

# Towards a Connected Climate

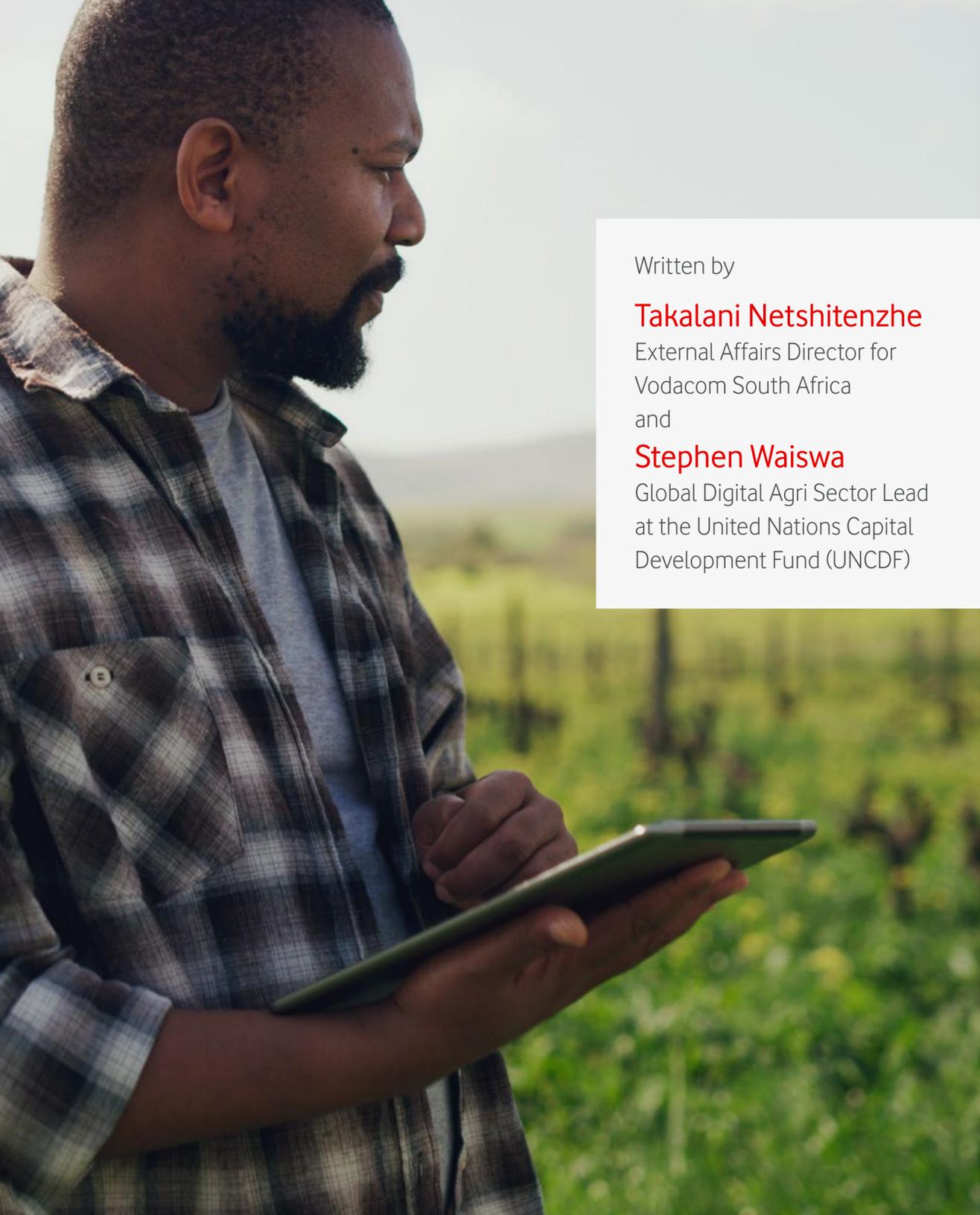
Leveraging digital technologies to break  
the cycle of food insecurity in sub-Saharan Africa



In partnership  
with



Unlocking  
Public and Private  
Finance for  
the Poor



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# Driving inclusive access to digital technology is how we help farmers mitigate the impact of climate change

**Climate change is severely hindering agricultural development in Africa.**

Increasingly extreme and unpredictable weather conditions cause lower livestock yields, greater crop volatility, and increased pest and disease outbreaks. It paints a bleak picture for smallholder farmers in developing markets on the African continent, leaving them at a distinct disadvantage. While farmers in developed nations can buy crop insurance and easily adjust what they plant to mitigate the impact of climate change, smallholder farmers do not have the financial means to do so.

Considering the continent's agricultural sector is made up of millions of these smallholder farmers, it's unsurprising that food insecurity across Africa is growing.

**Our farmers need access to sustainable solutions to protect against climate change so they can continue to meet growing food demands.**

Exacerbated by the pandemic, the rise in food insecurity across the continent is alarming. It's a dire situation that this policy paper seeks to unpack, looking to technology as a widely untapped solution for addressing climate change's impact on the agricultural sector, in a way that supports sustainable food security.

Of course, this solution cannot be actioned without collaborative efforts across the public and private sectors.



# SUSTAINABLE DEVELOPMENT GOALS



This is a fact underscored by one of the UN's 2030 Sustainable Development Goals (SDGs) that calls upon partnerships to action real change in our pursuit of the other SDGs.

On addressing the sustainability of Africa's agricultural sector, collaboration between Vodacom, Vodafone and the United Nations Capital Development Fund (UNCDF) has been critical, with both parties committed to enabling inclusive digitally-rooted progress that will future-proof the sector.

The interlinked SDG goals provide a global framework for addressing the most critical challenges of our time. In unpacking how inclusive access to digital solutions can uplift Africa's smallholder farmers, Vodacom, the UNCDF, and various other stakeholders are tackling multiple issues simultaneously, such as ending hunger (SDG 2), mitigating the effects of climate change (SDG 13), ensuring responsible consumption and production (SDG 12), protecting, restoring and promoting life on land (SDG 15), and enabling economic growth (SDG 8) while supporting industry, innovation, and infrastructure development (SDG 9). This is in line with the very purpose of the Africa.Connected campaign.

Launched by Vodacom, Vodafone, and Safaricom across eight African markets, the campaign is dedicated to closing the digital divides that hinder sustainable progress in the continent's key economic sectors, such as agriculture. This paper, the third in our six-part Africa.Connected series, is the starting point for change. By pinpointing where our farmers are struggling and proposing the path forward on the back of digital technology, we can make impactful, sustainable changes that will help Africa bolster its food security and end hunger for the millions who are suffering.

# Executive summary

## Leveraging digital technologies to fight food insecurity

In 2019, the United Nations Food and Agriculture Organization (FAO) published a regional overview of food security and nutrition in Africa, which highlighted a distressing reality: **hunger in Africa was getting worse.**<sup>1</sup>

By 2021, FAO<sup>2</sup> reported that around 346.4 million Africans suffered from severe food insecurity and an additional 452 million endured moderate food insecurity. That means that close to 800 million people (just over 60% of Africa's population) do not know where their next meal is coming from. Yet, by 2050, the population of Africa is expected to double in size – by which point, the continent will be unable to grow enough food for its own people, let alone export to drive economic growth.<sup>3</sup>

The FAO research showed that conflict, extreme weather events and economic slumps drove hunger between 2014 and 2019. This was pre-COVID-19. The various national and global measures to contain the coronavirus caused further economic disruptions, affecting food supply chains and preventing many from accessing work.



Between 720 and 811 million people in the world went hungry in 2020, according to the UN report on the State of Food Security and Nutrition in the World.<sup>4</sup>

**If we are to feed Africa's growing population, safeguard its natural resources and build resilience against market and climate changes, we need a renewed focus on the productivity and sustainability of the agri-food ecosystem.**<sup>5</sup>

This is where digital technologies, especially mobile-based solutions, can help. While these solutions are not a silver bullet to solve Africa's complex and multifaceted food security problems, tech gives farmers accurate information and real-time data they need to farm more effectively and raising yields on existing land.

**This paper addresses these issues.**

It analyses the stumbling blocks preventing African countries from improving agri-food systems and highlights the role smallholder farmers play in helping Africa leverage its incredible agricultural potential.

Below, we unpack some of the main takeaways from this paper.

## Firstly, the three main stumbling blocks that explain Africa's food insecurity crisis:

- **Climate change** threatens agricultural development because unpredictable weather conditions increase crop volatility, hamper livestock yields, and raise the likelihood of pest and disease outbreaks. All of this has a major effect on small-scale farmers.
- **Poor road conditions, unreliable electricity supply, and an extensive lack of communication and digital infrastructure** hinder Africa's attempts to alleviate widespread poverty and inequality. A lack of broadband connectivity and poor access to digital solutions prevents farmers from accessing the information they need to farm more efficiently.
- **Complex gender and socio-cultural dynamics** mean that women and young people often lack the financial means to access the information and tools to farm more effectively. They also typically lack the education and digital skills to leverage new technologies to farm more strategically and efficiently.

## Smallholder farmers are the key to the solution.

There are an estimated 250 million smallholder and subsistence farmers across Africa. They generally have access to fewer resources than commercial-scale farmers, are typically classified as part of the informal economy, and often depend on family labour to assist with production. These farmers are limited by several factors, including an over-reliance on rainfed farming, fragmented lands, limited use of agro-inputs, financial exclusions, poor communication infrastructure, gender imbalances and inadequate market access.



## How can digital solutions address the needs of these farmers, and consequently address food insecurity?

Our paper shows how digital tools enable farmers to access information and advisory services, financial systems and key markets. The paper outlines how digital technologies can

enable smallholder farmers to overcome the many challenges preventing them from implementing more sustainable farming methods. In addition, the paper highlights various examples of the work already being done to digitalise African farming communities and showcases what technologies are making the most impact. Some of the key points from these sections are outlined on the next page.

Examples of how digital solutions can address food insecurity and the needs of farmers



## Egypt

In Egypt, Vodafone helps local communities use technology to improve farming. By digitalising irrigation systems and adding sensors to the soil, farmers can water according to the needs of the plant. These soil sensors measure the moisture needs of the soil and the farmers can control the irrigation system remotely via their mobile phone.



## South Africa

In South Africa, the Women Farmers Programme is making agriculture more accessible and profitable for women by teaching them how to use apps to connect to potential customers and unlock enormous economic growth.



## Tanzania

In Tanzania, M-Kulima helps farmers list their produce on a digital marketplace and connects them directly with buyers without an intermediary. The platform also provides timely weather forecasts so farmers can plan better, and it shares important market information, which ensures that farmers secure the best price for their products.



## Kenya

In Kenya, DigiFarm leverages mobile and digital technologies for smallholder farmers. Using drones to perform aerial surveys of smallholder farms, DigiFarm gives these farmers a better understanding of the topography of the land, helping them keep track of the best time to spray fields for pests or to fertilise their crops.

Finally, we offer policy recommendations on ensuring these interventions have a far-reaching, long-term impact. This is only possible when these small-scale farmers, often living in remote and rural communities, have the support, information and resources they need to succeed.

The main policy recommendations highlighted in this paper are:



**Development of digital agriculture strategies:** Governments must develop digital agriculture strategies that set a clear vision of how digital enablement will support agricultural transformation and drive these strategies. The strategies should support smallholder farmers while creating special incentives in the form of training and development for women and young people to gain interest in playing a meaningful role in the agriculture and agri-business sectors.



**Policy and regulatory reforms that incentivise and protect long-term investment in critical digital infrastructure:** The ubiquitous availability of digital infrastructure will enable the collection, transmission and processing of data, which is key for the implementation of an effective digital agriculture strategy. Potential investors need policy and regulatory certainty and the assurance that the investment in infrastructure will yield reasonable returns over the long term.



**Free and secure movement of data:** Governments need to consider and adopt data protection laws that enable and promote regional free and secure cross-border data flows so that data can easily reach all farmers in the region. Regional integration of data management policies and principles aligns with the spirit of collaborative continental development as encouraged by the African Continental Free Trade Area (AfCFTA) – but it can only be achieved through intergovernmental coordination and cooperation.



**Access to digital devices and mobile phones:** Government and policymakers must engage with the industry to ensure affordable access to digital devices, particularly smartphones, are the universal entry point to a digital identity. Among the policies to consider would be the reduction, or even complete removal, of import duties and taxes on mobile phones and smartphones: this would improve their affordability and drive their adoption in the farming sector and other economically transformative sectors such as health, education and the small business sector.



**Fostering strong and lasting partnerships:** No single company, government, or institution has the means or capabilities to deliver the required transformation at a scale that yields significant economic impact. Governments should leverage their convening power to establish and play an anchor role for formidable cross-functional partnerships, where each partner can contribute its capabilities and play a clear and meaningful role in the ecosystem. Partnerships should be centred on a common long-term vision, collective prosperity and principles of humanity and sustainable development.

# Africa's agri-food system



## Why Africa's agri-food systems need an upgrade

Improving food security and nutrition in Africa is no small feat.

This task demands a co-ordinated approach and close collaboration between countries across the continent, with solutions implemented alongside various health, sanitation, and education interventions and, of course, public sector policy reform.

In addition to this, considerable efforts are needed to improve Africa's agri-food systems. This includes engaging the necessary stakeholders involved to ensure that Africa produces enough food to feed its population, to cater to international demand for exports, and to drive economic growth. But all of this adds pressure on the continent's arable land, as well as its natural resources.

For example, while there has been growth in total production across the continent over the past decade, this was predominantly driven by farming area expansion, not by yield growth.<sup>6</sup>

Thus, farms are not working more efficiently to increase outputs; they are just taking up more space by expanding into fragile ecosystems like forests, wetlands, and highlands.<sup>7</sup>

There are three major stumbling blocks when viewing Africa's food insecurity crisis through the lens of agriculture:

- Climate change
- Poor infrastructure and resulting financial exclusion
- Various socio-cultural and economic circumstances

These will be unpacked further later in this paper.

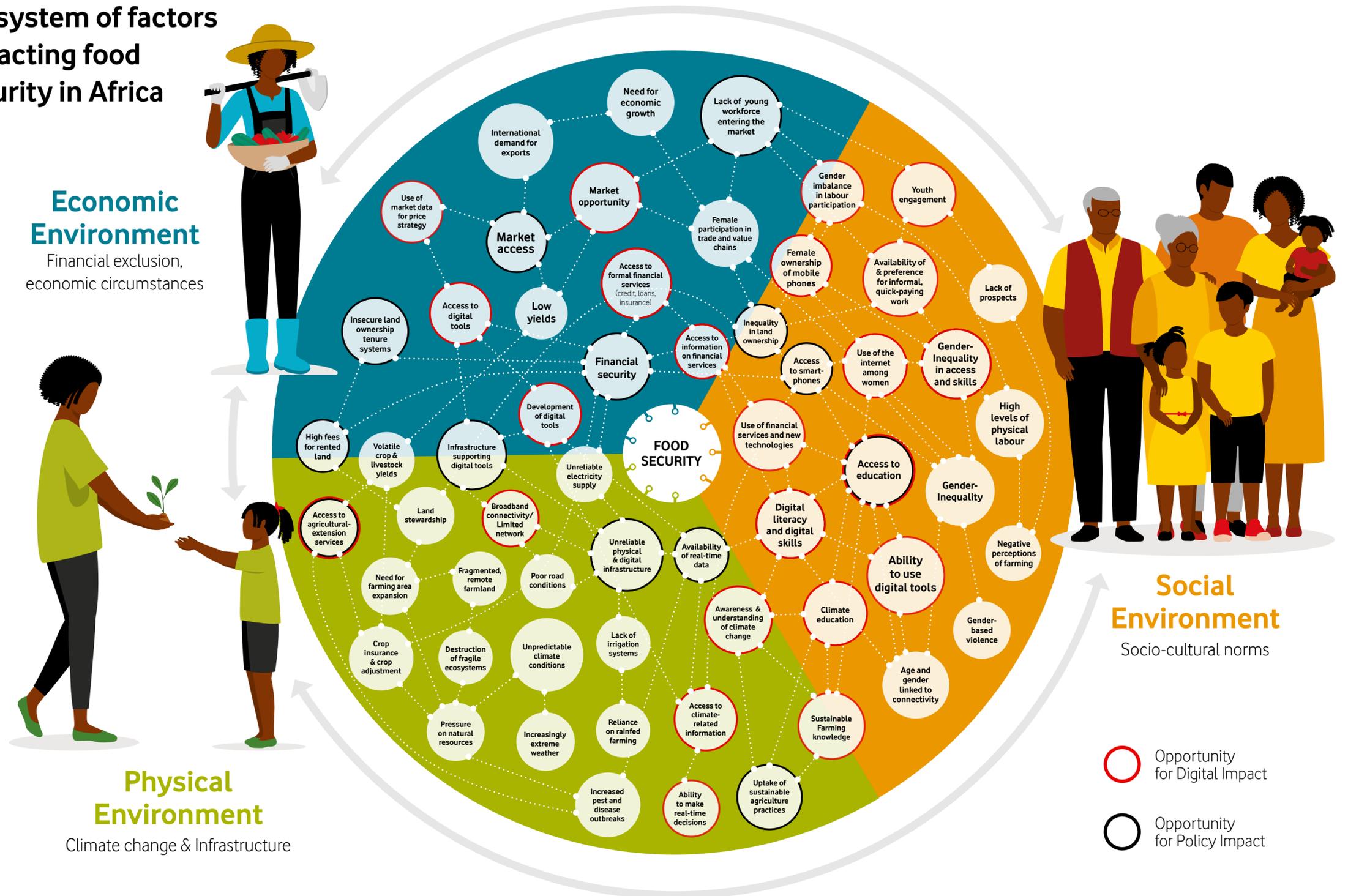
The role of new technologies is highlighted throughout this paper because these innovations have an important role to play.

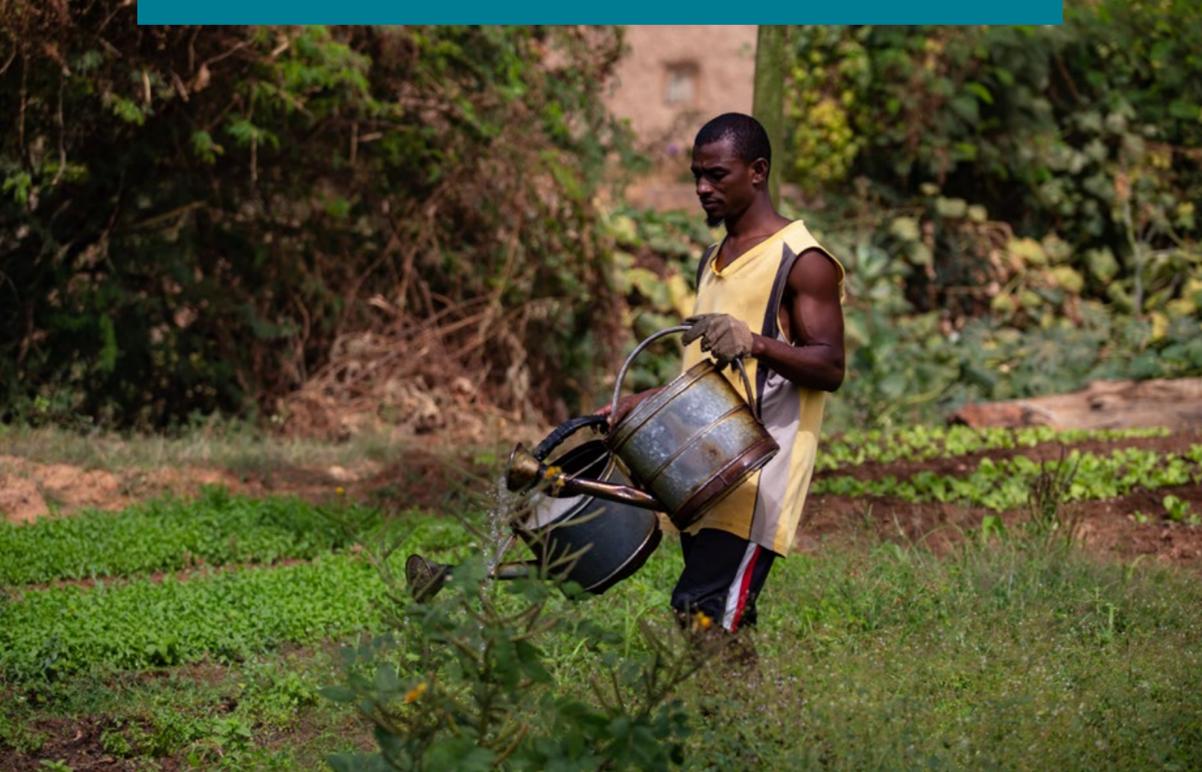
**But improving food security across Africa is a complicated and nuanced challenge;**

one that cannot be solved without a clear understanding of the many interconnected factors that dictate why so many people go to bed hungry each night.

Some of the different elements of this complex ecosystem are outlined in this visual on the right.

## Ecosystem of factors impacting food security in Africa





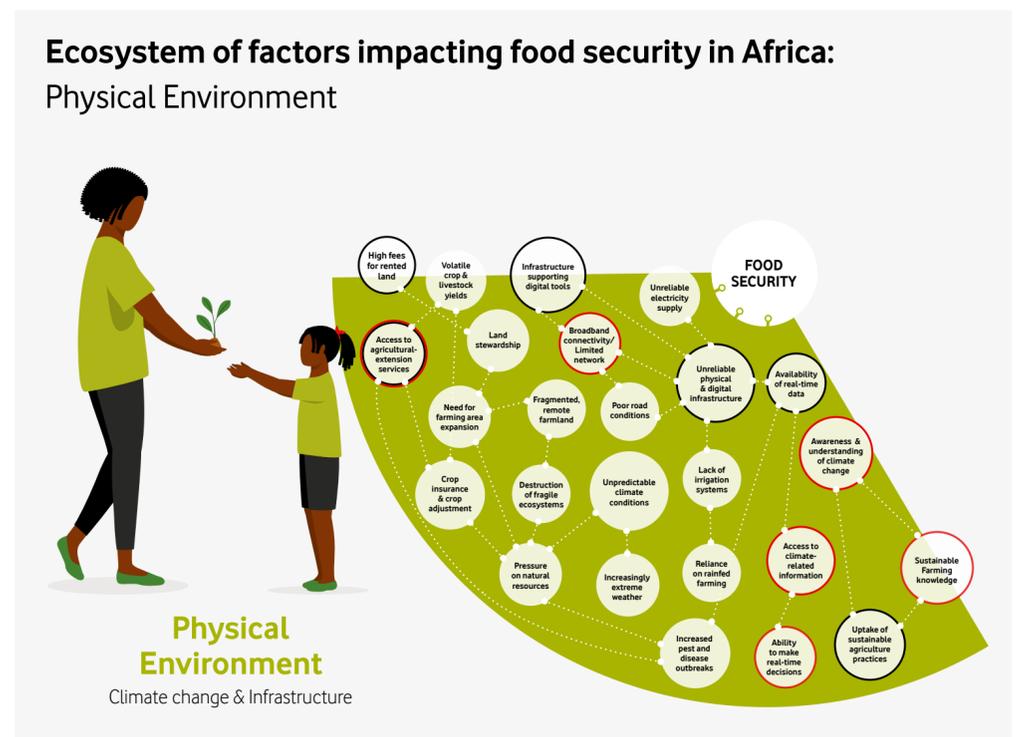
## Climate change

Across Africa, climate change presents a major threat to agricultural development in the form of extreme weather conditions such as: the increased intensity and frequency of droughts, extreme heat, erratic rainfall patterns, heavier storms, and flooding.<sup>8</sup> These unpredictable conditions cause greater crop volatility, hamper livestock yields, and increase the likelihood of pest and disease outbreaks, which, in turn, has a massive impact on the economy.<sup>9</sup> If you consider that about a fifth of sub-Saharan Africa's economic output depends on agriculture<sup>10</sup>, the region simply cannot afford for unpredictable weather systems to have a negative impact on farming. Farmers in developing markets are typically more vulnerable to changing weather patterns than farmers in developed nations. The latter can purchase crop insurance and easily adjust what they plant. They also have the means to irrigate their fields and, quite importantly, have access to the technology and information they need to make the right real-time decisions to protect their livelihoods.

Emerging evidence from Asia and Africa shows that digital solutions hold the key to addressing some of these challenges by increasing efficiency both on and off the farm.<sup>11</sup> Digital tools can dramatically enhance smallholder productivity and income by enabling farmers in even the remotest of areas to access real-time weather information so that they can better prepare and plan for extreme conditions. This also helps them to improve the timing around their product-to-market decisions.

Similarly, aerial images from satellites or drones, and the deployment of Internet of Things (IoT) tech such as soil sensors, can reduce vulnerability by making it possible for farmers to manage crop growth and crop health in real-time.

In Egypt, the agriculture sector consumes more than 75% of available water (more than 55 billion cubic metres annually), which is why Vodafone Egypt is working with local communities to help them use technology to improve farming processes.



By digitalising irrigation systems and adding sensors to the soil, it is possible to water according to the needs of the plant. These soil sensors measure the moisture needs of the soil and the farmers can control the irrigation system remotely via their mobile phone.

IoT (Internet of Things) initiatives like the above can help farmers optimise the use of agrochemicals, like fertilisers, and make better use of natural resources, like water. But these tools aren't readily available in rural communities. Despite being the most vulnerable, only about 13% of Africa's smallholder farmers have access to something as simple as climate-related information, such as weather reports.<sup>12</sup>



## Poor infrastructure and financial exclusion

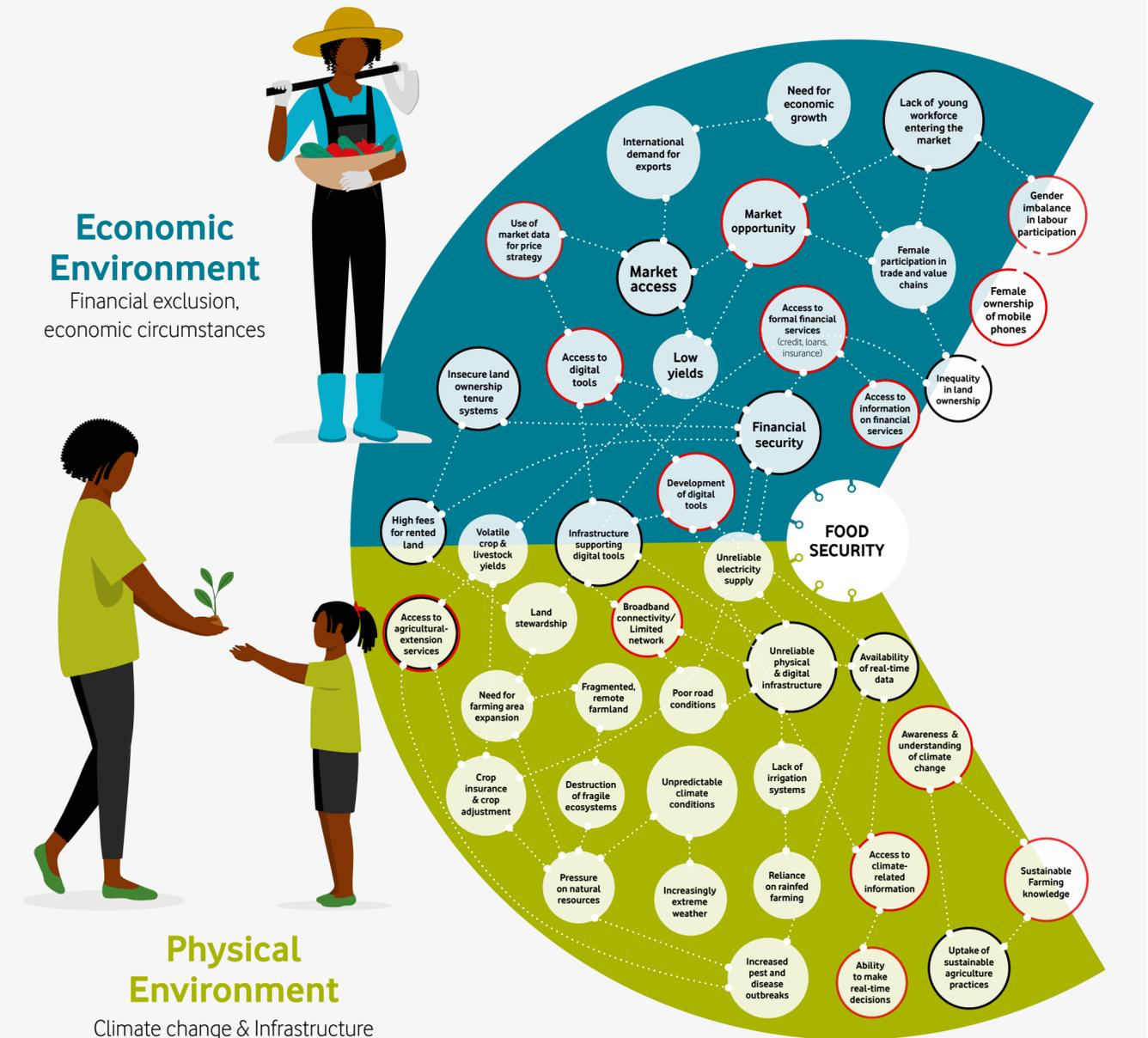
**Inadequate infrastructure remains a major obstacle.** Poor road conditions, unreliable electricity supply, and an extensive lack of communication and digital infrastructure – especially in remote farming areas – hinder the continent’s ambitions to address widespread poverty and inequality.<sup>13</sup>

Smallholder farmers living in rural communities need roads that provide year-round, unimpeded access so that they can reach the broader community and sell their produce to customers. Similarly, a lack of broadband connectivity and digital solutions prevent these farmers from accessing the information they need to farm more efficiently.

This also has major financial implications. According to the World Bank, financial inclusion among farmers is critical for growth, but most farmers in sub-Saharan Africa do not have access to formal financial services.<sup>14</sup>

If farmers cannot access the basic financial resources they need – from everyday banking services like credit, loans, or insurance to market data, which could help them sell their produce at the most competitive price – it is inevitable that their overall productivity will suffer.

### Ecosystem of factors impacting food security in Africa: Physical & Economic Environments



# Socio-cultural and economic circumstances

According to the FAO<sup>15</sup>, female farmers in Africa control less land, have less access to agricultural extension services and inputs like fertilisers, and are less likely to use basic financial services or new technologies. While the figures vary from country to country, this widespread “gender gap” inhibits the equitable and profitable participation of women in local agricultural trade and in national and international agricultural value chains. Similarly, the GSMA’s Mobile Gender Gap Report<sup>16</sup> highlights that women are 7% less likely than men to own a mobile phone and 15% less likely to use mobile internet. This means they don’t have access and often lack the necessary digital skills to leverage new technologies to farm more strategically and efficiently.

**Education plays a crucial role in strengthening female farmer resilience because knowledge and information empower women to farm smarter and to better leverage new income-generating opportunities.**

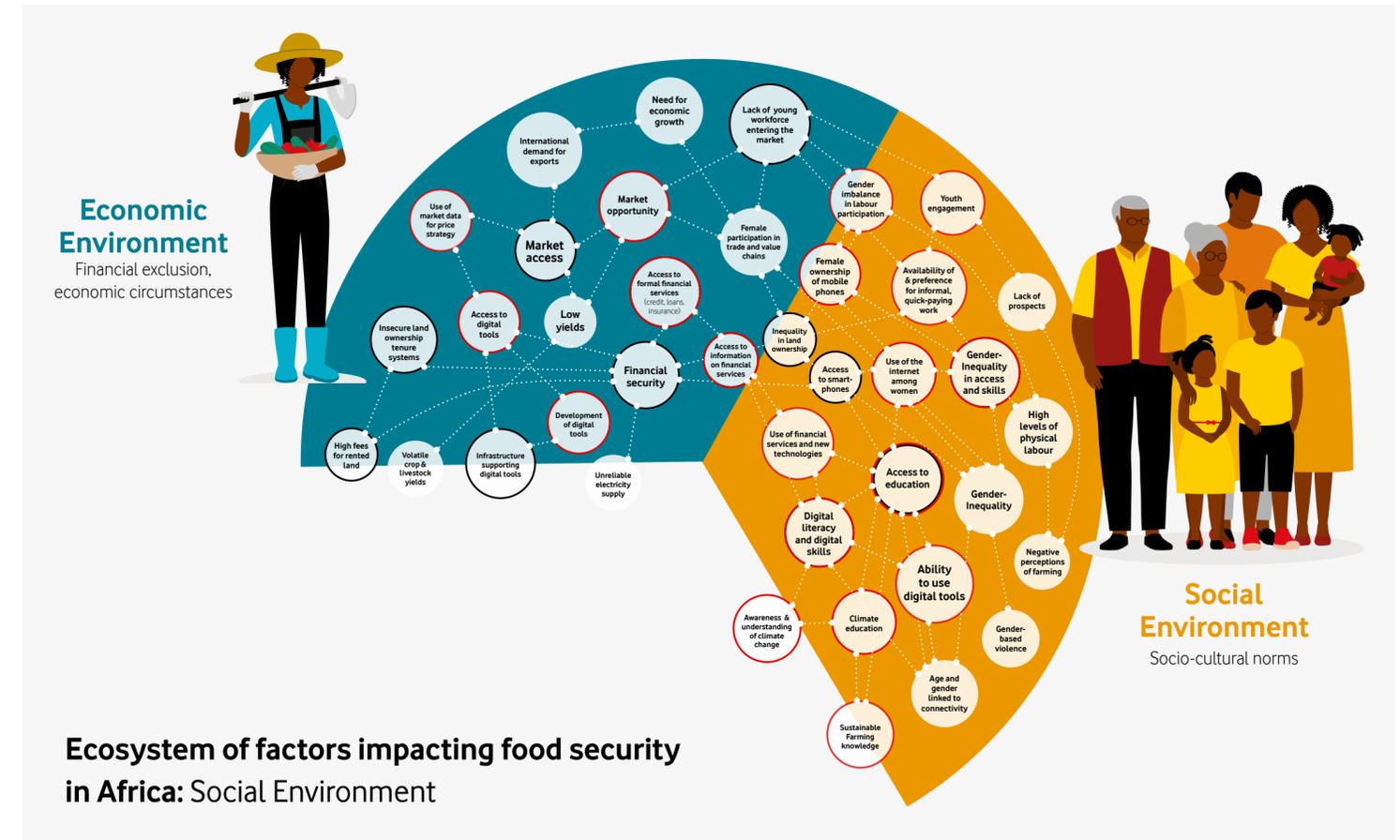
The industry needs to develop and promote initiatives that support women and open avenues for them to access the resources they need<sup>17</sup> – like the Women Farmers Programme in South Africa, which was

launched in 2018 by the Vodacom Foundation in partnership with UN Women and South African Women in Farming (SAWIF).

This programme seeks to make agriculture more accessible and profitable for women in South Africa by teaching them how to use apps to connect to potential customers and unlock enormous economic growth.<sup>18</sup>

**Acknowledging that technology plays an important role in helping smallholder farmers tap into new markets and grow their businesses, the programme aims to improve digital literacy and digital skills among female farmers.**

Given the changing context of agricultural trade, initiatives like this are a step in the right direction because they equip women with the skills they need to diversify their livelihoods and adapt to whatever changes come their way.<sup>19</sup> Similar to the Women Farmers Programme in South Africa, Safaricom’s M-Kulima in Tanzania is helping smallholder farmers with the critical information they need to farm more efficiently. You can read more about M-Kulima later in this paper.



Young people could also play a critical role in the smallholder agriculture value chain. Especially when one considers that roughly 317 million African youth will enter the job market between 2010 and 2025.

**This means that, by 2025, 45% of the African labour force will be under 30 years of age.**<sup>20</sup>

But many of these young people aren’t interested in working on farms. This is, in part, because of negative perceptions about farming, but also because there is greater availability of quick-paying informal work in urban environments.<sup>21</sup>

This rural-urban migration affects production on small-scale farms because it means that there are fewer hands to get the work done.<sup>22</sup>

## In conversation with the UNCDF

Stephen Waiswa is a technical specialist for Digital Financial Services and the Global Digital Agri Sector Lead at United Nations Capital Development Fund (UNCDF). Here he talks about the role of digital technologies in enabling smallholder farmers to mitigate the effects of climate change.

### How does climate change affect smallholder farmers in Africa?

**SW:** Weather patterns have changed and, because of this, we see that farmers don't know when the right time to plant is. There is no opportunity for precision farming and they can't be strategic about what they plant, how they plant, and when they plant because the weather is so unpredictable. Continued drought, over-cultivation, and pests and diseases are further stumbling blocks. I think that Africa, in general, has not taken climate change seriously because there is a lack of intelligent climate data, which could be used to inform farmers on the ground.

### Addressing climate change across Africa seems like a mammoth task – where do we start?

**SW:** We need to come up with innovative ways to offer farmers early warning systems so that they have the

information and the tools they need to mitigate climate shocks. At the UNCDF, our strategy is to leave no one behind in the digital era by expanding access to and usage of digital services (including finance) that contribute to achieving the Sustainable Development Goals. We are working to leverage different technologies as a means to build inclusive digital economies. Within agriculture, these technologies can play an important role in increasing productivity across the food system value chain. This means developing digital solutions that improve access to markets and climate information, for example.

A platform like Connected Farmer – an AgriTech digital solution from Vodacom's Mezzanineware subsidiary – aims to solve some of the issues faced by farmers using digital technologies. The platform that is being rolled out in Uganda as a partnership between Nilecom, Cordaid and Vodacom's Mezzanine, has already reached over 60,463 farmers. UNCDF has partnered with Nilecom, Mezzanine (Vodacom), and Cordaid in Uganda to support farmers in Northern Uganda grow incomes by leveraging digital agricultural services. The consortium aims to adapt and scale up the Connected Farmer digital agriculture application (localised as UgFarmer) to improve efficiency, access and utilisation of actionable information, markets, management of payments and inventory.

And, taking things a step further, these platforms also serve as a digital marketplace where farmers can get familiar with the prices in the market and connect with interested buyers. Device ownership and device affordability is still an issue. If we want to digitalise agri-food systems, we must increase access to mobile technologies. Within all our projects, accelerating phone penetration is a key priority. Something like a device lending programme is one approach we have taken to improve access to some of the latest technologies.

### In your opinion, what needs to be done to improve agri-food systems and achieve a better and more sustainable future for all?

**SW:** It's important to support these farmers so that they understand smart agricultural practices and precision farming. When this is done, we can enhance their productivity to boost yield and connect them with the right output markets so that they can get the right premium for their inputs.



**Stephen Waiswa**  
Global Digital Agri Sector Lead  
at the United Nations Capital  
Development Fund (UNCDF)

# The importance of smallholder farming

## Small scale, big impact: the importance of smallholder farming in Africa

Consensus holds that transforming agri-food systems – in a way that promotes greater efficiency, resilience, inclusiveness, and sustainability – is essential if we are to achieve the UN’s 2030 Sustainable Development Goals.<sup>23</sup> But there is still much work to be done.

According to the International Fund for Agricultural Development (IFAD), a specialised agency of the United Nations that works to address poverty and hunger in rural areas of developing countries, sub-Saharan Africa has a quarter of the world’s arable land – much of which is unutilised – but only produces 10% of the world’s agricultural output.<sup>24</sup> This means that Africa’s agricultural potential remains largely untapped. There are an estimated 250 million<sup>25</sup> smallholder and subsistence farmers across Africa, constituting a large portion of the agricultural sector. As such, these farmers play a crucial role in reducing poverty across the continent.<sup>26</sup> Smallholder farmers typically operate on about two hectares of land and produce in relatively small volumes. They generally have access to fewer resources than commercial-scale farmers, are typically classified as part of the informal economy, and often depend on family labour to assist with production.



### Smallholder farming fast facts



There are **250 million** smallholder farmers across Africa,

producing **10%** of the world’s agricultural output,

typically operating on about **two hectares** of land in relatively small volumes.



Despite playing a critical role in African economies, smallholder farmers face an uphill battle as they attempt to feed the continent's growing population. Some of the challenges hampering smallholder agriculture on the continent include<sup>27</sup>:



A reliance on rainfed farming, which means that these farmers are more vulnerable to climate shocks.



High levels of physical labour mean that farming is less appealing to young people in rural areas.



Fragmented lands, often located in remote or inaccessible areas, make interventions like irrigation complicated, which can limit yield and productivity.



A gender imbalance in relation to labour participation, with much of the tilling of farms to prepare the land for crops done by women.



Low use of agro-inputs, such as insecticides, pesticides and fertilisers.



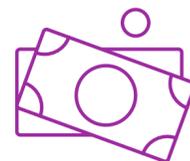
Insecure land tenure systems and, where land is rented, rental fees are high.



Limited access to technology, which can be used to increase farming efficiency and improve outputs.



Smaller farmlands lead to over-cultivation due to shorter fallow periods.



Unavailability of financial resources such as credit, loans, and insurance.



Lack of awareness and climate education plus poor communication infrastructure limits farmers' ability to access agricultural information, reach potential customers, and participate in markets.

## Case study

# Up in the air – how digital tools are making it possible to monitor Nairobi’s air pollution and increase awareness

In September 2021, air pollution took centre stage in the Kenyan capital of Nairobi after a series of billboards were debuted showcasing just how bad, or good, the air quality was at any particular time. The pilot initiative – launched by the United Nations Environment Programme (UNEP) in partnership with Kenyan telecoms provider Safaricom, among others – aimed to address the lack of awareness around climate change and educate and engage the public about different pollutants, which can cause a number of serious health issues, including asthma, lung cancer, and heart disease. The digital billboards stream real-time air pollution data that is also available on the IQAir App, the world’s largest air quality data platform.



According to Sean Khan, Programme Manager for Global Environment Monitoring System (GEMS) Air at UNEP, there is a massive data gap on air pollution across Africa, as well as in parts of Asia, and a general lack of understanding around how air pollution contributes to climate change. Extreme weather patterns and a warming planet threaten food systems and food security, says Khan, stressing that digital technologies have a critical role to play in raising awareness about these issues.

Strategic partnerships between the UN, the private sector, academia, non-governmental and local governmental organisations have the potential to transform lives, says Khan. In this particular case, the initiative could be a catalyst for change around how services like transport and waste management are managed in cities so that air pollution is reduced. The potential for expansion into other areas is there, he adds. By working with some of the region’s telcos and tapping into their extensive telecoms infrastructure, organisations like UNEP can gather a wealth of rich and valuable data, which can be used to address many environmental issues and, ultimately, inform interventions to act against climate change.

# The potential of digitalisation

## Digitalisation in the agricultural sector – where does the potential lie?

According to an analysis of research data by McKinsey<sup>28</sup>, sub-Saharan Africa will need much help to fulfil its agricultural needs.

This includes as much as eight times more fertiliser, roughly six times more improved seed, an investment of at least US\$8 billion in basic storage (not including cold-chain investments for horticulture or animal products), and roughly US\$65 billion for irrigation.

Digital agriculture will enable the continent's farmers to fulfil these agricultural needs, with technologies offering access to actionable agricultural insights in real-time.

Digital solutions are already transforming how rural farming communities run their businesses and secure their livelihoods. Digital agriculture systems are highly productive, capable of anticipating events, and adaptable to change.<sup>29</sup>

The digitalisation of agriculture will transform every part of the agri-food chain, which, in turn, could lead to greater food security, resilience, profitability, and sustainability.

To fulfil its agricultural needs, sub-Saharan Africa will need:



**x8**  
more fertiliser



**x6**  
more improved seed



**US\$8 billion**  
in basic storage investment



**US\$65 billion**  
for irrigation



Currently, a range of digital technologies and services are being made available to help the continent reach its agricultural potential, spanning the entire agricultural value chain. The rapid proliferation of information and communication technologies (ICTs) could totally transform how smallholder farmers operate by increasing efficiency on farms and addressing many of the challenges raised above.

**When farmers have access to digital tools and the connectivity to enable these tools, they are empowered with the information, support, and market access they need to succeed.**

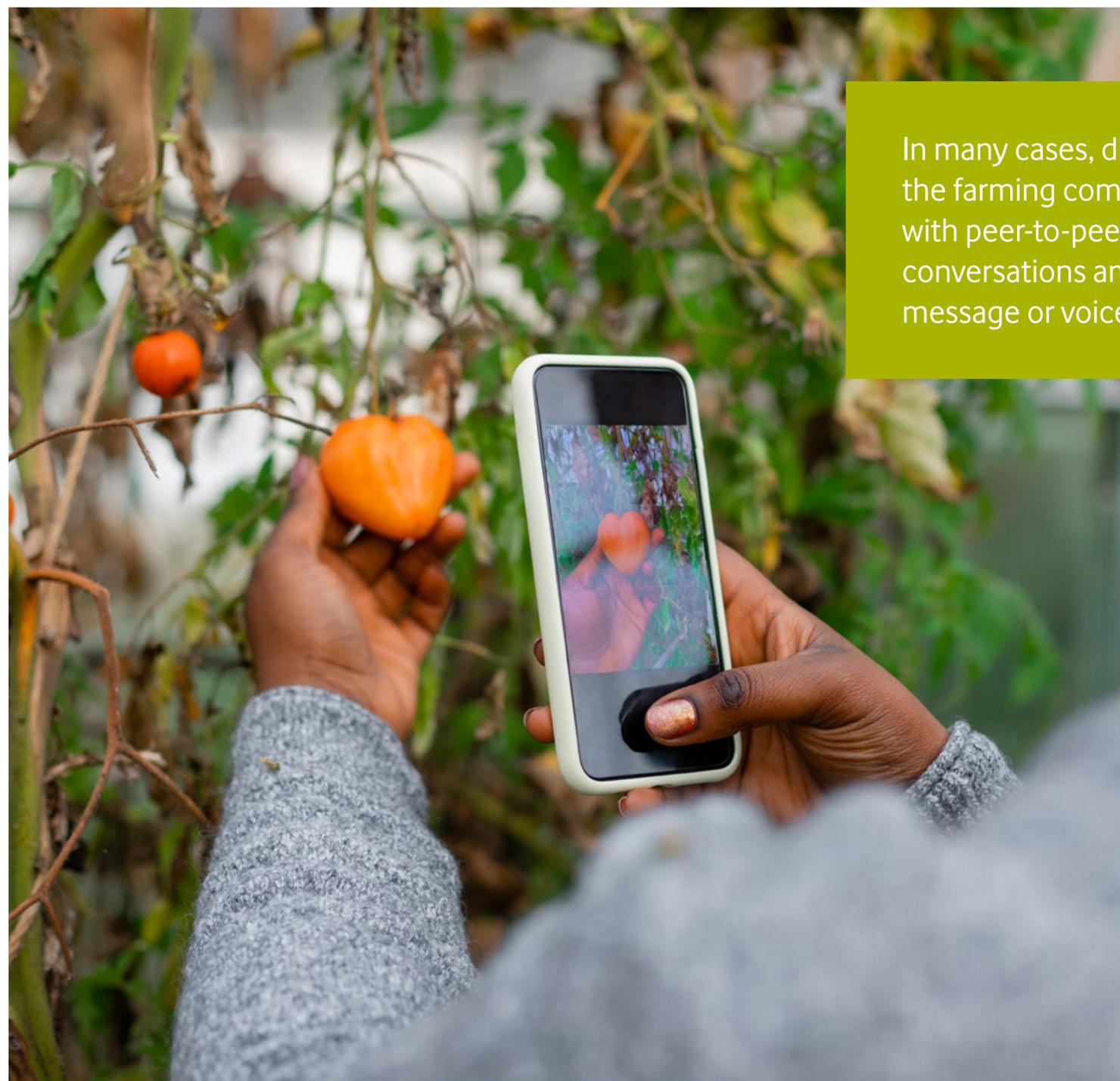
Farming populations may be getting older but, with the right solutions in place, farming becomes less physical as many labour-intensive tasks are replaced with precision farming techniques. Finally, when smallholder farmers are connected, they can, for example, better track soil and crop health so that they can ensure that their irrigation and fertiliser use is as efficient as possible.

Some of the key use cases for ICTs in agriculture include information and advisory services, market access, and financial access.

## Information and advisory services

Digital information and advisory services allow smallholder farmers to access agricultural information that they can use to learn more about good agricultural practices and value-chain services. Some smallholder farmers are already using digital solutions to get information sent to them via short message service (SMS), unstructured supplementary service data (USSD), and interactive voice response (IVR) either through a call centre or through agents from government extension services, NGOs, agribusinesses agents, financial service provider agents, and other farmers. As a result, farmers have information around every aspect of their operation from planting and weeding to irrigation, fertiliser application, plant protection, and harvesting.

For smallholder farmers in Africa, precise information on weather, and pest and disease control minimises risks and increases yield. For example, drone surveillance is a precision farming technology that provides crop insights via aerial imagery. The information captured is relayed to the farmers, providing farm-specific and customised advice that can be used to mitigate the effects of climate change, identify issues, and prevent waste.



In many cases, digital advisory services rely on the farming community to share information, with peer-to-peer exchange platforms allowing conversations among farmers either via text message or voice-based messages.

Video and social media platforms are also used for information sharing. But access to mobile devices, a lack of internet connectivity, poor digital literacy, and the growing digital divide remain an issue. Without the broadband networks, tools and skills to access farming information and advisory services, smallholder farmers continue to be left behind. Internet adoption stood at around 28% in sub-Saharan Africa at the end of 2021, which means that the region currently accounts for about half of the total global population not covered by a mobile broadband network. Given this fact, there is still much work to be done to connect these farming communities.<sup>30</sup>

## Case study

# How M-Kulima is enabling Tanzania's smallholder farmers

Farming wasn't Doris Paul's dream job, but she is adamant that making the move into agriculture is one of the best decisions she has ever made. As a female smallholder farmer, farming with seasonal crops in central Tanzania, she explains that her farm supplies enough food to feed her children. Doris then sells any surplus to the market and uses the money she earns to buy goods she needs for her home.

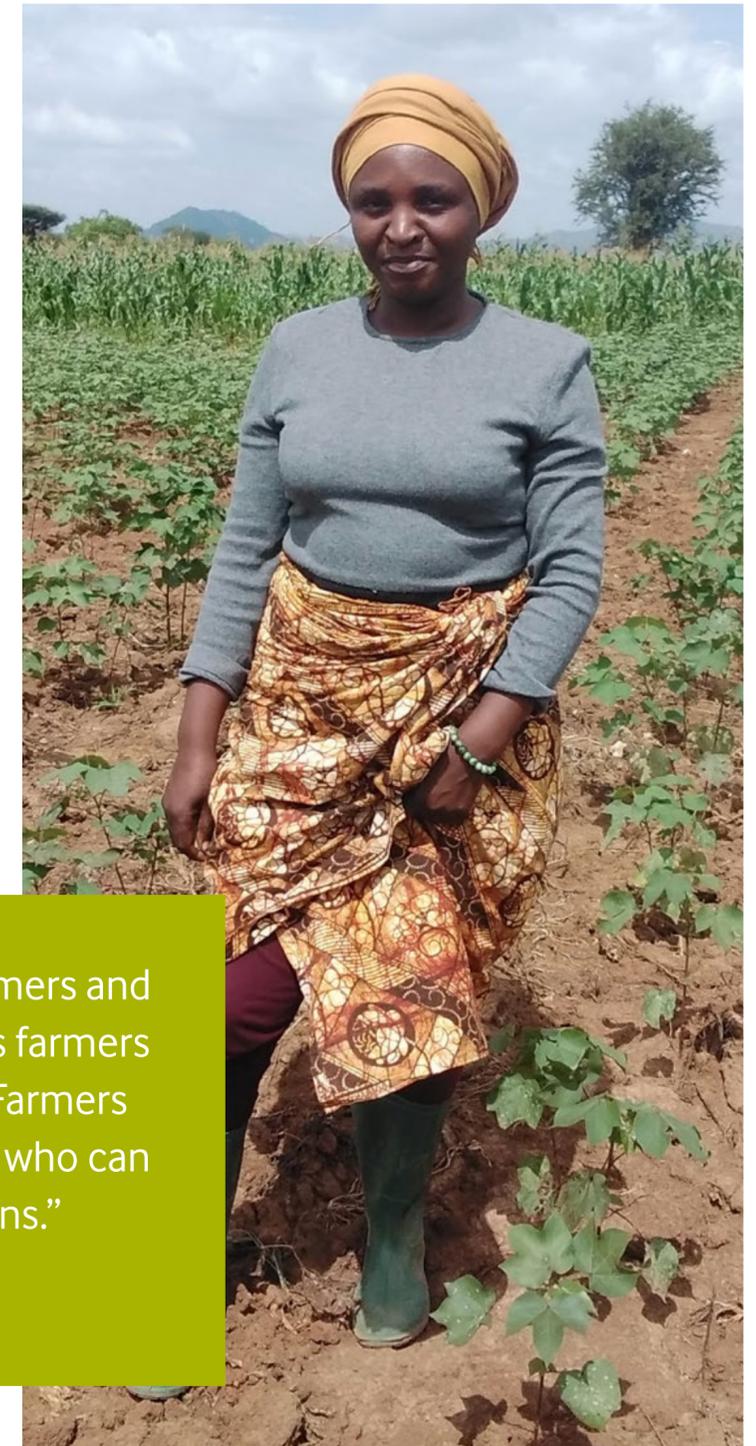


But it isn't always easy. For Doris, there are lots of challenges on the farm, climate change being the biggest one. She highlights pests and disease as yet another stumbling block. "We also struggle to get information about current market trends and produce prices," says Doris.

This is where M-Kulima has made a major difference in her life. M-Kulima is an online marketplace developed by a farmer for farmers. Sellers list their produce on the marketplace and can connect directly with buyers without any need for an intermediary. "M-Kulima has helped me a lot by providing market information; I get alerts on trending prices of food stuff," she says. "It also helps me to cope with climate changes because it gives me timely weather forecasts. This helps me plan my seasons right – I get to know when to plant and can also forecast what challenges I am likely to face. I prepare my farming activities depending on this information and decide what to grow using M-Kulima."

"Technology can do so much to help develop farmers and get them connected. And technology also helps farmers in mapping the farm through GPS applications. Farmers can then share pictures with agriculture experts who can discover the problems and provide quick solutions."

Doris Paul, Smallholder Farmer in Tanzania





## Market access

Digital solutions can connect smallholder farmers with people who can transform their products into sellable goods and then, ultimately, sell the product on to customers. These linkages extend all the way down the supply chain to virtual buyer-seller e-commerce marketplaces, offering high-quality farm inputs to post-harvest machinery services, mechanisation services, and off-taker markets, including agro-dealers, wholesalers, retailers, and customers, both urban and international. This reduces costs, accelerates time to market, and guarantees transparency and accountability, making it possible for smallholder farmers to access new markets and connect with customers who they would never have sold to in the past.

Online agricultural marketplaces exist with little or no human intermediation required, which eliminates the need for smallholder farmers to hire more workers to help them get their products to consumers. Produce and products are posted on these digital marketplaces to be bought by interested parties online. Similarly, these marketplaces make it possible for farmers to access the resources they need, exactly when they need them. These platforms offer everything from farming equipment hire and solar-powered irrigation, to fertiliser and pesticide application, processing, milling and cold-chain services. Examples of such platforms include iProcure and Connected Farmer. iProcure, the largest agricultural supply chain in rural Africa, connects smallholder farmers to the manufacturers of agricultural inputs like fertiliser and animal feed. This Kenyan-based startup allows farmers to buy all the supplies they need using mobile vouchers on the platform. Connected Farmer is a digital platform that improves productivity, revenue, and resilience for smallholder farmers in Africa by connecting them to information, inputs, credit, and buyers.

These solutions benefit both farmers and suppliers. For farmers, being linked with potential buyers through a mobile trading platform makes it possible to cut out the middleman so that they can get the best price for their produce. For suppliers, these solutions open new sources of food supply, enabling them to source from a more diverse range of producers.

## Case study

# How tech solutions can change the face of smallholder farming – and consequently – global food security outlook

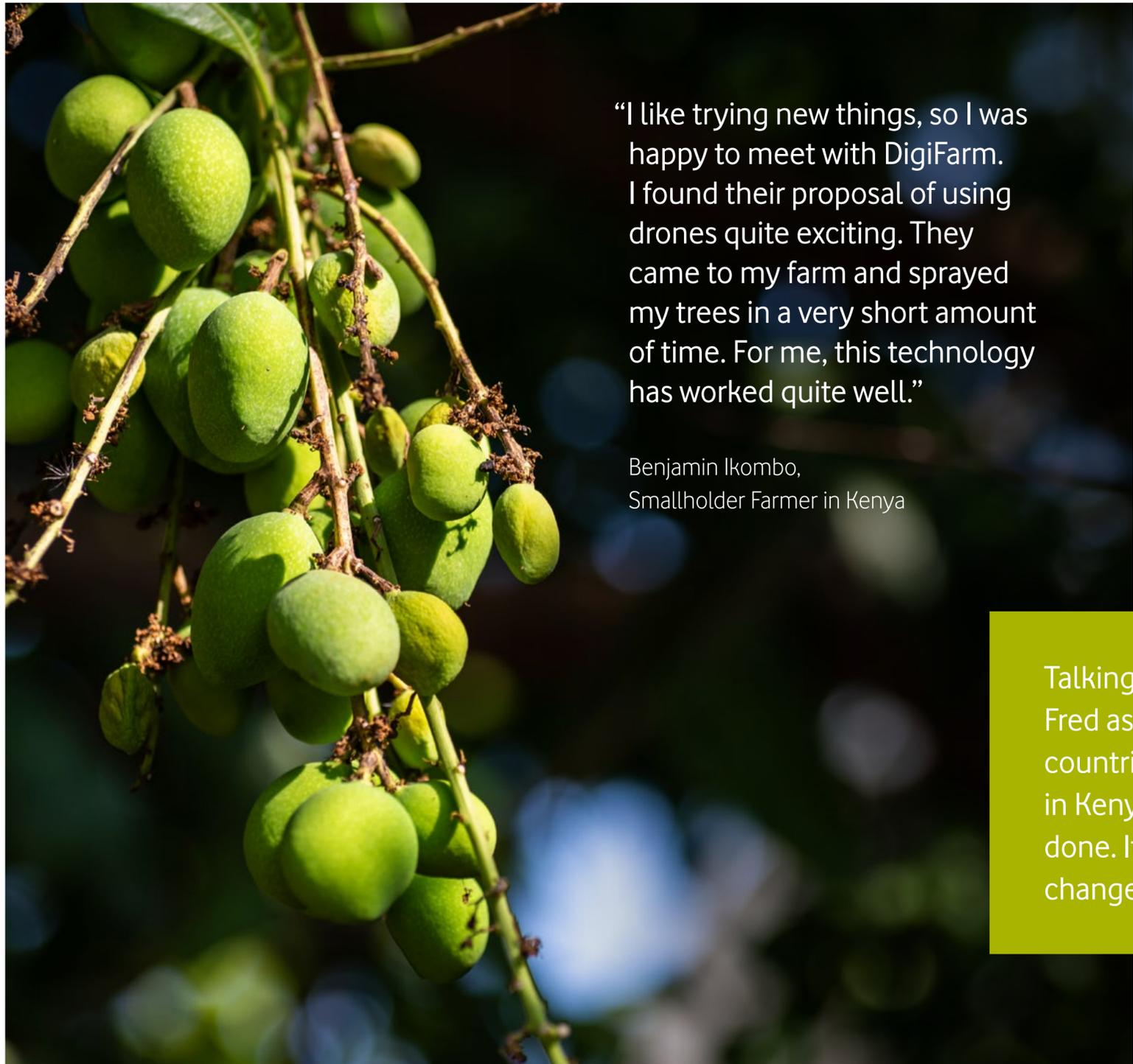
DigiFarm, a Safaricom subsidiary, leverages mobile and digital technologies to provide much-needed free agricultural-related services to smallholder farmers in Kenya. In the past, these farmers had challenges in accessing quality farm inputs at discounted prices, input loans, learning content on best farming practices, extension support as well as access to market. “Our mission is to create wealth among smallholder farmers by increasing their productivity in the fields and then, once they have a product to sell, we enable them to connect with a suitable market,” says Fred Kiio, Ag. Director at DigiFarm. The end-to-end platform – available via USSD or via app – provides everything from basic advice to more advanced and mechanised support. “When farmers join our platform, we want to make sure that they receive everything they need to do the work they do better, more sustainably and with the ability to access greater market opportunities,” Fred explains. Keen to make it as simple as possible for farmers to register for the service, users can either download the DigiFarm app and follow the instructions to register or dial \*944# and follow the prompts to sign up. “This approach has made it possible to target all farmers whether they have a feature phone or a smart phone,” adds Sylvia Nyamai, DigiFarm’s Sales and Marketing Lead.

One of the more innovative services offered by DigiFarm leverages drone technology to do aerial surveys of smallholder farms. “Previously, someone would have had to walk around the farm with a basic GPS device to map the location but now we can use drone mapping to better understand the topography of the land so that they can create efficiencies and mechanise processes where possible,” Fred notes. In the past, when it was time to spray fields for pests or to fertilise crops someone with a knapsack would have walked up and down the entire farm spraying the different plants by hand. “This is a very slow and expensive process. And because the chemicals are being applied by hand, there is a higher chance of wastage and it is more likely that the distribution will be uneven. Our drones automate this process.” When speaking to farmers about the impact of the platform, Sylvia highlights cost savings as a major advantage. “When the farmers compare the costs of manually applying inputs, like herbicides, pesticides or crop protection, to their fields with the costs of using DigiFarm’s drones, they find that our platform is far more cost-effective.”



“Previously, someone would have had to walk around the farm with a basic GPS device to map the location, but now we can use drone mapping to better understand the topography of the land so that they can create efficiencies and mechanise processes where possible.”

Fred Kiio, Ag. Director at DigiFarm



“I like trying new things, so I was happy to meet with DigiFarm. I found their proposal of using drones quite exciting. They came to my farm and sprayed my trees in a very short amount of time. For me, this technology has worked quite well.”

Benjamin Ikombo,  
Smallholder Farmer in Kenya

When Benjamin Ikombo first tested out DigiFarm’s drone services, buses full of farmers from the local community came to his farm to see what he was doing. A small-scale farmer in his seventies who has been farming mangoes and other crops in Kenya for over 20 years, has consistently struggled with crop management. Spraying, he says, is a challenge because it is tedious, very labour-intensive and time-consuming. And this approach to crop management isn’t always effective because spraying is less precise, which increases waste and decreases accuracy. “I like trying new things, so I was happy to meet with DigiFarm. I found their proposal of using drones quite exciting. They came to my farm and sprayed my trees in a very short amount of time. For me, this technology has worked quite well.” According to Ikombo, this approach has improved the quality of his yield, opening up opportunities for him to possibly even export his produce internationally. Going forward, DigiFarm wants to use the information they are gathering to help farmers gain access to financial services, says Fred. “In Kenya, and in other areas across Africa, you find that there is limited financing for smallholder farmers because there is a lack of information that banks and other financial institutions can use to gauge whether or not a farmer is likely to pay back a loan. We hope to be able to use some of the information gathered to help these farmers access basic financial products.”

Talking about the possibility of expanding DigiFarm into other African countries, Fred asserts that it all comes down to policy: “For this to scale across Africa, other countries will need to spend time developing policies like the government has done in Kenya. Luckily, these countries can model their policies on the work that has been done. It definitely can happen anywhere,” he says. “But the pace of deployment and change will correlate with the pace of policy change and reform in different regions.”

# Digital financial services

When financial services – like credit, funding, payments, and insurance – are available online or via a mobile phone, smallholder farmers are empowered to transact with less friction. Mobile technologies and mobile-payment systems offer the unbanked an affordable and secure way to transfer, access, and save money using their mobile phones. By enabling smallholder farmers to save small amounts of money, receive payments promptly in times of need, and securely pay for agricultural goods via their mobile phones, these platforms and applications replace traditional financial services and eliminate the need to travel long distances to collect funds. In line with this, agricultural insurance helps smallholder farmers avoid devastating financial losses, and limits the downside risks associated with relying on their own resources. To this end, other value-add services provided through DigiFarm includes soil testing, insurance yield cover and access to e-extension services through remote agronomists located at the DigiFarm call centre, WhatsApp for Business Agronomy support or on ground DigiFarm Village Advisors (DVA).

Perhaps the most successful business case is Safaricom and Vodafone’s mobile money transfer service, M-Pesa. The service, that serves over 51 million customers in seven countries, has boosted financial inclusion among rural populations, including farming communities, by providing a mobile-phone-based money transfer service and enabling payments and micro-financing. Addressing the historical exclusion of smallholder farmers from formal financial markets, M-Pesa provides farmers with a more secure way to pay for agricultural products, while also providing their suppliers with enhanced reliability and traceability of payments.

Another interesting example of these new ways of transacting using digital technologies includes crowd-farming, which offers an alternative way for farmers to raise money. Farmers are connected with sponsors who wish to invest in their work. Popular crowd-farming platforms include Ghana’s Complete Farmer and Livestock Wealth, a startup out of South Africa. According to Disrupt Africa’s recent African Tech Startups Funding Report 2021, African agritechs saw positive growth in 2021 after a period of stagnation. In fact, these businesses had a record funding year in 2021, securing a total of just over \$95 million, which is an increase of 58.5% from 2020.<sup>31</sup>



## Case study

# Startups are key to African innovation

Investments in the African agritech sector are on the up. According to Disrupt Africa’s 2021 African Tech Startups Funding Report, these startups have a huge impact across the continent by helping farmers access markets, inputs, insurance, financing, and knowledge, in addition to improving farm management and increasing outputs. And funding numbers for 2021 reveal that investors know how much potential these digitally driven agriculture ventures hold. Sean Khan, programme manager for Global Environment Monitoring System (GEMS) Air at the United Nations Environment Programme (UNEP), reiterates that agriculture is threatened by pollution and changes in climate. Technology though, can play a role in helping farmers across the continent mitigate the impact of climate change and by helping people to communicate and share information in unique ways. For example, Khan has heard stories about people using missed calls to send messages, with a certain number of missed calls sending a specific message.

There is a lot of creative talent and resourcefulness in Africa and there are a lot of people with creative ideas, but Khan thinks that **there is incredible potential for these innovative thinkers, like those launching agritech ventures, to think outside of the box and do so much more with new technologies.**

# What is holding African agriculture back?

We know that digital technologies are transforming the agricultural sector by creating entirely new business models. When smallholder farmers can access technologies and the resulting real-time information it provides, they can conduct their farming operations in entirely new ways. But this is only possible if they have the necessary connectivity, access to funds, information and advisory support and if the right policies are in place to support the changing industry.

Earlier, we outlined three major stumbling blocks holding the African agricultural landscape back – climate change, poor infrastructure and resulting financial exclusion, and socio-cultural and economic norms.

Breaking these hurdles down in more detail, there are seven key obstacles preventing the digitalisation of small-scale farming in Africa. These are unpacked in the following pages.



## #1 Limited network coverage and poor infrastructure

In rural communities, limited network coverage prevents farmers from accessing digital insights or information about issues that affect them, like climate change. This aligns with findings from the GSMA's State of Mobile Internet Connectivity report<sup>32</sup>, which reveals that the unconnected are more likely to be poorer, less educated, and living in rural areas. Age and gender were also found to impact the likelihood of connectivity, with older people and women at a greater disadvantage.

**Government, the private sector, and civil society must make a concerted effort to collaborate on delivering connectivity to underserved, rural areas, ensuring that no one is left behind.**

To this end, in 2021, Vodacom invested R13.3 billion in infrastructure across its markets to bolster coverage. In South Africa's rural communities, Vodacom expanded 4G coverage to reach 82.9% of communities by adding an additional 192 network sites, bringing total sites up to 2 784. In Tanzania, the company extended its coverage reach to 52% of the population, which equates to 1,184 villages.



## #2 Restricted access to smartphones

As our Access Report explains: “Once you’ve helped place a smartphone in a person’s hand, what you’re doing is opening a world of opportunity that the internet brings”.<sup>33</sup> However, affordability is a barrier to adoption, not to mention the high cost of data for using them. According to the GSMA (2021)<sup>34</sup>, less than half (48%) of people living in sub-Saharan Africa have access to a smartphone. The high cost of smartphones, relative to average income levels, remains a major barrier to mobile internet adoption across the continent, which means that many in Africa are left behind, the GSMA report reveals. This is where feature phones and low-cost “smart” feature phones play a role.

**In 2021, over 1.3 million of Vodacom’s low-cost smart feature phones were sold across South Africa, Mozambique, and Tanzania, highlighting the demand for affordable handsets.**



## #3 Financial exclusion

**The main barrier preventing smallholder farmers from accessing agricultural technologies is affordability.**

The affordability conversation isn’t only about having enough money to purchase the technologies needed to make farming more precise and efficient, it’s also about being able to use and secure basic financial services, such as credit, so that farmers can access better resources.

If financial exclusion and unequal access to finance is not addressed, the digitalisation of the sector will bear little fruit as those who really need new technologies to make their operations more efficient won’t be able to access these agri-tech innovations.

In line with this, a lack of a digital identity makes it challenging for smallholder farmers to access credit from banks and other institutions or receive social protection grants. The rise of simpler, digitally-managed micro loans, which use a combination of user data and behaviour to inform credit lending, can address this by giving farmers a simple digital identity, fixed around a SIM or other KYC-related data. This enables the building of a longitudinal digital record linked to the farmer’s production location, their production yields by crop type, their borrowing history, and many other layers of data. With this, farmers can gain an economic identity so that any enterprise, like a bank, insurer, input provider or IoT vendor, can assess and engage the beneficiary against their own appetite for risk.



## #4 Limited literacy and a lack of digital skills

Unfortunately, many of the farmers in rural communities have a limited understanding of the digital tools, the internet and the benefits of these. Furthermore, they lack the digital literacy and skills needed to use new technologies and tend to have trust and safety fears relating to the use of new technologies.<sup>35</sup> Low levels of literacy among smallholder farmers means that rural farming communities are often less informed about what value technology and connectivity can bring. As a result, they are less willing to get involved in the development and use of digital solutions.



## #5 A lack of local solutions

IT experts who are familiar with the local context Africa's farmers operate in can make valuable contributions to the design of suitable digital agriculture solutions. When local developers are not involved, there is a massive reliance on farmer engagement and feedback to ensure the solutions meet their needs. However, reaching these farmers can be challenging.



## #6 Restrictive data practices

Without standardised data in the form of large agricultural databases, it can be tricky to design impactful and tailored solutions. This is exacerbated by a general lack of digitalisation across agricultural infrastructure like farmer registries, agronomy data, soil mapping, pest and disease surveillance, and weather data infrastructure. In addition to this, increasingly restrictive regulatory policies and practices around digital, cloud and data services are hindering the growth of Africa's digital economy, and the related socio-economic benefits across the continent. The key to unlocking this growth is to create an enabling regulatory environment that supports the secure flow of data between jurisdictions, via innovations like cloud computing. Without real-time access to accurate, critical agricultural insights from free-flowing data, smallholder farmers will remain at a disadvantage.



## #7 Outdated policy frameworks

The digitalisation of the agricultural sector presents opportunities to reduce unemployment and poverty in rural communities and contribute towards economic growth. But this is only possible if agricultural policies are updated to cover rapid developments in digital agriculture and the agri-tech sector. This demands a coordinated effort by the public and the private sector. In line with this, public-private partnerships are essential for strengthening digital infrastructure so that reliable internet connectivity is also available in rural areas.

# Making positive changes today

Digitalisation in agriculture can help farmers work more effectively, boost resilience, connect with customers in new ways, grow sustainably, and better prepare for market and supply chain disruptions. All of these benefits apply along the entire agricultural supply chain.

However, the reach of these digital resources is still limited.<sup>36</sup> As Section 4 explains, seven key obstacles are blocking the development of digitalisation in agriculture.

## So, how do we overcome these obstacles and foster a growth culture in Africa's agriculture sector?

There is no single measure that can address all the issues facing the farming sector. The seven obstacles may overlap and compound one another, but they need to be addressed with different measures.

## Decision-makers need to look at the challenge from a broad perspective and apply changes across various areas.

agriculture strategies that set out a clear vision of how digital enablement will support agricultural transformation, particularly within the context of climate change and its impact on natural ecosystems. The strategies must leverage digital technologies for output, productivity, and profitability. These strategies should promote the inclusion and participation of women and youth in various activities across the agricultural value chain. And they must underline green and sustainable digital transformation, progressively reducing total carbon emissions to net-zero by 2040.



**Infrastructure:** Access to affordable and equitable infrastructure, both digital and non-digital, is a prerequisite for rolling out digital agriculture at scale. Digital infrastructure investments must be accompanied by investments in other types of service infrastructure, like electricity and roads. And it should be delivered through strategic partnerships between the public and private sectors. Infrastructural development must be orientated towards the future so that rural communities can tap into current and emerging digital technologies and solutions. But governments cannot do it alone. Improving access for all, particularly within underserved areas, is best delivered by meaningful and sustainable strategic public-private partnerships where partners are enabled to share their expertise and contribute to the collective prosperity of programmes and positive socio-economic outcomes.



## Case study

# Early childhood development centres across South Africa go green

Vodacom's Green Early Childhood Development (ECD) Programme aims to enable eight ECD centres across South Africa to become more sustainable and improve the quality of life for the children and the communities they serve. The programme intends to green ECD centres across South Africa through the planting of food gardens, the installation of clean solar energy, and the provision of a sustainable water supply via 5 000-litre rainwater collection tanks, as well as supplying energy-efficient appliances and lighting. Initiatives like this enable children to be cared for and educated in safe, sustainable spaces that have a low impact on the environment. Critical to this programme, educators, parents, and other community members are also being taught about sustainable farming practices so that they have the skills needed to effectively manage the food gardens, to ensure sustainable food production, and also so that they are able to educate and guide young children about the importance of making better choices for the planet.

**Data:** Regulatory limits on cross-border data transfers stifle growth. Farming, like other sectors, needs an efficient movement of real-time data within supply and value chains. Governments need to coordinate data protection laws to enable free and secure cross-border data flows. That means policies are needed to improve the ability of farmers to trade regionally and internationally, as laid out by the African Continental Free Trade Area (AfCFTA). Restrictive data-protection laws must also be revisited as these create unwarranted market barriers that prevent cross-border services from going to market, making it even more difficult for new, domestically incorporated small businesses (such as smallholder farmers) to compete effectively because they do not have the resources of their larger, international counterparts.

**Engagement:** Stakeholders must be engaged as partners with government and business if digital farming is to succeed at scale. This is vital, as there are major knowledge and information gaps across communities: sharing information around challenges and experiences could help smallholder farmers across different communities make more informed decisions. By creating a central hub for agricultural knowledge and resources, the flow of quality information can be supported among industry stakeholders. It also means integrating digital tools and technologies into education so that farmers – including the next generation – have the tools and skills they need to run a successful business.

**Access:** The lack of affordable digital devices holds people back from effectively participating in the digital economy. Affordable access can be achieved by cutting, and even completely removing, import duties and taxes on mobile phones to improve affordability and drive adoption within the farming community. With more devices connected, mobile operators can focus their resources on the rollout of 4G and (where appropriate) 5G network technologies, which farming communities can leverage to enhance their productivity and improve their profitability. One way to help is by fostering digital financial inclusion, allowing fintech start-ups and telcos to fill the gaps left by traditional banks: the financial revolution brought about by M-Pesa in Kenya shows what can be achieved when solutions are designed with the end user need in mind.



# Conclusion

There is immense potential in Africa's agriculture. If the promise of this sector combines with innovative technologies, farmers can safeguard themselves against the effects of climate change. But this is only possible if we address issues around access to information and financial resources, improve overall farm efficiency and market access, and ensure equitable digital resources.

If we are to leverage digital technologies to create an innovative, climate-proof farming sector in Africa, we need to set political priorities:



## Develop digital agriculture strategies.

Governments need digital agriculture strategies that set a clear vision of how digital enablement will support agricultural transformation. These strategies need to leverage digital technologies.



## Policy and regulatory reforms to incentivise investment in critical digital infrastructure.

The availability of ubiquitous digital infrastructure will enable data transmission and processing, which is key for an effective digital agriculture strategy.



## Free and secure movement of data.

The agricultural sector will flourish when there is an efficient movement of real-time data within supply and value chains. Governments need to coordinate on data protection laws to enable free and secure cross-border data flows.



## Access to digital devices and smartphones and reliable network coverage.

Policymakers must ensure affordable access to digital devices, particularly smartphones. This means reducing or even removing import duties and taxes on smartphones to drive their adoption within the farming community. Everyone benefits in a digitally inclusive society where all citizens can engage meaningfully through digital platforms.



## Fostering strong and lasting partnerships.

Stakeholder engagement is key in digital farming. No single company, government, or institution has the means or capabilities to deliver the digital transformation at scale.





The Africa.Connected campaign aims to bolster the continent's efforts to close the digital divide and improve lives. If we are to address food security, we must do more to support Africa's farmers. There are huge opportunities to transform the agricultural sector through digitalisation. However, this will require significant investment and co-operation across multiple stakeholder groups.

Partnerships with like-minded institutions and economic blocks will drive digital skills development and boost agricultural entrepreneurship and farming innovation. These partnerships will, in turn, lift the African economy while upholding the human principles in growth and development, and positioning the continent as a digital hub for agricultural entrepreneurship.

If you would like to discuss digital agricultural partnerships, please email: [mediarelations@vodacom.co.za](mailto:mediarelations@vodacom.co.za)

# References

- 1 FAO, 2020
- 2 FAO. (2021). The State of Food and Agriculture (2021) Making agrifood systems more resilient to shocks and stresses. Rome, FAO. <https://www.fao.org/documents/card/en/c/cb4476en>
- 3 van Ittersum, M., van Bussel, L., Wolf, J., Grassini, P., van Wart, J., Guilpart, N., Claessens, L., de Groot, H., Wiebe, K., Mason-D'Croz, D., Yang, H., Boogaard, H., van Oort, P., van Loon, M., Saito, K., Adimo, O., Adjei-Nsiah, S., Agali, A., Bala, A., Chikowo, R., Kaizzi, K., Kouressy, M., Makoi, J., Ouattara, K., Tesfaye, K and Cassman, K. (2016). Can sub-Saharan Africa feed itself? Proceedings of the National Academy of Sciences, 201610359 DOI: 10.1073/pnas.1610359113
- 4 State of Food Security and Nutrition in the World. Transforming Food Systems for Affordable Healthy Diets (2022). <https://www.fao.org/publications/sofi/2020>
- 5 Jayne and Sanchez, 2021
- 6 AGRA. (2021). Africa Agriculture Status Report. A Decade of Action: Building Sustainable and Resilient Food Systems in Africa (Issue 9). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 7 AGRA. (2021). Africa Agriculture Status Report. A Decade of Action: Building Sustainable and Resilient Food Systems in Africa (Issue 9). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 8 AGRA. (2021). Africa Agriculture Status Report. A Decade of Action: Building Sustainable and Resilient Food Systems in Africa (Issue 9). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 9 Woetzel, et al., 2020
- 10 McKinsey & Company (2020). How will African farmers adjust to changing patterns of precipitation? <https://www.mckinsey.com/business-functions/sustainability/our-insights/how-will-african-farmers-adjust-to-changing-patterns-of-precipitation>
- 11 Jeehye, K., Parmesh, S., Gaskell, J.C., Prasann, A. and Luthra, A (2020). Scaling Up Disruptive Agricultural Technologies in Africa. International Development in Focus. World Bank, Washington, DC. © World Bank. <https://openknowledge.worldbank.org/handle/10986/33961> License: CC BY 3.0 IGO.
- 12 Ferdinand, Rumbaitis del Rio, & Fara, 2021
- 13 AGRA. (2020). Africa Agriculture Status Report. Feeding Africa's Cities: Opportunities, Challenges, and Policies for Linking African Farmers with Growing Urban Food Markets (Issue 8). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 14 Nair, A and Varghese, M. (2020). Digitization of Agribusiness Payments in Africa: Building a Ramp for Farmers' Financial Inclusion and Participation in a Digital Economy (English). Washington, D.C. World Bank Group. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/915271601013162558/digitization-of-agribusiness-payments-in-africa-building-a-ramp-for-farmers-financial-inclusion-and-participation-in-a-digital-economy>
- 15 FAO, 2011
- 16 GSMA. (2021). Connected Women The Mobile Gender Gap Report 2021. <https://www.gsma.com/r/wp-content/uploads/2021/06/The-Mobile-Gender-Gap-Report-2021.pdf>
- 17 AGRA. (2020). Africa Agriculture Status Report. Feeding Africa's Cities: Opportunities, Challenges, and Policies for Linking African Farmers with Growing Urban Food Markets (Issue 8). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 18 Vodacom. (2021) Women Farmers: using tech to boost their farm businesses in Africa <https://www.vodafone.com/news/technology/women-farmers-tech-africa>
- 19 Njobe, B. (2015) Women and Agriculture: The Untapped Opportunity in the Wave of Transformation. [https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Women\\_and\\_Agriculture\\_The\\_Untapped\\_Opportunity\\_in\\_the\\_Wave\\_of\\_Transformation.pdf](https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Women_and_Agriculture_The_Untapped_Opportunity_in_the_Wave_of_Transformation.pdf)
- 20 Minde, I., Terblanche, S., Bashaasha, B., Madakadze, I., Snyder, J. and Mugisha, A. (2015), "Challenges for agricultural education and training (AET) institutions in preparing growing student populations for productive careers in the agri-food system", Journal of Agribusiness in Developing and Emerging Economies, Vol. 5 Iss 2 pp. 137 - 169 <https://www.emerald.com/insight/content/doi/10.1108/JADEE-02-2015-0011/full/html>
- 21 AGRA. (2020). Africa Agriculture Status Report. Feeding Africa's Cities: Opportunities, Challenges, and Policies for Linking African Farmers with Growing Urban Food Markets (Issue 8). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 22 AGRA. (2020). Africa Agriculture Status Report. Feeding Africa's Cities: Opportunities, Challenges, and Policies for Linking African Farmers with Growing Urban Food Markets (Issue 8). Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).
- 23 FAO. (2021). The State of Food and Agriculture (2021) Making agrifood systems more resilient to shocks and stresses. Rome, FAO. <https://www.fao.org/documents/card/en/c/cb4476en>
- 24 ayaram, K., J. Riese, and S. Sanghvi. (2010) Agriculture: Abundant opportunities. McKinsey Quarterly.
- 25 De Vos, Jacques (2021). Smallholder farming in Africa and the opportunities for digital enablement. <https://www.vodafone.com/news/digital-society/smallholder-farming-in-africa>
- 26 Kamara, A., Conteh, A., Rhodes, E. R., & Cooke, R. A. (2019). The relevance of smallholder farming to African agricultural growth and development. African Journal of Food, Agriculture, Nutrition and Development, 19(1), 14043-14065.
- 27 Haggblade, S., Hazell, P., & Reardon, T. (2010). The rural non-farm economy: Prospects for growth and poverty reduction. World development, 38(10), 1429-1441.
- 28 Otsuka, K., & Larson, D. F. (2013). Towards a green revolution in sub-Saharan Africa. In An African Green Revolution (pp. 281-300). Springer, Dordrecht.
- 29 Gollin, D. (2014). Smallholder agriculture in Africa. IIED Work. Pap. IIED, London (2014).
- 28 McKinsey and Company (2019) Winning in Africa's agricultural market. <https://www.mckinsey.com/industries/agriculture/our-insights/winning-in-africas-agricultural-market>
- 29 Trendov, N.M., Varas, S. and Zeng, M. (2019) Digital technologies in agriculture and rural areas. Briefing Paper. Food and Agriculture Organization of the United Nations.
- 30 GSMA. (2021). The State of Mobile Internet Connectivity 2021. <https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf>
- 31 Disrupt Africa. (2021) African Tech Startups Funding Report 2021. <https://disrupt-africa.com/funding-report/>
- 32 GSMA. (2021). The State of Mobile Internet Connectivity 2021. <https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf>
- 33 Vodafone. (2021). A lifeline, not a luxury Accelerating 4G access in Sub-Saharan Africa. [https://www.vodafone.com/sites/default/files/2021-09/Vodafone\\_Africa\\_Access\\_Paper.pdf](https://www.vodafone.com/sites/default/files/2021-09/Vodafone_Africa_Access_Paper.pdf)
- 34 GSMA. (2021) The Mobile Economy Sub-Saharan Africa 2021 [https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/09/GSMA\\_ME\\_SSA\\_2021\\_English\\_Web\\_Singles.pdf](https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/09/GSMA_ME_SSA_2021_English_Web_Singles.pdf)
- 35 CTA, 2019; GSM Association 2021
- 36 UNCDF. (2021). Bridging Uganda's Digital Divide: Gender Mainstreaming in Digital Agriculture. <https://www.uncdf.org/article/7221/bridging-ugandas-digital-divide-gender-mainstreaming-in-digital-agriculture>