STUDY

BeatDrone: Making drone services accessible to farmers by aggregating demand

Launch date: January 2015 **Users:** 300 clients covering 13,000 hectares **Country of operation:** Nigeria

BeatDrone provides drones-as-a service to smallholder farmers via cooperatives or farmer associations that aggregate demand and requests for the services, and then place orders through the company's website or over the phone. BeatDrone's services cover three agricultural activities: crop spraying, farm mapping and crop health inspection. By using drones, farmers are provided with detailed farm maps to assess the health of their crop, including soil analysis data to determine what crops to grow and what fertilisers to use based on their soil conditions. Using normalised difference vegetation index (NDVI) and thermal imaging to determine the stress levels of crops and farmland, crops are sprayed with the precise amount of pesticides or chemicals based on the amount of weeds or pests present.

Value proposition

Typically, it takes one or two individuals and an entire day's work to spray one hectare of land, leaving significant margin for error. This can result in losses of up to 50 per cent of farmers' crops by harvest time. BeatDrone's services are helping farmers harvest up to 90 per cent of their crop, reduce operational costs by 60 per cent and minimise human exposure to chemicals. Drones can spray one hectare in 15 minutes, reducing the cost of spraying fertilisers from $30 per hectare to $10 per hectare, and provide track-and-trace information for areas that have been covered via land mapping. Information is then sent to farmer organisations via email with a link to download.

Business model

BeatDrone operates under a PAYG model backed by a three-year service agreement. Individual farmers or groups must have a minimum of 30 hectares to request services via the company website or customer centre. Seventy per cent of the cost of the service is collected before the scheduled date of drone deployment and the other 30 per cent is due four business days after service delivery. In addition, BeatDrone sells devices and provides PAYG services to agribusinesses and agritechs, which operate large areas of land. The company reports that 90 per cent of its sales come from the agricultural sector. BeatDrone also offers a six-week drone theory and operation training course through the BeatDrone Academy in partnership with the University of Ibadan.

Milestones

BeatDrone started as a traffic information platform in Lagos in 2015. However, after finding it difficult to establish a sustainable business model, the company pivoted to the oil and gas, infrastructure and agriculture sectors in 2017. BeatDrone has reached 300 clients with 13,000 hectares of farmland. BeatDrone is planning to launch in Côte d'Ivoire in 2020.

Future roadmap

BeatDrone is targeting expansion in Kenya, South Africa and Morocco. It is also planning to develop its drone data processing software and create a plant for assembling drones in Nigeria. The company wants to expand into selling its own drones as it expects that, in future, farmers will purchase, operate and process drone data directly. In the next five years, BeatDrone aims to reach over 250,000 farmers and cover 1.5 million hectares of farmland, expanding that to 20 and 30 million hectares under a service agreement in the next 10 years.

CASE STUDY

TROTRO Tractor: Making tractor services available to farmers through a digital solution

Launch date: 2016 **Users:** 98,000 farmers, 2,400+ tractors **Countries of operation:** Ghana & Zimbabwe

TROTRO Tractor is an on-demand platform enabling access to mechanised farming equipment by connecting farmers and nearby tractor owners. TROTRO Tractor allows farmers to request and schedule tractor services within three days of when they will use it, increasing their productivity and efficiency. Farmers must have at least three acres of land to join the platform while tractor owners must have at least a 75 horsepower tractor to join. On average, one tractor will serve 150 farmers and cover approximately 450 acres in one season.

Value proposition

TROTRO Tractor enables access to capital-intensive equipment via USSD, making it widely available to smallholder farmers. Prices for hiring a tractor are competitive for farmers and a viable alternative to employing manual labour, particularly when the time saving is also taken into account. For tractor owners, the platform allows them to maximise usage of their equipment by renting it out rather than letting it sit idle on their farm when they are not using it. Tractor owners can also track the location and usage of their equipment remotely via a GPS-enabled tracking device installed on the tractor, which minimises the risk of theft and damage. All financial transactions are conducted using mobile money, and the data generated can be used to predict the risk of extending insurance services to both farmers and tractor owners.

Business model

In Ghana, TROTRO Tractor charges farmers on a pay-per-use basis, while it charges tractor owners a commission for each job secured via the platform. Revenue is also generated from the sale of GPS tracking devices to tractor owners. A nascent revenue stream is from input suppliers paying to advertise on the platform and financial institutions paying for data to be used for credit scoring of farmers and tractor owners. In Zimbabwe, the company has partnered with EcoNet to provide tractor hire services as part of the MNO's portfolio of services for the agriculture sector.

Milestones

In 2016, TROTRO Tractor won the 2016 Kosmos Innovation Centre (KIC) Agritech Challenge, which awarded a seed investment of $50,000. In the three years since launching the service, TROTRO has focused on building a platform that can be expanded to multiple countries. The service launched in Zimbabwe in 2019, and in less than a year had onboarded 70,000 farmers and 2,000 tractor owners, benefiting from a partnership with EcoNet that allowed access to its mobile money service and short codes.

Future roadmap

Over the next three to five years, TROTRO Tractor is planning to launch in Nigeria, Ethiopia, Uganda, Tanzania, Burkina Faso and Benin. In Ghana, the company is looking to introduce decentralised mechanisation centres to perform equipment maintenance at the community level and support local economies. Following this, TROTRO Tractor is seeking to develop operator training programmes so that users can learn proper maintenance of their machinery.

5 Building resilience: the impact of COVID-19 on digital agriculture

Disruption to food and input supply chains caused by the COVID-19 pandemic in 2020 has put the finances and food security of smallholder farmers at greater risk, hindering their ability to plan and invest in the next growing season.

COVID-19 has magnified the systemic challenges faced by all actors in the agricultural sector, including smallholder farmers, intermediaries, agribusinesses and cooperatives. Government lockdown measures have made it almost impossible to provide face-to-face extension services to farmers, while social distancing measures have resulted in farm labour shortages and transporting produce to market has become even more difficult.

Farmers already struggling to access markets and adequate storage facilities have had to cope with radical market changes and drops in demand, especially in international markets. Sub-Saharan Africa has experienced a significant decline in demand for many varieties of fruits and vegetables from the European Union (the region's largest export market). Kenya has recorded an 8.5 per cent drop in tea exports to countries such as Iran, Pakistan and the UAE,[116] while in March, the country's cut flower exports took the biggest hit. Seventy to seventy-five per cent of Kenya's cut flowers are exported to Europe, but lockdowns across the continent have reduced demand and led to a near collapse of the industry, affecting thousands of flower farmers who lost buyers for their main income-generating crop.[117]

Digital agriculture tools have become critical for farmers to become more agile, improve efficiency and maintain market access. There is growing evidence that existing digital solutions are helping farmers and other value chain actors adapt to the challenges of COVID-19. Value chain players that have already digitised their processes and operations and invested in critical infrastructure are finding it easier to scale, pivot and support farmers in a time of crisis. **Farmcrowdy**, a crowdfunding platform that also links farmers to commercial off-takers, introduced a new e-commerce platform called **Farmcrowdy Foods** to provide B2C services to customers. We have seen emerging trends in COVID-19 adaptation across all five use cases discussed in this report, from digital advisory and digital procurement to agri e-commerce, digital financial services and smart farming.

With the threat of increased food insecurity looming in LMICs, the effective delivery of time-critical agronomic advisory to smallholder farmers is more important than ever. There is an opportunity to add information on COVID-19 prevention to existing digital advisories to help farming communities adapt, as well as launch new services. In Ghana, agri advisory service **Farmerline** is sharing COVID-19 updates with at-risk farming communities through its

116 Obasanjo, O. and Boshe, H.D. (14 May 2020), *COVID-19 response must target African agriculture and the rural poor*. *IFAD*.
117 Otieno, S. (24 March 2020), "Flower sector faces collapse as Covid-19 hits main markets", *Daily Nation*.

voice message service.[118] The same opportunity exists for value chain actors, cooperatives and agribusinesses that use digital tools to communicate with their farmer base. In Indonesia, Olam has issued guidance on hygiene and social distancing to 20,000 cocoa and coffee farmers via its **OFIS** and **OlamDirect** platforms, while in India it has reached 1.2 million farming families via its **AgriCentral** app.[119] The Inter-American Institute for Cooperation on Agriculture (IICA), in coordination with the European Union, have launched **AgroInfoCovid19**, an app that provides preventive recommendations and measures to strengthen biosafety within the agrifood chain of countries in the Americas, and ensure that food supply chains are not interrupted.[120]

In agricultural value chains, COVID-19 has highlighted the need to enhance and develop more formal and cooperative-based value chains that provide a full range of support to smallholder farmers. Digital procurement tools can streamline access to inputs, training, storage, pre-financing and market access in times of crisis and uncertainty, and COVID-19 has demonstrated how all these are essential for smallholders to realise return on investment in their farms. Digital technologies, including geotagging, digital profiles of farmer producers, communication and payments, will all be essential to make value chains more agile and efficient.

One of the global trends during the COVID-19 pandemic has been a surge in agri e-commerce for fresh products. Companies around the world are seeing increased demand, highlighting the importance of agile, tech-enabled local food supply chains. Based on evidence from interviews conducted with agri e-commerce companies off-taking fruits and vegetables from farmers in Sri Lanka and Kenya, the number of daily orders has increased. In India, agri e-commerce platforms are playing a greater role in collaboration with agri input suppliers to redraw distribution networks and facilitate consistent supply of farming inputs to farmers, such as seeds and crop protection products.[121]

Similarly, in Kenya, **Twiga Foods** has signed a partnership agreement with e-commerce player **Jumia** to allow customers to buy fresh produce from smallholder farmers via Jumia's platform.[122] Pakistan-based agri e-commerce platform **Farm to Home** has reported that average daily orders have surged from 20 to 30 a day at the end of March to over 100 orders a day in April. To deal with this spike in orders while still maintaining quality standards, the company capped orders at 75 a day and hired more staff to expand its operational capacity. At the same time, Farm to Home has more than tripled the number of farmers they procure from to meet the increased demand.

There has been a surge in the use of mobile money as it facilitates efficient, contactless money transfers and payment services. This has the potential to spur growth of DFS, with mobile money generating key transactional data to establish credit histories and digital footprints for farmers. In Rwanda, mobile money transactions have risen five-fold during the 2020 lockdown. At the start of the pandemic, the government endorsed mobile money as an essential service and discouraged the use of cash. As a result, MNOs we interviewed saw an increase in the value and volume of transactions, with one reporting a record 500,000 new mobile money subscribers to their platform since March. By late April 2020, mobile money users in Rwanda were making three million transactions a week, five times higher than pre-pandemic figures.[123] Rural communities, which traditionally prefer cash, began to organically adopt mobile money to receive and make payments. Higher agricultural production and market risk are also likely to stimulate demand for agricultural insurance, with digital channels offering a way to automate service delivery, including mobile money payments for premiums and payouts.

Finally, the need to monitor operations remotely through sensors, drones and satellites, and for more accurate, localised data to feed into smart advisory services, can stimulate innovation and growth in smart farming. IoT-based smart farming is highly efficient compared with conventional approaches, and can help minimise human contact and maintain social distancing. There is also the possibility to adapt existing smart farming solutions to new market needs. For example, Indonesian agri IoT company **Jala** has added a trading feature to its shrimp epidemiology app, originally developed to collect and analyse data to reduce the risk of shrimp diseases. The company is buying products through the app and reselling them to local buyers, helping farmers who are unable to access markets during the pandemic via traditional sales channels.

118 Farmerline (6 April 2020), *COVID-19; how we are working to keep farmers and employees safe*.
119 Olam (1 May 2020), *Update on our response to COVID 19*.
120 Inter-American Institute for Cooperation on Agriculture (6 May 2020), *EU and IICA Launch App to Recommend Preventive Measures for the Agrifood Sector During COVID-19*.
121 Narain, D. (25 June 2020), "COVID-19: Lessons that we learnt during lockdown on agri-supply-chain", *The Financial Express*.
122 Pshenichnaya, N. and Mustafa, Z. (20 May 2020), "Post COVID-19 business un-usual in agricultural value chains", GSMA *Mobile for Development Blog*.
123 The Economist (28 May 2020), *The covid-19 crisis is boosting mobile money*.

6 Future outlook: innovation and expansion of the digital agriculture sector

Business models

- **Digital agriculture in LMICs is evolving in two main directions.** First, towards highly specialised, localised and data-driven services that address specific pain points for farmers (e.g. lack of localised weather information) and value chain actors (e.g. enterprise solutions). Second, towards developing tools that bundle services to address multiple pain points for farmers and value chain actors. Whichever direction agritech companies pursue, solid product development and human-centred design will both be crucial.
- **Partnerships with MNOs and MMPs are key to scaling digital solutions, as shown by our digital advisory and e-commerce examples.** Partnerships with MMPs and FSPs are also vital to scale DFS for the agricultural sector, such as agricultural loans and insurance products. Together with opportunities to bundle and cross-sell services, scalable service delivery channels (2G, 3G) and customer relationships, MNOs have key assets and data to enable better services (network data, mobile money) and contextualisation (location data). Data-sharing partnerships are increasingly critical to improving services and offering a unique value proposition.
- **There is an opportunity for donors and commercial and impact investors to influence the agritech sector, but this will require patient capital investment.** There are examples of sustainable and scalable services, and a range of commercialisation models have emerged: B2C, B2B2C and B2G. To attract continuous investment, agritech companies should focus on bringing a strong value proposition to the market that offers an end-to-end solution and a clear revenue model.
- **The adoption of digital agriculture tools has made smart farming solutions more accessible to smallholder farmers with varying levels of income and literacy.** Through innovative pricing and service delivery models, solutions providers are extending the reach of drones and mechanised farming equipment by deploying PAYG or shared economy solutions. B2B2C business models are also enabling value chain actors, such as agribusinesses and cooperatives, to provide services to smallholder farmers. Trends indicate a growing number of agri e-commerce companies are undertaking a wider range of functions to get produce to markets beyond providing a digital marketplace, making it possible for even marginal smallholder farmers to participate in formal value chains.

- **Bundling services is an increasingly viable strategy to strengthen a value proposition, and a growing number of providers are developing holistic end-to-end solutions to address multiple pain points for farmers and value chain actors.** Advisory services, including agronomic, weather and/or price information are increasingly being provided as add-ons to digital procurement services through a B2B2C model and to e-commerce services. Crowdfunding services are increasingly introducing off-take functions to ensure markets for farmer produce and guarantee investments, while e-commerce companies are introducing investment either directly or through input financing schemes, for example, to ensure farmers have access to the funds or inputs they need to meet demand. The range of solutions being bundled is diverse and can include any mix of use cases. They also instil more confidence in value chain actors. For example, if farmers are guaranteed a market for their produce, they are more likely to invest in higher quality inputs.[124]

Technology

- **Innovation at the "back-end" (big data, AI, IoT and remote sensing data) is driving innovation in digital agriculture, not only in developed countries, but also in LMICs.** This innovation is transforming all use cases (e.g. data-driven approaches to digital advisory, smart farming, credit scoring and e-commerce). Agri e-commerce companies, for example, are using big data to feed algorithms for demand forecasting and reducing wastage. Advisory providers can predict market prices to help farmers sell at the best possible times, while others are using these technologies to provide smart location-based advisory. In smart farming, solution providers can automate processes using connected devices. At the "front-end", however, there are persistent challenges (tech availability, digital literacy etc.), which means there are no one-size-fits-all approaches and apps and smartphone-based solutions are not always viable. Iterative product development that takes a user's context into account is an ever-greater priority.
- **Growth and adoption of big data, AI and analytics in LMICs will continue to drive uptake of data-driven approaches to digital agriculture, such as smart advisory services.** It will also drive further growth in smart farming solutions aimed at smallholder farmers. To take hold in LMICs, smart farming needs greater availability of scalable mobile IoT networks and more resilient business models. Agri e-commerce stands to benefit greatly from AI and analytics by becoming more intelligent and adaptive to customer and farmer needs, pushed by strong demand in the wake of the COVID-19 pandemic.
- **Mobile money integration is critical not only to agri digital financial services, but also to agri e-commerce and digital procurement.** The growth and differentiation of digital financial services geared toward the rural sector in East Africa demonstrate the importance of enabling mobile money environments to reaching farming communities. Mobile money also provides the key transactional data farmers need to build economic IDs and support the growth of DFS beyond payments and person-to-person (P2P) into derivative services like credit and insurance.

User needs

- **Climate change continues to put stresses on the global food system with increased climate variability and temperature and rainfall extremes.** As shifting seasonal patterns make climate risks less predictable, and more intense weather events mean the consequences are more severe, digital agriculture services can support agricultural value chain actors to adapt to, anticipate and recover from these climate risks. Weather and climate-smart agricultural advisory services can provide the information needed to adjust and optimise agricultural practices, while financial services such as weather index insurance can provide the safety net required to overcome the effects of an extreme weather event. Access to assets and mechanisation through innovative, digitally enabled business

124 Velde, K. and Maertens, M. (2015), *Contract-farming in staple food chains: the case of rice in Benin*.

models allows farmers to maintain productivity despite adverse climatic conditions.

- **Digital agriculture tools must consider the needs of all type of users.** Women in particular are likely to be digital agriculture users, but agritech service providers may not be aware of how women are using technology. Agritech requires a high level of understanding of agriculture and rural households where women often play a central role. As adoption of digital agriculture solutions increases, service design will need to take the needs of other user segments into account, such as older farmers and persons with disabilities, who are likely to engage in agricultural-related activities, but are at high risk of being excluded by the benefits of digitisation. Universal design principles could be used from the onset to increase inclusion in digital agriculture.
- **Value chain digitisation in LMICs is boosting the growth of digital procurement and agri e-commerce.** This trend highlights the importance of service design, not only for smallholder farmers, but also for agribusinesses, cooperatives and their front-end and back-end staff. Taking the different needs, technical and digital literacies of multiple users into account is making product design increasingly complex, but successful agritech companies have paid close attention to the needs of a range of users. Fundamentally, agritech companies have the right expertise and tools in place to design relevant, engaging solutions for all users.
- **As user needs evolve, agritech companies should focus on developing agile, flexible and modular tools that allow them to meet the shifting needs of users.** Farmers and value chain actors that have adopted flexible digital tools are better equipped to adapt to new challenges in the agricultural sector and beyond, as demonstrated by the repurposing of digital agriculture tools to respond to the COVID-19 pandemic.

Annexes: Methodology

The backbone of DAMs is the **GSMA AgriTech Services Tracker**, a proprietory database aggregating industry data for over 700 digital agriculture services in LMICs. This database is the culmination of an ongoing effort, which started in 2014 with the mAgri Deployment Tracker, a publicly available website which tracked products and services in the digital agriculture space.

We define active services as those that have scaled beyond the pilot stage and have been in operation for at least one year. As the work of the GSMA AgriTech programme has expanded in the past few years, we have built on our effort to track digital advisory services (183 as of March 2017) to cover an increasing number of services under the use cases discussed in this report (713 as of January 2020). In the Services Tracker we collect data under the following categories:

Company name	Service name	Description	Company type*	Primary use case**	Secondary use cases**	Region	Country	Launch date	Number of users***

*** Company type includes AgriTech, MNOs, Agribusinesses etc.**
**** See Appendix 2, Defining the use cases**
***** We collect data on registered users and active users. An active user is a registered user who has used the service in the past 90 days. While we aim to always collect user data, this dataset is incomplete, as there are services for which this data is missing.**

To compile the database, we use a combination of primary and secondary research. Through secondary research, we build the foundations of the Services Tracker by accessing publicly available information on digital agriculture services including CTA's Digitalisation of African Agriculture Report 2018–2019,[125] Grow Asia's database and reports.[126] Through our collaboration with IDH, we have been able to expand our database of digital procurement solutions, leveraging IDH Farmfit's digital solutions database.

We conduct qualitative research on an ongoing basis to update the Services Tracker, speaking with selected service providers such as agritech companies and MNOs. Our selection process for prioritising qualitative interviews is based on scale, commercial viability and impact of digital agriculture services. We have also concentrated on organisations that are addressing more nascent use cases (e.g. agri e-commerce and smart farming) or are using innovative technology approaches to digital agriculture (e.g. AI and big data solutions). To update the Services Tracker database that was used for this report, GSMA AgriTech conducted qualitative interviews with sector practitioners in the period September-December 2019.

125 Tsan, M., et al. (2019), *The Digitalisation of African Agriculture Report 2018–2019*. The Technical Center for Agricultural and Rural Cooperation (CTA).
126 www.growasia.org

We conducted semi-structured in-depth telephone interviews with service providers informed by questionnaires with approximately ten open-ended questions. We aimed to understand the user journey and the value proposition delivered by the service, the business model, technologies implemented and the future roadmap for the service provider. For this report specifically, we analysed our data to identify key trends in each of the use cases and regions. After identifying trends, we used key informant interviews with industry practitioners to refine and prioritise our findings with the GSMA AgriTech team and the IDH Farmfit team.

In this report, we also use GSMA proprietary data. Our main source of mobile industry data is GSMA Intelligence's[127] (GSMAi) global dataset, which includes historical, current and forecast data for every mobile operator, network and market worldwide. We also use data from the Mobile Connectivity Index[128] measuring the performance of 165 countries against key enablers of mobile internet adoption.

Other GSMA data sources include internal reports such as GSMAi's Mobile Economy series,[129] providing insights on the mobile telephony sector, as well as socioeconomic and financial datasets for regions (e.g. Sub-Saharan Africa, Asia Pacific, Latin America), and GSMA Mobile Money's flagship State of the Industry Report,[130] which uses survey data from mobile money providers covering 21 metrics. In addition, we used extensive literature produced by GSMA Mobile for Development, in particular, publications from the Mobile Money, Connected Society and Connected Women programmes.

We place our research in the broader context of literature on digital agriculture, financial inclusion, climate resilience and rural development. In addition to GSMA's databases, for this report, we have used a range of data sources such as World Banks's Open Data[131] on agriculture and rural development, climate change, economy and growth, as well as Global Findex Data[132] on how adults save, borrow, make payments, and manage risk. We have also leveraged research materials from organisations such as IDH, CGAP, CGIAR, UNCDF, UNDP, FAO, Mercy Corps, ISF Advisors and Dalberg.

While the focus of the report is global, it is not attempting to offer a comprehensive view of the digital agriculture sector in LMICs. The database used for this report is skewed towards Sub Saharan Africa (61 per cent of all services tracked) and South Asia (15 per cent of all services tracked), given the relative importance of agriculture and GSMA AgriTech's historic and active presence in these regions. To offer a balanced view of trends and opportunities across LMICs in this report, our latest update of the Services Tracker (September-December 2019), focused on countries in South east Asia Asia and Latin America where agriculture is a key driver of GDP.

127 GSMA Intelligence
128 GSMA Connected Society (2018), *The GSMA Mobile Connectivity Index*.
129 GSMA Intelligence (2020), *The Mobile Economy*..
130 GSMA Mobile Money (2020), *State of the Industry Report on Mobile Money 2019*
131 The World Bank
132 Demirgüç-Kunt, A., et al. (2018), *The Global Findex Database 2017: Measuring Financial Inclusion a and the Fintech Revolution*. The World Bank.

Annexes:
Defining the use cases

Characteristics	Sub-category	Characteristics
1 Digital advisory		
Information-based services providing smallholder farmers with agronomic and livestock advice and best practices, information on market prices, weather and climate information as well as financial and digital literacy training.	**1. Agricultural value-added services (Agri VAS)**	One-to-many advisories covering agricultural and livestock information, weather and climate information and information on market prices. Agri VAS are delivered via voice channels (IVR, helplines), text channels (SMS and USSD) and via apps.
	2. Smart advisory	Data-driven advisory based on tailored, farm-level agro-climatic and crop-specific information to support decision making, maximise productivity and reduce costs. Technologies such as sensors, satellites and drones, as well as big data analytics and AI, underpin many of these services.
	3. Weather information	Specialist services that provide regional and localised weather forecasts. This sub-category may include weather-adaptive and climate-smart advice.
	4. Pest and disease management	Digital tools that help farmers diagnose plant disease and develop strategies to treat diseased plants as well as mitigate future outbreaks. Most of the services are accessible via mobile applications and require a farmer to upload a picture of the infected plant for diganosis. Some services are also accessible via USSD. Also includes national and regional-level pest and disease early warning systems.
	5. Product verification	Digital tools designed to enable farmers to validate the authenticity of agriculture inputs such as seeds, fertilisers, agro chemicals and other agro inputs and prevent the proliferation of counterfeit products. Most services require farmers to send a scratch-off code from the product to a specified number via SMS.
	6. Record keeping	Digital tools that enable farmers to keep detailed records of livestock, including health and feeding data, to help mitigate diseases and avoid missed conceptions. Record keeping tools are also used to keep details of input usage, procurement, cost and revenue and sales records.
2 Agri digital financial services		
Digitally-enabled financial services for smallholders to facilitate their inclusion in the formal financial economy and allow investment in farming activities. These services are customised to meet farmers' needs and tailored to suit their cropping cycles. This category also includes financial products that enable financial service providers to lower the risk of lending to smallholders.	**7. Credit and loans**	Lending products that target smallholders and address specific agricultural needs. Most of these products enable the provision of short-term financing for agricultural inputs.
	8. Credit scoring	Digital solutions that assess the creditworthiness of smallholder famers using aggregated data from multiple sources including bio data, procuremement records and mobile money transactions. These tools enable financial service providers to serve smallholder farmers and lower their risks.
	9. Crowdfunding	Online platforms that enable investment in smallholders by sourcing funds from individuals (investors or sponsors). Most platforms also allow investors to"follow" the farmers they have invested in by providing updates via text, pictures and videos from their dashboard through a website or an app.

	10. Input financing	Digital tools that enable financing for the purchase of inputs like seeds, fertiliser, pesticides/herbicides from various sources including governments through subsidies.
	11. Savings	Targeted digital savings products for farmers designed to match their spending and savings habits, enabling them to put money aside for agricultural activities.
	12. Digital agri wallets	Digital wallets enable farmers to transact with various actors within the agriculture ecosystem, for instance, making and receiving payments, including electronic vouchers with which to redeem agricultural inputs. Digital wallets also allow farmers to save money and develop a transactional history, which can be used alongside other types of data to access additional financial services.
	13. Insurance	Digitally-enabled agricultural insurance services that help smallholder farmers mitigate the risks associated with external shocks such as weather events and pest and disease outbreaks. Agricultural insurance includes weather index, area yield index, multi-peril, livestock and livestock index insurance products.
	14. Accountability tool	Digital tools designed to help farmers view farming as a business by allowing them to track farming expenses and revenues and prove their creditworthiness.
3 Digital procurement		
Digital solutions in the agricultural last mile that enable a range of digital systems and processes to transition from paper to digital. These solutions help agribusinesses increase transparency in their transactions with smallholders and improve efficiency and operational profitability. At the same time, farmers benefit from more transparent transactions, improved market access and from being able to access a digital footprint, which can be used to access financial services.	**15. Digital records**	Digital solutions that replace paper-based systems and digitise transactions between farmers and agribusinesses.
	16. Digital records with payments	Digital solutions that replace paper-based systems, digitise transactions between farmers and agribusinesses and enable the integration of digital payments for the procurement of crops.
	17. Digital records with traceability	Digital solutions that replace paper-based systems, digitise transactions between farmers and agribusinesses and support the traceability of produce from "farm to fork".
	18. Digital records with payments and traceability	Digital solutions that replace paper-based systems, digitise transactions between farmers and agribusinesses, enable the integration of digital payments for the procurement of crops and support the traceability of produce from "farm to fork".
4 Agri e-commerce		
Digital platforms that enable the buying and selling of agricultural produce and inputs online. Although most agri e-commerce businesses sell domestically to urban consumers, agri e-commerce also enables farmers to reach international buyers.	**19. Inputs**	Agri input platforms enable the sale of inputs such as seeds, fertilisers, pesticides/herbicides from input suppliers to farmers. Such platforms may also enable groups of farmers to aggregate demand and place bulk orders.
	20. Outputs	Platforms that enable farmers to sell to consumers (B2C model) and to enterprise customers (B2B model) such as companies in the catering industry (e.g. hotels, restaurants) and market retailers, or a hybrid of the two.
	21. Inputs and outputs	Platforms that enable the sale of agricultural inputs to farmers from input suppliers, as well as the sale of agricultural produce from farmers to consumers and businesses.
5 Smart farming		
Smart farming refers to the use of sensors, drones, satellites and other farm assets to generate and transmit data about a specific crop, animal or practice to support agricultural activities. Smart farming solutions rely on connectivity between IoT-enabled devices to optimise production processes and growth conditions while minimising costs and saving resources.	**22. Equipment monitoring**	The smart monitoring of equipment such as irrigation systems that enable farmers to remotely control, track and look after their equipment and farming operations, leading to a reduction in water consumption and wastage.
	23. Livestock and aquaculture management	Digital tools that allow farmers to monitor herds remotely in order to determine their exact location at anytime, track the health and habits of livestock including when they are in oestrus or about to calve. Similarly, aquaculture management systems enable farmers to monitor feeding patterns of fish and other aquaculture, detect diseases in advance, control water quality, and in some cases automate feeding altogether.
	24. Smart shared assets	Digital tools that enable the sharing economy for assets such as tractors, drones and other mechanised farming equipment. They provide smallholder farmers an opportunity to mechanise processes such as crop spraying, crop monitoring and land preparation.

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