The European Commission's Knowledge Centre for Global Food and Nutrition Security

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Knowledge Review: Digital technology for agriculture: What's in it for smallholder farmers?

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I. Background

Digitalisation is a cornerstone of the European Union (EU) policy on international partnerships. Following the release of its Digital Strategy in 2020, the EU has been promoting a human-centric vision for the digital economy and for society across the globe, with the objectives of ensuring that technology works for people, digital economies are fair and inclusive, and societies are open, democratic, and sustainable[1]. In line with this vision, the EU established the Digital4Development (D4D) Hub in 2020 to promote multi-stakeholder dialogue and leverage expertise and resources in order to establish new digital partnerships. In 2021, the Hub launched its first operational regional component, the African Union-European Union D4D Hub [2], which helps African institutions implement inclusive and sustainable digital transformation initiatives and other projects [3] related to digitalisation and sustainable development. Meanwhile, under the guidance of the European Farm to Fork Strategy, the EU announced its support for a global transition to resilient, safe, and sustainable food systems (SFS) in order to address the twin challenges of malnutrition and food insecurity. The communication "Towards a Comprehensive Strategy with Africa"[4] highlights the role that digital technology can play.

Based on the above policy background, this Knowledge Review aims to inform policymakers and practitioners about the capacity of digital technologies and digital hubs to transform agricultural and food value chains to achieve SFS. The primary focus is on smallholder farmers, fisherfolk and pastoralists in food-insecure and low- and middle-income countries. To highlight the opportunities for and barriers to digitalisation in the agricultural sector, the review shares opportunities, key challenges and lessons learned, and recommendations gleaned from a synthesis of 34 publications. These publications were selected from the European Commission's Knowledge Centre for Global Food and Nutrition Security[5] based on the need to cover a large spectrum of technologies, while also keeping the focus on smallholder agriculture and developing countries. They are a representative although limited proportion of the literature available on this topic, which is being updated at a very fast pace. Consequently, the knowledge presented in this review should not be considered exhaustive. Instead, it gives the key messages of the selected publications and does not necessarily reflect the position of the European Commission. This Knowledge Review uses verbatim quotes without quotation marks for formatting reasons. However, all sources have been systematically indicated.

II. Introduction

Artificial intelligence, blockchain, remote sensing, geographic information software, virtual reality, drones, application programming interfaces, and precision technology for decision-making are examples of important innovations that can help smallholder farmers, fisherfolk, pastoralists and others [R14] achieve important outcomes in agriculture. Such outcomes include increased resilience and efficiency, adaptation to climate change, improved market integration and

[1] See the Digital Strategy on the EC website at: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en

[2] See the African Union-European Union D4D Hub's website: https://d4dhub.eu/au-eu-project

[3] See the D4D Hub's dedicated page: https://d4dhub.eu/projects

[4] See the Communication at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020JC0004

[5] See the Knowledge Centre at: https://knowledge4policy.ec.europa.eu/search_en?f%5B0%5D=det%3Ahttp%3A//data.europa.eu/uxp/7219&f%5B1%5D=knowledge_service%3AGlobal%20Food%20and%20Nutrition%20Security

better food security [R14, R19]. In addition to positively impacting farmers, fisherfolk, and pastoralists, especially those in least-developed countries (LDCs), digital tools can also help those in the private sector and civil society to build inclusive business models, and governments to create trade policies and better enabling environments for connectivity and digital growth [R2, R7, R26]. Digital start-ups are currently attempting to leverage the potential impacts of digitalisation [R14]. Innovation brokerage offered by both public and private actors is a powerful way to help navigate the plethora of players. The AgriHub, JengaLab, and Briter Bridges maps are all good places to start understanding the variety of actors in the field, and the opportunities and challenges presented by each.

Key Takeaways

- Digital tools can provide users with targeted information and opportunities to connect with each other, to increase farmers' knowledge and access to markets and finance, and ultimately to improve income and food security. However, the impact of digital solutions for agriculture is not well documented.
- Crowd-sourced User data based on digital tools can be used to better inform policymaking and support policy implementation.
- In developing countries, supply of digital solutions for smallholder farmers currently exceeds demand, while at the same time rural penetration of digital services remains limited. Lack of connectivity infrastructure and the costs of mobile phones and web-based services are significant barriers to the adoption of digital solutions by rural populations.
- Gender, income, education and digital literacy are the main factors in the growing digital divides. Enabling policy environments is key to tackling these challenges.
- In developing countries, the regulatory environment is weak and partly fails to secure digital privacy and freedom. Digital technologies can lead to increased concentration of power.
- The capacity of digital technology to provide simple context-specific solutions and generate benefits for their users, that outpace the cost of their use, is critical for their sustainability and scalability. In general, bottom-up approaches that include and empower local stakeholders increase adoption rates. Economic incentives have also an important role in the initial phase.
- Digital solutions for agriculture can influence farming practices in very different ways, ranging from supporting the agroecological transition to encouraging the use of chemical inputs.
- Digital solutions will not reach their full potential in developing countries without a transformative approach that combines digital and non-digital solutions for smallholder farmers, such as face-to-face advisory and extension services.

Definitions

Application Programming (Apps): Self-contained programs that perform precise functions and tasks on behalf of users.

Artificial Intelligence: The ability of a machine to simulate human intelligence, or of an object to be controlled by a computer, in order for it to conduct certain tasks that are normally completed by humans.

Crowd-Sourced Data: The collection of information or opinions from individuals or groups of people, typically through internet technology.

Blockchain: Technology (often referred to as "Digital ledger Technology") that allows the distributed storage and exchange of information in a decentralised, immutable, autonomous and trustworthy manner without any central authority governing the process.

Digitisation: The process of transforming data (i.e. audio, text, images) into a format that can be processed by a computer.

Digitalisation: The application of digital technologies to transform business models into digital business solutions, providing new revenue and value-producing opportunities.

Drones: Unmanned aircrafts or ships that can function on their own without the control of a human.

Geographic Information Systems: Software that collects, stores, cleans, manages, analyses and presents data related to the position and characteristics of geographic features.

Precision Technology (or precision agriculture): Design and assembly that focuses on cost-effective, high-quality solutions that decrease inputs and optimise returns.

Remote Sensing: Satellite, drone or aircraft technology that scans properties of the Earth's surface and provides information related to its features (e.g. on vegetation).

Virtual Reality: Computer-generated simulation that allows for near-physical interaction with images or environments.

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III. Opportunities for Digital Tools

As of 2019, there were at least 390 distinct and active "digital for agriculture" solutions across Africa, 60% of which were launched since 2016 [R24]. Over 50% of these tools can meet a combination of needs, including a mix of advisory and supply chain management services, market linkage opportunities and financial access capabilitie [R24]. To better understand the potential impact of such tools on LDCs and their agricultural populations, this section outlines major opportunities and case studies. The opportunities are categorised as follows:

- Access to information
- Improvements to equitable labour force development
- Access to finance and markets
- Data for policymakers and for environmental protection

Access to information: Smallholder farmers, fisherfolk and pastoralists can obtain useful and targeted information for decision-making through a variety of digital platforms and mobile applications [R3, R21]. By allowing users to upload and provide personal details on their location, farms and crop performance, digital technologies can help them make better and more specific estimates about their farming activities and risks, as well as about the application of fertiliser and disease treatment for crops and animals [R9, R12, R20]. Digital platforms can also educate and provide users with technical guidance and advice to help them to increase efficiency and stay up-to-date on best practices [R14, R19, R26]. This helps farmers, fisherfolk, and pastoralists to increase output, production, and quality, make better decisions about the timing of certain activities, and, ultimately, improve their incomes [R1, R9]. They can also increase their awareness of and response to on-farm and other risks [R19]. In turn, this increases food security, GDP and food production for the populations of LDCs [R14, R26].

The first case study below demonstrates how access to digital visual libraries can help farmers make informed decisions to mitigate crop losses. The second highlights how digital tools can help farmers shift towards organic, agroecological approaches. The third demonstrates how low-tech solutions can also contribute to agricultural outcomes, but with limited success if not properly targeted.

*Designed by German start-up Progressive Environmental & Agricultural Technologies (PEAT), **Plantix** is a free-to-use smartphone application that leverages photo recognition technology to offer relevant and timely information about plant diseases and pests for approximately 50 different types of crops. In 2017, more than 10,000 smallholder farmers from Tunisia, including digitally illiterate farmers, received training in the use of Plantix as the app was built to display pictures and icons and allow text-to-speech functionalities with relevant translation. To date, there is insufficient data to allow for a robust evaluation of results, but Plantix expects their technology and tool to lead to a reduction in crop losses and food insecurity, greater environmental protection, and increased incomes, especially for women [R3].*

***AnaliSAFS** is an online platform created in 2018 that supports cocoa producers, agricultural extension workers, researchers, and others by providing them with financial and socio-environmental analyses of their agro-forestry-related activities. Through data collected in the field, the application can monitor and analyse farmers' restoration activities and provide users with information about how to maximise the sustainability of their agro-ecological production. The application was built in partnership with the International Union for the Conservation of Nature (IUCN), The Nature Conservancy (TNC), the World Agroforestry Center (ICRAF) and Embrapa [R29].*

***8028 Farmer Hotline** is a free service developed by the Ethiopian Agricultural Transformation Agency (ATA) in 2014. It leverages Interactive Voice Response and Short Message Service (IVR/SMS) to deliver information directly to farmers through mobile phones. Smallholder farmers can access the hotline by calling the short code 8028; they then receive information on a range of agricultural activities by selecting their particular areas of interest. In 2016, 8028 Farmer Hotline launched a survey tool to collect and later broadcast information on the occurrence, spread, identification and prevention of various crop diseases [R31]. While highly accessible, information is automated, which sometimes leads farmers to receive information that is not targeted or relevant. In addition, some farmers have not been sufficiently trained in the use of the information service as outreach campaigns have not been robust; farmers are also often unable to put into practice the information obtained. Still, the service is in high demand and shows the potential of low-tech solutions, particularly given their opportunities for scale [R32].*

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Improvements to equitable labour force development: As digital services can be designed to target specific populations and account for their realities, they can better support disadvantaged populations, increase labour force integration, and improve dignity at work [R19, R22]. Depending on how digital applications are built and marketed, they can target and exclusively reach women, young people and other vulnerable populations, and meet their context-specific needs in order to increase their equitable participation in agriculture [R20, R24]. Given that a 10% increase in Global Value Chain (GVC) participation can result in an estimated 1.2% increase in labour productivity [R7], promoting digital for GVCs can, alongside stimulating food and export production, also boost employment rates. When targeting certain users effectively, digital tools can thus increase employment in more vulnerable populations [R1, R6, R8, R22]. While engaging people in gainful employment, digital tools can also help improve worker and smallholder safety and inclusivity by facilitating conversations among farmers and workers [R8, R22]. The following case study demonstrates how digital applications can also support

workers' rights. Finally, digital tools have been shown to help increase animal welfare, and, in turn, ensure disease reduction and greater health among rural populations [R12].

In the region of Assam, India, tea workers — especially from the Adivasi tribes — face structural inequality, extreme poverty and chronic vulnerability. They earn below the legal minimum wage, lack access to services, and suffer the highest rate of maternal mortality and one of the highest rates of infant mortality in India. ***Nazdeek*** *is a legal-capacity-building organisation that has worked since 2013 to combat maternal mortality in India, and in Assam in particular. In 2014, they developed End Maternal Mortality Now, a collaborative project to train more than 40 female Adivasi volunteers in Assam on maternal and infant health and rights. After their training, the volunteers reported, via an anonymous SMS system, incidents of healthcare rights violations they were either aware of or had witnessed on tea farms in the region. These incident reports proved essential for Nazdeek to be able to litigate on behalf of tea plantation workers in Assam, and specifically for the rights of Adivasi tribes [R33].*

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Access to finance and markets: The agricultural sector and GVCs are made up of diverse businesses, from smallholder family enterprises to large agri-corporations. In all cases, to be successful, agricultural actors require sustainable access to finance and markets. While traditional, large agri-businesses have had the greatest access to market information and financial services to date, digital solutions are able to equitise and increase this access for smallholders [R19]. By providing users with digital access to micro-credit and savings, insurance, market and pricing information, and inventory and supply chain management tools, agricultural actors of all sizes can professionalise their operations, increase the quality of their products, and improve their market share [R3, R19]. Digital platforms and marketplaces can also directly connect buyers and sellers as well as insurance brokers and lenders, equipping users with information and often lowering transaction and transport costs [R19]. This increases the bargaining power of the most vulnerable actors, promotes more diverse means of pricing, and improves opportunities for traceability [R19, R22]. The first case study below shows the potential for digital tools to increase access to insurance for farmers by decreasing transaction costs and relying on objective data; it also highlights the importance of cost-effective solutions and public-sector buy-in for digital initiatives. The second case study provides an example of a successful bundling of services, including financial services and market information.

SUM Africa *is a digital insurance product initiative of the Geodata for Agriculture and Water (G4AW) project under the Netherlands Ministry of Foreign Affairs. By leveraging satellite technology to collect objective information on temperature, rainfall, crop yield and evapotranspiration[6] , SUM Africa allows insurance companies to avoid visiting farms to assess real crop loss. This reduces their transaction costs and allows them to provide more favourable rates to farmers. By the end of 2021, SUM Africa had connected 200,000 farmers in Uganda to index insurance[7] that was provided by local insurance companies. Of note, the Ugandan government provided a 50% subsidy to insurance companies so they could offer lower premiums to new users for a few years, encouraging widespread adoption. This played a huge role in SUM Africa's success in Uganda. In Mali, the project ultimately failed when the government wanted to apply an insurance tax on the premium, which made the product too expensive for farmers [R18].*

Safaricom is the largest mobile network company in Kenya offering a range of services, including mobile communication, mobile money, e-commerce and cloud computing. They have 33 million subscribers in total, or about 64% of the Kenyan market. In 2016, Safaricom partnered with Mercy Corps AgriFin Accelerate (AFA) to create ***DigiFarm****, a free digital platform that offers a range of services to smallholder farmers and connects them to third-party providers that offer a range of products. Some of these products include credit scores, discounted farm inputs, yield insurance, input loans, agronomic and financial information, mobile-based training and market linkages. DigiFarm also employs remote agronomists called DigiFarm Village Advisors (DVA) who provide extension services either via phone or on the ground [R27].*

Data for policymakers and environmental protection: As digital solutions boast diverse user bases, governments and policymakers can rely on user data analysis to build a responsive enabling environment and solution framework for their populations [R9, R20]. For example, data can be leveraged by governments as input to improve development outcomes and stakeholder connectivity, and even to understand patterns of behaviour in times of crisis [R1]. This allows public sector actors to be more responsive when the need is greatest. The case study below highlights the potential of incentivised crowd-sourced data to provide reliable time- and location-specific agricultural information that can influence governmental policy- and decision-making.

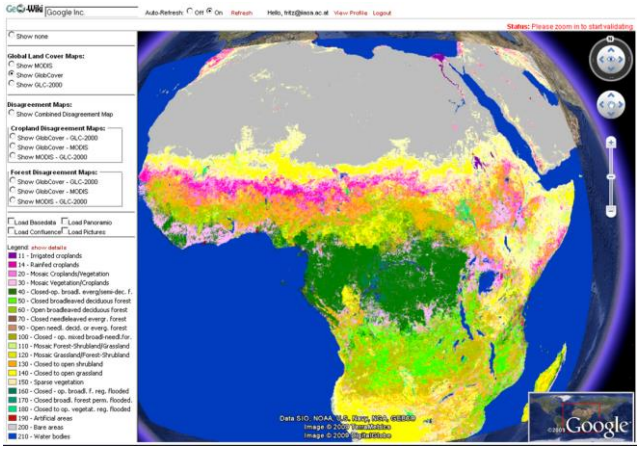
Piloted in 2018 by the European Commission's Joint Research Centre, The ***Food Price Crowdsourcing Africa*** ***(FPCA)*** *platform is a web-based mobile application that collects real-time price data on food commodities from volunteer data contributors. Between 2018 and 2020, 236 volunteer contributors in two Nigerian states, Kano and Katsina, submitted 24,000 data points on the local prices of four staple food items. The data was validated based on the geo-location of data entry as well as pre-identified relevance factors and algorithms. Results showed that during COVID-19, the retail prices of some foodstuffs increased and FPCA users travelled 54% less distance to buy food. When compared to national statistics, the crowd-sourced data was found to reflect the national average. Because such crowd-sourced data, when validated, can offer time- and location-specific information, it can provide reliable granularity that can lead to policy interventions, especially during times of crisis when a quick response is needed. However, it should be noted that volunteers received both SMS reminders and micro-rewards to motivate*

[6] Evapotranspiration is the sum of evaporation from land surface, plus transpiration from plants.

[7] Index Insurance is a innovative approach to insurance provision that pays out benefits on the basis of a predetermined index (e.g. rainfall level) for loss of assets and investments, resulting from weather and catastrophic events.

their participation during the pilot phase of the platform. Once the pilot ended and these incentives stopped, submissions declined. This reveals that in order for crowdsourcing tools to be most successful, modest investments in rewards and reminders can be worthwhile[R1].

*Another successful example of leveraging crowdsourced data to inform and orient policymaking is **Geo Wiki**, a platform that provides citizens and governments with user-friendly tools to share and integrate their observations with authoritative data for improving land-use mapping [R34]. Over 15,000 registered users have contributed to the Geo Wiki community since 2009[8]. These users directly support the implementation of citizen science campaigns such as the mapping of tropical forest loss.*



Credits: © Geo-Wiki.org

As new governmental requirements based on trade laws or legislation develop, digital tools can help users to adapt and comply by providing them with necessary information and other resources [R9]. For example, by promoting precision agriculture and the improved application of fertilisers and other inputs, digital solutions can lead to better environmental outcomes as well as improved environmental monitoring, which may be required by new environmental laws [R14, R19].

IV. The Challenges for Digital Tools

Phone applications are the most commonly used digital tools in agriculture, and typically provide advisory and information services to users [R22]. While there has been an annual increase in the number of farmers reached through phone applications and the diversity of services has improved, not all users that are registered on applications are actively using them, often preferring to use their mobile phones for activities such as social media and other purposes [R24, R26]. In addition, supply exceeds demand, as the sophistication of digital tools is outpacing the readiness of diverse user bases and governments [R24]. This section describes these and other intersectional barriers to digital growth in the agricultural sector. The insights are grouped into the following key challenges:

- Cost, connectivity, and infrastructure
- Trust, inclusivity, and literacy
- Investment in digital tools for agriculture
- The broader regulatory environment

Cost, connectivity, and infrastructure: The extent of user engagement with digital tools depends on their access to mobile phones and the internet, and the connectivity infrastructure in their areas [R3, R23, R25]. In LDCs, country-wide, rural connectivity infrastructure – and therefore digital penetration – is weak [R20, R24]. In addition, many farmers, fisherfolk and pastoralists cannot afford mobile phones and internet packages [R14]. In Africa in particular, where internet coverage lags behind other regions, uptake is an even bigger problem. In total, 70% of the population has access to mobile internet, but less than 25% actually use it [R30]. These challenges impact data availability and quality [R6] as, given the lack of access to data and baseline information from many regions and contexts [R22], digital tools may only provide data snapshots in specific settings, and comparative analysis remains largely unfeasable [R9]. Furthermore, given cost constraints, investments in data validation are often deprioritised [R19, R21]. This prevents the collection of meaningful impact data, even though such data could support the business case for the further scaling up of digital solutions. As businesses do scale up their solutions, however, they must ensure that the impact of their tools outweighs their cost. The following case study demonstrates how, when efficiency gains from digital tools do not outpace the cost of their use, rates of adoption may decline. Efficiency and cost-effectiveness depend on the size of the business or farm, making it even more critical that tools are as responsive as possible to the needs of smallholder farmers — as they will have the most difficultly in affording digital tools [R14, R23, R25].

***Esoko**, founded in 2005, provides market information to smallholder farmers through short message service (SMS) technology. Over time, the company also offered updates on market prices, weather forecasts and good agricultural practices through voice messages and call centres, allowing farmers to speak directly with technicians. From 2005 to 2017, Esoko was able to reach over 1 million farmers in ten different countries in East and West Africa, increasing their knowledge about how to access quality inputs, credit and formal markets. Because of Esoko's services, farmers reportedly gained increased bargaining power with traders. However, because Esoko was a fee-for-service model, the company struggled to remain solvent, as farmers were often unable to afford the application, even with the increased farming revenues that resulted from greater access to information. In 2017, Esoko was forced to restructure, creating a completely separate business model that focused on mobile commerce services and credit provision [R23].*

It is important to note that there is also a significant gender component to mobile access, connectivity and infrastructure. First, the relative uptake of digital solutions among women is low [R19]. Women face more barriers to digitalisation as, while certain fundamental inequities such as lower levels of literacy do not necessarily affect women's ability to make use of services [R27], solutions are not always designed with women's realities and working conditions in mind. The digital uptake gap, for example, is wider for women, and there are growing digital divides in use between rural and richer, urban, literate and better educated households [R30].

[8] See the website of the initiative: https://www.geo-wiki.org/

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Trust, inclusivity, and literacy: At present, most digital tools for agriculture are designed in a top-down fashion with little or no input from vulnerable populations and end users [R13]. This leads to a sense that data collection through digital tools is extractive, unprotected and irrelevant to real needs and identities of those in rural settings [R3, R9, R19]. Tools may be further irrelevant if they do not take into account that even people from the same families have divergent needs and lives, such as women, men and young people who live together in one household, but whose roles in agriculture vary. In addition, because digital literacy is low among people in LDCs [R24] – especially for women and girls – the capacity of many vulnerable users to engage with or interpret their data is weak, leading to an asymmetry in value gained from data collection [R6, R9]. In many cases, farmers do not even own their own data, as it is managed, controlled and analysed by a third party – either by the company supplying the digital tool or by other stakeholders involved in a digital project, such as governments [R5, R9]. This reality demonstrates that those who are more resourced, educated or digitally literate are more likely to benefit from digital tools or to engage with their own data to make informed choices. It also points to a growing concern that digital technologies could lead to increased concentration of power among those with greater awareness of how to engage with digitalisation, or to develop their own platforms [R5, R19]. The case study below highlights this risk and shows how agro-input suppliers are playing a role in increased consolidation.

*Started in 2015 by the Netherlands Ministry of Foreign Affairs as part of their G4AW project, **GEOPOTATO** is a digital text message alert service that provides farmers with advice about how to control potato late blight. To make its recommendations, GEOPOTATO uses satellite data to continuously monitor, measure and predict weather and potato growth patterns. The service aims to reach 750,000 small farmers in Bangladesh, helping them to earn between 100 and 250 additional euros per hectare per harvest season. While GEOPOTATO initially intended to use a fee-for-service model, the project found that digital agricultural services are still new in Bangladesh, and unlikely to attract a sufficient number of early adopters. As a result, they changed their strategy to building partnerships with agro-input suppliers, who are currently providing inputs for demo plots, and collaboratively testing the GEOPOTATO service before it is taken to scale. These input suppliers will benefit in the future as they will be able to demonstrate that their products function appropriately and precisely, thus gaining more traction on the market [R16].*

Investment in digital tools for agriculture: Given that many rural residents in LDCs cannot afford to pay for technology, most digital tools rely on donor funding [R24]. To ensure scalability, most tools also look to develop attractive and sustainable business models in order to secure investment [R24]. At present, there is a high degree of country and regional variability in investment levels, and solutions remain costly for farmers, fisherfolk and pastoralists [R24]. Furthermore, with the threat of climate change, digital solutions may or may not lead to the increased productivity that would be required to ensure a return on investment [R6]. Each of the case studies in this Knowledge Review demonstrates that, without subsidies or changes in costs of agricultural goods sold, fee-for-service digital models are not yet sustainable for rural and vulnerable populations.

The broader regulatory environment: Given the aforementioned challenges of data ownership and uneven benefits between stakeholders throughout GVCs, responsible data sharing is crucial. However, there is a limited amount of policy on data sharing, privacy and digital freedom and standards [R9, R23, R25]. In some cases, farmers experience a lack of freedom in switching providers [R5], and perceived corruption leads to a lack of faith in various platforms [R9, R15]. In addition to a dearth of standards, many governments lack digital agendas, communities of practice, and legislation, which leads to reduced interoperability between platforms, and trade policies that fail to leverage digitalisation for improved equity and efficiency [R4]. Interoperability is critical to scale, as are supportive governments and enabling environments [R9]. The following case study highlights the absolute necessity for good governance in the scaling up of digitalisation for agriculture.

*In Kano, Nigeria, the Centre for Information Technology and Development (CITAD), developed a system for victims of cattle theft called the Cattle Rustling Information System (**CaTRIS**). As a web-based platform that leveraged social-media-based crowdsourcing and open-source software, CaTRIS allowed users to send robbery alerts to authorities and share information with each other in real time about a cow's possible location. Despite CaTRIS' relevance and low cost, it found it difficult to attract users. Pastoralists feared retaliation if they were to report theft – especially if authorities were part of cattle-thieving networks – so maintaining the platform became financially unviable [R15].*

Key Challenges

- Low amounts of investment in digital solutions, and the inability of many solutions to operate sustainably without donor funding
- Low use among rural populations due to perceptions of digital irrelevance, lack of connectivity, or high cost
- Lack of interoperability or bundled solutions
- Weak regulatory environments that do not ensure digital privacy and freedom, leading to a lack of confidence among users
- Lack of quality data for stakeholders, and farmers' inability to analyse and learn from their own data
- "Big data" ownership of farmers' information and the consolidation of power among corporations
- Domination of top-down approaches that do not take into account diverse user needs and realities

V. Key Enablers and Lessons Learned

In reviewing the opportunities for and challenges facing digitalisation for agriculture, several key enablers emerged for the success of publicly or privately funded digital projects. These include:

- Access to capital (including affordable mobile phones) for users and for the testing of solutions among a diverse user base [R14].
- Long-term economic viability of a given solution, based on subsidies or higher incomes among users [R12].
- Parallel investment in policy, logistics infrastructure, and rural connectivity/electricity networks [R3, R21].
- Shared digital literacy and data awareness among users and stakeholders [R21].
- Shared trust and cooperation among users and stakeholders, including public and private sector actors [R14, R22].
- The interoperability of solutions and the accuracy and use of data to drive rural well-being, policy and investment [R12].
- Legislation supporting digital freedom and privacy, and discouraging predatory behaviour and tactics [R9, R12, R25].

Meanwhile, key lessons learned include:

- Digitalisation will shape the productive capacity of LDCs in the future [R26].
- Those with greater access to resources (e.g. time, education, finance and land) will experience increased benefits from digitalisation [R19].
- Rural residents often lack the resources, skills and access to benefit from digital technologies [R26].
- Gender disparities limit the capacity of women and girls to benefit from digitalisation [R24].
- The balance of power in GVCs impacts the profitability of smallholders, despite the promise of digital solutions [R26].
- It is essential to increase the financial sustainability of solutions by ensuring a) that many different users have access, b) the replicability and usability of data, and c) the interoperability of solutions [R9].
- Government policies and frameworks can be the driving forces behind digitalisation, but increased investment is needed in order for this to be case [R21].

VI. Recommendations

Key recommendations emerging from the publications are:

Investment and Efficiency

- Promote greater investment in infrastructure, training and research and development (R+D) to increase supply of and demand for digital solutions [R12].
- Invest in spaces or hubs that promote discussion, innovation, competition and collaboration [R14].
- Improve the affordability of services through subsidies, while ensuring that users can reduce costs and increase the efficiency of their businesses using digital tools [R14].

Policy and Practice

- Build public and private partnerships to improve and disseminate digital solutions [R20, R27].
- Build country-wide consensus while developing data policies that protect the most vulnerable [R4].
- Promote data sharing, and safeguard data privacy [R23, R25].
- Introduce parallel policy and training to ensure a multidisciplinary and equitable approach to innovation [R26].

Training and Promotion

- Promote the combination of digitalisation with soft skills, and increase agricultural literacy among agri-tech entrepreneurs [R20].
- Develop digital skills among the workforce and prioritise digital literacy for all populations [R8, R22].
- Champion bottom-up approaches to build trust with smallholders, and include actors such as universities and other local institutions in the conversation [R3, R9].

Evaluation and Research

- Collect evidence of impacts through robust monitoring and evaluation protocols, and disseminate impact data [R9].
- Ensure both right-fit (adapted and customisable) and gender-responsive solutions by establishing targeted marketing and conducting more research and technology assessments [R19].
- Standardise data, make solutions interoperable, and build national and global systems for data management [R9]

VII. Conclusion

Access to digital technology and connectivity will continue to improve and digital solutions will become increasingly relevant in the future. Investment in digital for agriculture will also grow and data will become more readily available [R24]. While globally the development and agricultural sectors are already moving toward this future, it is paramount to prioritise local contribution and collaboration to ensure that the future is equitable and that rural welfare remains the primary goal of any digital action [R2]. This ultimately necessitates a focus on farmer feedback, parallel investments in the development of rural livelihoods, and supportive legislation. Moreover, rural populations still crave advice from peers, face-to-face conversation and data-informed actions [R26]. This demonstrates that while the power of digitalisation is underestimated and underleveraged by many agricultural actors, it will not reach its full potential without a transformative approach that combines digital and non-digital solutions [R26]. Digitalisation for agriculture must rely on local knowledge and systems thinking, and promote knowledge sharing and stakeholder networking [R13]. It needs to prioritise diversity, adaptability, context-specific solutions, data privacy, farmer compensation, and the circular and solidarity economies [R13].

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VIII. References

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