Food and Agriculture Organization of the United Nations

Pilot Digital Villages Initiative in Africa

Findings of country assessments and recommendations for effective implementation


ISUZU

Pilot Digital Villages Initiative in Africa

Findings of country assessments and recommendations for effective implementation

Food and Agriculture Organization of the United Nations
Accra, 2023

Required citation:
FAO. 2023. Pilot Digital Villages Initiative in Africa – Findings of country assessments and recommendations for effective implementation. Rome. https://doi.org/10.4060/cc6131en

ISBN 978-92-5-137888-5

Contents

List of Tables

List of Figures

Foreword

At the root of persistent poverty faced by agropastoral communities in rural areas of Africa are socio-economic barriers which includes lack of access to digital tools such as the internet and mobile phones.

To complement its interventions geared towards transforming agrifood systems, the Food and Agriculture Organization (FAO) of the United Nations is increasingly mobilizing digital information and communication technologies. As exemplified since the outbreak of the COVID-19 pandemic, digital solutions have strong potential to help address important production challenges, expand market access and enhance the performance of agrifood system investments. They also provide unique opportunities for young people who constitute 70 percent of users in the digital agriculture ecosystem in Africa.

The Digital Villages Initiative (DVI) was established by FAO against this backdrop. It supports the acceleration of rural digital transformation to combat hunger, poverty and inequalities. A variety of technology-enabled services, addressing farm and non-farm needs (related to health, education, job creation etc.), are facilitated in partnership with key institutions to empower rural communities including young male and female producers. It is one of the instruments put in place to operationalize the vision of the FAO Strategic Framework 2022-2031 and the FAO Science and Innovation Strategy. The Initiative is also executed in line with the guiding implementation framework of digital agriculture in the Africa region.

As in other FAO regions, a pilot has been launched in Africa currently involving nine countries. Scoping assessment reports have been completed in most of them, to identify conditions for effective deployment of services to be offered. Some initial activities have started and success criteria have been identified. This report presents key insights from these undertakings in the Africa region and will guide the full deployment of the Initiative.

The DVI is an important platform which supports the achievement of FAO's regional priorities in Africa. It provides a framework for integrating many of FAO's digital initiatives and for expanding impacts of digitalisation interventions in rural localities, complementing governments and other stakeholders' efforts. It has for example leveraged in Senegal FAO's Digital Service Portfolio (DSP) and private sector services to empower farmers, in collaboration with the national extension agency ANCAR. It offers effective opportunities to create synergies with other international organizations, such as the United Nations Population Fund (UNFPA) and the International Telecommunications Union (ITU), with which linkages are established for the deployment of the initiative in countries such as Nigeria and Liberia.

A stronger collaboration with all partners is imperative to scale up the DVI and digital agriculture interventions and facilitate the achievement of food security and the Sustainable Development Goals in targeted countries, for the benefit of agricultural and rural communities. At FAO, we stand ready for the challenge

Abebe Haile-Gabriel

FAO Assistant Director-General and Regional Representative for Africa

Acknowledgements

This publication has been coordinated by Ken Lohento, Digital Agriculture Specialist (Food and Agricultural Organization of the United Nations [FAO] Regional Office for Africa), who prepared this synthetic report leveraging content provided by national consultants and teams. Anthony Renner-Micah, Regional IT Officer (FAO Regional Office for Africa) also contributed.

The national scoping assessment reports were prepared by consultants with direct supervision by FAO country teams as presented below:

Ghana
- Consultant: Dr Godwin Kojo Ayenor
- FAO Ghana team: Benjamin Adjei (Assistant FAO Representative) and Jefferson Edem Attipoe (Programme Officer)

Kenya
- Consultant: John Kieti
- FAO Kenya team: Stuart Tippins (IT Officer / CSI); Anne Chele (National Policy Officer) and Williams Hamisi (Assistant FAO Representative - Programme)

Malawi
- Consultant: Emmanuel Khumbo Banda Ndilowe ;
- FAO Malawi team: Samuel Kirichu (Programme Officer); Margaret Mugo (GIZ and Information Management Expert); and Edna Sibale (GIS Programme Specialist)

Niger
- Consultant: Daouda Hamadou and Aminou Salifou
- FAO Niger team: Maliki Bachir (Programme Assistant) and Salifou Boulkassim (Junior Expert)

Nigeria
- Consultant: Olu Ajayi
- FAO Nigeria team: Abubakar Suleiman (Assistant FAO Representative); Austin Odia (IT Officer); Jesse Yuan (Programme Development Specialist) and Kenneth Kihumbu (Emergency Operations Specialist)

Senegal
- FAO Senegal team: Amadou Thiendella Fall (IT Expert); Makhfousse Sarr (Assistant FAO Representative); with contributions from Mamadou Beye (Consultant)

Somalia
- Consultant: Nicholas Kimolo and Abukar Mohamed
- FAO Somalia team: Kiprotich Chemweno (Head of Information and Systems Management); Benjamin Gichane (M&E Data Analyst); Madete Pauline (Agriculture Inputs Officer); Viola Kaaria (Programme Specialist, Resource Mobilization) and Francesco Diasio (Communication for Development Specialist)

We would also like to thank the Liberia and Zimbabwe Digital Villages Initiative (DVI) teams
- Octavius Quarbo, Assistant FAO Representative (Programme) Liberia
- Edwin Sarvice, National Project Coordinator, Liberia
- Constance Pepukai, Assistant FAO Representative, Zimbabwe
- Innocent Chamisa, DVI Country Focal Person, Zimbabwe

The contributions of other FAO staff for the DVI Africa project are also acknowledged.

Our warm appreciation to Ade Freeman, FAO Regional Programme Leader, Regional Office for Africa, who ensures oversight of the DVI in Africa.

Abbreviations and acronyms

ADMARC	Agricultural Development and Marketing Corporation
AMIS	Agricultural Market Information System
ASTGS	Agricultural Sector Transformation and Growth Strategy
CABI	Centre for Agriculture and Biosciences
CCPF	Chipatala Cha Pa Foni
CTA	Technical Centre for Agricultural and Rural Cooperation
DAES	Department of Agriculture Extension Services
DLIS	Desert Locust Information Service
DMN	Niger's National Meteorological Department
DSA	digital solutions for agriculture
DVI	Digital Villages Initiative
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussions
FMT	Form Management Tool
GDP	gross domestic product
GPS	global positioning system
ICT	information and communications technology
IoT	Internet of things
KIAMIS	Kenya Integrated Agriculture Management Information System
MACRA	Malawi Communications Regulatory Authority
MoFA	Ministry of Food and Agriculture
NAVSA	National Adopted Village for Smart Agriculture
NITDA	National Information Technology Development Agency
NSO	National Statistical Office
PIT	programme implementation team
PSE	Plan Sénégal Emergent
SAIDA	Services and Digital Inclusion in Africa
SDG	Sustainable Development Goals
SMS	short messaging service
SVP	Smart Village Project (Programme Villages Intelligents)
TAHMO	Trans African Hydro-Meteorological Observatory
TNM	Telekom Networks Malawi
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USSD	unstructured supplementary service data
VSLA	village savings and loans associations

1 Background

1.1. The Digital Villages Initiative

The Digital Villages Initiative (DVI) of the Food and Agriculture Organization of the United Nations (FAO) is a corporate programme aiming to combat hunger, poverty and inequality by fostering digital rural transformation. This is being carried out through the establishment of, or support to 1 000 smart rural villages supplied with the digital services needed for agrifood systems and rural transformation to achieve the Sustainable Development Goals (SDGs). The DVI supports the FAO Strategic Framework 2022–2031, which responds to key global challenges, including those engendered by COVID-19, "a global crisis, which highlighted the critical mandate of FAO to ensure functioning and sustainable agri-food systems that allow for sufficient production and consumption of food" (FAO, 2021).

The programme is being implemented in various regions of the world, including Africa. In sub-Saharan Africa, it is led by the Regional Office for Africa (RAF) of FAO and is being deployed on a pilot basis in a few countries. Lessons learned will be shared while opportunities for scaling up/replication in other countries will be explored. A call for expressions of interest was made to identify which countries were interested in participating in the initiative. Seven countries responded positively and have been preselected to be part of the initial pilot: Ghana, Kenya, Malawi, Niger, Nigeria, Senegal and Somalia.

For the project's purposes, a "digital village" or "smart village", may be broadly defined as a rural (or semi-rural) community in which specific digital solutions are used to support socioeconomic activities collectively targeting farmers and other rural stakeholders to empower them and strengthen their livelihoods. These activities would be led with the involvement of various institutions, notably the central or local governments, rural community institutions, private sector organizations, local associations or international institutions. The definition of village varies between countries, depending on national/territorial administration regulations. First and foremost, for the purpose of the project in Africa, a village is a rural or semi-rural locality, with a low population and/or human density, comprising largely underserved communities. A cluster of villages may also be treated as a village in the framework of this initiative.

For the project, agrifood transformation is mainly pursued in synergy with addressing other rural

socioeconomic needs, challenges and opportunities, including those related to health, education, environment, disaster risk reduction, women empowerment and youth development. In line with this, three pillars of activities have been identified:

- **Pillar 1** refers to activities that focus on digital activities that support the achievement of higher productivity.
- **Pillar 2** involves activities relating to market linkages and financial services facilitated by digital tools.
- **Pillar 3** focuses on the village as a whole and involves digital services that support rural transformation to improve the delivery of services in health, social protection, education, jobs, welfare, tourism (especially ecotourism and agritourism).

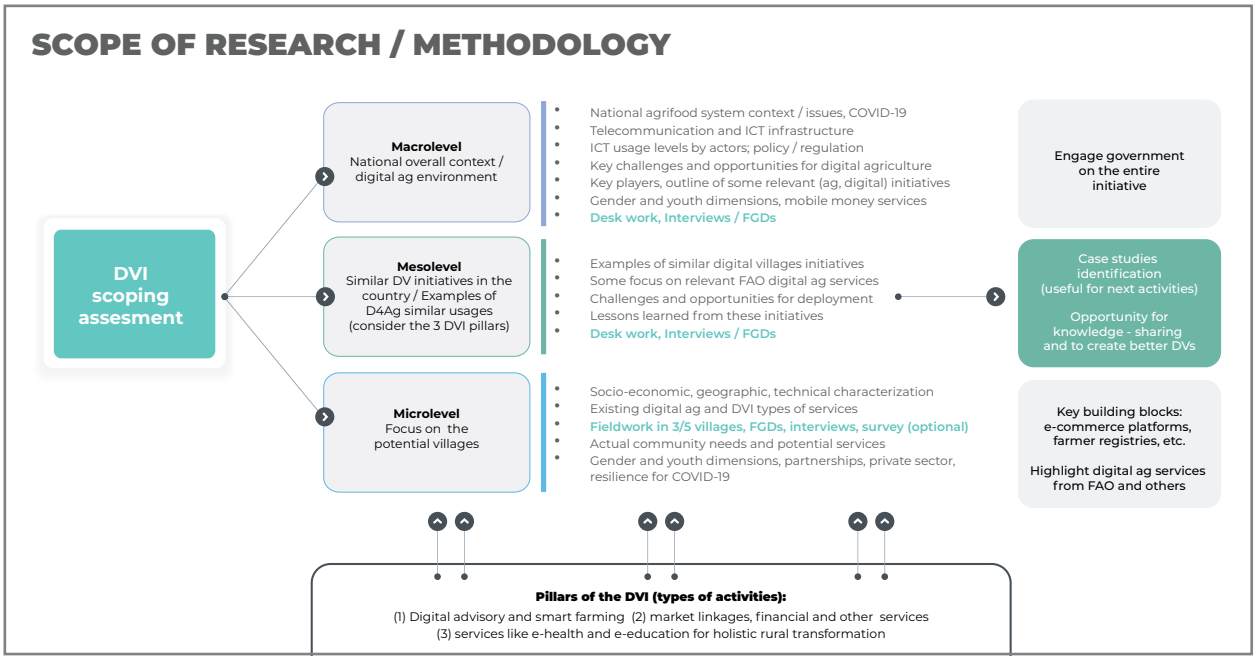
Key building blocks that may be leveraged in digital villages include e-commerce and related services, advisory services, digital farmer registries, insurance services, e-agriculture strategies and digital financial services.

1.2. Content of the publication

This report is an output of preliminary activities carried out by the project in the seven pilot African countries. Insights on two other countries, Liberia and Zimbabwe that have later joined the project, are also included. These activities include scoping assessment studies, DVI prelaunch service delivery and various awareness creation interactions with stakeholders. The resulting key findings and recommendations are outlined.

The scoping assessment studies aimed to elicit the conditions and identify existing assets for the successful design and implementation of the DVI in the countries. They were conducted between July and November 2021 by consultants who were selected by the DVI regional team at RAF. The research involved three levels of analysis: i) national context (macrolevel), ii) identification of examples of similar digital village activities existing in the country (mesolevel) and iii) identification and characterization of villages that may be turned into digital village hubs through field research (microlevel). The scope of the assessment and the research methodology are illustrated in the figure below.

Figure 1. Scope of the research/methodology



***Notes:** Information and communications technology (ICT); Digitalisation for Agriculture (D4ag); digital villages (DVs).*

The research methodology mainly involved qualitative analyses through desktop research, interviews of key agrifood and digitalization stakeholders (policymakers, start-ups, agribusinesses, extension institution officers, development partners, etc.), focus group discussions (FGDs) (mostly with farmers in the field) and stakeholder workshops to gather additional insights and validation workshops in some countries.

More specifically, the research presented and/or analysed each country's:

A. national agriculture development landscape including the policy setting, key constraints and opportunities.
B. national telecommunications and ICT policy environments, the situation in terms of access to digital technologies for socioeconomic development (with data disaggregated by gender as much as possible), key constraints and opportunities.
C. state of digital agriculture (including its livestock, fisheries and forestry where relevant), key agrifood activities targeted, opportunities, challenges faced, existing capacity and level of access to digital tools (mobile phone, internet, etc.) for smallholder farmers, producer organizations, extension officers, agribusinesses, key projects planned, examples of existing digital agriculture service or platforms, impact elements, and key players involved in the area.
D. potential villages that may be initially selected in the framework of the DVI for a pilot. The framework was expected to:
    a. provide rationale for village selection (including criteria for selection)
    b. characterize the geographic location, key socioeconomic activities, governance profile, access to ICTs, geophysical profile
    c. suggest activities which may be developed for the three key pillars of the initiative as well as any related activities (being) deployed in the candidate village(s) that the DVI may build upon
    d. present available or potential partnerships in terms of telecommunications connectivity; ongoing or possible (digital) agrifood-related projects put in place by public authorities (central/local governments, municipality, etc.), private sector or international players that may be leveraged upon
    e. articulate existing and possible (future) collaboration opportunities (existing and with other ecosystem players including youth and women groups)

A synthesis of findings from each national report is presented from Chapter 2 to 8. Chapter 9 presents other DVI initiatives launched in Liberia in the framework of a joint United Nations project and another one that is starting in Zimbabwe. The final chapter presents insights from initial implementation of the DVI in three countries in Africa as well as lessons learned and recommendations for an effective full deployment of the DVI in Africa.

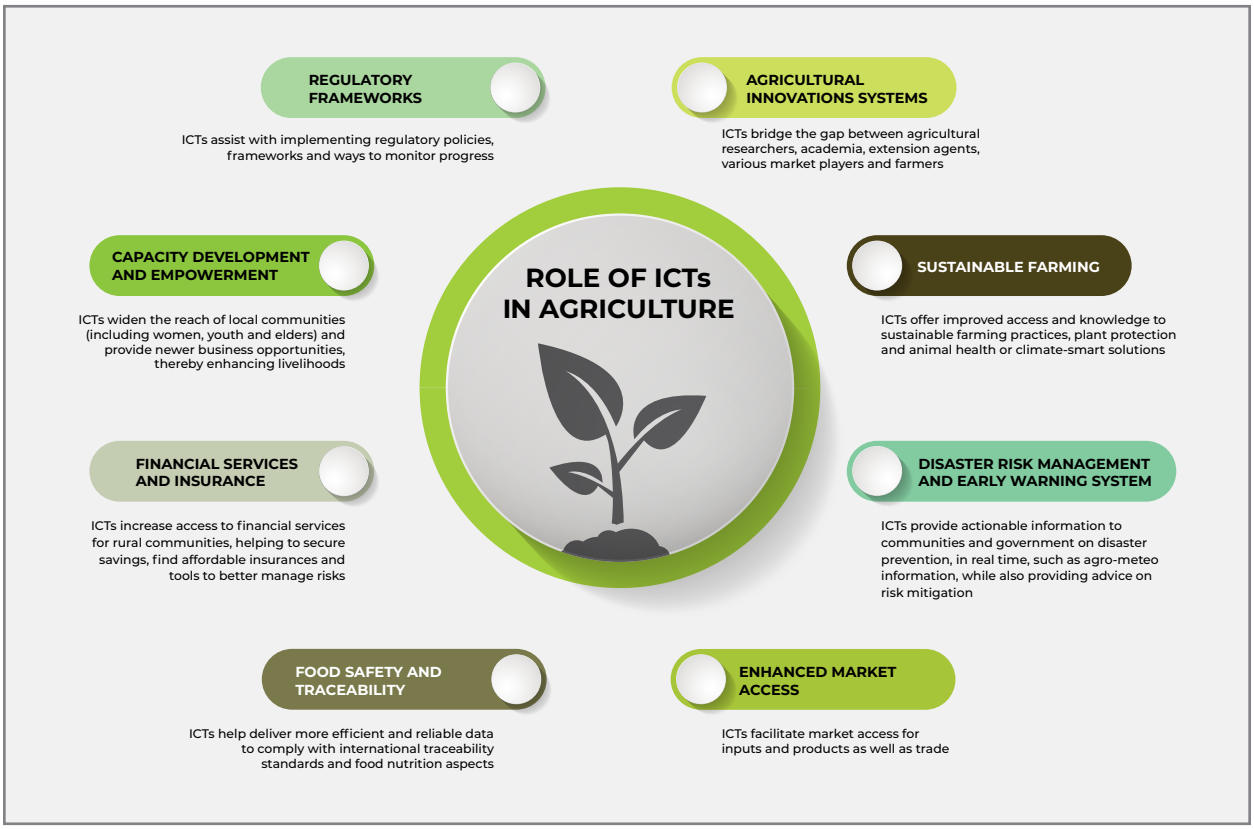
IMPORTANT OBSERVATION

The country reports were produced in 2021. The situation of the DVI has evolved in some countries. For example, in some cases additional or alternative villages/counties are being considered for the implementation to take into account new priorities and contexts.

1.3. Digital agriculture opportunities and key challenges in Africa

Digital agriculture may be defined as the use of any type of digital device or technology (from digital radio to virtual reality) to support agrifood activities from farm to fork, in all subsectors (livestock, crop production, fisheries, aquaculture and forestry) including for agrifood system and sustainable natural resource management. In line with the definition of e-agriculture adopted at the United Nations World Summit on the Information Society, digital agriculture involves

Figure 2. Role of ICTs in agriculture



Source: FAO and International Telecommunications Union, 2016.

the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies in agriculture. It requires and involves standards, norms, methodologies and tools that are developed and needed in that framework (FAO, 2007). Digital technologies are expected to help accelerate the achievement of the SDGs, particularly zero hunger, zero poverty, inclusive and sustainable economic growth, gender equality and successful management of natural resources and climate-change challenges.

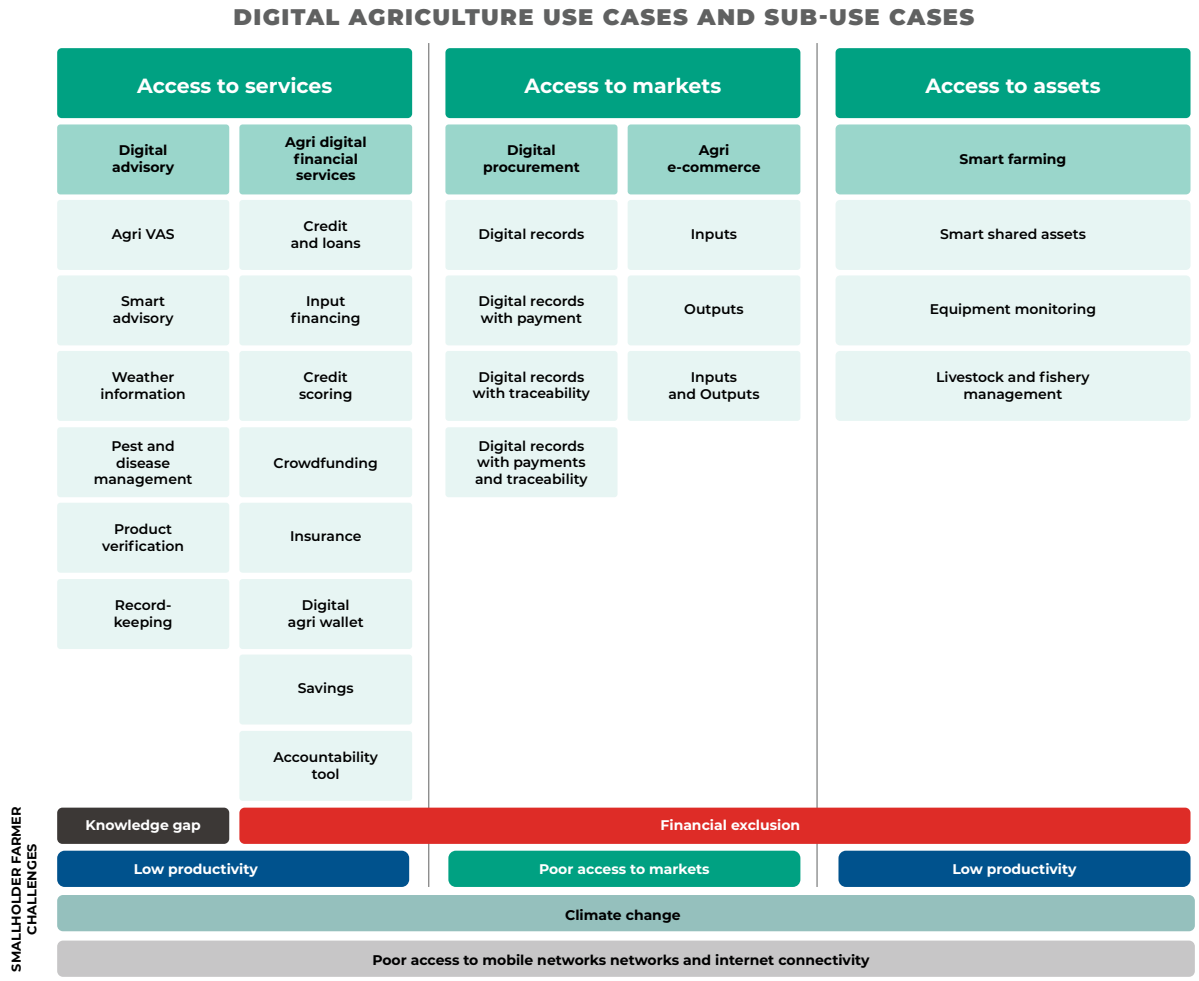
Digital agriculture involves key use cases structured generally in five categories which are:

- according to the Technical Centre for Agricultural and Rural Cooperation (CTA) and Dalberg: Advisory services, market linkages, financial services, supply chain management and macro agri-intelligence.
- according to the GSM Association: Digital advisory, e-commerce, procurement, financial services and smart farming.

Considerations of these two acclaimed reports reveal that the use case categories relating to production advisory services, market linkages/e-commerce and financial services are commonly acknowledged. To date, most digital agriculture use cases for small-scale farmers fall in these three categories. The other categories relate to the use of data analytics, including for public agrifood development planning, and to the management of the supply chain for procurement and other value chain business interactions.

Although impacts are still scattered and not always independently accessed, digital agriculture solutions are already helping to optimize production, expand

Figure 3. Digital Agriculture Maps



Source: GSM Association, 2020

market access including for small-scale farmers – helping them to increase revenues and supporting the effective management of agrifood system planning. In optimum conditions, digitalization can impact all aspects of the agrifood system. "Management of resources throughout the system can become highly optimized, individualized, intelligent and anticipatory. It will function in real time in a hyperconnected way, driven by data. Value chains will become traceable and coordinated at the most detailed level while different fields, crops and animals can be accurately managed to their own optimal prescriptions. Digital agriculture will create systems that are highly productive, anticipatory and adaptable to changes such as those caused by climate change. This, in turn, could lead to greater food security, profitability and sustainability" (Trendov, Varas and Zeng, 2019).

This uptimal picture is yet to materialize, particularly in rural Africa, as illustrated by findings in the scoping assessment reports presented in the next chapters.

The digital inequalities in Africa are widespread and multifaceted. These include gender imbalances and the urban/rural divide. According to the 2021 Facts and Figures report by the International Telecommunications Union, in 2020, while 35 percent of men are using the internet, only 24

percent of women were using it on the continent. Fifty percent of the urban population were using the internet, but only 15 percent of the rural population could benefit from that resource.

Better leveraging these technologies would entail addressing four types of access barriers (motivational, material, digital skills and usage access barriers) as distinguished by Van Dijk (van Dijk, 2006) and further specified as follows:

(a) ***motivational and cultural access barriers*** (lack of interest or trust in online services, confusions created by the availability of too many apps that farmers are invited to test, mental technology barriers)
(b) ***material access barriers*** (lack of telecom infrastructure, energy, digital devices, etc.)
(c) ***digital skills access barriers*** (capacity building, digital illiteracy, etc.)
(d) ***usage access barriers*** (including unaffordability of mobile credits, services and devices, language barriers, local content and ineffectiveness of digital solutions that are sometimes proposed to users).

Some of these core digitalization challenges relate to democratic governance issues, policy issues, gender inequalities and more. Other bottlenecks are related to local and national agrifood system challenges, such as the lack of investment in agriculture that can curtail production, the poor market and logistic infrastructure (road, transport, lack of cold storage facilities), market inefficiencies, the fragmented and disorganization of value and supply chains for many commodities, and so on. Addressing these challenges would yield strong opportunities for the DVI to achieve its potentials.

Table 1. Profile of the DVI countries

	Ghana	Kenya	Liberia	Malawi	Niger	Nigeria	Senegal	Somalia	Zimbabwe
Agriculture, forestry, and fishing, value added (% of GDP)	19.7	22.4	37.2	22.7	36.4	23.4	15.3	62.7	7.6
Mobile cellular subscriptions (per 100 people)	123	123	32	60	59	91	118	52	89
Existence of a digital agriculture strategy	In process	Yes	No	No	In process	Yes	No	No	Yes
Number of digital agriculture solutions	30	140	-	5	5	50	60	3	7
Agriculture Digitalization Index (Schroeder, Lampietti and Elabed, 2021)	50.9	48.8	29.7	28.2	25.4	46.2	41.0	Unavailable	29.4

Notes: in the "Number of digital agriculture solutions" row, the numbers are estimated based on multiple sources consulted in the framework of the production of the publication. These sources include a report prepared by Dalberg for FAO and the African Development Bank on digital agriculture as well as on the findings of the national consultants.

Source for the mobile subscriptions: https://data.worldbank.org, consulted in 2023; the statistics are mostly from 2021)

Source for the agriculture value added statistics: https://data.worldbank.org, consulted in 2023; all statistics are from 2021, apart from Somalia (2019)

2 Ghana

2.1. The agrifood systems and digital agriculture landscapes

2.1.1. Importance of the agriculture sector

The agriculture sector remains strategically important in the Ghanaian economy. It contributes to food security, poverty reduction, rural and industrial development as well as earnings from export crops and livestock. The Government's Coordinated Programme of Economic and Social Policies from 2017 to 2024 captures key objectives for agricultural development and rural transformation in Ghana. Agriculture employs 38.3 percent of the country's labour force. The second largest producer of cocoa in the world, Ghana provides employment for the majority of its smallholder farmers. In 2016, cocoa export accounted for USD 2.27 billion as the third foreign exchange earner after petroleum (USD 2.66 billion) and gold (USD 2.39 billion) (Wikipedia, 2021). With the boost in export and commodity prices, Ghana is expected to fare better in the foreseeable future, particularly as the international prices of its three major export commodities (gold, cocoa and crude oil) have been projected to edge upward.

In 2017, the Ghanian Government's Ministry of Food and Agriculture (MoFA) initiated the Planting for Food and Jobs campaign and its derivatives to address the productivity and job-limiting causes. The yields and total production of major staples have increased significantly in the 2017–2019 period, largely because of the interventions by Planting for Food and Jobs. Yields of maize, rice and soybean have shown significant increases of 131 percent, 58 percent and 69 percent respectively over base-year (2016) yields.

Ghana continues to be relatively self-sufficient in the production of cereals and roots and tubers, but has a deficit in rice production, with a high import dependency ratio of 50 percent in 2020. The average growth rate of the livestock subsector from 2014 to 2019 was 5.4 percent. Although domestic meat production has seen a steady increase from 111 390 megatonnes (MT) in 2010 to 175 751 MT in 2019, this still falls short of meeting local demand. The sector imports about 90 percent of its meat requirements.

The fisheries sector contributed an average of 6.1 percent to agricultural GDP from 2014 to 2019. Fish provides about 60 percent of Ghanaians' protein requirements. From 2010 to 2019, the country imported an average of 182 296 MT of fish per annum compared with average annual exports of 55 855 MT. Post-harvest losses continue to be a challenge because of poor infrastructure and limited expertise in food stock management, particularly perishable produce. Key Government interventions are under way to reduce post-harvest losses, such as the "One District One Warehouse" initiative, its warehouse receipts system project and the establishment of the Ghana Commodity Exchange (GCX). The Ghana Incentive-based Risk-Sharing System for Agricultural Lending was established in 2019 as a risk-sharing vehicle for financial institutions lending to agriculture in Ghana.

Prior to COVID-19, Ghana had not suffered from food insecurity because of relatively improved food production. The pandemic initially affected distribution, and more recently in 2021 decreased domestic production of selected staple food crops (i.e. maize, soybeans and cowpeas) thereby momentarily shifting from surpluses to a manageable deficit.

2.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

The main thrust of the Food and Agriculture Sector Development Policy (FASDEP II) is agriculture modernization. Its six policy goals are: food security and emergency preparedness; increased incomes; increased competitiveness; sustainable management of land and environment; application of science and technology and improved institutional coordination.

Regarding digital agriculture, the Ghana ICT for Accelerated Development Policy represents the vision for Ghana in the Information Age. It fully considered the aspirations and the provisions of key socioeconomic development framework documents including the Ghana Poverty Reduction Strategy 2002–2004 and the Coordinated Programme for Economic and Social Development of Ghana. The Government's recent efforts in developing ICT have focused on promoting rapid development and deployment of ICT infrastructure, strengthening institutional and regulatory frameworks. Ghana has been one of the pioneers in the African telecommunications sector, leading the region in market liberalization and deregulation while serving as a hub for submarine cables, linking southern and northern Africa to Europe with impressive internet bandwidth.

There are currently four registered mobile network operators in Ghana. In addition, 52 internet service providers have been authorized to provide data services in the market. As at the end of March 2021, the mobile voice subscriptions stood at 41.4 million, with a penetration rate of 133.14 percent (Ghana, MoFA, 2021). Mobile data subscription stood at 22.9 million, representing a penetration rate of 73.73 percent. The proportion of individuals using the internet (including via mobile phones) has consistently increased for both urban and rural areas, reaching an average of 98 percent in 2017. Males had a higher proportion of internet usage than females, though the general trend for both has been rising (Ghana, National Development Planning Commission, 2019).

Following the COVID-19 pandemic, internet usage has increased significantly. As of 2011, internet users in Ghana constituted less than 10 percent of the total population, and mobile broadband usage was extremely low (1.7 percent in 2011).

The mobile phone is the most dominant digital tool being used by stakeholders in their agricultural activities. Seventy percent of these stakeholders use mobile phones, particularly voice calls, to either arrange for meetings or for data collection from farmers and trading. The next important service is text messages for sharing commodity prices, followed by weather information sharing.

A study conducted on the review of digital tools deployed in the emerging e-agricultural landscape in Ghana (Ayenor, 2019, p.25) by MoFA underscored the importance of using digital tools, not only to

accelerate effective extension service delivery, but also to improve efficiency in the entire agriculture system in Ghana. The study also highlighted that the use of an e-agriculture system to transform the economy fitted squarely into the country's policy objectives of using ICT to modernize agriculture and improve wealth and job creation (FAO, 2022). However, the proposed national e-agricultural policy is still being developed.

In response to these recommendations and others, the Modernizing Agriculture in Ghana project, sponsored by the Canadian Government, is assisting MoFA to develop the national e-agriculture policy. The mission of the draft national e-agriculture strategy is to "facilitate the adoption and use of ICTs and digital innovations in agriculture, forestry, fisheries, natural resource management, and rural development in a manner that promotes increased productivity, poverty reduction and higher incomes."

The specific objectives are: a) to ensure efficient and effective extension and advisory service by bridging the ICT gap between agricultural researchers, extension agents and farmers to enhance agricultural production; b) to promote environmentally sustainable farming practices; c) to establish robust disaster management and early warning systems; d) to enhance market access for inputs, product marketing and trade; e) to promote food safety and traceability; f) to promote financial inclusion, insurance and risk management; g) to facilitate capacity building and empowerment and h) to facilitate regulatory and policy implementation of subsidies and inputs supply. FAO is collaborating for the finalization of the e-agriculture strategy development process.

KEY INITIATIVES AND SOLUTIONS

a) Selected highlights

MoFA's e-agriculture extension project for improved productivity

The agricultural resource and call centre under the MoFA hosted a pilot project funded by West Africa Agricultural Productivity Programme in collaboration with the World Bank. This project primarily looked at the e-agricultural system from the perspective of an electronic extension where it provided technical services to farmers and other stakeholders using Global Positioning System (GPS), web portal and digital photography-assisted smartphone applications. The overriding objective of developing the e-agriculture portal was to provide a platform for farmers, fishers, foresters, animal husbandry workers, MoFA staff and other stakeholders to share knowledge, skills and experiences in agriculture business development. The pilot project successfully established three e-agricultural centres in Accra, Kumasi and Tamale to help provide services to its clients (agricultural extension officers, farmers and other stakeholders) in different commodity value chains. The main digital tools and/or services deployed by MoFA during implementation involved included an e-agricultural portal, an interactive voice response system, a resources and e-learning centre, a multi-directorate call centre, an e-subsidy management for fertilizers and more.

Use of drones for medical delivery services in rural areas

In 2019, the international company Zipline launched drone technology services for the delivery of emergency medical commodities to save lives in remote areas. They have established four strategic delivery centres in Suhum, Sefwi, Mampong and Tamale. A recent impact study revealed that these centres were doing 600 flights per day, targeting a total of about 12 million people (JoyNews, 2020). The use of drones in Ghana's health sector for medical delivery has not only proved effective in reaching otherwise inaccessible communities, mostly rural farmers, but has also reduced the time of reaching such places quickly (i.e. from 3-4 hours by road to 30–45 minutes). It has also created jobs for the youth. These kinds of services could be facilitated in the DVI (Pillar 3) in partnership with relevant institutions, including Zipline, MoFA and the Ghana Health Service.

Weather stations mitigating some effects of climate change on farming

Financed by ARCHIPELAGO within the framework of the European Union Emergency Trust Fund for Africa, Kwadaso Agricultural College has developed a course that aims to create employment for the youth (both females and males) in the horticultural sector in Ghana (and other countries in Africa). The project has developed new models combining practical horticultural and entrepreneurial skills including the use of new methods and technologies for farming targeting students at Kwadaso Agricultural College and young farmer participants in communities such as Juaben, Offinso, Oforikrom and others in the Ashanti Region. One of the key components of the project is the use of Trans-African Hydro-Meteorological Observatory (TAHMO) technology, which basically entails the establishment of a localized automatic weather station. Within this station, sensors are installed to automatically measure, collect and transfer climatic (i.e. rainfall and temperature) data and information to designated meteorological centres. These in turn send weather reports or data to recipients through community radio stations, information centres and mobile devices which target farmers to make real-time operational decisions.

The beneficiary farmers testified that the introduction of the TAHMO helped them to gain access to real-time weather reports and soil management data, which supported decision-making over whether to spray, irrigate, alongside the regular alerting on hazards such as storms. Though the cost of USD 1 500 is 13 times cheaper than a conventional weather station (estimated at USD 20 000), it is still very expensive for the average Ghanaian farmer. Partners of the initiative have included Delft University of Technology, Kumasi Business Incubator Centre at the Kwame Nkrumah University of Science and Technology. Similar projects are being undertaken by Farmerline and NWO WOTRO.

FAO's digital services

Several FAO digital services that have been developed at corporate level have been used in Ghana as well. This is the case for example with Global Animal Disease Information System (commonly known as EMPRES-i) and Fall Armyworm Monitoring and Early Warning System. More on FAO's digital platforms are in the Appendix at the end of the report

Agronomic early warning system

FAO, the World Food Programme and the United Nations Development Programme (UNDP) collaborated and technically supported MoFA and the National Disaster Management Organization to develop an automated integrated platform called GH AgroEWS. This system aims to collect critical information on production, market pricing and hazards and facilitate access to critical data in real time. It was piloted in selected districts, Akatsi and Techiman in the Volta and Bono regions respectively.

b) Other initiatives

Various initiatives as well as a selection of companies offering digital agriculture services are briefly introduced in the next paragraphs.

i. Active between 2003 and 2007, the Trade and Investment Program for Competitive Export Economy, sponsored by the United States Agency for International Development (USAID), made widespread use of GPS to map out the exact size of farmers' fields in many commodity value chains including cashew, mango and other horticultural and food crops.

ii. The Government of Ghana is making efforts to reform fertilizer subsidy programmes using digital technology to optimize and protect them from smuggling. The e-registration targeted will contain information on farmers' biodata, crops cultivated, acreage, the digital locations of farms for tracking subsidized seed and fertilizer to farmers. By the end of February 2022, 1.2 million farmers should be registered.

iii. **Esoko**: operating from Ghana, it is one of the first companies to offer digital agriculture services in Africa. It provides simple but

powerful communication business tools for connecting with farmers. It uses a mix of web and mobile apps, call centre services for marketing, monitoring and other value chain services.

iv. **Mfarms:** The company uses mobile and web-based systems for managing and communicating with clients' network within a given value chain. Tools developed help build linkages and improve communication and operational efficiencies in areas such as field agent management, crop production, extension monitoring, price data collection, weather information and so on.

v. **Farmerline:** Headquartered in Kumasi, the company's major services include access to weather forecasts, market prices and good agricultural practices through mobile phones. All its contents are usually customized to meet the local and stage of-production needs of client farmers, and could be delivered via voice in local languages.

vi. **Cowtribe:** Beginning its operations in 2017, the start-up builds smart logistics platforms and solutions "that aggregate last-mile farmer demand for livestock products and then deliver them to their farms".

vii. **AgroCenta**: A start-up that provides market services, AgroCenta connects farmers and buyers.

viii. **TROTRO Tractor:** This start-up offers on-demand mechanization services to producers, notably through dialling *714*85# on a mobile phone. They are involved in the Smallholders Agricultural Mechanization Project, which supports farmers' access to mechanized tools. Trotro's platform not only connects farmers and tractor operators, but also helps tractor owners to monitor the movement and work progress of their equipment.

ix. **Kuafo MarketPlace:** A website and app, it was developed by the Council for Scientific and Industrial Research through the Modernizing Agriculture in Ghana project to address the disconnect between farmers and traders as well as other value chain actors. An online version is also available.

x. There are a number of drone service operators in Ghana, some of them having been supported by the CTA. They offer services including use of drones in pest scouting and spraying, farm aerial mapping and more.

These are only a few of such companies, many of which are operated by young entrepreneurs. Services offered by such start-ups still face challenges to become sustainable and effective, but many are trying to adapt by offering effective services and involving themselves in the operations of the DVI.

THE SUPPORTIVE ECOSYSTEM

Key stakeholders supporting digital agriculture feature in the paragraphs below.

The main national public sector stakeholders include MoFA (which coordinates all activities regarding agricultural development in the country), the various ministries in charge of communication, information, technology, rural development and local government. MoFA has been leading national efforts in e-agriculture with support from the Ministry of Communications and Digitalisation.

Other stakeholders include the Kwadaso Agricultural College, Kumasi Business Incubator Centre at the Kwame Nkrumah University of Science and Technology, Accra Digital Centre, the Ghana-India Kofi Annan Centre of Excellence in ICT, Ghana Chamber of Technology, Ghana Chamber of Agribusiness, Ashesi University, the German Federal Ministry of Economic Cooperation and Development, the Feed the Future Ghana projects of USAID, notably Mobilizing Finance in Agriculture.

2.2. Implementation options for the DVI

2.2.1. Field research methodology and village selection

Village selection for a pilot of the DVI in Ghana has been undertaken following interactions with FAO Ghana, other key stakeholders, and field research. This research employed mainly qualitative research methods, including virtual mediums (interviews). Following interactions with FAO, researchers decided to conduct their field research in selected localities covering the three economic belts of the country. The agreed criteria for the specific regions and localities to visit for piloting the project were based on the following criteria:

- Presence of acceptable basic infrastructure such as accessible roads and electricity including basic ICT infrastructure (network system) to build on
- Existing potential for partnerships with MoFA's e-agricultural resource centres in Accra, Kumasi and Tamale
- The existence of a nationwide scalable initiative that uses digital tools to address relevant agricultural and/or societal problems
- Existence of a key public sector (MoFA District Directorates) initiative, or government initiative with active private sector *(farmer-based organizations, agropreneurs, agro-related digital tool investors)* involvement
- Presence of well-motivated young *(male and female)* smallholder farmers organized into farmer-based organizations (i.e. association, group or part of a federation)

The following localities were then selected:

i. Southern Belt: Brong-Densuso and adjoining villages
ii. Middle Belt: Nsawkaw, Akrobi and adjoining villages
iii. Northern Belt: Sandema, Chuchuliga and adjoining villages

Secondary data from literature and other relevant documents were equally considered. Stakeholders met during the field visits warmly embraced the objectives of the DVI project. The presence of MoFA's e-agricultural centres provides enormous opportunities for collaboration and partnerships so that the DVI can build on existing institutional and physical infrastructure, not only to make the designing more cost-effective, but also efficient in the use of resources and, hopefully, sustainable.

2.2.2. Characterization of villages and potential activities

Based on the identified needs, the digital offerings of companies like those mentioned in the sections above can be leveraged to provide specific digital agriculture services covering the first two Pillars of the DVI (which address the use of digital tools for production, market access and financial services).

Brong-Densuso and its cluster of villages

Brong-Densuso contains the Brong No. 1, Brong No. 2, Ayisaa and Obuotunpan villages, where the first organic cocoa farmers association in Ghana and West Africa is located. Brong-Densuso is located between Nankese and Akwadum; it holds good network connectivity to the major telecom operators (i.e. MTN, Vodafone, AirtelTigo). The main crops in order of priority are cocoa, cassava, maize, plantain, orange and oil palm. Cocoa farmers give around 80 percent of their annual revenue to community members. Most of them involved in this area are organic cocoa farmers operating under the Cocoa Organic Farmers Association, which, along with the DVI, targets cocoa farming – an example of producer organizations being strongly involved in the entire process.

There is a need to address the ICT technical skills gaps through a training centre for organic communities. This could focus on the ways to

establish and use available ICT media, how to conduct a search for new buyers or identify digital networking tools (e.g. Facebook, WhatsApp, Zoom) and business promotion tools to advertise organic cocoa production. A network of farmers such as the Cocoa Organic Farmers Association needs assistance with digitally recording (e-registration) and managing its members and information. Farmer groups also need digital platforms to connect with other stakeholders in the value chain beyond Ghana.

Partnerships with the farmers have been established in the localities with institutions such as Yayra Glover for marketing cocoa beans, the Convergence of Sciences project under Wageningen University (training opportunities), and the Cocoa Research Institute of Ghana for pest and soil fertility management. These assets would be leveraged to implement the DVI services.

Wenchi-Akrobi and its cluster of villages

Akrobi has a population of around 3 000. Situated about 3–5 kilometres (km) from the town of Wenchi in Ghana's Middle Belt, it is the capital of Wenchi Municipal District in Bono Region. Wenchi town has a population of 40 000. The population of the municipality is largely rural, as 58.6 percent (59 875) live in rural settlements while 41.4 percent (42 300) live in urban ones. Its main socioeconomic activity is crop farming, and its main crops in order of priority are cashews, maize, cassavas, yams and tomatoes. Cashews and yams have become the main sources of cash income. Sheep rearing has become the focus of livestock production, followed by goats, cattle, poultry and grasscutters.

There are hardly any problems with electricity, roads or interconnectivity in the locality. Sustained and reliable technical advice have been the main challenges for these farmers. The local radio station (Royale FM, Ghana) currently collaborates with both MoFA and Farmer Radio International in the use of this medium to disseminate information and improve the livelihoods of the local rural communities. There are other challenges in terms of value addition opportunities, marketing and pricing. The establishment of relevant digital platforms to address those needs have been requested by stakeholders. One of the most vibrant farmer organizations in the locality, which could play a key role for the DVI operations, is the Federation of Maize Farmers, who emphasized the need to improve the existing radio programmes and revitalize the e-agricultural and e-extension call centre in Kumasi, as well as the need for an e-registration system for member management and networking. ICT training needs have also been expressed (i.e. for the internet, WhatsApp, etc.) with the intention of facilitating access to real-time market price data and effective market linkages. They also wish to strengthen links with GCX.

Through the existing collaboration frameworks, involving institutions (e.g. Farm Radio International, Royale FM, FAO in Ghana, GCX, MoFA, and the Municipal Assembly) at different levels will remain a key asset for piloting the DVI.

Nsawkaw and its cluster of villages

Situated at the north-west of Sunyani (regional capital), Nsawkaw is the capital town of Tain District. The district's population stands at 88 104 with 43 508 (49.38 percent) males and 44 596 (50.62 percent) females. The population in the district is mostly rural, standing at 69.9 percent. Although the district capital (Nsawkaw) seems to be rapidly increasing in terms of infrastructure provision, diverse employment opportunities and population, it still exhibits rural characteristics in terms of housing, transportation system and social amenities.

Nsawkaw, the district capital, sits 60 km from Techiman, which is arguably one of the largest agricultural commodity markets in West Africa. Generally, the district is well drained. Cashews are the major cash crop and primary source of income for farmers. Tain District is the main cashew-producing area in Ghana, serving as the source for a third of all cashew nuts exported from Ghana. The other cash crops include mango and teak (for timber or for electric poles) and few of oil palm. The staple crops grown in the district include maize, plantains, yams, cassavas, groundnuts and cowpeas. The rest are peppers, soya beans, sorghum and okra. Primarily cattle, sheep, goats, ducks, pigs,

guinea fowls, local fowls and exotic fowls are reared in the district. Except for a few hamlets, Nsawkaw and most of the cluster of villages have accessible road connection, electricity and reliable internet connectivity.

It is recommended that the Tain Cashew Farmers Association and Marketing Union be selected as one of the key organizations involved in the locality. The major challenge of the 1 000 farmers registered as members of the Tain Cashew Farmers Association and Marketing Union lies in organizing themselves better to obtain better prices for their cashew nuts during sales. Hence, the farmers seek training in the proper use of digital tools, such as GPS, to accurately measure their farm size and in turn pay for the exact cost of services and labour as well as estimate their yields before the marketing season and use the accurate yield data to search for alternative buyers. Reliable data from e-registration and expansion of membership together with precisely estimated yields (using digital tools) will provide them with the leverage to negotiate as a larger group.

Currently, cashew regulation comes directly under MoFA's Ghana Tree Crops Development Authority. In terms of research, the Cocoa Research Institute of Ghana played a key role in the establishment of the cashew germ plasm plots. The African Cashew Alliance and African Cashew Initiative have also provided varied interventions to the industry, including the African Cashew Alliance's focus on investment promotion, market linkages and the exchange of information among stakeholders. The African Cashew Initiative has shown greater concern with preparing farmers for specialty markets, training on good agricultural practices, quality and food safety standards (News Ghana, 2016). Collaboration with these players as well as with the Cashew Farmers and Marketing Union, the German Agency for International Cooperation, and USAID's Feed the Future Ghana "Mobilizing Finance in Agriculture" project will be appropriate for implementation of DVI pilot project.

Sandema and Chuchuliga

Sandema is the district capital of Builsa North Municipal District. Currently, Sandema and Chuchuliga are the only two settlements in the district that are supplied with the national grid's electricity. There is, however, an ongoing rural electrification programme to extend electricity to most of the other key settlements. The estimated population of Sandema and Chuchuliga is over 20 000. Builsa North Municipal District is one of nine districts in Upper East Region. With a total land area of 2 220 km^2, the district accounts for over a quarter of the total land area of Upper East Region, thereby making it the largest district in the region.

Crops such as millet, sorghum, rice, maize, soya beans and groundnuts are cultivated in the district. In the dry season, onions, tomatoes, maize, watermelons, okra, peppers and other vegetables are cultivated along the Tono Dam around Chuchuliga and at other irrigable dam sites in Wiaga and Kunkwah. Shea nuts and dawadawas, the economic trees found in the district and other parts of the region, grow widely in the bush while those found on farms are protected by the farmers. Livestock reared in the district include cattle, sheep, goats, guinea fowls and fowls, turkeys, ducks, pigs and donkeys.

Internet connectivity is present but not strong in all areas.

About 3 000 farmers have a running contract with a reputable private firm called Akandem Farms. The main challenges for these farmers include poor soil fertility, lack of tractor services, lack of post-harvest facilities, and cheaper means of organizing and connecting the highly dispersed farming communities for easy produce-sourcing and communication. Linkages must be strengthened with the existing e-agricultural centre in Tamale. To address the problem of poor soil fertility management, unpredictable weather conditions and floods resulting from storms, a TAHMO (automatic weather station) may be deployed in partnership with the Ghana Meteorological Station, where relevant.

Akandem Farms and the farmers have a strong partnership with the District Agricultural Development Directorate, which bolsters their extension and technology delivery efforts. Other

institutions supporting this network include the Savanna Agricultural Research Institute and Builsa Community Rural Bank. Akandem Farms and its network of farmers have a strong collaborative relationship with both the warehouse receipts system project and the GCX. This existing collaboration could be further strengthened to accommodate or complement the potential DVI project at Sandema and Chuchuliga.

2.2.3. Specific recommendations/ conclusions

There is an opportunity to build on MoFA's existing infrastructure obtained from the e agricultural project. Similarly, the DVI project could establish partnerships with other ongoing projects such as the warehouse receipts system project being implemented by the International Finance Corporation, the Swiss State Secretariat for Economic Affairs, and GCX. Other potential collaboration may include USAID's Feed the Future programme and the Modernizing Agriculture in Ghana initiative funded by the Canadian Government.

Within the digital agriculture landscape, there is no clear regulatory or observatory system and structure in place. Therefore, stakeholder activities cannot be easily identified and tracked. For this reason, it is recommended that MoFA establishes systems and structures where data on the types of services, devices and other key information on digital agriculture can all be properly tracked or regulated within the emerging digital agriculture landscape. For now, there is no comprehensive and accurate data on users nor their profiles according to gender and other categorizations, as may be required.

3 Kenya

3.1. The agrifood systems and digital agriculture landscapes

3.1.1. Importance of the agriculture sector

Kenya aspires to become a middle-income country. Its economy is the largest in the eastern Africa region with a nominal growth in gross domestic product (GDP) of 10.8 trillion Kenya Shillings in 2020 according to the Kenya National Bureau of Statistics (2021). The country's leadership has identified four priority growth areas as part of its Big Four Agenda: manufacturing, food security, affordable housing and universal health coverage. The agenda item of food security places the country's agrifood sector in an elevated priority position for transformation and growth. This prioritization is emboldened by a 100 percent Food and Nutrition Security commitment by the Government.

The Kenya Agricultural Sector Transformation and Growth Strategy (ASTGS) of 2019 acknowledges the sector's importance to the country's economy. According to the ASTGS, the sector directly contributes to 33 percent of Kenya's total GDP, of which 80 percent comes from crops and 15 percent comes from livestock (Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives [MoA], 2020). The sector indirectly contributes an additional 27 percent to the GDP, and also employs about 70 percent of the country's rural population. From a population of 47 million people, an estimated 8.6 million of them are farmers. These farmers represent 4.5 million households. According to ASTGS, the country has the second-largest livestock herd in Africa.

The sector is also characterized by low mechanization relative to other sub-Saharan African economies. Vulnerable to climate volatility, the sector heavily depends on rainfall as less than 7 percent of farming land is irrigated. Farmers are generally financially constrained, receiving inadequate access to credit services, and their investments in improved agriculture practices compete with their subsistence needs for prioritization of their low incomes. The majority of Kenyan farmers have been observed making farm management decisions without adequate knowledge of crucial information such as the weather forecast, market demand and prices.

3.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

ASTGS involves nine flagship initiatives. The first six are organized around the following three Anchors:

Anchor 1 - Increasing the incomes of farmers, pastoralists and fishers

- ***Flagship 1:*** Increasing the incomes of ~0.8 million farmers through ~1 000 farmer-facing small and medium enterprises
- ***Flagship 2:*** Optimizing nationwide subsidy programmes to empower farmers

Anchor 2 - Increasing agricultural output and the value addition

- ***Flagship 3:*** Setting up five agroprocessing hubs through a rapid public-private partnership process
- ***Flagship 4:*** Unlocking approximately 50 new private farms (>1 000 hectares [ha] each) with multiple crops and farmland under irrigation up to 60 000 ha

Anchor 3 - Increasing household food resilience

- ***Flagship 5:*** Increasing food resilience of ~1.3 million households living in arid and semi-arid land regions
- ***Flagship 6:*** Increasing food supply through the strategic food reserve with competitive bidding for stocks and storage, as well as through cash transfer programmes

The remaining three flagships are intended to enable the flagships under the three anchoring themes as follows:

- ***Flagship 7:*** Enhancing knowledge and skills by launching knowledge and skills building programmes focused on technical and management skills in agriculture
- ***Flagship 8:*** Strengthening research, innovation and data in the sector with the documentation and implementation of priority use cases for better decision-making and performance management
- ***Flagship 9:*** Sustainability and crisis management with active monitoring of key food system risks

The World Bank's Digital Economy Assessment of Kenya in 2019 identified the country as a continental leader in the digital economy. The country's Digital Economy Blueprint and subsequent Digital Economy Strategy, developed by the Ministry of ICT (2020) identifies five pillars to focus on: (a) digital infrastructure, (b) digital government, (c) digital business, (d) innovation and entrepreneurship and (e) skills and values.

Some findings of the Kenya Population and Housing Census 2019 (Kenya National Bureau of Statistics, 2019) relating to the access to digital tools are presented in Table 2.

Table 2. Distribution of ICT infrastructure-related indicators

INDICATOR	NATIONAL	URBAN	RURAL
3yrs+ Owning a mobile phone	47.3%	62.6%	40.5%
3yrs+ Using the internet	22.6%	42.5%	13.7%
3yrs+ Using a desktop computer / laptop / tablet	10.4%	21.6%	5.3%
Conventional households using mains electricity for lighting	50.4%	88.4%	26.3%

Source: Kenya National Bureau of Statistics. 2019. 2019 Kenya population and housing census results. Nairobi, Kenya National Bureau of Statistics. https://www.knbs.or.ke/2019-kenya-population-and-housing-census-results/

The report informs that, of the population of males over three years of age, 25.1 percent were reported to use the internet. This was 20.1 percent for the female population, a 5 percent point gap, which was smaller in the ownership of a mobile phone (47.6 percent of males and 47.0 percent females). Widespread use of mobile money is one of the more salient features of Kenya's digital business.

Tsan *et al.* (2019) found that over 25 percent of farmers in Kenya owned smartphones. Koyama *et al.* (2021) established that, of the Kenyans older than 15 years, 98 percent owned a mobile phone SIM card and 52 percent of Kenyans of all ages own smartphones. Kenya is among a handful of African countries conducting 5G trials beginning 2020. Kenya also holds 3 percent of sub-Saharan Africa's cellular Internet of things (IoT) connections, placing fourth after South Africa (49 percent), Nigeria (16 percent) and Ghana (7 percent). The Dalberg (Koyama *et al.*, 2021) study estimated digital literacy in Kenya to be 38 percent, terming it as moderately high.

The Digitization and Coordination of Kenya's Agricultural Sector Data report (Kenya, MoA, 2021), which may be seen as a digital agriculture strategy, prioritizes and documents seven use cases to be implemented by MoA. The five-year plan is intended to guide implementation of the data and eighth innovation flagship of the ASTGS. The seven use cases are listed below:

a) Improving subsidization of farmer inputs
b) Improving farming practices through customized e-extension
c) Using a food balance sheet to monitor national emergency reserves
d) Implementing an early warning system for food price inflation
e) Optimizing agricultural value chain selection
f) Establishing monitoring and evaluation dashboards for data collection, verification and visualization
g) Establishing standards and protocols for a national data-sharing platform

KEY INITIATIVES AND SOLUTIONS

Most digital solutions for agriculture (DSAs) in sub-Saharan Africa are operated in eastern Africa, particularly in Kenya. About 124 DSAs have been identified in Kenya in the framework of this study, mostly operated by private sector stakeholders. Private-sector-led platforms include early impact and scaled-out stories such as Safaricom's Digifarm and Twiga Foods. Government-driven digital agriculture includes more than 32 mobile applications deployed by the Kenya Agricultural and Livestock Research Organization for use in a variety of value chains as well as digital solutions by the Kenya Plant Health Inspectorate Service for pest management and produce export certification.

A review of the DSA providers and their services in Kenya indicated that among them, 89 (74 percent) offered production level optimization functionality, 57 (48 percent) offered output market coordination, 43 (36 percent) offered digital finance for agriculture and 25 (21 percent) offered macrolevel agricultural intelligence.

Digitization of input subsidy programmes by the Government was also notable under the National Value Chain Support Programme as well as with the Kenya Management Information System (KIAMIS) developed by FAO in collaboration with the Government. More than 20 disruptive agriculture technologies were deployed in partnership with more than 27 counties through the One Million Farmer Platform, funded by the World Bank.

Details on some of the digital agriculture initiatives available in Kenya are provided in the paragraphs below. Possible lessons for or linkages with the DVI implementation are specified. In addition, a selection of platforms is presented in the Appendix.

DigiFarm by Safaricom

DigiFarm is a product of Safaricom, Kenya's dominant mobile network operator. It was developed with support from Mercy Corps' AgriFin Digital Farmer program funded by the Bill and Melinda Gates Foundation. DigiFarm is characterized in Kieti *et al.* (2021) as an aggregator

platform for digital services in agriculture, meaning that it comprises a variety of DSAs, some of which are developed by parties other than Safaricom, the platform's main orchestrator. Its DSA provider partners include Arifu, DigiCow, iProcure, FarmDrive, the Kenya Livestock Producers Association, AgroCares and Pula. DigiFarm's portfolio of services are accessible by dialling the Unstructured Supplementary Service Data (USSD) code *944# in Kenya or via its android mobile application. It is estimated to have over 2.5 million farmers as registered users (Vodafone, 2021), about 27 percent of whom are active users (Busara and Dalberg, 2021).

The Digital Village Project / Pasha Centres by the Ministry of ICT

The Digital Village Project was initiated by the Ministry of ICT in 2009. It was intended to establish digital technology access centres named Pasha to increase the focus and growth of ICT and e commerce in rural Kenya. However, different stakeholders shared the view that the initiative did not carry a notable impact on the rural communities in regard to ICT growth or empowerment of the communities (Tole, 2013). According to Karume and Shisoka (2017), the impeding factors relate to infrastructure, political interest, digital skills, security, financial constraints, location and weak monitoring and evaluation. Lack of impact by the project was also attributed to a lack of follow-up procedure on established centres as well as inadequate alignment with the economic interests of the rural communities (Tole, 2013). Although the impacts of the Digital Village Project have been considered dismal, learning and training were argued to be the most important application of the Pasha Centres (Hallberg *et al.*, 2011). The project's implementation challenges provide relevant lessons for the DVI execution strategy.

Arid Lands Information Network's Maarifa Centres

Since 2007, an NGO named Arid Lands Information Network has operated a network of community knowledge locations named Maarifa Centres. The locations comprise small buildings or remodelled shipping containers equipped with computers connected to the internet. Communities at these centres access free internet and digital services such as online markets, publications, advisory and digital government services as well as ICT training. The centres also act as hubs for sharing information resources with the community and for capturing Indigenous and local knowledge (Mugo, 2012). To date, the NGO has established and ran as many as 15 donor-funded Maarifa Centres in Kenya as well as similar centres in Tanzania and Uganda. A key informant reported seven of these centres to be active. The sustainability strategy entailed handing over the Maarifa Centres for community-based ownership by local organizations such as Church groups and other community-based organizations. According to a key informant, however, this strategy has not yielded sustained vibrancy of the centres, which suggests the need for elaborate mechanisms for sustainability of the FAO DVI beyond ownership by local organizations, especially where physical resource centres are included in implementation.

One Acre Fund's digital agriculture services

One Acre Fund is a non-profit social enterprise founded in 2006. It "supplies one million farmers with everything they need to grow more food and earn more money" while rigorously tracking the gains it creates in farmer incomes. Its model pursues a holistic and long-term approach to addressing rural poverty with an acre of land as the primary unit of analysis. Rather than rely on farmers directly interacting with its digital solutions, One Acre Fund employs field officers who act as intermediaries, performing digital tasks on behalf of the farmers. Loan repayment is one of the digital functions that farmers are required to carry out by themselves digitally, leveraging the ubiquitous usage of mobile-money services in the country. Farmers also receive Short Messaging Service (SMS) messages with their loan statements as well as alerts and advisory messages relevant to the crop production cycle. The training and sensitization of farmers was also deemed crucial for trust building expected to result in a long-term fruitful relationship. Among the commodities provided through One Acre Fund's loans are solar kits.

The Kenya Integrated Agriculture Management Information System

FAO has supported the development of the Kenya Integrated Agriculture Management Information System (KIAMIS). The prioritized use case of "improving farmer inputs subsidization" was deemed crucial to leverage. The KIAMIS platform is also designed to deliver information on production, yields and the effectiveness of subsidy programmes to high level decision-makers. FAO envisions KIAMIS as a platform that provides innovation-driven entrepreneurship to create "value-added services" for farmers. This includes the incorporation of locally relevant information on weather, soil analysis, pests and disease, market prices, crop traceability, logistics data (transport, cold storage, processing), link-to-markets, land tenure, precision agriculture and other aspects of digital agriculture while leveraging public-private partnerships. KIAMIS implementation is in its early stages with training of trainers being provided to all county agricultural and ICT officers, national livestock, aquaculture, crops and cooperatives, state officers and enumerators.

The DVI can benefit from FAO's existing investment in KIAMIS. The system may not have all the features to deliver on the DVIs' three pillars of farmer productivity, market support services and holistic transformation of the village, but it nonetheless has a robust farmer registry and processes to actualize the first prioritized use case on improving farmer inputs subsidization in the country's digital agriculture plan for the ASTGS. As part of DVI's Pillar 2, the implementation of the KIAMIS in the pilot would need to incorporate the digitalization of output market coordination activities as well as digital financial services. On the one hand, FAO Kenya has an option of directly investing in the development and deployment of the required digital elements that do not exist as modules within KIAMIS for the DVI pilot. On the other hand, FAO Kenya has the option of opening up the KIAMIS platform for the incorporation of additional modules by third-party service providers to handle the variety of the digitalization elements required. Relevant approaches that may be considered regarding this open innovation model are presented in Chapter 10 which presents key success factors for the DVI.

THE SUPPORTIVE ECOSYSTEM

Stakeholders that may support digital agriculture in Kenya include:

1. **Government:** Apart from ministry authorities in the digital and agriculture sectors, as agriculture is a devolved function, county governments play a major role in the implementation of agricultural development programmes. The office of the Council of Governors provides a point of coordination between national Government and county governments' activities. National research centres that may play a role include the Kenya Industrial Research and Development Institute, Kenya Agricultural and Livestock Research Organization, Kenya Forestry Research Institute, and Kenya Marine and Fisheries Research Institute. Supervisory and regulatory actors such as the Kenya Plant Health Inspectorate Service, the Agriculture and Food Authority, and the Communications Authority can play important roles. The Kenya Agricultural and Livestock Research Organization has, for example, developed some agriculture mobile applications.
2. **Private businesses and business associations:** Examples include Technology Service Providers of Kenya, the East African Internet Association, the Kenya Private Sector Alliance, the East Africa Grain Council (which operates the digital agriculture platform, Regional Agricultural Trade Intelligence Network), the Eastern and Southern Africa Dairy Association, the Eastern Africa Farmers Federation (which operates a DSA called E-granary), along with the numerous agrodealers operating in the country.
3. **NGOs:** Local and international civil society associations include One Acre Fund, which implements a DSA, and Farmers' Pride.
4. **Investors:** Examples include the Africa Media Ventures Fund, Kitendo Capital and Khosla Impact.
5. **Accelerators and incubators:** Examples include C4DLab, GrowthAfrica, and @iLabAfrica.

Farmer organizations are considered an alternative entry point as well as a unit analysis for engaging with farmers. Community-based advisers are individuals living within the villages or the larger community with an elevated status of driving the uptake of DSAs. They were found in this research to be an essential player in a model for increasing the awareness and adoption of DSAs and other disruptive agriculture technologies.

Kenya's innovation and entrepreneurship ecosystem supports homegrown firms to generate world class products and services that help widen and deepen digital economic transformation. In 2020, start ups in the ecosystem attracted the second highest amount of venture capital funding in the continent at USD 305 million, after Nigeria with USD 307 million (Partech, 2021). Partech's 2021 Africa Tech Venture Capital report also found bias towards male founders with only 14 percent of total equity funding going to female-founded start-ups. The DVI implementation can contribute to Kenya's innovation and entrepreneurship ecosystems by fostering the development of relevant groundbreaking digital solutions in agriculture.

CHALLENGES AND OPPORTUNITIES

Alignment of incentives and whether the value proposition of a DSA resonated with farmers will determine its uptake according to the participants in FGDs. Some farmers shared that they were often too busy to invest time in learning about new digital initiatives. This was more because of the fact that the timing of learning and sensitization activities organized by the digital initiatives were often incompatible with the schedule of farming activities. The fees charged by the digital agriculture initiatives are also not always affordable, according to the participants in FGDs who also expressed concerns that some initiatives had hidden charges. Participants also observed a mismatch between what was delivered as tangible value versus what was marketed by DSAs, diminishing their trust in the services.

A shared model of data ownership between the value chain actors and DSA providers was recommended. Along with the data co-ownership model was the expectation by value chain actors that the digital service provider should provide individual data to the actor upon request for onward use with other digital service providers. Moreover, the actors demanded to give consent before their data was shared with other forms of third-party entities.

The operating environment for digital agriculture in Kenya was observed among key informants to have high risks for multiple, siloed implementations, with duplication of resources and missed opportunities for collaboration. This is consistent with the findings of Tossou *et al.* (2020) that in-country actions on digital agriculture are weak in coordination and synergies. Key informants in the study gave examples of the existing multiple digital solutions for input subsidization from a variety of funding sources. Fragmentation in the implementation of digital agriculture in Kenya was also evident in the sheer number of DSAs deployed. Having a multiplicity of DSAs was criticized by some (Ngotho, 2020), who deemed the many services to be of little value. In this study, we observed an enhanced sense of collaboration among donors in the country to reduce instances of donor-funded duplicative siloes.

3.2. Implementation options for the DVI

3.2.1. Field research methodology and village selection

The research design for this assessment primarily used qualitative methods. It focused on eliciting

the opinions of key stakeholders on the prospects of DVI implementation given the underlying environmental conditions in Kenya. A total of 22 individuals participated in key informant interviews. Another 52 individuals took part in FGDs carried out in the Nyandarua, Nakuru and Uasin Gishu counties. Direct observation was also used by the consultant by participating as a user of KIAMIS and other digital services as a live or dummy user. The researcher also carried out direct observation of the workings of One Acre Fund and DigiFarm in the West Kanyamkago ward of Migori County, a location with intensified application of such DSAs, similar to the DVI. The qualitative data was supplemented with quantitative evidence gathered through a desk review from secondary data sources such as the country's 2019 census data as well as industry reports.

The findings from all the methods were triangulated to arrive at overall findings. Computer-assisted qualitative data analysis was undertaken on the insights gathered through key informant interviews and FGDs using the ATLAS.ti software. Consultations to solicit feedback and suggestions for improvement of preliminary findings were held throughout the scoping process, leading to iterative refinement of the findings. These consultations included at least ten experts on value chains and agricultural development policy within FAO in virtual meetings and at least 15 county government agriculture officials in Nakuru Town. The consultations also included a virtual national stakeholder forum attended by at least 60 participants.

Regarding the choice of localities, focus on a few prioritized value chains in the DVI pilot was deemed important for considering the complexity and nuances of any value chain chosen for intensified digitalization.

A two-stage selection process was used to arrive at candidate villages, the first of which was to identify hosts among Kenya's 47 counties. Three counties, namely Uasin Gishu, Nyandarua and Nakuru were selected for this. The rationale for selecting these three counties was twofold: 1) building on FAO and the Kenyan Government joint investments relating to KIAMIS and initiatives such as the Nakuru Agricultural Training Centre and was therefore also included as a host county and 2) agricultural potentials in those counties considered as the food basket of Kenya.

The second stage of village selection involved settling on the elective ward as the preferred representative of the village or village cluster in the Kenya DVI implementation. While the county governments have defined village units under a village administrator and with a village council, the ward was selected as the geographical unit of analysis in DVI implementation. It was also argued that a unit of implementation smaller than a ward may be too small to generate replicable lessons and to benefit from the likely economies of scale. The following nine criteria items were suggested by participants in the assessment as important for the selection of candidate villages under the DVI.

a) KIAMIS/ National Value Chain Support Programme registrations
b) Value chain mix – A village cluster having a variety of value chains to be supported by the DVI meant increased opportunities for learning about different value chain dynamics at the pilot stage of the DVI
c) Commercial agriculture and agribusiness vibrancy
d) Technology accessibility
e) Demographics – existence of a youthful, educated population in particular
f) Existence of DSA providers
g) Demand of county government
h) Value chain formalization
i) Demand for services by village

Based on the two-stage criteria above, the scoping zeroed in on the four village clusters in the Uasin Gishu, Nyandarua and Nakuru counties.

Suggested activities focus more on Pillars 1 and 2 of the DVI model. Pillar 3's activities were deemed similar to all localities and are included separately after presentation of the village clusters.

3.2.2. Characterization of villages and potential activities

Tapsagoi Ward, Uasin Gishu County

Tapsagoi Ward is one of the 30 electoral wards in Uasin Gishu County. It is situated approximately 30 km from Eldoret County. The ward is part of the Turbo subcounty. According to the 2019 census, the ward had 7 891 conventional households and a population of 34 624. An estimated 60 percent of the population is below 35 years of age. Women make up 58 percent of the population in the ward and over 70 percent of the population in the ward has some form of basic education literacy. The population in Tapsagoi engages in a variety of economic activities namely farming, teaching, armed forces, motorcycling and taxis. Many youths were reported to be involved in agriculture by providing labour in farms and engaging in farming funded by the county government. Of the conventional households, 5 611 practised farming with 88 percent being primarily in subsistence farming according to the 2019 census. Major crops grown in Tapsagoi according to FGD participants were maize, sugarcane, coffee, avocadoes, bananas, beans, and potatoes. The major livestock kept in the ward are dairy cows, sheep, poultry and bees according to FGD participants.

The main DSA in Tapsagoi Ward is plant clinics (Plantwise), funded by the International Centre for Agriculture and Biosciences (CABI). The One Million Farmer Platform is active in other subcounties of Uasin Gishu in partnership with One Acre Fund, Kuza Biashara, Digital Green, DigiCow, Amtech and agriBORA. Under the platform in collaboration with the county government, the maize, dairy, chicken and potato value chains are prioritized. Ownership of mobile phones in the ward is at 34.3 percent of the population above 3 years old.

It is proposed to prioritize the **avocado**, **banana**, **bean and dairy** value chains in this ward. Under Pillar 1, activities may include, in partnership with CABI, to expand the use of the Plantwise solution for enhanced crop health among the prioritized crop value chains. Production-related efforts can also leverage the presence of Digital Green and Kuza Biashara in neighbouring subcounties for the training and propagation of modern practices. Likewise, a partnership with DigiCow can be targeted in the dairy sector. Under Pillar 2, Kuza Biashara's network of village agripreneurs can be leveraged for produce aggregation. The DVI can also tap into Kuza Biashara's networks for produce offtake in the pursuit of enhanced market efficiency for the benefit of farmers. Amtech and One Acre Fund can also be engaged in partnerships for access to credit facilities.

Kanjuiri Range Ward, Nyandarua County

Kanjuiri Range Ward is one of the 30 electoral wards in Uasin Gishu County. It is situated approximately ten km from Olkalou Town. It is part of the larger Olkalou subcounty covering an area of 122.8 km^2. Kanjuiri Range ward has 6 412 households and a population of 30 768 according to the 2019 Census. 4 717 of the conventional households practised farming with 73.6 percent of the farming households practising subsistence farming while only 26.4 percent practised commercial farming. The major crops grown in Kanjuiri Range Ward according to FGD participants include potatoes, maize, cabbages, pyrethrum, peas, carrots, beans, kales, spinach, spring onions, aromatics, avocado and tree tomatoes. Dairy cows, poultry, rabbits, sheep goats, bees and donkeys were noted to be the major livestock reared. The general literacy level in the ward is low with the majority of the adults being of primary education level. The youth are involved in agricultural activities in addition to working as cyber outlet attendants, motorbike mechanics, construction workers and casual workers in flower farms.

Internet coverage in the ward is good but network signal strength and quality are occasionally low. The One Million Farmer Platform has a presence in Nyandarua County partnering with One Acre Fund, Kuza Biashara, M-shamba and SunCulture.

It is proposed to prioritize the avocado, potato and dairy value chains in this ward. These value chains can benefit from leveraging the presence of CABI's Plantwise, DigiCow and the agriculture call centre to empower farmers with knowledge for production

optimization under DVI Pillar 1. Other production optimization level activities for avocadoes and potatoes that are possible with partners in the county include soil health management using UjuziKilimo and access to mechanization equipment through Hello Tractor. Under Pillar 2, Kuza Biashara's, M-Shamba and Apollo Agriculture's network of village agripreneurs can be leveraged for produce aggregation and bulk offtake. Amtech and Apollo Agriculture can also be leveraged for increased access to credit among farmers.

Subukia Ward, Nakuru County

Subukia Ward is one of the three wards in Subukia Subcounty, Nakuru County. It is situated approximately 42 km east of Nakuru Town along Nakuru-Nyahururu highway. The number of households in the ward is 5 399. The ward has a population of 26 996 with women constituting 16 400 of the total population. The youthful population under 35 years of age is estimated at 49 percent. General literacy in the ward is estimated at 75 percent. The two main economic activities in Subukia Ward are farming and trading. The main crops grown in the ward are cereals (maize), pulses (beans), horticultural crops (avocadoes, French beans, tomatoes, cabbages, cut flowers, baby corn) and industrial crops (tea, coffee, ***pyrethrums***). The main livestock reared are dairy cows, sheep and local poultry. Other livestock reared are bees, pigs, goats, dairy and meat. Fishing and aquaculture are also practised. Farming is one of the major economic activities taking place with 6 317 households practising some form of farming according to the 2019 census. 80.2 percent of these households practised subsistence farming while 19.7 percent practised commercial farming. Most young people above 18 years engaged in casual work including agriculture, motorcycling, cyber-outlet attending and farming.

Many people in Subukia Ward were reported to own smartphones, and over 70 percent of the population was reported to be accessing the internet using mobile phones. The main DSA providers with a presence in the ward were reported to include Apollo Agriculture, DigiCow, an agriculture call centre, Plantwise, PestSmart Diagnostic Simulator and Telegram. Although not targeting this ward, the One Million Farmer Platform is present in the county, partnering with M-shamba, Kuza Biashara, Hello Tractor, DigiCow, Apollo Agriculture and Amtech. The main value chains prioritized by the platform are apiculture, dairy cows, chicken and potatoes.

It is proposed to prioritize the avocado, potato, and dairy value chains in this ward. Leveraging the presence of CABI's Plantwise, DigiCow and the agriculture call centre to undertake activities under DVI Pillar 1 is also recommended. Soil health management using Ujuzi Kilimo and access to mechanization equipment through Hello Tractor are also options. Under Pillar 2, Kuza Biashara's, M-shamba's and Apollo Agriculture's network of village agripreneurs can be leveraged for produce aggregation and bulk offtake. Amtech and Apollo Agriculture can also be leveraged for increased access to credit among farmers.

Kihingo Ward, Nakuru County

Kihingo Ward is one of the 55 electoral wards in Nakuru County. It is situated approximately 40 km south-west of Nakuru Town along the Nakuru-Njoro Mau Narok road. With 4 435 households, Kihingo ward has a population of 17 239 people. The population of people under the age of 35 (youth) is estimated at 60 percent. General literacy in the ward is estimated at 60 percent. The two main economic activities in the ward are farming and trading, and they strongly involve the youth. The main crops grown include maize, beans, potatoes, avocadoes, peas, kale, carrots, cabbages and pyrethrums. The main livestock kept includes dairy cows, sheep, goats, poultry and rabbits. It is estimated that at least ten fish ponds have been established within the ward stocked with tilapias. Farming is a major occupation in the ward with 3 532 of the households practising some form of agricultural production. Of these households 3 276 (92.8 percent) practise subsistence agriculture while 255 (7.2 percent) practise commercial agriculture.

DSAs operating in the ward include Hello Tractor, Kuza Biashara, Ujuzi Kilimo, M-shamba, Amtech, Apollo Agriculture and DigiCow, which are all

involved in the One Million Farmer Platform as part of the larger Njoro subcounty. Viazi Soko and the Government's e-voucher subsidies system are also operating in this ward.

It is proposed to prioritize the avocado, potato, and dairy value chains in this ward. This ward is in a subcounty where the One Million Farmer Project is active, which means that activities that intensify the application of digital tools in line with the DVI Pillars are a source of differentiation. Under Pillar 1, efforts can leverage the presence of Hello Tractor, Ujuzi Kilimo, and Kuza Biashara for intensified adoption of modern farming practices. We also propose a partnership with DigiCow for intensified production level improvements in the dairy sector. Under Pillar 2, Kuza Biashara's network of village agripreneurs can be leveraged for produce aggregation. The DVI can also tap into the bulk-offtake facilitation mechanisms of M-shamba and Kuza Biashara in the ward. A collaboration with the National Potato Council of Kenya, Viazi Soko. Amtech and One Acre Fund can also be engaged in partnerships for access to credit facilities. The bundling of services by Apollo Agriculture across DVI Pillar 1 and Pillar 2 is also worth availing.

Pillar 3 activities for all village clusters

Activities that may be considered to boost holistic rural transformation include:

- Digital health activities such as M-TIBA for savings towards future health costs, Totohealth for maternal and child health care, and Ilara Health for artificial intelligence powered disease diagnostics
- Digital education solutions activities such as Eneza Education and Elimu revisions based on the official education curriculum
- The use of jobs- and skills-matching solutions such as Lynk
- Civic tech initiatives for the enhancement of democratic governance and accountability principles such the Mzalendo portal, the National Government Constituencies Development Fund, and other citizen information portals such as county government websites, and the eCitizen portal

It is also proposed to digitalize interventions around access to clean energy such as solar home systems acquired on a pay-as-you-go basis with potential partners such as One Acre Fund, M-KOPA, and Angaza, powered by mobile money.

3.2.3. Partners and partnerships models

Given the need to build on FAO's investment in the KIAMIS platform, a technology-centred DVI model is implied as well as a public-private partnership model for creating a whole digital village ecosystem. The partnership model for the DVI in Kenya is likely to be a unique mash up of different partnership models. With KIAMIS as the core of a platform ecosystem, other digital agriculture providers, be it public or private actors, can plug in to extend functionality through an application programming interface (API) framework. A closed ecosystem, being arguably more manageable than an open ecosystem, could revolve around the 20 disruptive agriculture technologies preselected to the One Million Farmer Platform. This is more as the World Bank-funded platform is already operational in the three counties of focus in the DVI pilot. Opening up the ecosystem to more actors may however be necessary to the extent that actors may exist or emerge who are more qualified for value chain DVI prioritized value chains than cohort members in the World Bank-funded platform. Other than partnerships with the World Bank and county governments, the DVI implementation may also pursue partnerships with other donor agencies such as the Swedish International Development Cooperation Agency and the European Union,

leveraging existing projects such as the National Land Management Information System (NLIMS). Partnerships with bulk offtakers, agroprocessors, farmer organizations, professional associations and actors are also required.

Starting with a 'small set of known developers' approach, for the purposes of taking initial lessons while leading up to the 'large set of unknown developers' approach of an open innovation ecosystem can result in a graceful scale-out. It can become a sustainable strategy, notably for government, for replicating and scaling out impactful approaches to digital agriculture. More information on data integration and sharing options are detailed in Chapter 10 which covers success factors identified.

While the need for buy-in from the Government to implement the DVI and other digital agriculture initiatives in the public sector is obvious, the devolved nature of the sector was shown to call for a dual approach to government engagement. Improved collaboration between the Government at the two levels was deemed crucial for the success of public digital agriculture initiatives such as the DVI. Finally, the DVI implementation offers a unique opportunity to strengthen the engagement and opportunities for youth and women.

4 Malawi

4.1. The agriculture and digital agriculture landscapes

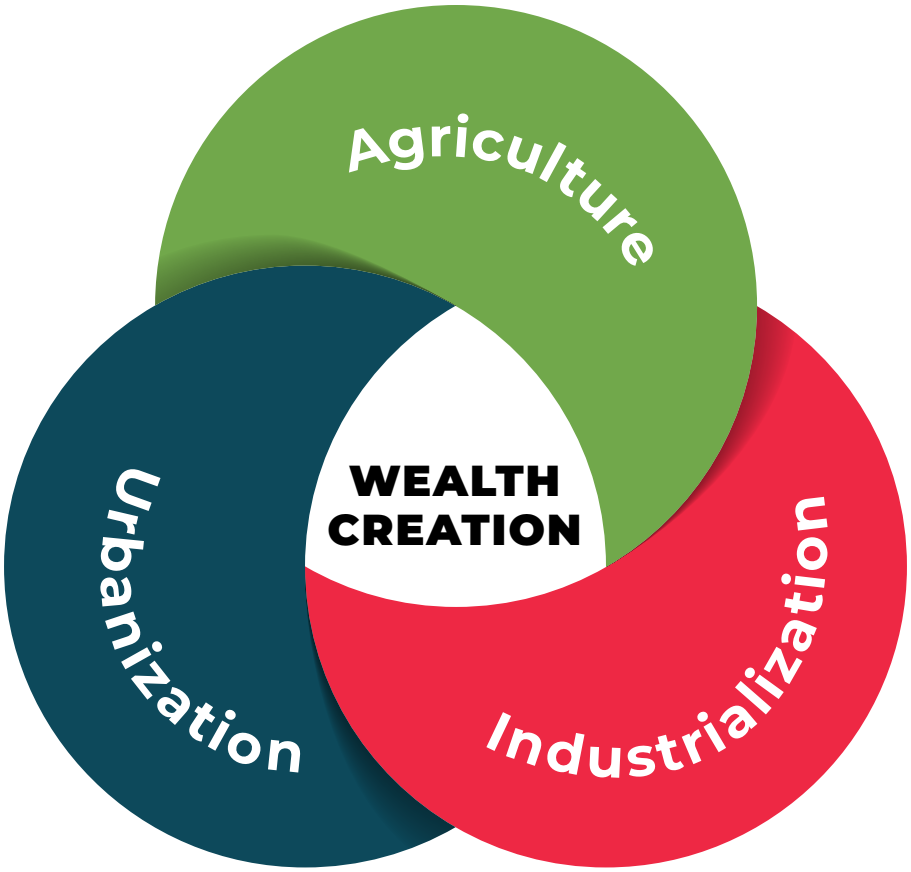
4.1.1. Importance of the agriculture sector

Malawi is a low-income country with a GDP of USD 11.96 billion in 2020 (World Bank, 2020a) and a population of 18.6 million people. It is estimated that 82.3 percent of the population are still living in rural areas and more than half are living below the national poverty line. Malawi's economy is largely agro-based with about 80 percent of the population directly and indirectly employed in agriculture related activities, making the sector the highest employment sector (World Bank, 2021a). Agriculture contributed 42 percent to the country's GDP and 81 percent of total national exports, with the major export value coming from tobacco (63 percent), sugar cane (10 percent) and tea (8 percent).

The sector's production has remained well below the country's potential and is insufficient to match the increasing demand from domestic and export markets. Several factors have contributed towards such a situation and among them are: increasing environmental degradation; increasing adverse climatic conditions; low adoption of climate-smart agricultural technologies; low access to land; low access to farm inputs; low mechanization; poor land management practices; poor access to finance; weak linkages to markets; high dependence on tobacco for export earnings; increasingly fragmented land tenure system; and limited irrigation among most of the farmers. Because of the unstable food production and supply, 82 percent of the population experiences moderate or severe food insecurity and 18.8 percent are typically undernourished.

The Malawi Vision 2063 is the overarching development framework. It envisions an inclusively wealthy and self-reliant industrialized upper middle-income country and a vibrant knowledge-based economy with a strong and competitive manufacturing industry that is driven by a productive and commercially vibrant agriculture and mining sector. The vision involves three pillars, agriculture, industrialization and urbanization. The agricultural pillar constitutes the key part of the vision, focusing on agricultural productivity and commercialization.

Figure 4. Pillars of the Malawi Vision 2063



4.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

The National Agriculture Policy as well as the National Agriculture Investment Plan stress the importance of harnessing strategies to enhance productivity, market access, inclusive agrifood systems, climate-change adaptation, including by leveraging innovations systems. Malawi through the National Planning Commission developed a five-year Digital Economy Strategy that aims at boosting access to connectivity by 2026 and making internet access more affordable, reliable, and available. Though there is no dedicated strategy for digital agriculture, several documents have highlighted the importance of digitalization for agricultural development. The Digital Economy Strategy has thus planned to exponentially transform all sectors of the economy starting with the agriculture sector. In line with this, key target, objectives and actions planned for digital agriculture have been defined – they are outlined in the following table.

Table 3. Key objectives of the Digital Economy Strategy of Malawi for the agriculture sector

TARGET, OBJECTIVES, AND ACTIONS FOR DIGITAL AGRICULTURE	
TARGET Increasing average farm family earnings from USD 1 800 to USD 2 250 by increasing the adoption of agricultural services and access to agricultural technology	
Objectives	**Actions**
Farmers access high-quality inputs and plug into a rich end user market supported by a variety of platforms	Develop e-verification to ensure quality of inputs distributed through the Affordable Inputs Programme
	Digitize food safety certification processes to improve access to export markets
	Pilot IoT-enabled storage monitoring of national storage facilities
Digitally delivered services support modern farming practices to increase productivity	Provide government extension workers with tablets to use and promote adoption of digital support applications
	Develop an open repository of common extension content and farmer feedback to support demand-driven innovation
	Develop public sector-delivered mobile applications for digital extension services that support USSD and voice functionality for increased uptake by farmers
	Subsidize the costs of asset-sharing services when delivered to farming cooperatives and associations
Rich and timeous data supports innovation and investment	Target additional funding to expedite the implementation of the National Agriculture Management Information System and prioritize integration with Esoko for pricing information
	Develop an open geographic information system repository under NSO

Malawi currently has four operational mobile telephone licensees providing both voice and data services. Two mobile network operators (MNOs) dominate the market: Airtel Malawi and Telekom Networks Malawi (TNM). There are over five million unique mobile subscribers and a growing population of mobile internet users. Analysis by place of residence shows that 61.4 percent of the households in urban areas owned a mobile phone compared with 31.8 percent of households in rural areas (NSO, 2019). Of the total subscribers in the mobile network services, 71 percent are on Airtel, 61 percent are on TNM, 0.1 percent on Access Communications, and another 0.1 percent on Malawi Telecommunications (many people own more than on SIM card).

In 2018, approximately 78 percent of the population had 3G coverage, and 88 percent of people had access to either a 3G or 4G signal (Research ICT

Solutions, 2021; International Telecommunications Union, 2020; World Bank, 2021a). In the same year, only 6.3 percent of households owned a computer and 11.1 percent had internet access. The proportion of male-headed households that reported owning a mobile phone was higher (40.4 percent) than the proportion of female-headed households (27.0 percent). By place of residence, 15.6 percent of urban households owned computers compared with 1.2 percent of households in the rural areas.

In 2019, urban areas had the highest proportion of individuals using a mobile telephone (87.3 percent) compared to 60.5 percent in rural areas. Analysis by region indicates that the highest proportion of individuals who used a mobile telephone were from the northern region (81.1 percent) followed by the southern region (64.1 percent) and 60.8 percent from the central region. In terms of sex, 68.0 percent of males used a mobile telephone compared to 56.2 percent of females. (NSO, 2019). The highest proportion of individuals that used a mobile phone by age group belonged to the 25–34 years group (69.3 percent) followed by the 35–44 years group (69.2 percent) and 45–54 years group (69.0 percent).

Overall, 14.6 percent of individuals used the internet. Analysis by place of residence shows that 40.7 percent of the population in urban areas used the internet compared with 9.3 percent in rural areas. Internet use in Malawi is at 15.4 percent among males compared with 12.4 percent among females according to NSO.

The NSO report (2019) on the Access and Usage of ICT Services Survey in Malawi indicates that the most common use of digital financial services in the country was sending or withdrawing money (94.6 percent). Individuals with a mobile-money account came to 29.5 percent, mostly in urban areas. The main mobile money accounts used by individuals in Malawi are Airtel Money and TNM Mpamba. The rate of access to electricity is low at 18.02 percent as at 2018, with 55.2 percent for urban and 10.4 percent for rural (World Bank, 2019).

KEY INITIATIVES AND SOLUTIONS

Among key digital initiatives targeting the national agrifood system, previously implemented or ongoing, we highlight the following:

a) Selected highlights

Zaulimi App

In 2019, the Malawian Agricultural Commodity Exchange developed the agricultural extension app, Zaulimi, with the contribution of the organization Welthungerhilfe. In addition to disseminating market information, the app is also loaded with agricultural extension messages in the form of audio, videos and pictures so that farmers can access information in different ways. Market information is provided on selected crops (including maize, groundnuts and soya) and also on livestock.

FAO's services

FAO is working with the government in strengthening market-led digital agriculture platforms. The organization, in collaboration with the Government through the Ministry of Agriculture's Department of Agriculture Extension Services (DAES) and the Department of Planning Services (DAPS), has provided 250 smartphones to smallholder farmers, to enhance market-led digital extension services. The initiative is implemented under the "Marketing capacity building for smallholder farmers in Mzimba and Kasungu districts" project. In addition, over 700 smartphones and tablets to extension workers to facilitate their day-to-day activities including enhancing real-time geo-data collection, monitoring and reporting. The FAO Emergency Agriculture and Food Security Surveillance System platform as well as the Fall Armyworm Monitoring and Early Warning System have been used in the country.

Chiweto

Chiweto AgriTech Solutions is an initiative that focuses on providing mobile-based livestock insurance and extension services. Their two products

currently being tested are an SMS platform and livestock insurance for farmers with the involvement of the Ministry of Agriculture. The Chiweto SMS platform is a service for sourcing and delivering information such as advisory and agricultural extension services in real time via SMS. The livestock insurance service aims at increasing farmers' resilience to the impacts of disasters and diseases severely impacting animals. The service is still under development.

Telecentre for rural development (Connect a Constituency Project)
This is an initiative by the Government of Malawi through the Malawi Communications Regulatory Authority (MACRA) which established these facilities with funding from international organizations such as the International Telecommunications Union. The first telecentre started operating in 2007. By 2017, more than 50 telecentres were established (Kapondera and Chigona, 2017). Chiradzulu, Karonga, Kasungu and Mzimba are among the districts that have benefited. However, governance issues have affected their performance. The challenges faced were also attributed to the lack of follow-up/ monitoring procedures of the established centres and inadequate alignment with the economic interests of the rural populations. The Connect a Constituency Project's implementation challenges constitute relevant lessons for the DVI execution strategy.

Chipatala Cha Pa Foni – health centre by phone
Chipatala Cha Pa Foni (CCPF) provides access to health services (sexual, reproductive, maternal, and child health) via mobile phone. It runs on a technology platform designed to meet the challenge of low resource communities. The organization Village Reach and other development partners built the associated technology components needed to support the program and developed its requirements. CCPF has been expanded to all 28 districts in Malawi, ensuring a reach of about 18 million people. A memorandum of understanding has been signed with the Ministry of Health and Population, laying out the Government's commitment to fully own and operate the service (Village Reach, 2021). DVI's collaboration with CCPF will enable deployment of the DVI's Pillar 3 activities.

b) Other initiatives

- DAES is working on a digital extension platform that should be launched in 2022.

- USAID, through DAES, promoted the AgReach Extension Helper app, a multifaceted ICT tool (Avelardo Rivera, 2019) whose objective was to support the Malawian Government to improve extension workers' ability to teach farmers and help improve the adoption of beneficial technologies and practices; improve data quality towards better monitoring and evaluation and evidence-based planning; and improve the coordination, efficiency and cost-effectiveness of services through mapping activities to determine areas of oversaturation and where access is low.

- Techno Brain, a private company that provides various ICT solutions in Africa, is working with the National Association of Smallholder Farmers on a program that involves collecting data to inform smallholder farmers on rainfall and weather patterns, soil nutrition, and more for decision-making, through SMS and voice platforms (Techno Brain, 2020).

- Noble Agriculture Technologies is a start-up providing agriculture technology products and services to local farmers while striving to reduce their vulnerability to risks associated with climate change. They are developing agriculture automation systems for horticultural farmers (Banda, 2021).

- GreenFingers Mobile facilitates various agribusiness services, including farm management, commercial transaction collections and impact assessment.

- The M'chikumbe 212 mobile app is an initiative developed by Airtel Malawi to enable farmers

to access farm advisory services and markets across Malawi. With a call made to #212 on Airtel, farmers can access seed selection, planting, fertilizer and manure application, pest control, harvesting, and storage. All this is free for the first three calls, giving a chance to any farmer to experience access to such services.

- The services of the international businesses Viamo and Esoko, which facilitate the dissemination of agriculture information and market information via mobile phone, also operate in Malawi. Esoko is present via services of the Agricultural Commodity Exchange and the Malawi Market Linkages Initiative.

The supportive ecosystem

At the national level, Malawi's Ministry of Agriculture is the policy and strategies holder for the country. As agriculture is a devolved sector, the Malawi District Assemblies (which total 28) play a major role in the implementation of agricultural development programmes throughout. Other ministries play critical roles and functions in the area of agriculture transformation, including the Ministry of Local Government, Ministry of Lands, Ministry of Natural Resources and Climate Change, and the Ministry of Water and Sanitation. Similarly, the Ministry of Information and Digitalization, the Ministry of Finance and Economic Affairs, the Ministry of Trade and Industry and the Ministry of Energy are also importantly concerned.

Multilateral organizations such as the United Nations Development Programme, the International Fund for Agricultural Development, the World Food Programme, FAO, the World Bank and the African Development Bank Group play a key role. Other development partners that may support agriculture digitalization activities include the Foreign Commonwealth & Development Office, the European Union, Irish Aid, the Norwegian Embassy in Lilongwe, the Japan International Cooperation Agency as well as USAID, which operates Feed the Future, its global hunger initiative.
A multiplicity of international NGOs and local associations form part of organizations operating at the national and subnational levels in the agriculture sector. These include Care International, Save the Children, Concern Worldwide, Emmanuel International, Inter Aide, Christian Aid, World Vision International, Catholic Relief Services, GOAL, and Total LandCare. The sector also benefits from the participation of a few national and international research institutions, including Lilongwe University of Agriculture and Natural Resources, the International Institute of Tropical Agriculture, the International Crops Research Institute for the Semi-Arid Tropics and the International Food Policy Research Institute.

Farmer and advocacy groups that may support digital agriculture efforts include the Farmers Union of Malawi, National Smallholder Farmers' Association of Malawi and savings and credit cooperatives.
Other actors include the Forestry Research Institute of Malawi, the Malawi College of Fisheries, and the Fisheries Research Unit. Lilongwe University of Agriculture and Natural Resources, University of Malawi, the Centre for Social Research and other universities also contribute to the agricultural research agenda in the country.

Government through the Ministry to ICT has embarked on the establishment of telecentres in all districts as a project managed by MACRA and other stakeholders. The project aims at providing, among other tools, a platform for the youth to access the internet and use information for creating digital innovations.

Establishing a digital agriculture ecosystem requires an enabling environment for innovation by farmers and agripreneurs. Already, there is increased funding and collaboration on digital agriculture projects, and start-ups are beginning to attract investors and media publicity. The DVI implementation can contribute to Malawi's innovation and entrepreneurship ecosystems by fostering the development of relevant groundbreaking digital solutions in agriculture.

CHALLENGES AND OPPORTUNITIES

While Malawi has made progress in expanding digital infrastructure coverage, connectivity remains unpredictable and expensive for many. There is a need to develop a model of digital skills training aimed at farmers so that they can learn to assess and implement the best practices and technologies for their farming business. In the villages visited during the assessment, it was evident that the limited access to digital equipment and skills had created digital skills gaps among the people, especially farmer households. Even most of those with smartphones only used them for texting and calling.

From 2015, as a result of the decline in research and development expenditure and suspension of donor funding, 37 percent of the researchers in Malawi's Department of Agricultural Research Services left and moved to the higher education sector where they were offered relatively better benefits and salaries.

Despite provisions planned in the Digital Economy Strategy, there is a need for a clear and well-defined digital agriculture strategy. The last mile[1] connection policy and practice by the Electricity Supply Corporation of Malawi also remains an issue, especially in rural areas where the majority of agriculture activities takes place. The lack of access to electricity bears a major impact on connectivity and internet access as expressed elsewhere in this report. A major cost-related aspect has been the high data landing costs which are a significant driver of the costs of mobile data.

4.2. Implementation options for the DVI

4.2.1. Field research methodology and village selection

The selection of potential villages hinged on four key elements:

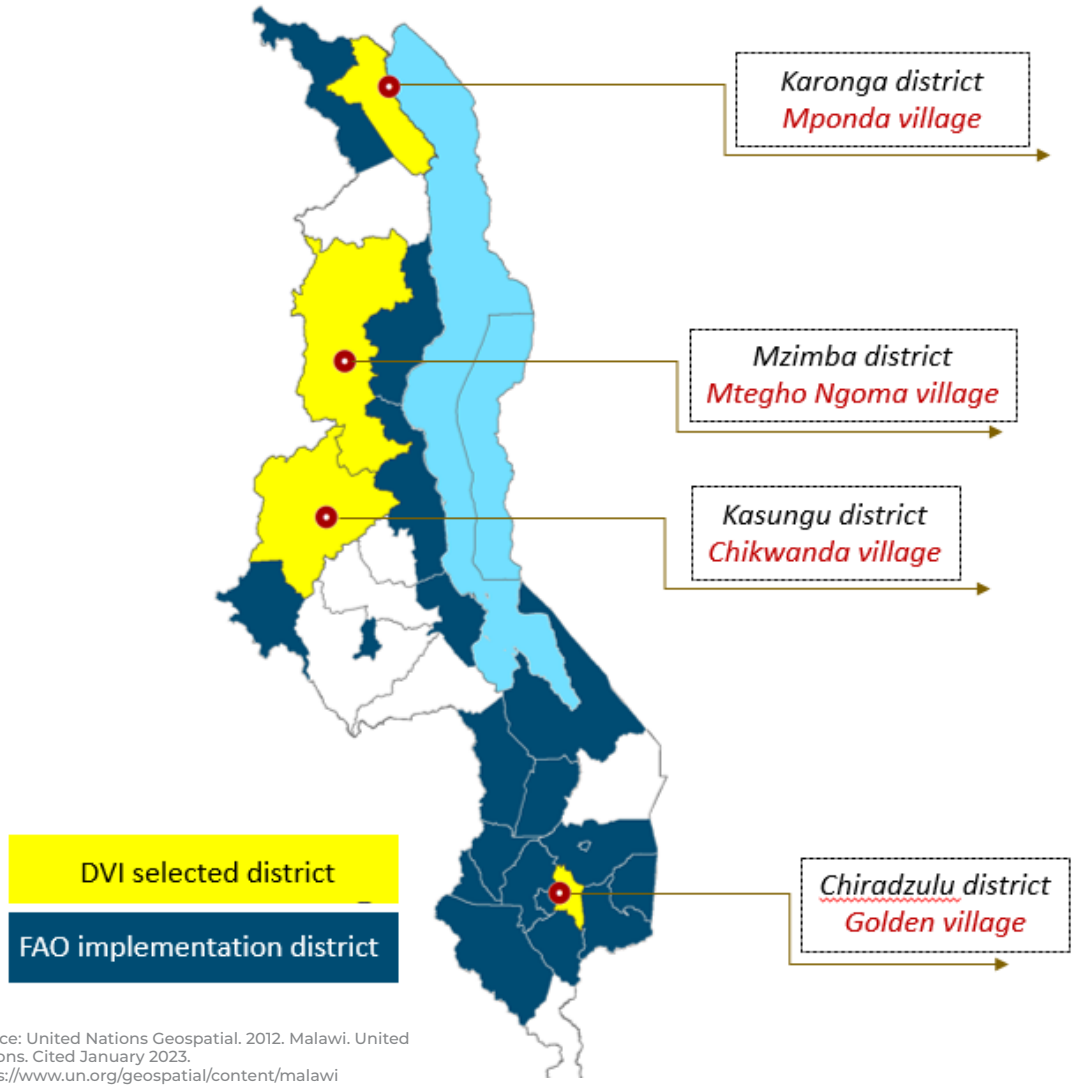
i. Accessibility (location accessibility and ease of reach)
ii. Internet access (reliable internet connection)
iii. FAO presence
iv. Access to electricity

Four districts were initially selected, namely Kasungu, Mzimba, Chiradzulu and Karonga representing the northern, central and southern regions. Further screening was then done and, out of 20 pre-identified villages, four of them were selected and assessed based on the scoping assessment methodology.

A total of 32 individuals participated in key informant interviews and 60 individuals took part in FGDs. These were carried out in Mponda Village (Karonga District) and Mtegho Ngoma (Mzimba District) in the northern region, Chikwanda Village (Kasungu District) in the central region and Golden Village (Chiradzulu District) in the southern region.

These villages are suggested to be DVI villages especially when a microlevel implementation is planned. The qualitative data was supplemented by quantitative evidence gathered through desk review from secondary data sources such as the country's 2019 population census data, district socioeconomic profiles and other sectoral reports. Stakeholder consultations also included a virtual forum attended by at least 30 participants from all over the country.

1 The 'last mile' or 'last kilometre' is a phrase widely used in the telecommunications, cable television and internet industries to refer to the final leg of the telecommunications networks that deliver telecommunication services to retail end users (i.e. customers)



Source: United Nations Geospatial. 2012. Malawi. United Nations. Cited January 2023. https://www.un.org/geospatial/content/malawi

4.2.2. Characterization of villages and potential activities

Karonga District

Karonga is a district in the Northern Region of Malawi located along the lakeshore. It consists of three distinct topographic zones which offer arrays of natural resources, ranging from forest reserves and local wildlife to marine and aquatic species. Environmental degradation is a huge issue in the district. The district's economy relies on agriculture, fishing, forestry, mining, local commerce, industry and tourism. Agriculture makes up a large proportion of the district's economy (85.4 percent). The largely agricultural economy is supplemented by fishery outputs, forestry products and minerals because of productive mining industries. There are 20.3 percent of households with access to electricity in the district.

Most people in Karonga use their mobile phones, rather than computers, to access the internet. Airtel Malawi, Telecom Networks Malawi, and Malawi Telecommunications provide data services. Karonga has one functional telecentre, located at Lupaso in the jurisdiction of Kyungu.

Mponda is a village located in the Kilupula traditional authority[2] in the Kaporo Extension Planning Area[3], Karonga District. Kilupula has a total number of 16 338 households (11 828 male-headed and 4 510 female-headed). The traditional authority has ten markets. Mponda village mainly comprises customary land, which is mostly owned by men. There is infrastructure in the area for active irrigation, where farmers use motorized irrigation and divert stream irrigation systems (gravity-led irrigation). The recommended value chain crop is rice as there are already existing structures and cooperatives actively producing rice and practising value addition. The village is also within the grid of the Electricity Supply Corporation of Malawi. For every household, there is at least one mobile phone, showing that the use of some digital services is above average. The usage of digital services including mobile-money services is high among the youth.

Both Airtel and TNM are MNOs providing mobile and digital services in the village. Mponda is also among the localities benefiting from the Government initiative of care groups and Village Savings and Loans Associations (VSLAs) model services. In addition, FAO is working through Farmers' Field and Business Schools in the locality.

Chiradzulu District

Over 90 percent of the Chiradzulu population living in the rural areas derive their livelihood from agriculture. The district is characterized by an acute shortage of arable land and about 99 percent of farm families have less than a hectare of land. The scarcity of land in Chiradzulu has forced the expansion of cultivation onto marginal land and steep slopes exacerbating soil erosion which limits the production of adequate food at the household level. The main crops grown in the district are maize, groundnuts, cassavas, sweet potatoes, pigeon peas, phaseolus beans, sorghum, tobacco, and coffee. These crops are mostly grown in estates and by smallholder farmers. Other crops grown in the district include horticultural crops such as chillies, peas, paprika, citrus fruits, mangoes, pawpaws, and avocadoes. Major constraints to production include inadequate farm inputs, limited access to agricultural extension services, poor produce prices, decline in soil fertility, and limited access to agricultural loans and farm inputs.

Chiradzulu has one telecentre established by the Malawi Government via MACRA. TNM, Airtel and Access Communications are all available in the districts with the majority using the first two service providers and with a few using Access mobile network. Mobile-money services are provided by TNM, Airtel, Zoona, and Mukuru. Apart from the mobile data services, internet access in the district is also available from the internet service provider Skyband.

In Golden, the village where the field research was undertaken, there is a trading centre, a health centre, secondary schools, a teacher's college and a power grid. The village is part of Thuchira Plain which is found on the east of the district covering Milepa, Namitambo, and Nkalo. Golden Village is in the traditional authority Onga, which has 49 villages and a total population of 21 788 in 6 065 households. The village is near the Providence Industrial Mission market which features a trading centre with mobile-money agents, bank agents, agroprocessors and ICT communication centres.

The village also has irrigation schemes run by smallholder farmers who operate in groups organized by extension officers. There are also Farmers' Field and Business Schools established by OXFAM and FAO, as well as ICT bureaus and centres offering printing services, and a TNM shop.

In Chiradzulu, FAO is already working with One Acre Fund, an organization that supplies financing and training to help smallholders grow their way out of hunger and build lasting pathways to prosperity. The

2 Traditional authorities are analogous to subdistricts.

3 This is an ecological zone under the Ministry of Agriculture.

partnerships present an opportunity for DVI to build apps; agrodealers can be involved in the scheme. Both Airtel and TNM provide mobile and digital services in the village. Through the FAO-led projects Kulima and Afikepo, the village is benefiting from initiatives such as care groups, VSLAs and farmer field schools.

Kasungu District

Kasungu is predominantly flat and most of its rivers receive deposits of soil from surface run-offs, causing siltation. This affects agricultural productivity as well as various irrigation efforts, the fishing industry, and water management. The economy of the district is predominantly dependent on agriculture. At least 80 percent of agricultural production is derived from smallholder farmers who produce their crops on customary land (NSO, 2008). NSO (2017) indicates that about 33 percent of Kasungu's population lived below the national poverty line in 2011, while 11 percent were ultrapoor. The major crops grown are maize, tobacco, groundnuts, cassavas, soya beans, sweet potatoes, and beans. Tobacco has been predominantly the main cash crop in the district but has recently seen wide fluctuations in prices on the auction floors. Unlike other crops, tobacco marketing does not follow the laws of supply and demand, as prices are decided by the buyers. In recent years, production of burley tobacco has fallen drastically as a result of reduced demand following policies to ban additives in Canada and flavourings in the United States of America. There have been major reductions in both areas under cultivation and production resulting from unpredictable low prices on the auction floors and increased cost of production.

There are 25 Agricultural Development and Marketing Corporation (ADMARC) markets spread across Kasungu District. According to some stakeholders, because of the unreliability of ADMARC markets and low market prices, most farmers are at the mercy of vendors who dictate the prices of commodities. Besides ADMARC, other private traders play an important role in the marketing and provision of agriculture inputs. This includes the National Smallholder Farmers' Association of Malawi, Export Trading Company, and Farmers World.

Kasungu district has three cellular service providers: TNM, Airtel, and Access. TNM has 13 towers in the district and provides services to an estimated 280 000 people. Airtel has 24 towers in various traditional authorities with 113 843 subscribers in the district. There are some areas in the district that still experience poor connectivity and reception. Internet services in Kasungu are accessed through Malawi Telecommunications, Skyband, Burco, Airtel and TNM connections. There are also several internet cafes such as Vikwa, Nkhamenya, Lighthouse and Softech, each charging an average of MWK 20 per minute. High charges by internet service providers – currently at MWK 25 000 for 15 days with Airtel and MWK 60 000 per month with Malawi Telecommunications – limit the number of internet users.

Activities could focus on villages such as Chikwanda Village if a microlevel of implementation is considered. The village has 260 households. It is close to Chulu market, which is located in the traditional authority Chulu, in the central region of Malawi. The village is close to one of the main trading markets in the districts, which provides infrastructure for off-taking of the farmers' produce. Chikwanda is characterized by the presence of the following structures: electricity grid, mobile-money agents, a solar energy company (Yellow Solar Power) providing the community with access to power, and trading markets. The main value chain crops are tobacco and legumes.

In Kasungu District, DVI may utilize the already existing working relationship between Plan International Malawi and FAO to form a partnership in promoting digitalization. Plan International Malawi is offering digital literacy to youth in the district to contribute to the efforts of the Malawi Government in strengthening the resilience of youth, women and men to the effects of socioeconomic and climate-change shocks as well as the impact of disasters, through sustainable livelihood interventions. Through the Kulima and Afikepo projects, the village is benefiting from VSLAs model services and FAO's Farmers'

Field and Business Schools approach. FAO is also implementing a Flanders' Government funded project aimed at supporting smallholder market-oriented agricultural production.

Mzimba District

Mzimba District has four main geological features: hills, plateaus, ridges and a natural drainage system. The Viphya Highlands is a high plateau in the east at an altitude of 1 954 metres above sea level. There are large pine plantations and natural forests on the plateau popularly known as Viphya Plantations or Chikangawa, which are an important source of timber products for construction and exports for the entire country.

The plains in the west extend into Kasungu and Zambia. Mount Hora is a significant location in the Ngoni history of Mzimba, as annual Ngoni cultural and historical events are held there. South Rukuru is the biggest and longest river in the district and the northern region. Lake Kazuni is situated on this river near Vwaza Marsh to the north and offers potential for tourism activities. The South Rukuru River Basin is a major tobacco production area but suffers from siltation because of deforestation and soil degradation, which are attributable to farming along riverbanks as well as sand mining.

The major economic activities in the district are agriculture, forestry and fishing, accounting for 68 percent of income and employment, followed by household enterprises (30 percent) and wage employment (23 percent). Much of the land is under subsistence farming. The average landholding size is about 4 ha per head, which is much higher than the national average. Tobacco is the major cash crop, while maize is the main food crop, which is grown by subsistence farmers. Paid employment is limited to the civil service, the service industry, and a few companies. ***Ganyu*** (casual and very temporary tasks) is the most dominant form of informal wage employment.

The commercial sector is growing slowly, but it is dominated by micro-, small- and medium-scale enterprises. There are some financial lending institutions but access to them is limited, covering a small number of businessmen and women because of the high costs of borrowing. About 15.1 percent of the population in Mzimba District has bank accounts and this compares favourably with the 15.3 percent registered at the national level (NSO, 2019). According to MACRA's Access and Usage of ICT Services Survey 2014, 54.7 percent of inhabitants own a mobile phone, above the national average. The main network providers are Airtel and TNM. An estimated 48 percent of the population in Mzimba District owns a radio. The most popular stations in the district are Mzimba Community Radio 93.3 MLZ FM (50 percent); MBC Radio 1 and 2 FM, MW (30 percent); Zodiak Broadcasting SEW, SW, FM (90 percent); Tigawane FM; Radio Maria FM, and Trans World FM.

The major telecentre services are at the main post office at Mzimba Boma, which has six computers. A new telecentre at Jenda Rural Growth Centre will also provide access to the internet, improve community access to information about markets, and help farmers and traders make transactions.

Mtegho Ngoma, located in the Manyamula extension planning area and traditional authority M'mbelwa of Mzimba District, is a potential village for the DVI, if a microlevel of implementation is considered. The village has about 250 households. Mtegho Ngoma has the following structures in place that may aid the successful implementation of DVI: electricity grid, access to seasonal/agriculture roads and active youth groups. It also has maize mills, treadle pump generators for irrigation, an NBS Bank ***pafupi*** (bank agents), Mukuru agents, Mpamba, Airtel Money, Hello Paisa, and Western Union. The village has a good road network and market as well as various sources of power available, apart from the national power grid i.e. solar power, cell power and fuel (petrol, paraffin, or diesel).

In Mzimba District, DVI may utilize the already existing working relationship between Plan International Malawi and FAO to form a partnership in promoting digitalization. Both Airtel and TNM are MNOs providing mobile and digital services in the village.

KEY ACTIVITIES AND PARTNERSHIPS

Digital activities that may be implemented in villages targeted by DVI could include:

- Advisory services (SMS or web platform) mainly for aquaculture (fish farming) and veterinary services as they are limited to crop production
- Capacity building on digital services for agricultural production and marketing linkages
- Warehouse and marketing systems through rice-producing cooperatives
- Improved irrigation schemes management and applied technologies
- Promotion and advocacy of sustainable public services through healthy living, reproductive health and education services
- Provision and support on Technical-Vocational Education and Training leveraging digital technologies as needed
- Digital monitoring of fields and production using remote sensing and drones
- Identification and establishment of digital and data management governance structures to be responsible for capacity building and rural digital services planning and development

FAO may partner or collaborate with the World Bank, which is working on a digital Malawi project, a Government wide area network project, and a last mile project. The overall objective of the project is to increase access to affordable, high-quality internet services for Government, businesses and citizens, and to improve the Government's capacity to deliver digital public services. Similarly, the European Union and German Agency for International Cooperation are working on Green Innovation Centres for small and medium enterprise groups or cooperatives. The districts, through the Afikepo project, are benefiting from care groups and VSLAs model services. The DVI will need to establish collaboration with these initiatives.

The DVI may leverage the local government structure where a village is under a Group Village Head, and the Group Village Head is under the authority of the traditional authority who reports to the district council. DVI implementation can also take advantage of the FAO community and local extension services structures already existing under the Kulima project. Further collaboration could be considered with Village Reach and other public service providers in the district.

4.2.3. Recommendations

Overall, the country has an existing digital agriculture landscape, providing a conducive environment for innovations and improvements in the sector, though this needs more improvement. Mechanisms that will assist the achievement of DVI objectives include the use of community-based digital intermediaries including digital village volunteers, agrodealers and contracted field agents, as well as institutionally via producer organizations. A successful DVI project will thus require:

- A hybrid service package with compelling value to farmers
- Digital agriculture awareness and capacity
- Addressing social, cultural and gender barriers
- Advocacy for some subsidized services at least at pilot level
- Effort towards sustainability

The DVI ought to create a participatory environment where young people and women can actively and independently implement social change. Some young entrepreneurs can take part in the development of agricultural solutions and innovations that can ensure a successful implementation of the digital initiative in their locality.

5 Niger

5.1. The agrifood systems and digital agriculture landscapes

5.1.1. Importance of the agriculture sector

With a population of more than 24 million in 2021, the Niger's economy is primarily based on the agricultural sector, which accounts for 42 percent of gross domestic product (GDP) ***(Institut National de la Statistique du Niger, 2015)***. More than 80 percent of the working population is involved in the sector. The country has sufficient natural resources to guarantee its food security. This includes 62 million hectares (ha) of grazing land and 11 million ha of irrigable land. The number of agricultural households is 2 511 303 but only 6.08 percent are managed by women. The main rainfed crops are cereals (millet, sorghum, rice) and cash crops such as cowpeas, groundnuts, sesame and souchet ***(Cyperus esculentus)***. In 2013, livestock contributed 25 percent to agricultural GDP.

In this country, where agriculture is practised with rudimentary means, economic growth faces many challenges, including irregular rainfall and flooding, the security crisis and the COVID 19 health crisis. The current performance of this sector is insufficient to meet the food needs of the population and reduce poverty and inequality in rural areas. More than two-thirds of the population live below the poverty line. According to the World Bank, the extreme poverty rate of 42.9 percent affects rural areas above all.

The rural development sector cuts across several ministries in charge of agriculture, livestock, environment, water, etc. The strategic and guiding framework for the Government's economic and social policy is the Sustainable Development and Inclusive Growth Strategy Niger 2035, which the State aims to operationalize via their Economic and Social Development Plan from 2017 to 2021. A further Economic and Social Development Plan 2022–2026 is under development. The technical assistance provided by FAO to the Niger is set out in the 2017–2022 Country Programming Framework.

The sector's development guidelines are governed by the Nigeriens Nourishing Nigeriens (3N) Initiative.

The objective of the 3N Initiative is to ensure that people are sustainably safe from hunger and malnutrition and able to participate fully in national production, thus improving their incomes by 2035 *(Haut Commissariat à l'initiative 3N, 2017)*. The 3N Initiative is intended as a framework for fighting poverty and inequality by reducing the proportion of those living in poverty from 45 percent in 2015 to 31 percent in 2021.

5.1.2. Digital agriculture

POLICY FRAMEWORK AGRICULTURE AND KEY INDICATORS

Since the start of 2010, authorities of the Niger have undertaken reforms to further create favourable conditions for accessing information and communications technology (ICT), thus reducing the digital divide, notably through the creation of the National Agency for the Information Society (ANSI). Through the Niger 2.0 Strategic Plan, ANSI intends to support the transformation of Niger's society towards a digital and information-driven society, particularly in rural areas. This plan is structured around 4 themes:

- Theme 1: digitization of the administration
- Theme 2: deployment of "Intelligent Villages", which consists of digitally opening up all villages and rolling out basic services in an efficient and sustainable manner (in the fields of health (e-health), education (e-education), agriculture and livestock (e-agriculture), e-administration (extension of e government)), including by facilitating the use of electronic payments (e finance)
- Theme 3: establishment of an innovation city around a national data centre, incubators, research and development, and promotion of local start-ups
- Theme 4: promotion of digital technology through, for example, "open days" to be held regularly in the country's regions

This strategy aligns with the national sectoral ICT policy adopted by Decree No. 2013–158 of 12 April 2013 for the 2013–2020 period, which is structured around five strategic themes:

- Theme 1: Implementation of the legal and institutional framework adaptation
- Theme 2: Infrastructure development
- Theme 3: Promotion of universal access to ICT services
- Theme 4: Application and content development
- Theme 5: ICT capacity building

The Niger's electronic communications market consists of eight telecom operators, including Celtel Niger SA, Niger Telecoms, Atlantic Telecom Niger and Zamani Telecom, all of which offer mobile phone services. The mobile phone market penetration rate is 53.64 percent. Regarding mobile phone internet access, nearly 7 million people of the Niger have access via 2G, 3G and 4G technologies (Regulatory Authority for Electronic Communications and Post, 2020). According to DataReportal (Kemp, 2021a), there were 590 000 social media users across the Niger in January 2021. Mobile financial services are not well developed in the Niger. Less than 3 percent of the population has an active mobile money account. The volume of transactions carried out in mobile money accounts for only 3.7 percent of GDP, compared with 20 percent for Senegal and Togo and over 40 percent for Benin, Burkina Faso, and Côte d'Ivoire (United Nations Conference on Trade and Development, 2020).

FAO is currently supporting the Government of the Niger to develop a national e-agriculture strategy.

KEY INITIATIVES AND SOLUTIONS

There are various platforms and projects in the Niger aimed at agricultural digitalization, initiated by State services, private companies or development projects led by national or international associations as well as by cooperation. A number of these are presented on the following pages.

a) Selected highlights

Activities on e-extension by Niger's National Meteorological Department
The National Meteorological Department of the Niger (DMN) provides agrometeorological information and flood risk warnings in the country's communes. This information is broadcast on radio and TV, web SMS, their website and via WhatsApp groups. Users can also access databases on hydrological and flood information.

Regional System of Analysis for Agroclimatological Risks
Held by the Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications, this software provides satellite data on soil typology, fertility levels, crop production at the plot level, and more. This system is used by various institutions in the Niger, including DMN and the Centre for Global Development.

The e-extension platform of the National Network of Chambers of Agriculture (RECA)
This electronic system in the Niger has several platforms. These include its website, a call centre where rural producers can call and interact with an agricultural advisor, and WhatsApp groups and Facebook pages to interact directly with producers. There is also a mobile application for strengthening agricultural advice, a community radio programme for disseminating information, and SMS and voice messages. The system provides advice on crop protection, inputs (seeds, fertilizers, pesticides), prices of vegetable products, etc.

Digital Innovations for Agro-Pastoralists in the Niger
Launched in April 2021, this is a project of the SNV Netherlands Development Organization in the Niger, aimed at promoting the use of digital technology in agropastoral value chains (in particular live cattle and milk). Implemented in the areas of Dosso, Tahoua and Tillabéri, this project aims to "increase the resilience and food security of agricultural and pastoral households through the generation of economic (productivity gains, income) and social benefits related to the use of a digital solution integrated within an innovative service".

Support Programme for Secure Family Farms
This is a Swiss cooperation project, which conducted a study into the potential for transforming the Niger's agriculture through digitalzation in the regions of Maradi and Dosso.

German Agency for International Cooperation's Digital Transformation Centre in the Niger
The Digital Transformation Centre works to transform the agricultural sector through innovation. It is implemented by the Programme Promotion of Productive Agriculture (PromAP) project and has four main pillars: (i) advice and training for public officials, (ii) digital learning methods, (iii) an e-hub and forum for exchange between actors of the digital ecosystem and (iv) digital resources. PromAP also offers a digital learning platform with certified courses and is implementing a project to create a digital land registry.

ANADIA, a flood early warning database
The Niger's official flood database (ANADIA or BDINA) was established in 2014 within the framework of the ANADIA 2 project (Climate Change Adaptation, Disaster Reduction and Agricultural Development for Food Security – Phase 2). This system provides real-time seasonal forecasts via a bulletin for each location. The platform also provides weather, flood and drought forecasts (up to ten days in advance) to guide producers in their decision-making. This information is disseminated in national languages via community radio, web SMS (particularly to warn of natural disasters) and WhatsApp groups.

The Early Warning System against the River Sirba's floods (SLAPIS)
Implemented since 2017 as part of the ANADIA 2 project, the **Local Early Warning System against the Sirba Floods** aims to combat flooding in the villages around the Sirba River – the most important tributary on the right bank of the Niger River – but also targets

other regions. A digital platform was established in June 2019 in both web and mobile versions. This platform could also be used to issue alerts on pest attacks.

The E-Karkara platform

E-Karkara is a digital platform for agricultural advice developed by FAO, ANSI and the Ministry of Agriculture of the Niger, available since May 2021. Users are able to access telephone voice content in French and local languages (Hausa and Zarma) as well as instant messaging services in French by dialling 703.

Tech Innov's Ecological Digital Farm solution

The Ecological Digital Farm is an innovation developed by the company Tech Innov. It is a fully automated integrated platform for plant and animal production, supported by various digital innovations (sensors, mobile weather, "discreet scanner", "intelligent biofertilizer", automatic watering, and more). It is based on a tele-irrigation system that allows for remote control of irrigation and fertilization of the soil by means of a mobile phone, solar installations and sensors that make it possible to monitor several parameters such as temperature, soil moisture and sunshine. It is now established in more than ten villages in the regions of Maradi, Tahoua, Tillabéri and Zinder, often in partnership with different actors. The digital farm in Simiri, for example, was funded by the World Food Programme under the supervision of the NGO Karkara and the Simiri women's group. Partnerships with organizations such as the United Nations Development Programme (UNDP) and the United Nations Population Fund (which plans to make this innovation available to more than 30 000 young girls in the country) are underway. The operation of the farm is being hampered by various challenges, including the quality of the internet connection.

The e-Voucher project

E-Voucher is a digital platform created for better monitoring and transparent and traceable management of resources allocated to rural producers. It was initially adopted in 2017 as part of the West Africa Agricultural Productivity Programme in collaboration with the Directorate General of Agriculture. The Niger experience involved the distribution of inputs (seeds, fertilizers, agricultural materials and equipment, motor pumps, livestock feed and animal kits) to producers. The system has three main components: a database of beneficiaries, a directory of input and equipment suppliers, and an electronic tool (server, website, mobile phones). The project is currently facing operational, financial and administrative difficulties that are hindering its continuation. It was reported during the surveys, however, that the e-Voucher is being tested by the World Food Programme through its SCOPE project for cash and food distribution as well as by World Vision International during animal kit distribution operations.

Niger Poste's Kaomini online marketplace

Kaomini is an online sales service of Niger Poste. Created in November 2017, the platform exists in web and mobile versions and allows entrepreneurs and producers of the Niger to have a link to the market.

Agritech Shop

Agritech Shop is an e-commerce platform created by Itech Center for the sale of agro-silvo-pastoral products. It suffers from a lack of publicity and is currently supported by PromAP, which plans to roll out these services in its areas of intervention.

ANSI's Smart Village Project (SVP)

The SVP Rural Growth and Digital Inclusion project aims to increase access to mobile broadband services in rural areas and bring digital financial services to underserved localities. It is financed by the World Bank (USD 100 million mobilized, partly in the form of a loan) and the Government of Niger and has partners such as the International Telecommunications Union. The project comprises several components, including: an enabling environment; rural connectivity; digital financial inclusion; project management and stakeholder capacity building. More than 2 000 villages are targeted. Although the project is in the study phase for some components, 16 villages have started

receiving equipment to provide connectivity. FAO's DVI is collaborating with ANSI's SVP.

b) Other initiatives

FAO's Digital Services

A number of digital services developed by FAO's central services are also used in the Niger. This is notably the case of eLocust3, used by the National Locust Control Centre.

There are many other platforms and initiatives that fall within the context of digital farming activities. These include: the Agricultural Market Information System[4], the Livestock Market Information System, the Sahel Institute's Pesticides Database, the Fertilizer and Seed Recommendations Map for West Africa, the Interprofessional Platform for Livestock, Meat, Leather and Skins, the map of soils in the regions of the Niger, the Duddal Digital Agricultural Library, the Last Mile Mobile Solution digital platform of the World Vision organization that facilitates the distribution of animal kits, the Atlas of land use maps and the electronic platform of the Centre for Food Security and Nutrition, which disseminates information on agricultural activities, opportunities and advice, and the platforms of the Sia-Kouanza 2 project concerning land tenure and plus e-payment systems that are widely used by producers.

THE SUPPORTIVE ECOSYSTEM

In the Niger, there are structures to support young people and women in the management of digital and/or agricultural businesses. These include the Abdou Moumouni University Incubator Centre, the Incubator Center of Small and Medium-Sized Entreprises in Niger, the Technology Pole for Digital Development of the University of Dosso, and the Oasis Center, which is exclusively dedicated to women. In order to coordinate the activities of these entities, the Network of Support Structures for Entrepreneurship in Niger was created in February 2021, acting as an umbrella to the actions of some 20 support structures. Activities such as ANSI's e-Takara are organized in the country to promote digital entrepreneurship.

CHALLENGES TO WIDER ADOPTION

During the surveys, discussions on the main constraints to the adoption of ICTs in rural socioeconomic areas were held with the participants. The main challenges raised were language barriers due to low literacy levels, the low quality of internet connection and poor access to broadband, high subscription costs for digital services, lack of digital literacy and poor access to energy. The participants also mentioned the dependence of State institutions on external financing, the inadequacy of digital content to the real needs of the population, and the low penetration rate of banking, which hinders the adoption of mobile payment solutions. The lack of awareness was widely discussed.

4 A regional platform also exists, in which the Niger participates: Système d'Information de Deuxième Génération (Second Generation Information System/SIM2G), which is managed by AGRHYMET/Permanent Interstate Committee for Drought Control in the Sahel

5.2. Implementation options for the DVI

5.2.1. Field research methodology and village cluster selection

The field study was conducted in six villages in the regions of Dosso, Maradi, Tahoua and Tillabéri. One important selection criterion was the existence of schemes already implemented by FAO or within the framework of the SVP or other development projects (including those of United Nations agencies). The "Village Clusters" were formed around the administrative centres of the municipalities within a radius of 2–20 km. The preselected localities are listed in the following table:

Table 4. Pre-selected village clusters in the four study regions

Village Cluster	Municipality (region)	Number of inhabitants	Comments
Chadakori, Dan Madatchi, Bougoudji and Kermo	Chadakori (Maradi)	14 900	Intervention area of several FAO projects (agropastoral school fields) and other United Nations agencies within the framework of the Rome-based Agencies approach; possibility of creating a smart village within the context of the ANSI's SVP
Bagaroua, Loukoudoussou and Fadama	Bagaroua (Tahoua)	13 400	Intervention area of FAO projects (Water and Food Security in Africa Initiative), agropastoral school fields) and other United Nations agencies; possibility of creating a smart village within the context of ANSI's SVP
Karofane, Dama and Tahigga	Karofane (Tahoua)	12 125	Intervention area of FAO projects (Water and Food Security in Africa Initiative, agropastoral school fields) and other United Nations agencies
Falwel, Malam Koara and Kokoukou	Falwel (Dosso)	7 900	Area of intervention of FAO projects (rural women's economic empowerment) and other United Nations agencies
Fabirdji, Bilingol Zarma, Gobéri Zarma and Rodji Peuhl	Fabirdji (Dosso)	13 391	Intervention area of FAO projects (project to promote social cohesion between farmers and herders, Hand-In-Hand Initiative, Dimitra Clubs) and other United Nations agencies. A smart village is being created within the context of the SVP in the village of Irrah
Simiri, Guessé, Kanda, Tolkoboye and Boutoumbou	Simiri (Tillabéri)	10 330	Intervention area of FAO and other United Nations agencies projects, possibility of creating a smart village within the context of the SVP

SOME COMMONALITIES AMONG CLUSTERS

The economy is dominated by agriculture, livestock and small-scale trade. The agricultural market information system (AMIS and SIMB) does not cover most of these localities. The agricultural sector faces many challenges, including irregular rainfall, poor access to high-quality and appropriate agricultural and veterinary inputs, poor access to information on good agricultural practices and market information, and soil erosion accentuated by climate change. The rural exodus among young people is often significant, sometimes with border countries as destinations.

The use of ICTs is marked by the presence of four Mobile Service Providers (MSPs): Airtel, Zamani, Moov and Niger Télécoms, which provide a 2G/3G network. Simiri (with only the Airtel network) and Falwel (Airtel and Orange) are the only villages with poor network coverage. The quality of the mobile internet connection varies from 10 megabits per second (Mbps) in Chadakori to less than 400 kilobits per second in Falwel and Simiri. The proportion of people with a basic phone varies from 80 percent in Chadakori and Bagaroua to 40 percent in Simiri. In terms of smartphone ownership, the figures vary from 60 percent in Bagaroua to 10 percent in Simiri. Smartphone ownership can mostly be seen among young people. The gender gap is very pronounced. Women account for only 10 percent (Simiri) to 30 (Bagaroua) percent of the smartphone-owning population. The frequency of recharging phone credit is weekly with an amount that varies from XOF 100 to 500. The most frequent uses of ICT are either via basic phones or smartphones (WhatsApp) as well as radio. All villages visited have a ***Station Météo Automatique*** weather station installed by DMN to provide agrometeorological information to the villages. There is no e-commerce platform in the six villages visited, nor is there any use of FAO's digital services despite FAO being active there.

The most frequent digital uses are the use of the telephone for basic phone calls, the use of WhatsApp, including for receiving agricultural advice or various alerts, and the use of Facebook and YouTube by young people. People really have no other experience of using digital agricultural applications. As far as digital money is concerned, people usually transfer money (cash-in and cash-out) via Airtel Money, Moov Money or Zamani Money. The proportion of women with a smartphone is generally estimated to be around 10 percent of mobile network subscribers.

The following sections list the localities visited along with indications of some specific features related to their geographical and socioeconomic situations, including digital uses.

5.2.2. Characterization of villages and potential activities

Chadakori Cluster

The "Chadakori Cluster" here refers to the villages of Chadakori, Dan Madatchi, Bougoudji and Kermo. It is located in the central south of the country, in the department of Guidan Roumdji in the Maradi area. Agriculture, particularly crop production, is the main economic activity in Chadakori. There are two types of crops: rainfed crops (millet, sorghum, groundnuts, cowpeas, sesame, souchet), and irrigated crops (watermelons, tomatoes, cabbages, lettuce, moringas). All households practise livestock rearing. The main animal species present are goats, sheep and cattle. In 2020, the livestock population was estimated at 93 314, of which 50 773 were cattle, 13 575 sheep, 12 517 goats and 10 577 donkeys. Fishing is not undertaken in the area.

In Chadakori, four MSPs provide telecommunications network services: Airtel, Zamani, Moov and Niger Télécoms. All of these MSPs provide a 2G/3G network within the main town. The quality of the connection is strong throughout the village. According to tests carried out on site, the speed is around 10 Mbps with the operator Airtel Niger in 3G mode. The use of the Centre for Global Development's services for data collection by the Regional Livestock Directorates in Maradi is noteworthy.

This cluster includes the Amate Seed Farm, a seed company specializing in the sale of seeds and fertilizers through a network of 96 sales outlets, including at least 12 in Maradi. The company has experience of the e-Voucher project. There are 37 village protection committees in the municipality whose role is to prevent all forms of violence, abuse and exploitation of children (neglect, punishment, early/forced marriage, etc.).

The Bagaroua Cluster

Named after the main town in the municipality, Bagaroua is located in the southwest of the Tahoua region, 115 kilometres (km) from the regional capital. For the purposes of this text, the Bagaroua Cluster refers to the villages of Bagaroua, Loukoudoussou and Fadama. These last two villages are located 15 and 5 km respectively from the main town in the municipality by rural track. Young people under the age of 35 account for 81.76 percent of the inhabitants. Irrigation is practised in the lowlands at Loukoudoussou and Fadama. The main irrigated crops include onions, potatoes, cabbages, lettuce and cowpeas.

Of more than 1 500 ha of exploitable land in the municipality, only 450 ha are currently being developed by some 2 500 market gardeners. Livestock is the second pillar of the Bagaroua economy. Due to the presence of several pools, Bagaroua is suitable for fishing and fish trading. The presence of large markets has enabled the development of trade and transport in the area. People derive 35 percent of their income from this activity (Communal Development Plan, 2014). Bagaroua is characterized by a semi-arid climate.

Bagaroua has eight primary schools and two secondary schools. The primary school enrolment rate is 80.47 percent (Niger, National Institute of Statistics, 2018); the proportion of girls in secondary school is only 26.68 percent. In 2014, the health coverage rate was 73.44 percent.

The 4 MSPs Airtel, Zamani, Moov and Niger Télécoms are all present in the village and provide a 2G/3G network. With a speed of 3 Mbps, the quality of the mobile network is average. Thanks to the commune's Agricultural District Chief, who broadcasts weather information and technical data sheets on the WhatsApp group "Pluviométrie à Bagaroua" (Rainfall in Bagaroua), producers in 20 villages have access to advice. The World Food Programe is setting up a digital platform called School Connect to connect communities involved in emergency and resilience activities in order to create a network between partners. Bagaroua is covered by AMIS and SIMB.

Karofane Cluster

The main town in the municipality, Karofane, is located in the department of Bouza, southeast of Tahoua Region. The Karofane Cluster refers to the villages of Karofane, Dama and Tahigga, where there are favourable conditions for irrigated crops. Since 2007, thanks to the support of FAO within the framework of the Small-scale Hydraulics for Food Security project, the people of Karofane have been cultivating rainfed rice on 11 sites divided between 1 347 farmers in 2021 and covering a total of 507.47 ha. Production in 2020 is estimated at 2 000 tonnes. This is the second pillar of Karofane's economy.

Agricultural production is marked by cereal deficits linked to irregular rainfall, which has a major impact on household food security. Karofane has three tourist sites, including the classified forest of Karofane, more than 300 ha in size, a handicrafts site and the site of Wiyan Rakoumi.

The use of ICTs is marked by the presence of 3 MSPs: Airtel, Zamani and Moov provide a 2G/3G network. The quality of the connection is strong, averaging a speed of about 6.3 Mbps with Airtel, which is sufficient for using mobile applications. This year, the broadcasting of images of locust invasions raised the alarm about plant protection.

Market information distribution platforms (AMIS and SIMB) are present in the village thanks to the presence of large wholesale and livestock markets. However, there is no mobile agricultural information platform or e-commerce in the village.

Although the village faces difficulties of access due to poor roads, Karofane does not face problems of

insecurity, and its position in the Tarka Valley with the presence of large markets makes it an ideal location for a successful SVP. In addition, there is the commitment and enthusiasm of the local authorities, who are convinced of the potential ICT carries for the development of agriculture in their area. Young people also use other social networking platforms such as Facebook and YouTube. Cases of mobile money use with Airtel Money and Moov Money for the payment of electricity bills (prepaid account) and subscription to the Canal+ package have been reported.

Falwel Cluster

Named after the main town in the municipality, Falwel is located 75 km north of the city of Dosso and 43 km from Loga, the main town in the department. For the purposes of this document, the Falwel Cluster is made up of the villages of Falwel, Malam Koara and Kokoukou, the latter two of which are located 12 and 18 km respectively from the main town by rural track. The main economic activities are agriculture, animal husbandry, and small-scale trade (among women). Irrigation is mostly practised in the lowlands, such as in Malam Koira and Kokoukou. Agriculture is practised on family farms of 0.5 to 5 ha. The main irrigated crops include moringa, tomatoes, cabbages, lettuce and squash.

In Falwel, only the MSPs Zamani and Airtel are present. The internet connection speed of only 400 kilobits per second does not guarantee the use of simple mobile applications. Most of the villages around Falwel are not connected because of the poor quality of the network. In addition, the lack of electricity in this village hinders access to ICTs. Even in the main town, electricity is only available for 12 hours a day (from noon to midnight).

In terms of the presence of money transfer companies, only Al Izza is present in the main town. The AMIS and SIMB information collection service is not present in the village.

Fabirdji Cluster

The Fabirdji town hall is headed by a young mayor who is convinced of the potential digital technology carries to transform the rural parts of his municipality. Named after the capital of the municipality, Fabirdji is located in the department of Birni N'Gaouré (Dosso Region). The Fabirdji Cluster includes the villages of Fabirdji (Hausa and Zarma), Bilingol Zarma, Gobéri Zarma and Rodji Peuhl. Located in the Dallol Bosso area, the zone is favourable to irrigated crops. Rainfed crops are dominated by millet, sorghum and cowpeas. Bambara nuts ***(Vigna subterranea)***, sorrels, sesame and groundnuts are also grown in combination with millet or sorghum. Livestock is the second pillar of Fabirdji's economy. In 2018, the municipality's livestock consisted of 43 941 cattle, 48 078 small ruminants, 1 666 camels, 4 998 donkeys and 11 horses. The area also exploits forest resources in the form of firewood, the gathering of palm leaves and fruit, gum arabic, Gamsa and tamarind, and the extraction of natron, an activity practised mainly by women.

Trade is conducted around seven main markets in the commune, including Bilingol Peuhl, Tondo and Gobéry Goubeye, as well as those of Birni N'Gaouré, N'Gonga and Bélandé. In addition to these connections to Dosso via Birni N'Gaouré and Niamey via the RN1 road, Fabirdji is on the RN35 road linking Margou to Boumba and has 25 rural tracks.

The commune does not suffer from problems of insecurity even though it borders municipalities such as Kirtachi.

The mobile network is provided by Airtel, with Zamani and Moov providing 2G/3G. The quality of the connection is average; the speed averages around 5 Mbps with Airtel. Thanks to WhatsApp, people are organizing fundraisers among the diaspora for the construction of several health and school buildings.

As part of the implementation of the Dimitra Clubs, FAO has distributed smartphones to beneficiaries who use them to share general information via WhatsApp. FAO's farmer-pastoralist social cohesion projects and the Hand-In-Hand Initiative are being implemented here. Other projects, including Swiss Aid, Millennium Challenge Account, Lux Dev, Support Project for Climate Risk-Sensitive

Agriculture and the Small Irrigation Support Programme – also operate in the village.
As part of the implementation of the SVP, ANSI has established a smart village at Irrah, located around 30 km from Fabirdji. The technology installed has Wifi and a very-small-aperture terminal powered by solar energy. This equipment, installed in June 2021 at the Irrah Community Solutions Initiative as part of the implementation of the Metropolitan Strategic Plan's e-health strategy, is intended to connect the Community Solutions Initiative to the District Health Information Software 2 database. According to those surveyed, Wifi covered a radius of less than 15 metres and still suffered malfunctions.

Simiri Cluster

Named after the capital of the municipality, Simiri is located 78 km from Niamey. Simiri Cluster refers to the villages of Simiri, Guessé, Kanda, Tolkoboye and Boutoumbou. Irrigation is practised in the lowlands of Guessé, Kanda, Tolkoboye and Boutoumbou. In 2016, the municipality's livestock consisted of 133 877 animals including 15 600 cattle, 32 270 sheep, 32 834 goats and 44 029 poultry.
Although it is only 78 km from Niamey, the only operator present in Simiri is Airtel. The 2G/3G connection was considered "not good" by the respondents. Thanks to support from the World Food Programme, a modern eco-digital farm has been set up in Koum, located some 3 km from Simiri, with the aim of improving the population's resilience to climate change.

Mobile money services are provided by Airtel Money but there is too much speculation as a 10 percent commission is taken on each transaction. The village is not covered by AMIS or SIMB. The ANSI smart village planned under the SVP has not yet been established. Located in the department of Oullam, the village is facing marked security problems, notably restrictions on motorcycle traffic.

POTENTIAL DVI ACTIVITIES

Based on the information collected, the profiles of the six villages are almost the same in terms of connectivity and use of digital services. Although some development projects are working to deploy digital technologies and innovations in the villages, most Agtech and Fintech companies and start-ups are located and/or headquartered in Niamey. The field surveys conducted as part of this study identified a variety of digital solutions that can be deployed by FAO under the DVI in either the producer-driven Model 1 or the technology-driven Model 2 via public-private partnerships.

Table 5. Solutions proposed according to the difficulties encountered by the populations

NO.	PROBLEM IDENTIFIED	SOLUTIONS THAT CAN BE PROVIDED DIGITALLY
1	Poor access to land	Better distribution of land within the villages: link landowners with those who do not have land, formalizing the acquisition of land and mapping farms within the villages
2	Poor access to advisory services	Establish a call centre or an interactive voice server providing information on good agricultural practices. Provide information on the integrated management of the main pests for the crops grown in the village. Provide information on weather and crop calendars (rainfed and irrigated)
3	Poor access to inputs	Make recommendations on improved seeds, pesticides and fertilizers and their availability.

NO.	PROBLEM IDENTIFIED	SOLUTIONS THAT CAN BE PROVIDED DIGITALLY
4	Poor access to funding	Promote financial inclusion in villages through the use of mobile money Various other actions can be considered, such as: Facilitating access to credit (reducing the security required) - Providing dedicated guarantee funds for start-ups; - Introducing a grant system similar to the Investment Fund for Food and Nutritional Security's funding (FISAN)
5	Lack of market information and difficulties in accessing markets	Develop a system for collecting market data at the local level and disseminating information Deploy/create e-commerce platforms
6	Flood and natural disaster management	Disseminate weather information and flood alerts
7	Resilience of vulnerable populations	Deploy platforms for the distribution of food, inputs, livestock feed and animal kits
8	Access to healthcare, education and water	Deploy platforms for online consultation, telemedicine, online courses and modern water point management

DVI MODEL IN AGROPASTORAL VILLAGES

In agropastoral areas such as Bagaroua, Karofane and Fabirdji, digital solutions that take into account the different links in the livestock, meat, and hides and skins value chain should be promoted. These activities can be carried out gradually: first by setting up an information and advisory platform on fattening practices and animal health. The platform should also include awareness-raising modules on conflict prevention and management between farmers and herders and on legislation in order to assist users in making decisions regarding grazing areas. The next step is to provide services on the availability of veterinary inputs and products through a network of approved suppliers as well as to provide villages with information on animal prices and consumer products (e.g. sugar and salt) in the markets to improve their resilience during the lean season and to counteract speculation on product prices. This can be carried out using locally collected data.

5.2.3. Partnership opportunities

The success of the IVN will be achieved with various actors such as municipalities, decentralized State services, producer organizations, digital start-ups, and MSPs. With the presence of FAO in the Rome-based Agencies approach, IVN can draw on the experiences of World Vision, the World Food Programme, United Nations Population Fund, and the United Nations Children's Fund. ANSI's SVP project offers tremendous opportunities for the success of the initiative, through collaborations with the World Bank and ITU. The deployment of telecommunications and data infrastructures, platforms and certain services (e.g. financial, health and education) should be done within the framework of public-private partnerships involving various actors (telephone operators, satellite data providers, digital companies, administrative authorities, farmers' organizations, mobile money companies and other microfinance institutions if necessary).

6 Nigeria

6.1. The agrifood system and digital agriculture landscape

6.1.1. Importance of the agriculture sector

In 2013, Nigeria became the largest economy in Africa thanks to its oil-producing assets.

The share of agriculture in the country's gross domestic product (GDP) has been ranging between 20 and 25 percent since the 1980s and currently stands at the lower end of this bracket. Economic growth has slowly resumed after the initial COVID-19 shock. The pandemic was expected to push an additional 11 million Nigerians into poverty by 2022, taking the total number of people classified as poor in the country to over 100 million (World Bank, 2021c). In general, poverty is higher among rural than urban dwellers: 52 percent of people in rural areas live in poverty, compared with 18 percent in urban parts of the country. The country's agriculture is characterized by considerable regional and crop diversity, and crop production is the major driver of the sector. The dominant crops are maize, rice, cassavas, guinea corns, yams, beans and millet. Animal production has huge potential, but it has remained underexploited. Key livestock reared by smallholder households are cattle, goats and sheep, especially in the northern part of the country.

According to the World Bank (2020b), Nigeria is classified as one of the ten most vulnerable countries to the impacts of climate change and natural hazards. Agriculture is one of the sectors most sensitive to climate change, with productivity set to decline by 10–25 percent by 2080 and yields of rainfed agriculture in some northern areas predicted vulnerable to decline by up to 50 percent, which may result in a 4.5 percent reduction in GDP by 2050.

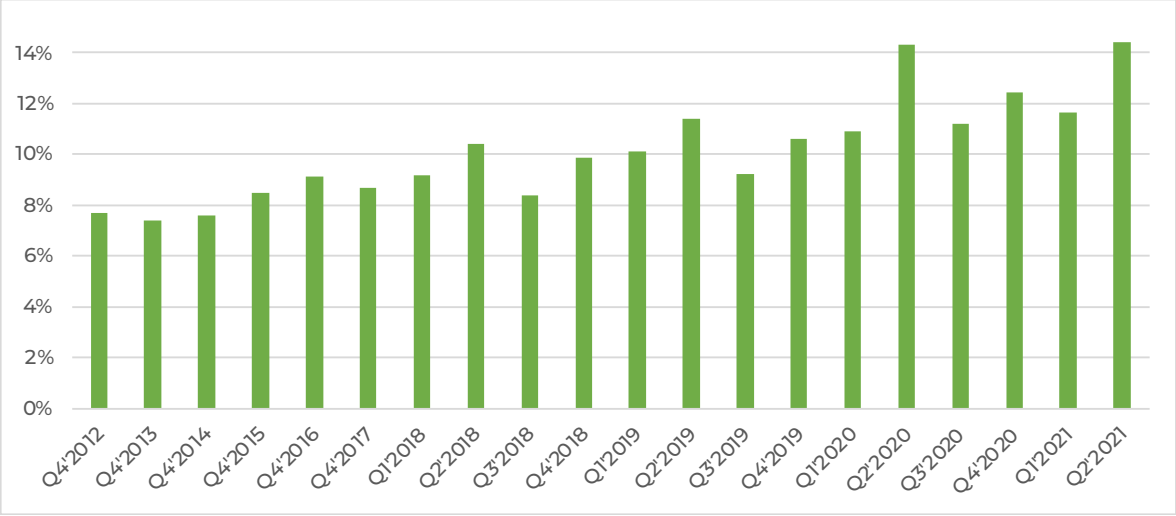
The Nigerian Government has been accelerating efforts to increase agriculture's contribution to the GDP and diversify the country's economy through different policies, including the Agriculture Promotion Policy adopted in 2016. This framework aims at unlocking the sector's potential, minimizing dependence on crude oil export and enhancing the growth of the national economy.

6.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

The National Digital Economy Policy and Strategy 2020–2030 states the vision and mission of the country's digital economy vision as being "To transform Nigeria into a leading digital economy providing quality life and digital economies for all." ICT is one of the fastest growing components of GDP in Nigeria. Its contribution to the GDP has shown an increasing trend in the past decade (Figure 5). The latest report of the National Bureau of Statistics of Nigeria (UNDP and National Bureau of Statistics of Nigeria, 2021) reveals that the ICT sector contributed 17.92 percent to the real GDP of Nigeria (or 20.54 percent of nominal GDP) in the second quarter of 2021. The digital activities have become increasingly important in recent times, fuelled by the exigencies of COVID-19-induced online and remote transactions.

Figure 5. Contributions of telecoms industry to GDP in Nigeria (percent), 2012–2021



Source: Nigerian Communications Commission 2021

Mobile phone penetration has been increasing almost linearly. Active phone subscriptions increased from 154 million in 2016 to over 200 million in 2020, a 32-percent jump within five years, and the teledensity has been consistently higher than 100. Forenbacher ***et al.*** (2019) estimated that, taking into account the ownership of multiple SIM cards and sharing of mobile phones among multiple users, the real rate of mobile penetration in Nigeria is about 46 percent (Forenbacher ***et al.***, 2019). Most mobile users own feature phones while only 10–20 percent of the population use smartphones. The National Broadband Plan 2020–2025 aims to attain a 90 percent broadband penetration rate in terms of population and a 70 percent penetration rate in terms of total land mass by 2025 (Nigerian

Communications Commission, 2020). The plan also aims to deliver data download speeds across Nigeria of a minimum 25Mbps in urban areas, and 10Mbps in rural areas.

Nigeria has one of the most active digital agriculture markets in Africa in terms of the count of solutions, but the number of players is rather limited, and only a few of them have reached scale. The Government has developed a ten-year digital agriculture strategy, called the Nigeria Digital Agriculture Strategy 2020–2030 (Nigeria, National Information Technology Development Agency, 2020), whose vision is "to make Nigeria one of the top three most food-secure country in Africa and, among the top 20 largest exporter of standard agricultural produce by 2030 through the use and application of digital technologies and innovations". Some of the key targets of the plan are as follows:

a. Increase research and development and the deployment of digital technologies and innovations to (1) raise agriculture productivity by 50 percent, (2) achieve food security and reduce food losses by 50 percent and (3) reduce the effect of climate change on agriculture by 40 percent.
b. Support agriculture programmes with digital capabilities to create sustainable business models and opportunities that lead to 1) the creation of 10 million decent jobs across the agriculture value chain, and 2) attract seven 7 million youths into agriculture business.

More than 70 percent of all registered users of digital agriculture services are youth (Tsan ***et al.***, 2021). A survey reported that in Nigeria (and six other African countries), youth aged 18–34 were far more likely to own a smartphone than their older counterparts (USAID, 2019). Women farmers face a digital, rural and gender divide, or the so-called "triple divide", largely because of cultural and societal norms and perceptions, which creates challenges in accessing and using ICT tools.

The developments above illustrate a positive policy environment for digital agriculture in the country. However, most stakeholders met during the scoping exercise, especially in rural areas, described very challenging conditions for the use of digital technologies, a high cost of data, and important digital literacy and divides in remote communities, as well as a weak integration of these technologies into the farming activities.

KEY INITIATIVES AND SOLUTIONS

A selection of initiatives and digital solutions are presented below.

a) Selected highlights

The National Adopted Village for Smart Agriculture https://navsa.ng

In 2019, the National Adopted Village for Smart Agriculture (NAVSA) was initiated by the National Information Technology Development Agency (NITDA), a government parastatal, as an ecosystem-driven digital platform envisioned for the transformation of the agriculture sector in Nigeria. The main thrust of the programme is the integration of digital technologies and innovations to improve the productivity and income of farmers and other ecosystem players. Attracting the youthful population is also its objective.

Among actions such as supporting production and market activities that include access to inputs and various services, NAVSA created an electronic wallet with a seed capital of NGN 100 000 (about USD 250) for each smart farmer registered under the scheme. The wallet scheme is designed to domicile the seed money into two types of wallets:

- *Closed wallet:* Funds in the closed wallet are not allowed to exchange hands and the only way a farmer could access the fund is through request on the platform to a NAVSA-registered input.
- *Open wallet:* Each registered farmer is allowed to transfer 75 percent of their net profit for a given agricultural season back to the open wallet where it can be cashed out as desired, while the remaining balance of 25 percent goes

into a restricted wallet to increase the investment capital available to the farmer in subsequent farming seasons.

The project is at the infant stages and presently being implemented in three states: Gombe, Jigawa and Ekiti. Aiming to reach farmers in all 36 states and 774 local government areas in the country, the scheme intends to create 6 million jobs in the next ten years.

The project officials demonstrated a keen willingness to accept and integrate new digital solutions into the platform as well as the flexibility to ensure that the platform addresses other areas of concern to farmers such as the integration of a digital health programme into the closed wallet. When farmers are sick, they can select from a range of health service providers to procure health services to be paid for through the close wallet. The close wallet may be increased by around 5–10 percent to take care of health insurance, school fees and more. Issues of funerals can be built into the close wallet, as funerals especially in the southern parts of Nigeria can be poverty-inducing when livestock and household assets are sold off to fund funeral ceremonies.

Initiatives of the Competitive Africa Rice Initiative
The Competitive Africa Rice Initiative has the overall aim to improve the livelihoods of farmers and the rice value chain. It is funded by the German Agency for International Cooperation, Bill & Melinda Gates Foundation, and is implemented in collaboration with the Economic Community of West African States. The project implements a digital-enabled agricultural advisory service and value chain development to farmers leveraging digital solutions. The project uses digital platforms including:

i. ***RiceAdvice App:*** Developed by the international organization AfricaRice, the app provides advisory services via extension officers regarding all aspects of field operations on rice including weeding management, timing of fertilizer application and targeted microdosage of fertilizers.
ii. Other apps used are Paddy Biz, which facilitates pre-financing for farmers, the digitization of transactions records) and ***Cash App***, which facilitates access to credits leveraging production data, creating effective linkages with financial service providers.

The e-wallet of the Growth Enhancement Support scheme
An e-wallet voucher scheme in the framework of the Growth Enhancement Support (agriculture sector component of the transformation agenda of the [then] Government of Nigeria) facilitated access to inputs for farmers working with ecosystem players. With these vouchers, registered farmers could redeem fertilizers, seeds and other agricultural inputs from agrodealers. Implementation began in 2012 with the support of a digital agricultural services provider, Cellulant. Following the implementation of the now phased-out scheme, over 14 million farmers were registered and benefited from seeds subsidies and other services for their farming activities.

b) Other initiatives

National e-agriculture web portal
This is a web portal set up by NITDA to facilitate access to various agricultural information.

Digital agriculture solutions
The next table includes examples of digital agriculture solutions available in Nigeria. Many are operated by young local entrepreneurs.

Table 6. Digital agriculture solutions available in Nigeria

#	Digital agriculture solution	Type of services	Link to website
1	Hello Tractor (international company operating in Nigeria, Kenya and other countries)	• Mechanization services • Supply chain management	https://hellotractor.com
2	Crop2Cash	• Access to finance • Market linkages • Advisory services	https://www.crop2cash.com.ng
3	Kitovu Technology Company	• Supply chain management • Market linkages • Advisory services	https://kitovu.com.ng
4	Integrated Aerial Precision	• · Precision farming • Macro Agri Intelligence	http://bit.ly/IAPrecision
5	FarmCrowdy	• Financial inclusion • Market linkages, production	https://farmcrowdy.com/
6	Cashbuddy	• Financial inclusion	https://cashbuddy.ng/
7	Easypay	• Financial inclusion	https://easypaybillsng.com/
8	AGRISAT	• Advisory services	https://www.agrisat.net/
9	Zenvus	• Advisory services	https://www.zenvus.com/
10	Prep-eez Tech	• Advisory services	https://www.prepeez.com/
11	Zowasel · Market linkages	• Market linkages	https://www.zowasel.com/
12	Foodlocker · Market linkages	• Market linkages	https://www.foodlocker.com.ng/
13	Farmcenta	• Financial inclusion	https://farmcenta.com/
14	AgroInfoTech · Financial inclusion	• Financial inclusion	https://agroinfotech.org/
15	Probity Farms	• Advisory services	https://probitysoftware.com/
17	Competitive Africa Rice Initiative	• Advisory services · Market linkage	https://www.cari-project.org/

CHALLENGES AND OPPORTUNITIES

Almost all the organizations and individuals interviewed during this study demonstrated a positive outlook regarding the prospects for digital agriculture in the country for reasons including:

- The high proportion of the population that are youth who are ICT-savvy. Nigeria will soon have one of the youngest and largest working-age populations in the world. Adolescents currently number 41 million (23 percent of Nigeria's population), a figure that is set to rise to 84 million by 2050.
- Favourable national policies and government strategies.
- Increasing access to cheaper mobile phones and ICTs.

However, there are key important challenges that include the following:

- Poor digital literacy, low level of education of farmers, an adult literacy rate of 35 percent with a wide gap between men (44 percent) and women (27 percent)
- Poorer connectivity in rural areas where farmers dwell, and irregular access to constant electricity/power supply to charge phones
- Poor digital infrastructure and local content and services development
- Lack of sound business case to ensure sustainability of digital agricultural platforms (beyond donor funding and "pilot" projects)
- Low willingness of consumers (farmers) to pay for services on digital agriculture platforms because of low income. In addition, there appears to be a cultural issue premised on the fact that public agricultural extension services have always been provided at no direct cost to farmers, and some farmers ask, "So why the change now?"
- Some digital agriculture projects that seem to face political interference, and policy instability that affects the sustainability of the projects
- Some Nigerians seem to have no confidence in digital online services, especially the ones related to financial transactions, because of the perception that the platforms are unsafe and/or that their privacy could be compromised online
- Many platforms focus on crops (rice and maize in particular). One of the noticeable gaps however is that the profile of livestock in the digital solutions is comparatively low

6.2. Implementation options for the DVI

6.2.1. Field research methodology and village selection

More than 20 localities were pre-identified as candidate villages for the DVI as part of the scoping assessment exercise. Information has been gathered on Jere and Konduga in Borno State and Hadejia in Jigawa State. More specifically, field data collection took place in Borno State involving four villages arranged in two clusters: Konduga village cluster and Jere village cluster. Eventually, field data collection could not take place in Hadejia because of logistics reasons and time constraints. Agroecological and socioeconomic and technical characteristics can be different but the findings from these villages illustrate possible opportunities and constraints that may be encountered in some localities involved in the DVI initiative.

Possible activities that may be organized as part of the DVI activities are presented after the introduction of all localities visited.

6.2.2. Characterization of villages and potential activities

Konduga Village Cluster

The Konduga village cluster considered is made up of the villages Amarwa and Mashamari, both located along Maiduguri-Bama road in the same local government area. Prominent physical features of the village cluster are the Bornu Plains and flat lands characterized by their Sahelian ecology. The major vegetation of the village cluster is Sahelian with severe desert encroachment covering most of the Chad Basin areas. The period of wet season varies from place to place because of the topography, but generally the rainy season is normally from June to September, with relative humidity of about 40 percent and evaporation of 203 milimetres per year.

Around four-fifths of Borno State's population rely on agriculture (crop, livestock and fishery) for their livelihoods (Mohammed, 2018), making agriculture the key sector in the region. The major crops cultivated are maize, millet, sorghum, rice and cowpeas. The land is also suitable for the cultivation of other crops including wheat, cotton, sweet potatoes, fruits and vegetables. The climate-change manifestations of irregular rainfall pattern, temperature rises, floods and prevalence of pests and diseases all lower productivity and significantly affect agricultural production and food security.

Two of the four major national mobile phone operators (i.e. MTN and Airtel), are functional in the two villages. Few farmers use e-banking in the village. Many of the farmers own mobile phones, which are often basic feature phones. The physical census of ownership of phones indicates a very clear gender disparity in ownership of mobile phones: in the Amarwa village, 86 percent of males present in community discussions own mobile phones, in contrast with only 40 percent among the females. In the Mashamari village, male ownership of phones is 90 percent versus 30 percent for females. Efforts to reach out to female farmers through digital options by the proposed DVI project should take careful consideration of this difference. For both genders, only 5 percent own smart/android phones. In the design of DVI project activities, there is a need to focus mainly on the use of USSD methods rather than broadband or internet-based channels. Lack of funds was identified as the major constraint limiting the participation of women in agricultural activities in Konduga. It is recommended that appropriate policies and strategies should be developed to ensure access by women farmers to extension services, credit, inputs and training necessary for improved agricultural production (Saleh, Mustapha and Burabe, 2016).

Many development agencies work in the communities in the villages. In Amarwa, the key development players are the different United Nations organizations, including FAO, UNHCR, UNDP and UNICEF. The Borno State Agricultural Development Project, Government agencies and the local government authorities are present. International NGOs active in the village include Plan International and Christian Aid, while local NGOs and individual foundations are also present. In Mashamari, the key development players are United Nations organizations such as FAO, UNICEF, UNDP, international NGOs such as Plan International, Rescue and Action Against Hunger, and government agencies such as Borno State's Ministry of Agriculture and Natural Resources, State Emergency Management Agency as well as Nigeria's National Emergency Management Agency and Ministry of Agriculture and Rural Development.

The multiple partners existing in the village clusters can help the implementation of DVI in several ways:

- Some of the partners have a quasi-database of farmers that they are presently working with, which includes their profile and the socioeconomic situation of their households. This will be a valuable resource for DVI as it targets farmers for appropriate development intervention. For example, the Borno State's Youths Empowerment and Social Support Operations has an established social registry that could help DVI deepen its understanding of the youth in Borno State and their needs for better implementation.
- Many of the partners have been working in the village clusters for longer period and can

provide background information, subtle cultural issues and other undercurrents that may not be immediately discernible to officials of a new project (such as DVI) that is planning to intervene in the villages.

- The presence of several UN agencies in the cluster villages provide an opportunity to fulfil the mandate of the UN system "to deliver as one" and to "leave no one behind" in development assistance. DVI could seek ways to leverage (financial and material) resources with these agencies.

Jere Village Cluster

The Jere village cluster is made up of two villages, Gongulong and Dusuman, which are located in different directions away from Maiduguri but in the same local government area. Gongulong lies 11 km north of Maiduguri, while Dusuman is located 15 km east of Maiduguri. Gongulong is closer to Maiduguri and much more accessible by road. Dusuman is accessible for up to 8 km of tarred road while the remaining portion (about 7 km) is a dirt road off the main road. The land is flat and has a Sahel-Sudan vegetative cover. The rainy season is normally from June to September.

Almost all the major national mobile operators have their presence in the cluster but only Airtel and MTN are reported to have strong reception in the area. Mobile phone ownership in the village cluster is characterized as follows: most of the farmers (over 80 percent) have basic feature mobile phones, the possession of smart/android phones is very low (about 5 percent), and women have much less access to both basic and smart phones in the cluster. In the proposed DVI project, efforts should be made to prioritize USSD options rather than broadband/internet-based ones, and deliberate efforts should be made to reach out to women.

Gongulong has a heavy presence of development organizations that are assisting the district and adjoining villages. The organizations include United Nations organizations such as FAO, UNICEF, WHO, UNDP, and governmental organizations such as the State Conflict Management Alliance, Borno State Agricultural Development Programme, Water Board, State Universal Basic Education Board and health care agencies. Various international and local NGOs are also present in the cluster.

The specific ways that some of the partners may support the DVI project are as described above.

A focus group discussion (FGD) among men in Mashamari village

Hadejia Cluster

Jigawa State, in which Hadejia is located, has a high potential for agricultural production for household consumption, commerce and industry uses. Over 70 percent of the state's territory is considered arable, making it one of the most agriculturally endowed states in the country. However, over the years the area covered by this potential agricultural land has been constrained by the problems of flooding, Typha grass and migratory birds. Hadejia falls within the agricultural extension oversight of the Jigawa State Agricultural and Rural Development Authority.

Hadejia is in the eastern parts of Jigawa State in northern Nigeria. The area is dominated by the Hausa ethnic group, but Fulanis, Kanuri and other ethnic groups also live there. Most of the population of Hadejia engage in crop farming and animal rearing but some are traders or engage in fishing. During the wet season, crop production is dominated mainly by rice, millet, sorghum and maize. But in the dry season, the main crop produced are rice, maize, wheat, vegetables and peppers (chilli). In addition to crop production, the village economy is boosted by other economic ventures including mat-making from doum, a specialized activity in many of the floodplain villages. The mats, rope and baskets are sold locally or exported to other regions by the residents of the area. Baobab leaves are used widely as an ingredient for soups and important as a 'drought food'. Honey, produced by local beekeepers, is a highly valued commodity. The forest reserves and bushland of the floodplains yield important non-timber forest products that are significant to the livelihoods and subsistence of local communities. The Hadejia has four tertiary institutions.

SUGGESTED DVI ACTIVITIES

Pillar 1 activities – Increasing productivity

Several activities have been identified after interactions with key players and community members. Some key ones are the following.

- ***Digital climate information services and agricultural advisory services:*** The communities must be helped to make informed decisions as they plan their farm operations. Digital-enabled dissemination of weather patterns to farmers supported with agricultural extension and advisory services will be important for the village clusters. Given the prevalence of rice cultivation in the area and the challenges with marketing of farm produce, digital solutions such as Rice Advice and Crop2Cash focusing on agricultural commodity marketing among others may be used to provide advisory services to extension officers and farmers regarding each and every stage of field operations on rice and to provide farmers with weather information to help them make informed decisions on farm operations. Some of these solutions are already used in Hadejia.

- ***Crop monitoring for famine and early warning:*** Currently, crop monitoring and early warning strategies are based on the self-reporting of data by farmers in the localities. The challenge of this is that the self-reported data are likely to be inaccurate. Drone services for flying over and recording data on projected crop yields will be helpful to provide a triangulation of data with those self-reported by farmers, thus ensuring more robust data for supporting operational and policy planning on famine early warning in the villages. Moreover, this will increase the effectiveness of monitoring and alerts strategies and help for multi-audience information in some cases in real time (dissemination of alerts via mobile phones).

- Some of the development partners interviewed during the field data (such as the substation base manager of FAO Nigeria in Maiduguri) mentioned the need to maximize input use efficiency. For example, some questioned the current practices of blanket fertilizer application as the soils are not the same. The fertilizer recommendation could be tailored to the quality and needs of the different locations. Integrated sensors, drone and GIS-based digitized maps of farms could help increase crop yield. The services of the drone companies such as Integrated Aerial Precision Nigeria could support this. The rationale for this proposal is

the strong demand and felt needs expressed for this service by the partners and potential beneficiaries in the cluster villages during the field data collection interviews.

Pillar 2 activities – Market access and financial services

- ***E-commerce and market aggregation:*** Farmers in the village are engaging in intense dry season farming. This opportunity to produce two cycles of crops throughout the year could potentially improve farm households' income and the village economy in general. However, given that most of the dry season crops grown (vegetables) are highly perishable, and given the poor state of the roads, one of the options to maximize income from the crops is through the aggregation of farm produce to procure a higher market margin for farmers. As a result of the high cost of transport, the cost of marketing farm produce in the communities is very high. Often there are delays in selling to the market, and often farmers do not have a firm assurance that the products will be sold at good prices. How can smart monitoring help? Paddy Biz and Crop2Cash services and related digital solutions may be deployed to digitize the records of transactions between individual farmers and offtakers, and minimize delays in paying farmers at the end of the season. Records of inputs and outputs can indeed be compared, and farmers can be paid at the end of the farm season. There is no information on whether these digital solutions are used in the villages studied, but there are strong preferences and felt needs for these services by partners and potential beneficiaries in the cluster villages during the field data collection interviews. Some e commerce platforms, including Facebook, may be useful.

- ***Financial inclusion:*** One of the targets of some NGOs in the communities is to help women register for the digital ID National Identification Number, which will aid them in opening bank accounts. Easypay Nigeria (or related platforms) can also be promoted for financial transactions management.

Pillar 3 activities – supporting whole digital transformation

Whole village development solution: The NAVSA digital platform being developed by NITDA has great potential to be deployed in the communities as an ecosystem-driven digital platform to contribute to the transformation of the villages. The open and close electronic wallet of the platform could be modified by allocating a certain percentage of the annual profit of farm households to the close wallet to procure health services for the entire farm household members through request on the platform to a NAVSA-registered health provider.

7 Senegal

7.1. The agrifood systems and digital agriculture landscapes

7.1.1. Importance of the agriculture sector

Senegal is the second largest economy in the West African Economic and Monetary Union (UEMOA) after Côte d'Ivoire (Consultative Group to Assist the Poor, 2016) from the point of view of GDP, which stood at XOF 15 085.9 billion in 2020. The *Plan Sénégal Emergent (PSE)*, initiated in 2014 to transform the country into an emerging economy by 2035, plays a major role in accelerating economic growth. Senegalese agriculture has undergone significant changes over the past 50 years. It is strongly oriented towards cash crops (groundnuts and cotton), which has reduced its family farming characteristics. Cereal crops such as cowpeas, millet, rice and maize are also grown, as well as fruits, vegetables and cassavas, in response to a growing local demand.

The PSE includes an agricultural component, the *Programme d'accélération de la cadence de l'agriculture sénégalaise (PRACAS)*, which aims to strengthen food security and reduce the trade balance deficit. More specifically, PRACAS aims to develop strategic sectors and enable the reconstitution of seed capital, increase irrigated areas and improve rural equipment. It also seeks to invest in infrastructure for the storage and conservation of agricultural products in order to reduce post-harvest losses, improve the marketing of products, create agro-industrial development centres, and so on.

Agriculture contributed 20 percent to Senegal's GDP in 2016; a lower level of contribution was observed in subsequent years, although it is still around 15 percent. There are various policy frameworks and subsectoral programmes such as the National Agricultural Investment Programme for Food and Nutritional Security, the Multisectoral Strategic Plan for Nutrition in Senegal and the National Support Programme for Food Security and Resilience.

In line with the Country Programming Framework, agreed between FAO and Senegal, FAO's strategic intervention axes in the country concern: (i) the promotion of a sustainable, diversified, competitive, inclusive and growth-generating agro-sylvo-pastoral

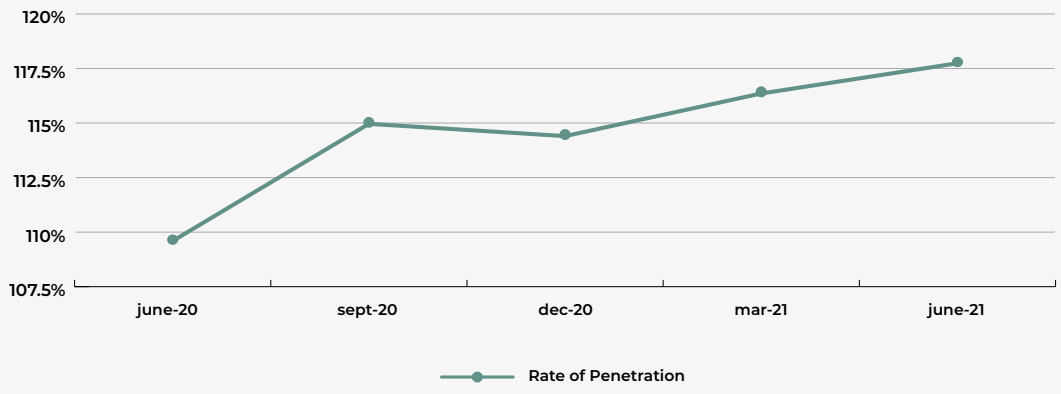
and fisheries sector; (ii) the improvement of food security and nutrition and the strengthening of the resilience of vulnerable populations and (iii) the sustainable management of the environment and natural resources.

7.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

Three mobile phone operators coexist in Senegal and share the national market. These are Orange (a subsidiary of the historical telecoms operator Sonatel), Free, and Expresso. In September 2021, there were 19 742 292 subscribers, corresponding to a penetration rate of 118.18 percent according to the Agence de Régulation des Télécommunication et des Postes, whose report, which the graph below relates to, shows the evolution of mobile connectivity between June 2020 and June 2021.

Figure 6. Quarterly evolution of the mobile phone penetration rate, June 2020–June 2021



Source: FAO Senegal

The PSE is based on the development of new growth engines around agriculture, agribusiness, social housing, mining and tourism, but also on a consolidation of traditional engines such as the telecommunications sector, known as the locomotive of the digital economy.

In this framework, a “Digital Senegal 2025” strategy was drawn up in 2016, embodying the country’s ambition to maintain its position as a leader in innovation. This 2016 strategy, which was subsequently updated, was based on three prerequisites (institutional and legal framework, human capital and digital confidence) and four axes.

- Pillar 1: Open and affordable access to digital networks and services
- Pillar 2: A connected administration at the service of citizens and businesses
- Pillar 3: The promotion of an innovative and value-creating digital industry
- Pillar 4: The diffusion of digital technology in priority economic sectors

The first orientation of Pillar 4 is dedicated to the agriculture sector. It has planned:

- to set up an open database of agricultural, livestock and fisheries statistics, with mobile and web access to the data
- to implement a system for modernizing agricultural activities covering the entire production cycle
- to promote devices such as geographic information systems and satellite imagery.

This digital strategy was reviewed and updated as the *Stratégie Sénégal Numérique 2025* (Senegal Digital Strategy 2025). The four pillars are still included. In the fourth, some priority actions have been planned for the agriculture sector, including:

a) The development of a system for measuring yield, soil and plant condition
b) The setting up of a system for identifying and securing livestock
c) The implementation of the digitalization programme for the fisheries sector

The other pillars also include priority actions that relate to the agricultural and rural domain, such as:

- Extending coverage to villages not covered by 4G using satellite connections
- Support and capacity building for rural women and women fish processors to sell their products online

Although Senegal does not have a formal digital agriculture strategy, these schemes provide a good understanding of the Government's ambitions for the agriculture sector.

KEY INITIATIVES AND SOLUTIONS

Senegal benefits from a favourable digital ecosystem for the development of innovative initiatives in agriculture thanks to the investments made in the country's digital infrastructure. A number of initiatives related to digital agriculture can be identified, such as those presented below.

Senlouma
This marketing and networking platform, developed by ANCAR with assistance from FAO, is used to link rural producers with traders and other urban customers, seed suppliers and input suppliers. It facilitates the shortening of value chains, the reduction of post-harvest losses, and the increase of producers' income. It is currently being scaled up across the country.

The SAIDA platform
FAO developed the digital platform Services agricoles et inclusion digitale en Afrique (SAIDA) for the benefit of interested countries. It is operated in Senegal in collaboration with the Senegal National Agency for Agricultural and Rural Council (ANCAR). Its main objective is to bring agricultural services closer to farmers, providing them with real-time information on weather forecasts, best agricultural practices, livestock care, market prices, health and nutrition directly available on their mobile phones. By 2022, SAIDA reached 300 000 farmers in Senegal through its web version and mobile application.

Tolbi
Tolbi services allow small farmers to take advantage of technologies such as drones, artificial intelligence, internet of things (IoT), satellite and adapted interactive voice response (in local languages). Its services help to assess crop water, fertilizer and plant care needs. With a simple phone equipped with a SIM card, users can remotely interact with their IoT device and collect the needed information.

Jokolante
Jokolante is a start-up that supports Senegalese rural producers for training programmes, facilitating access to production information, and raising awareness.

Soreetul
The company supports women in the agricultural value chain through e-commerce and other digital services. The company has won various prizes, including the Pitch AgriHack prize awarded by the Technical Centre for Agricultural and Rural Cooperation (CTA).

MLouma
MLouma is one of the first start-ups specializing in connecting and marketing agricultural products through e-commerce in Senegal. It works with the telecommunications operator Orange to offer its services.

Manobi
Manobi is one of the first African companies to offer digital agriculture business services, having started offering its services since 2001. The company now offers various digital services to optimize the agricultural value chain, including in the water sector. It facilitates farmer profiling and production mapping and data intelligence services in Senegal and beyond.

Aywajieune
Aywajieune is a young company created in the mid-2010s, specializing in providing market access services for fisheries products. In particular, it facilitates the sale of these products through its online trading platform. The company has won various prizes, including CTA's Pitch AgriHack prize.

GeoRisk Afric
GeoRisk Afric is a young Senegalese company that offers risk and disaster management services using geographic information systems.

SOWIT Senegal
SOWIT is a Franco-African start-up company with a presence in Senegal, offering precision agriculture services, notably through drones, aerial field-mapping, drone-assisted spraying and soil and plant analysis. Through its remote sensing and data analysis solutions, it supports farmers, farming organizations and policymakers in agricultural decision-making, including crop prediction tools for different crops. Access to data enables various services to be offered to producers, including financial services, access to the inputs they need and climate risk management.

THE SUPPORTIVE ECOSYSTEM

Some of the key actors supporting or that may support digital agriculture services are detailed below.

Ministry of Agriculture and Rural Equipment and its parastatals
The Ministry of Agriculture and Rural Equipment is the governing body playing a major role in the promotion of digital agriculture. It prepares and implements the policy defined by the Head of State in the fields of agriculture and rural equipment.

To achieve its objectives, the Ministry of Agriculture and Rural Equipment relies in particular on ANCAR, a public limited company with a minority public shareholding, created by the Government of Senegal with the support of the World Bank (within the framework of the *Programme des Services Agricoles et Organisations de Producteurs*, signed in 1999). The objective of ANCAR is to promote and pilot a decentralized agricultural and rural advisory service on demand, enabling small producers to sustainably improve productivity, production, food security and income. ANCAR is FAO's partner for various activities, including the deployment of SAIDA's digital platform and the launch of the pilot activity in Senegal.

These institutions operate in synergy with the Regional Rural Consultation Frameworks as well as producer organizations.

As far as non-public actors are concerned, in addition to companies and start-ups, various incubators and hubs are involved in supporting the

development of e-agricultural activities, some of which are listed below.

CTIC
It is one of the first digital business incubators in Senegal and one of the largest in French-speaking Africa. It was initially set up with the support of the Senegalese Government to support businesses.

Orange Digital Center – Senegal
This is a training school for software development, created by Senegal's historic telecommunications operator. It operates an incubator for start-ups that provides mostly free of charge services, as well as an investment fund to support digitalization projects.

A large number of international development partners are also involved in these activities, including the United Nations Capital Development Fund, which supports projects for access to digital finance by producers.

CHALLENGES FOR BETTER ADOPTION

Challenges to the wider adoption of digital tools in rural Senegal include weak access to electricity, low availability of internet connection, high cost of communication, and a lack of training in digital tools. Many digital tools developed are gradually being localized by integrating national languages. SAIDA, for example, is available in the six main local languages of the country. The low purchasing power of producers also hinders the adoption of smartphones in the rural world.

7.2. Implementation options for DVI

7.2.1. Field research methodology and village selection

For the field research, two production clusters were selected: the first in the geographic zone of the Saloum River where FAO's SAIDA was piloted the previous year, and the second in the Niayes zone where 80 percent of Senegal's vegetable production takes place. DVI could be piloted in two regions in these two areas: Kaolack (in the Saloum River) and Thies (in the Niayes). To identify specific districts where the research would be undertaken, some key criteria were identified. The presence of farmer field schools was a key selection criterion in order to harness DVI for ongoing initiatives supported by FAO and the Government. Another key criterion was the availability of 3G internet connectivity. The global mobile telecom organization GSM Association's connectivity platform was used to identify connectivity coverage. Five districts (called "communes" in French) were then selected: Diender Guedj, Kayar, Keur Moussa, Porokhane and Ndramé Escale.

Table 7. Selected districts for the research

Regions	District	Total villages	Preselected villages (randomly)	Number of producers sampled (50 per district)
Kaolack (Saloum River)	Porokhane	60	3	150
	Ndramé Escale	45	2	100
Thiès (Niayes)	Cayar	7	2	100
	Diender Guedj	20	3	150
	Keur Mousseu	36	2	100
TOTAL		**168**	**12**	**600**

The field research was implemented in 12 villages selected ramdomly, out of villages of the 5 districts: Darou Mougnaguene; Pakala Ngagne; Keur Diatta; Keur Malick Ndiere; Thiarene Djissa; Keur Abdou Ndoye; Tanty Yoff (Cayar); Thieudeme; Keur Matar; Thiamene Maka; Niakhip (Niakhip Serere); Yade.

7.2.2. Characterization of villages and potential activities

a) Agricultural activities and challenges

By and large, the two regions practise the same types of agricultural activities. These include crop production (involving horticultural, forestry, leguminous and cereal crops), livestock, trade, transport, fishing and processing. Different animal species can be identified: cattle, sheep, goats, poultry, horses, donkeys, pigs and fish.

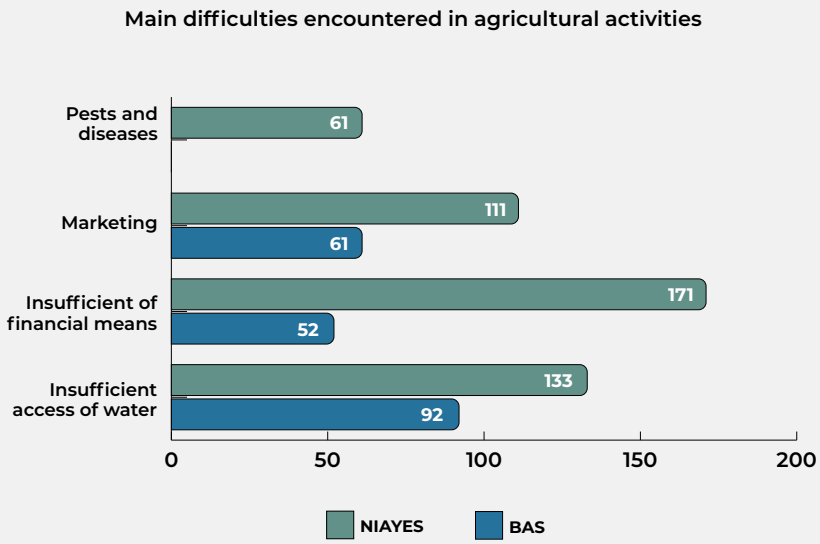
Out of the seven villages sampled in the Niayes zone, five have easily accessible markets, with paved roads linking Keur Abdou Ndoye and Tanty Yoff as well as other roads leading to the markets of Gollam, Keur Matar, and Thieudeme. In the Saloum River area, however, only the village of Pakala Ngagne has a big market, which is challenging to access.

Producers face enormous difficulties in their activities, both practically and organizationally. These include insufficient water supply, marketing and lack of production material as well as little access to finance. Pests and diseases are recurrent, particularly in the Niayes zone, where producers face more difficulties in addressing them. Figure 7 illustrates the main difficulties encountered by producers.

In addition, 70 percent of farmers in the BAS[5] zone (the Saloum River) and 61 percent in the Niayes zone report difficulties relating to climate change impacts, the main ones being higher temperatures, frequent strong winds and a significant rainfall deficit. These climatic variations, especially the heat peaks, are the cause of many damages, such as crop burns, and they generate a proliferation of certain fungal diseases and pests.

5 Bassin Arachidier Sud

Figure 7. Main difficulties encountered in agricultural activities in the two regions



Source: FAO Senegal

While the DVI, particularly for its scale-up, should consider all villages in two areas identified, the following villages might be prioritized if needed.

DISTRICTS	VILLAGES	SOME MAIN CROPS PRODUCED
Porokhane	Keur Diatta	cabbage; ocra; cucumber; tomato; onion
Ndramé Escale	Thiarène Djissa	bell pepper; diaxatu; cucumber; ocra; eggplant
Kayar	Kayar	hot pepper
Diender	Thieudeme	cabbage; corn; parsley
	Keur Matar	turnip; onion
Keur Moussa	Yadé	onion

b) ICT knowledge and use by farmers

In general, 56 percent of the farmers have some knowledge of digital technologies, even if they do not use them on a daily basis. This knowledge is higher in the Niayes zone which is closer to the capital city Dakar. Surprisingly however, the rate of use of digital technologies in agricultural activities is higher in the Saloum River area (BAS Zone) with 61.3 percent, than in the Niayes (27.5 percent). The rationale for ICT use according to farmers is related to marketing (through social networks, targeting customers by phone calls and more.) and to the search for agrometeorological advice and tips (interactions with peers or with extension officers through social networks). Farmers may be on the lookout for weather forecasts as well as phytosanitary products to combat possible diseases and pests. 95 percent of the farmers in the BAS zone use ICTs to search for agrometeorological information and 5 percent use them to market their production. On the other hand, in the Niayes zone,

62.5 percent of farmers use ICTs to sell their products and 51.4 percent to seek information to improve their activities. Furthermore, producers who do not use ICT in their agricultural activities explain that this is because they did not know that ICT had such usage. The lack of skills in relation to ICT prevents them from using such technologies.

OWNERSHIP AND ACCESS TO MOBILE PHONE

Given the producers' good knowledge of technology, 537 of the 600 producers surveyed have a telephone (89.5 percent), compared with 10.5 percent who do not. Out of the phone owners, 284 have smartphones (53 percent) and 253 simple phones (47 percent). The number of producers with access to a smartphone can be increased if most of the farmers without a smartphone can access a smartphone owned by at least one member of their household, which they can use to receive information. Considering this very important factor, the number of producers with access to (different from ownership of) a smartphone increases to 498 (or 83 percent).

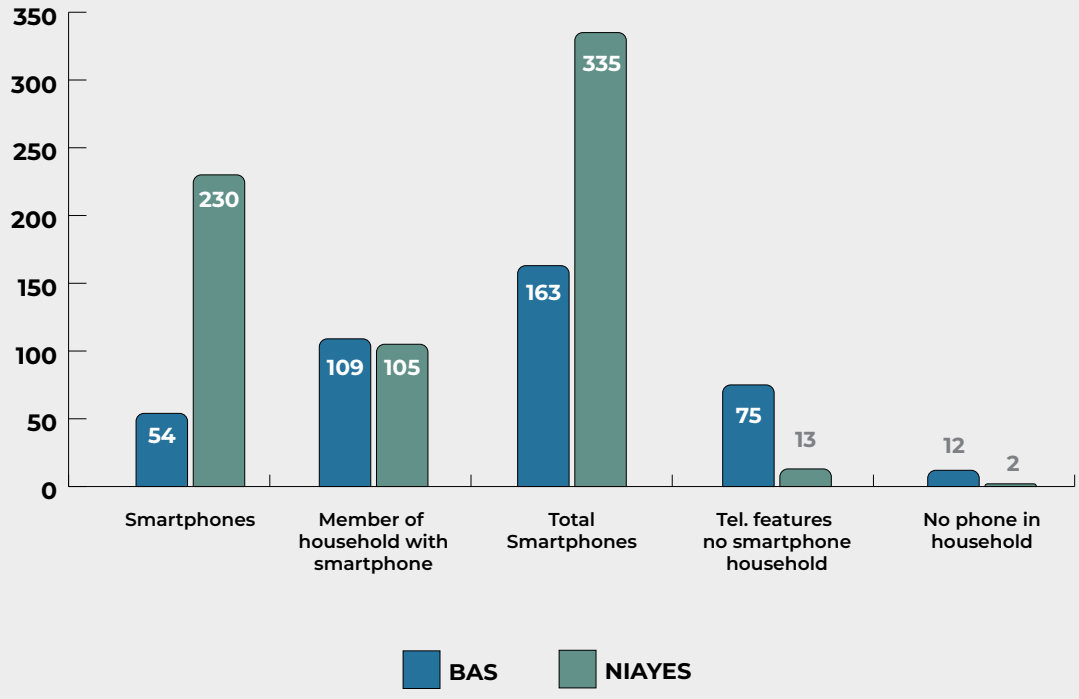
Other observations to note are the following:

- Fourteen percent of producers have a simple phone and without access to smartphone in the household
- Two percent of producers who do not have a phone have a member of their household that owns one

Thus, we may infer that 98 percent of producers have some access to a phone. The figure below shows the distribution of telephone types in the two zones (availability rates of 86.4 percent and 91.7 percent in the BAS (Saloum River) and Niayes respectively.

Of the 284 producers with a smartphone, only 129 (i.e. 45.4 percent) know that it is possible to use it for their farming activities. The trend is the same irrespective of the zone.

Figure 8. Ownership and access to telephones by producers

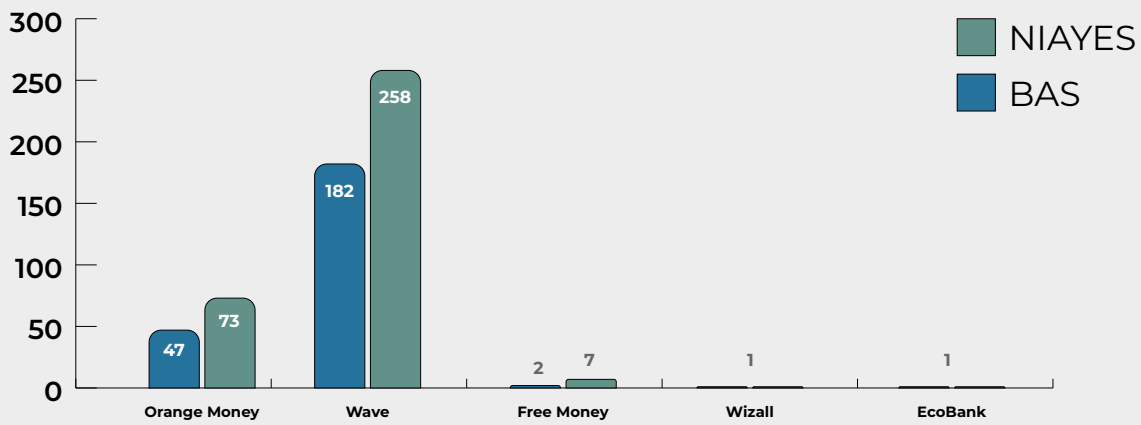


The Free and Orange mobile networks, generally considered the best, are the most widely used in Niayes and in the Saloum River (BAS zone) region, unlike the Expresso network. The Orange network is used more by producers in the BAS zone for internet connection; the quality is assessed to be moderately good in all villages sampled. The Expresso and Free networks are used less frequently. On the other hand, in Niayes, the Free network is preferred on account of its good coverage across all villages, though the Orange network is still used in parts of Niayes.

MOBILE-MONEY SERVICES

The table below provides information on the use of mobile payment services by producers. 77.5 percent of producers generally use these services compared with 22.5 percent who do not. The trend is the same irrespective of the zone, with 78.8 percent of users in Niayes and 76.5 percent in the Saloum River region. Wave Mobile Money and Orange Money remain the most used services, outperforming Free Money, WizAll and Ecobank mobile money services (see Figure 8).

Figure 9. Number of producers using electronic payment services in BAS and Niayes



ACCESS TO TRADITIONAL MEDIA

Traditional audiovisual communication is very important for good dissemination of information in the farming community. ***Télé Futurs*** Medias and SEN TV are the television stations that producers watch most in both zones. The most listened-to radio stations are RFM, Walfadjiri and Zik FM. However, there are other local radio frequencies that are well received by producers, of which 17.6 percent,

7.6 percent and 7.2 percent listen to Rip FM, Tawfekh FM and Kaolack FM, respectively in the BAS zone. On the other hand, Kayar FM is more popular with producers in Niayes.

c) Potential DVI activities

Several activities have been identified during research. They are mostly related to Pillars 1 and 2 of DVI.

PILLAR 1 ACTIVITIES – INCREASING PRODUCTIVITY

Digital climate information services and agricultural advisory services: Implementation of SAIDA services in those areas will help producers access the most up to date best practices to boost production as well as fight pests and diseases, one of their main challenges. SAIDA will also provide them with timely weather information as well as animal husbandry best practices, nutritional information about common foods in their areas as well as COVID-19-related advice. The addition of vegetable crops in SAIDA's portfolio will allow incorporating vegetable producers as beneficiaries.

Satellite and artificial intelligence-driven crop monitoring and early warning: FAO has been working with the company Tolbi in the framework of SAIDA to support farmers. The e-Tolbi service of the company is a tool that helps precisely monitor crop production by leveraging satellite imagery. Those images are interpreted with artificial intelligence to help produce advisory messages to producers and extension agents regarding crops' nutritious needs and disease presence. Messages are disseminated via mobile audio messages. Extension agents and farmers who are willing can access the digital platform. ANCAR, the national extension agency, has full access to a dashboard that provides production information for beneficiaries.

These services may be continued in the next phase. As needed, other digital agriculture services offered by other providers may be leveraged as well when possible and needed.

PILLAR 2 ACTIVITIES: MARKET ACCESS AND FINANCIAL SERVICES

The Senlouma marketplace managed by ANCAR can help farmers solve some of their access to market challenges. As mentioned above, access to the market is one of the main obstacles faced in the production value chain. Using social media for advertising and e-commerce services will help producers secure more clients throughout the country.

It would be helpful if ANCAR partners with service providers to achieve a successful incorporation of producers in the platform, which will help them boost their sales. A private service provider will more effectively facilitate the platform's marketing and ensure secured financial transactions, effective farmer enrolment and training, and logistics operations, all in partnership with the extension agency.

The last DVI pillar services may be implemented as needed and leverage available partnerships.

8 Somalia

8.1. The agrifood system and digital agriculture landscapes

8.1.1. Importance of the agriculture sector

Somalia is divided into six federal states (including the autonomous region of Somaliland), administratively divided into 18 regions, with the Government based in Mogadishu. It is estimated that almost half of the Somali people follow a mobile way of life, pursuing nomadic pastoralism or agropastoralism. As at January 2021, Somalia's population was estimated at 16.12 million, of which 50.1 percent were women and 49.9 percent men. 46.4 percent of its population lives in urban areas while the remaining 53.6 percent lives in rural areas (Kemp, 2021b). The International Monetary Fund forecast Somalia's economy to grow at an average rate of 4.3 percent till 2026 (TheGlobalEconomy.com, 2021). In 2019, 80.28 percent was employed in agriculture, 2.41 percent in industry and 17.31 percent in service sectors (International Labour Organization, 2021). From 2013 to 2017, Somalia's real GDP grew at an estimated average growth rate of 2.5 percent. The country unfortunately experienced severe economic shocks in 2019 and 2020 through drought, floods and locust invasions, which led to the economic growth rate's shrinking. 68.6 percent of the population lives below the poverty line of USD 1.90 per day. Youth unemployment is high, estimated at 37.4 percent being more rampant in urban areas than in rural areas. Agriculture's share of GDP (World Bank and FAO, 2018) is approximately 75 percent, and represents 93 percent of total exports, mostly linked to robust livestock exports.

Livestock farming is the main agricultural activity accounting for over 60 percent of total agricultural production. The main agricultural production areas are in the south, the north-east, and the inter-riverine regions of Bay and Bakool. Cereals are the main crops in cultivation although other crops like banana, sugar cane and horticultural crops do also make a significant contribution. Remittances contributed between 25 percent and 45 percent of Somalia's GDP until 2015, surpassing the amount of humanitarian aid and foreign direct investment combined (United Nations Industrial Development Organization, 2020).

8.1.2. Digital agriculture

POLICY FRAMEWORKS AND KEY INDICATORS

Several initiatives have been undertaken to develop relevant strategic direction for the agriculture sector. These include the country's Strategic Framework Vision 2016 (which established a road map for achieving national political settlement) and the Ministry of Agriculture's 2016–2020 Strategic Plan (Somalia, Ministry of Agriculture, 2016). FAO's Somalia Country Programming Paper (2019–2024) highlights key areas of intervention for resilience and transformation of the national food systems. The Ministry of Agriculture's Strategic Plan pursued three strategic goals: i) increasing agricultural production, ii) improving and rehabilitating productive agricultural infrastructure and iii) strengthening the institutional capacity of the Ministry of Agriculture. The main challenges facing the agriculture sector include the lack of security, lack of research and extension services, limited market options, poor road and transportation infrastructure, poor pest control capacity, lack of finance and credit, land disputes and weak policy environment.

Both the National Development Plan (2020–2024) and the National ICT Policy 2019–2024 (Somalia, Ministry of Communications and Technology, 2019) embrace the need for the digital economy and outline strategies to create an ICT enabling environment. These strategies include the development of e-commerce, the provision of e-government services and the deployment of automated agricultural support services. 4G connectivity is only available in urban centres, whereas most of the mobile coverage outside the urban areas is limited to 2G connectivity. The main focus areas of the National ICT Policy & Strategy 2019–2024 (Somalia, Ministry of Communications and Technology, 2019) include enhancing access (both cost and network coverage), improving the domestic digital infrastructure, supporting the generation of local content, strengthening ICT training and capacity building, establishing the relevant regulatory framework to guarantee citizen/consumer protection and the roll-out of e government services.

Currently the telecommunication market comprises five major operators (mobile network operators [MNOs]) and two mobile virtual network operators. The MNOs provide voice and data connectivity services to over 4 million subscribers.

Mobile phone subscriptions are estimated at 7.3 million active connections with an annual growth rate of 5.1 percent (Kemp, 2021b). Furthermore, the COVID-19 pandemic has led to a surge in e-commerce and accelerated digital transformation, causing businesses and consumers to progressively move to digital platforms for trade, communication and access to information.

The cost of an average internet bundle measured by the average bundle cost of USD 0.6 per 1 gigabit of data makes Somalia one of the cheapest countries to connect to the Internet (Ethiopia USD 1.67 and Kenya USD 2.25) (Howdle, 2021). The use of internet is fast growing with about 2m users having access to the internet mostly provided through mobile (about 12.8 percent of the population) (Internet World Stats, 2021).

The key stakeholders' interviews pointed out that the majority of internet subscribers live in urban areas (75 percent according to Hormuud's data). Women are less likely to use the internet daily (75.8 percent for men versus 54.8 percent for women). Younger generations use the internet more regularly (50.59 percent). Similarly, 83 percent of urban residents use the internet every day, whereas 17 percent of rural populations use the internet on a daily basis (Save Somali Women and Children, 2021). In 2018, in the third edition of its report on the Somali economy (World Bank, 2018), the World Bank estimated mobile-money penetration in urban areas to have reached over 80 percent, while in rural areas it was 55 percent (compared with 15 percent for formal bank accounts).
Somalia does not have a dedicated digital agriculture strategy. The National ICT Policy and Strategy (Somalia, Ministries of Posts, Telecommunications and Technology, 2019) seeks to support agriculture development in several ways. For example, it targets agriculture and research through the implementation of the SomaliREN Research and Education Network to interconnect

all tertiary and research institutions and support programmes for targeted innovation activities and spaces in agriculture and IoT generally. It seeks to establish a more effective and efficient land information system for effective agricultural and natural resource management. Further, the policy has identified the following strategies in support of digital agriculture:

- Digitize agricultural information (literature and records) and the provision of a geographical information system to record agricultural land use and manage natural resources
- Support the use of electronic payment platforms for agricultural and fishing producers
- Establish an online market for agricultural produce
- Provide strategic information to farmers on agricultural technologies and techniques, weather forecasts and market price information

KEY INITIATIVES AND SOLUTIONS

Although Somalia does not have a digital agriculture strategy, several of its ongoing initiatives are demonstrating success which, if further strengthened, can lead to improved agricultural productivity, resilience and access to markets. Examples include those presented below.

a) Selected highlights

iRise Hub farmer registry solution
iRise Hub is an innovation technology hub based in Somalia. Its activities include: i) training and capacity building to empower youths with digital skills and ii) an incubation programme ("Kobciye" innovation programme) that seeks to incubate small and medium enterprises and start-ups. In addition, through its microfinance initiative, iRise is participating in an initiative to register farmers to facilitate financial inclusion. This registration also suffices as a national registration solution in the interim until nationwide registration is implemented. The initiative expects 1.5 million rural dwellers to register.

Growth, Enterprise, Employment & Livelihoods
Somalia's Growth, Enterprise, Employment & Livelihoods initiative is a USAID-funded organization involved in establishing and supporting value chains in agriculture, livestock, fisheries, energy and finance across Somalia. Job creation and strengthening climate-change resilience are the defining activities of the initiative. The use of digital technologies as needed is included in the activities.

The Livestock Marketing Information System
The Livestock Marketing Information System is a web-based system that collects data from the three livestock markets, Hargeisa, Burao and Tog Wajaale, along with the port of Berbera and cross-border market of Lawyacado and disseminates it to the famers in the form of SMS. Farmers subscribe to market information, which is sent either weekly, every two weeks or monthly to them. Among others, the following datasets are collected at the market level: prices of export quality small ruminants, cattle and camels; number of exporters active in the market; retail prices of key staple food commodities.

TACAB Farmer Information Centre
TACAB-Line is an agro-advisory and consultant firm that uses spatial and other geographical information data to provide effective time- and location-specific advisory services to Somali farmers. They have initiated a call centre, where farmers call in to receive meteorological information, pest control information and seeds and land preparation advice. Further, the call centre issues alerts to farmers through SMS- and app-based services. The TACAB-Line also depends on a network of extension officers who proxy information access on behalf of the farmers. It uses a technology-based platform that integrates and links farm map fields with a database of analytical results on soil composition. Additionally, weather data is combined with in-field probes and sensors for irrigation scheduling. It uses Normalized Difference Vegetation Index imagery and drone flights to

monitor crop development during the vegetation cycle and crop development stages.

The SMS platform Digniin and the Somalia Water and Land Information Management project

The FAO Somalia Water and Land Information Management project has implemented an early warning system called Digniin, which enables the production and dissemination of early warning information to agencies, the Somali Government and vulnerable communities via digital tools. Digniin relies on the use of SMS alerts at the beginning of every season to provide crop production and any early warning information. It monitors flooding in the Shebelle and Juba rivers by using satellite imagery and generating timely flooding alerts and other climate-change phenomena. For example, during the El Nino climate phenomenon that occurred some years ago, about 8 800 SMSs were sent and over 3 000 copies of flood preparedness brochures were distributed within the vulnerable communities along the Juba and Shabelle rivers, helping to save lives and prevent huge economic losses.

E-voucher system

The e-voucher system has been used by FAO to ensure transparency, accuracy and accountability in cash transfers, payments and any form of assistance to bona fide beneficiaries. FAO works with local partners and agrodealers to reach targeted beneficiaries. This has been predominantly successful in the riverine and agropastoral regions of the country.

Field Integrated Database System

The Field Integrated Database System is an online repository of the Somalia Food Security and Nutrition Analysis Unit. It provides users with timely, relevant information and analysis for better market decision-making. It is a web-based system facilitating multiplatform access and a custom Data Exploration Tool for all of the Unit's primary datasets including crop, livestock, urban and other partner data such as the Somaliland Chamber of Commerce, UNDP Population, World Food Programme, and so on.

Form Management Tool suite of applications

FAO uses the Form Management Tool (FMT) to create, distribute, collect, process and store field- and office-based questionnaires and data. FMT enables the sending of questionnaires via email to field enumerators for real-time data capture. Once the data entry is completed, enumerators send the duly completed questionnaires via email, thus allowing more rapid processing, storage and dissemination of the data. The e-platform supports other building blocks, such as the Financial Management Module which facilitates the tracking and monitoring of resilience funds disbursed to populations in Somalia facing specific challenges such as COVID-19 impacts.

b) Other initiatives

DIGITAL AGRICULTURE SOLUTIONS

Table 8. Some digital agricultural applications

DIGITAL PLATFORMS	PURPOSE
Abaaraha	Crisis mapping platform helping relief responders connect with drought victims for faster response
Mdalag	Online market for farmers: Customized local produce and market prices
Sokaab and Bulsho Kaab	Crowd funding platform; some funded projects are rural or agriculture development activities
UNDP Weather App	Aiding pastoralists through weather disasters

Many of the solutions and technologies presented above can be used during DVI implementation.

CHALLENGES AND OPPORTUNITIES

The main challenges facing digital agriculture in Somalia can be grouped in four clusters as follows:

Large insecurity
The presence of armed militia in certain parts of the country not only makes it difficult for people to move about freely, it also restricts investment in development and ICT infrastructure and services. Many hotspot areas are in south-central Somalia. For instance, while FAO has invested DVI pre-launch activities in Baidoa, the rapidly evolving security situation made it impossible for consultants to travel to the villages targeted to conduct primary data collection. They had to rely on third parties to collect this data. Therefore, besides the ranking of villages made below, it is important for FAO to examine the context dynamics with regard to security in deciding on where to base DVI activities.

Technology-related challenges
These are challenges related to the availability of relevant technological infrastructure including network connectivity, mobile network availability, availability of supporting infrastructure (e.g. electricity) and internet connectivity. Poor connectivity outside urban areas presents a significant challenge to digital agriculture. This is coupled with intermittent connectivity and the destruction of infrastructure through years of conflicts. Electricity costs are estimated at USD 1 per kilowatt hour, compared with the neighbouring countries of Kenya and Ethiopia, whose average rates are USD 0.16 and USD 0.03 per kilowatt hour, respectively.

Lack of capacity
These challenges concern the capacity of the farmers and agriculture stakeholders to use digital technologies. There are also language barriers. Often, digital services should be provided in local languages, and basic technologies such as SMS/ USSD must be used instead of technologies that may require advanced computing knowledge or devices. In addition, even though Somalia has an emerging local ICT support industry, this is still hampered by capacity problems. Most of the ICT support for agribusiness is provided by start-ups and are yet to demonstrate survivability. The country's innovation systems are still at their infancy although there are some initiatives currently showing potential e.g. the iRise Innovation Hub, Ari.Farm and SOKAAB, among others.

Policy Framework
A dedicated digital agriculture policy has yet to exist despite the country having developed the National ICT Policy and Strategy as well as the National Development Plan – 9, which have highlighted the important role that agriculture and technology play in the country.

Critical success factors: Besides a relatively secure operating environment, a successful DVI in Somalia must address three key success factors relating to improving technology, the people aspects and the enabling environment.

8.2. Implementation options for the DVI

8.2.1. Field research methodology and village cluster selection

The key factors that were considered for the selection of the villages are the following:

- **Technology:** Access to telecommunication connectivity, including some availability of local support
- **Local institutional support:** Structured and established community-based organizations/

farm groups/savings and credit cooperatives/ VSLAs with clear leadership, vision and strategic interest as well as FAO presence

- **Security and accessibility:** A relatively conducive security environment that allows some level of physical access to project locations
- **People aspects/capacity:** Minimum digital skills capacity availability
- **Support services:** Availability of energy, including off-grid, health services, financial services, etc.
- **Agropastoral potentials:** An area with potential for agricultural and/or pastoral activities, ease of access to market

Considering these elements, at least in a first phase, south-central Somalia was initially targeted for the field research. The research methodology included desk research, interviews, FGDs and field research. The consultants collected data through FGDs with farmer groups in the south-central region of Somalia and hold key informant interviews with key stakeholders from Government ministries, private and international organizations, academic institutions and others. Seventy-two stakeholders (comprising 36 women and 36 men) were involved in the FGDs while 20 key informants participated in interviews.

The field research was largely implemented in south-central Somalia, prioritizing districts where FAO has existing farmer and pastoral groups. Given security volatility of most rural locations in Somalia, these districts were considered to be the most strategic to conduct the scoping exercise, as well as DVI pre-launch activities. Baidoa was particularly found to be interesting since it is Somalia's Sorghum Belt and food basket for the region, where trade and mobile transactions are quite significant. However, the choice of location for DVI activities in the future need to critically take into account issues such as security stability and the existence of supportive infrastructure, which present a more conducive environment to implement and monitor the impact of DVI.

As mentioned, one of the main challenges encountered after selecting south-central Somalia was that, because of security constraints, access to the region was severely restricted before the start of the consultant's mission. The field exercise was eventually conducted, leveraging on-site human resources, but the depth of information that could be collected was limited.

8.2.2. Characterization of village clusters and potential activities

Below are localities documented in south-central Somalia as part of the scoping assessment. As indicated in the methodology paragraphs above, it is important to remain open during implementation and consider other localities where security will not be an issue, including in Somaliland. The localities are presented alongside the villages that could be targeted.

Baidoa

Baidoa is the interim capital town of the South-West State of Somalia; it is situated around 250 km from Mogadishu. The city is traditionally one of the most important economic centres in southern Somalia, with its key economic activity being agricultural crop and livestock production. It primarily produces sorghum, maize, groundnuts and beans. The Bay region (of which Baidoa is a district) produces 50 percent of the country's sorghum output with most of it used for local consumption. Most farmers are organized into cooperatives and are registered by the Ministry of Agriculture in the South-West State of Somalia.

Through partnership with the Faculty of Agricultural Science at Zamzam University, small-scale farmers in Baidoa are able to receive information on modern farming techniques. The University is currently piloting potato, ginger, rice and maize production for dry land with the objective of developing a variety that can be used for the Bay's climatic

zones. As confirmed by the FGDs and key informant interviews, a big number of rural farmers have access to basic mobile phones with their demand being mostly driven by mobile money. Several villages in Baidoa district enjoy access to numerous services that are key for their development. The degree of service partake varies from one village to another. Most of the villages in this district have the potential to own and support DVI activities.

The two villages access basic mobile phones as well as digital mobile money, which sees significant use because of its convenience, accessibility and affordability. The accessibility of mobile phones and radios is particularly useful in agriculture advisory and extension services for the digitalization initiative.

Beledweyne

Beledweyne is the capital town of the Hiran region, with a population of 1 million people and is the largest urban centre of Hiran and the entire Hirshabelle State of Somalia. The town is strategically situated on the Shebelle River, 340 km north of Mogadishu and 50 km from the Ethiopian border. It is also a vibrant commercial hub thanks to its trade links with the capital Mogadishu and northern part of the country, especially the Puntland towns of Galkacyo and Bosaso. The built-up area in Beledweyne has grown steadily at an average rate of 5 percent per year over the last 15 years (Somalia, International Organization for Migration and United Nations Human Settlements Programme, 2020).

Therefore, because of its location along the Shebelle River, Beledweyne is a major agricultural production area.. According to the National Development Plan 9, Hiran has the largest livestock population in Somalia, estimated in 2018 at almost 5 million animals. Beledweyne enjoys relative peace and is connected to the Hormuud and Somtel telecommunications networks.

Nearly all the villages in this district enjoy various benefits from being strategically located within the district. The villages have access to radio communication, health facilities, a presence of entrepreneurs and community-based organizations that can sustainably co-own DVI.

Tulo-Hiran, one of the villages in Beledweyne with an approximate population of 3 060 households, continues to grow rapidly. It holds strategic importance because it is located in the main road that crosses the country and connects Mogadishu to the rest of the central regions and is in close proximity to the Ethiopian border. The town enjoys relative peace and is connected to the Hormuud and Somtel telecommunications networks, making it suitable for the DVI project.

Jowhar

Jowhar is the capital town of the Middle Shabelle region and the headquarters of the Hirshabelle State of Somalia. It has an estimated population of 600 000 and is situated along the Shebelle River. The town is rich in agricultural production, commonly producing maize, beans, rice, sesame, onions and sorghum in addition to fruits such as mangoes, guavas, lemons, bananas tomatoes and onions.

Most of the villages in this district have a population of less than 600 households. In addition to the above strengths, the villages all have access to very-small-aperture terminal connectivity and radio services which are key to communication and connectivity. The Government services and health facilities are available for the villagers to use. There is also good infrastructure that enables the movement of villagers within the villages and ease of access to the markets.

Bal'ad

Bal'ad District is one of the districts in the Middle Shabelle region of Somalia. It is located about 36 km northeast of the capital city of Mogadishu. The district has nearly 22 villages with an area of 4 400 km^2 (1 700 square miles) and an estimated population of over 120 000. Lying 70 km along the coast of the Indian Ocean, the district is famous for agriculture, livestock and marine resources, its most produced crops including cowpeas, sorghum, maize and sesame. Shebelle River also flows through Bal'ad, and while this makes the district prone to floods, it supports canal irrigation for over 600 farms.

Apart from having good network coverage and connection to Hormud, the villages in Bal'ad also enjoy good infrastructure. Better health facilities and Government services are readily available. Bilkeeys is one of the villages in Bal'ad district that has the potential to participate in this DVI pilot because of its advantageous position within the district. Located along the coast of the Indian Ocean, it is famous for agriculture, livestock and marine resources, with the most produced crops being cowpeas, sorghum, maize and sesame. Shebelle River, one of the two perennial rivers in Somalia, flows through this village and sometimes causes destructive flash floods. Farmers here mostly use irrigated tap water from Shebelle's many canals, sourcing it from the river, which provides constant water for irrigation throughout the year, boosting the farming sector.

Afgooye

Afgooye is a town in Lower Shabelle, southwestern Somalia. The Shebelle River passes through the locality, where most of the residents practise farming (particularly bananas and oranges). According to the 2014 census, Afgooye District's total population was estimated at 238 655 (United Nations Population Fund, 2014). Rich in crop production, Afgooye's main markets are located in the capital Mogadishu, which lies 30 km from Afgooye, giving the town strategic importance. Afgooye enjoys good network coverage powered by a terrestrial fibre-optic connection directly connected to a submarine communications cable.

Sabiid is a village in Afgoye District with a population of 1 700 households. The Shebelle River passes through this village, and most of its people farm bananas and oranges. The locality enjoys good network coverage as the terrestrial fibre-optic connection from the sea cable reaches the agricultural town. This also makes it suitable for DVI.

POTENTIAL DVI ACTIVITIES

Some digital agriculture activities that may be implemented in the identified localities:

- Development of easy-to-use digital applications that can be used to pass on key messages on farming, marketing and financial services etc.
- Development of learning programmes that can be aired on radio, incorporating innovative and participatory segments such as interactive radio sessions, question and answer sessions, drama, poems, plays, etc.
- The use of WhatsApp and other digital platforms for educational purposes, such as short videos with demonstrations to promote the uptake of sustainable production methods, training on financial literacy, nutrition etc.
- Activities to spark coordination and joint collaboration among groups for improved production and to encourage peer-to-peer learning
- Digital support to producer groups through e-platform enablers, for instance the development of e-wallet apps coupled with training on how to use these apps to improve financial management
- The use of short messages, voice messages and other digital platforms (such as Digniin) to share key weather information, early warning information to prompt early action, market information prices, availability of inputs, foods, etc.
- Linking producer groups with extension service providers through digital platforms
- Exploring partnerships with public and private stakeholders to develop digital platforms for delivery of extension services

PARTNERSHIP OPTIONS

Proposed partnerships are described in the following table:

Table 9. Some partnership options for the DVI in Somalia

TYPE OF PARTNER	ROLE	POTENTIAL ORGANIZATION
National Governments	• Creating an enabling environment and sustainable agricultural resources management • Strengthening resource mobilization capacity of the relevant ministries • Providing linkages between different Government agencies and state governments across the country	• Ministry of Posts, Telecommunications & Technology • Ministry of Planning, Investment and Economic Development • Ministry of Agriculture • Ministry of Energy and Water Resources
Private Sector	• Provide cost-effective and reliable services to DVI: Information curation, platforms, networks, applications, financial services, etc. • Participation through respective corporate responsibility programmes	• Hormuud/Golis/Telesom • Dahabshiil Bank • IBS Bank • Salaam Somali Bank
Non-Governmental Organizations and international organisations	• Sharing of expertise, data, and implementation strategies • Community involvement and rural development expertise	• UNDP • USAID
Small and Medium Enterprises	• Entrepreneurial Opportunity to provide appropriate services	• Midnimo Microfinance • Agrobank
Academic Institutions	• Research & Development • Training & Capacity Building	• SomariLen/SIMAD University/ Zamzam University/Hano University/ technical and vocational education and training
Farmers	• Target farmer groups and individual farmers for the implementation of the initiative's objective	• Farm groups and VSLAs
Cooperatives	• Farmer Registration Services • Support through existing initiatives	• Local farm groups/associations
Research Centres	• Research and development • Evaluation • Innovation and start-up	• iRise Innovation Hub/Tacab-line

9 DVI activities in Liberia and Zimbabwe

In addition to the initial seven countries that were involved in the DVI project, Liberia and Zimbabwe have joined the initiative.

9.1. Liberia

Alongside UNDP, the International Labour Organization, United Nations Women and the World Food Programme, FAO is coordinating the implementation of a USD 5-million joint project called “Building Resilience of Women, Youth and Vulnerable Groups through Social Protection Floor in Liberia using ICT”. The project is a three-year intervention funded by the United Human Security Trust Fund and aims to address the complex multisectoral and interconnected challenges of human insecurities, particularly food and the socioeconomic issues faced by the most vulnerable and neglected populations of the north-central region of Liberia at the community level. Digital activities to be implemented are linked to FAO’s DVI; in that framework, smart villages will be established to support the delivery of services to beneficiaries.

The partners involved include the Ministry of Agriculture, the Ministry of Commerce and Industry, the Ministry of Labour, the Ministry of Youth and Sports, the Ministry of Gender, Children and Social Protection, the Ministry of Internal Affairs, the Cooperative Development Agency, the Liberia Telecommunications Corporation, Orange Liberia, Lonestar Cell MTN, International Telecommunication Union, the Labor Congress of Liberia, the Liberia Chamber of Commerce, and civil society organizations working on bottom-up and livelihood support and development. The private sector will provide support under a public-private partnership model and as part of their corporate social responsibility. The project will promote the concept of human security with “protection” and “empowerment” measures as the most appropriate approach. It targets 3 000 young female and male household heads, including youth living with disabilities as direct beneficiaries (targeting 50 percent male and 50 percent female participants), and 10 000 indirect beneficiaries. As part of the intervention approach under this project, about 2 500 indirect beneficiaries will be targeted (50 percent males and 50 percent females).

The project will focus on three key interrelated outcomes: (1) increased access to digital innovation for women and young males and females in the targeted counties for inclusive human security and community empowerment; (2) increased access to

resilient food systems for women and young males and females in the targeted counties for sustainable and inclusive economic and human development and (3) increased knowledge for men and women of the concept of human security in all counties of Liberia through implementing this initiative as a model human security project.

To commence the implementation of project activities, the Joint Programme Implementation Team (PIT), along with key government stakeholders and the International Telecommunications Union undertook a joint assessment mission from 18 September to 26 September 2022. The purpose of the assessment was to map out vulnerable communities, identify needs, existing social protection gaps, assets, challenges and risks faced by the communities to inform the PIT decision for intervention in the targeted communities.

Deplorable road conditions, inadequate social services and lack of access to market were identified as challenges faced by communities during the joint assessment. The lack of electricity and reliable internet connectivity were also identified as challenges faced by the communities. These challenges have to be addressed holistically: "delivering as one".

Outcome 1 of the project aims to enhance access to and utility of services related to the Sustainable Development Goals (SDGs) using ICT and digital technologies and will involve the establishment of smart villages. Localities in three counties in the North-Central region of Liberia will be turned into digital villages. Activities will focus on promoting community-driven e-agriculture services (including weather and extension services, market access) as well as food system planning, implementation and management; education and skills development; livelihood strategies such as income generation, cooperative administration and health services including health insurance for women, youth and the vulnerable population.

Access to markets and financial services in rural communities will be given priority working with private and public sector digital technology actors. It will complement the United Nations Women forthcoming digital platform "Buy from Women", which connects smallholder farmers to information, finance and markets. The digital technology approach will help deliver activities related to the SDGs and improve the quality of life for rural populations through an inclusive digital transformation process. Enabling and enhancing access to digital financial services in underserved communities through safe and robust digital financial systems will empower unbanked populations, especially women and youths, to participate and contribute to building a digital economy for digital transformation.

Aimed at building resilient community-led food systems and holistically addressing the key aspects of sustainable food systems – including the environment, social, and economic bottlenecks undermining food and nutrition security – Outcome 2 of the project will focus on building local and community capacity for food systems planning, implementation and management, including access to agriculture inputs and services, economic livelihoods and cooperatives development. This outcome will build synergy and greatly benefit from Outcome 1 by, for example, providing digital solutions for food system planning, implementation and management, ensuring farmers' access to advisory services as well as buying local inputs and selling products through the Smart Village Approach, supporting cooperatives development through digital solutions.

Outcome 3 of the project will increase knowledge on the concept of human security among communities, civil society organizations, development partners, and public and private development institutions.

The project aligns with the Government of Liberia's Pro-Poor Agenda for Prosperity and Development 2018–2023, focusing in particular on its Pillar One, "Power to the People", the goal of which involves "Reducing developmental inequality to enable the people to prosper", focusing on the most vulnerable and extremely poor groups and regions as well as youth and women empowerment; and focusing on

Pillars Two and Three, “The Economy and Jobs” and “Sustaining the Peace”, respectively.

The intervention will also contribute to the Government’s progress towards achieving the SDGs, including SDG 1: Zero Poverty; SDG 2: Zero Hunger; SDG 5: Gender Equality; SDG 8: Decent Jobs and Economic Growth; SDG 13: Climate Action; and SDG 17: Global Partnership for Sustainable Development. As the lead agency, FAO will ensure coordination, coherence and complementarity in providing robust technical support and expertise for the successful implementation of the project.

PIT has completed the following as build-up activities leading to the full implementation of project activities on the ground: A resource mobilization strategy to mobilize funds and bridge the funding gap of USD 3.525 million has been formulated, Stakeholders Consultations have been completed, and a joint field assessment was conducted and report finalized for submission to the Resident Coordinator, Chairman of the Steering Committee of the project. A workshop funded by the International Telecommunications Union and project launch are pending.

9.2. Zimbabwe

The initial DVI project in Zimbabwe will facilitate support towards its full launch. It will help strengthen understanding of the local ecosystem and enhance national capacity to design, plan and deploy digital village services for improved food security and rural transformation. Activities planned include conducting a digital village scoping study (which will inform the subsequent steps, i.e. designing, testing and deploying digital innovations targeting agriculture and the rural sector), a light testing of some DVI services in a specific community to be identified, as well as the development of a full DVI project proposal.

The Ministry of Lands, Agriculture, Fisheries, Water and Rural Development will be the main project counterpart, who will work with FAO towards the delivery of project activities on the ground. The project will also work closely with relevant stakeholders such as the World Bank, African Development Bank, International Telecommunications Union and UNDP. Other relevant stakeholders, such as farmer organizations, civil society organizations, non-government organizations, and private sector organizations will be consulted during the project’s implementation and invited to participate where relevant. The project will ensure that youth and women are represented in all technical consultations and meetings, as well as relevant consultations that will be carried out throughout the project duration.

The project will seek to work closely with ongoing and developing FAO projects such as the Hand-In-Hand Initiative in the country to create synergies and ensure the relevance and sustainability of this project. FAO Zimbabwe is implementing a European Union-funded project in the southern parts of the country, seeking to increase the resilience of vulnerable communities in six districts in Zimbabwe. There is scope to roll out the DVI while leveraging this project by targeting specific DVI activities in relevant districts.

The activities will provide learning and capacities that will help the FAO Zimbabwe country office streamline and develop digital agriculture support to stakeholders in the country. They will also contribute to Government programmes in the implementation of the National AgriTech Strategy 2021–2025

Implementation has just started. The Ministry of Lands, Agriculture Fisheries, Water and Rural Development pre-selected Masvingo and Mashonaland West Provinces for piloting the initiative. FAO supported the Ministry in March 2023 for a scoping mission in Masvingo Province, where three clusters of villages were assessed. Consulted were local Mobile and Internet service providers, Provincial, District, Ward and Village leadership as well as 110 farmers (youth and women included). The results of the assessment will lead to the final selection of villages where initial DVI activities will be implemented at the pilot phase.

10 Key insights on implementation and success factors

10.1. Insights on initial service implementation in countries

10.1.1. Field activities in Kenya

For the initial activities implemented in Kenya, focus was put on Pillar 1 of the DVI model, relating to enhancing production through digital tools. Two wards in the Uasin Gishu County and one ward in Nyandarua County were selected as targets for pilot activities, though other counties such as Nakuru are involved in the various actions implemented.

A key platform being leveraged for the operations of DVI in Kenya is the Kenya Integrated Agriculture Management Information System (KIAMIS) that FAO funded for the Government. The platform has been facilitating the e-registration of farmers (about 130 000 registered) and supporting the offer of services such as the management of input e-voucher distribution.

The pilot activities carried out aimed at favouring the integration of e-extension services and other value-added digital services in KIAMIS so that it better responded to needs expressed by counties. These services also favoured partnership with other extension service providers, such as those involved in the World Bank's One Million Farmer Platform. The pilot activities also permitted the procurement of equipment to the targeted counties so that they better offer digital services.

Two reports have been commissioned in that framework.

The first report studied the state of extension and advisory services in Kenya in 17 counties.[6] Among others, the study established that, on average, the extension officer to farmer ratio for the counties under review is approximately 1:1 277, though in some counties (e.g. Narok, Kisii, Homabay and Bomet) the ratio is more than 2 000 extension

6 Bomet, Kisii, Kisumu, Kitui, Nyeri, Nakuru, Tharaka Nithi, Kirinyaga, Mombasa, Siaya, Homabay, Murang'a, Lamu, Wajir, Taita Taveta, Narok and Kwale

officers for one farmer. To be noted, the Agriculture Sector Transformation and Growth Strategy (ASTGS) aims to achieve an extension officer to farmer ratio of 1:600 by 2029. The most common extension approaches used across the counties included trade fairs (16 percent), e-extension (14 percent), farm visits (14 percent) and exchange visits (12 percent). The e-extension model in place includes the use of call centres, which is becoming popular. The Government of Kenya has planned to digitally upskill thousands of young extension officers to achieve the targeted extension staff to farmer ratio. The study also identified available training institutions (notably the Agricultural Training Centres present in 76 percent of the 17 counties researched) and provided an overview of their capacity and extension services challenges. Bottlenecks include lack of ICT skills and facilities (internet, smartphones, tablets). DVI can contribute to achieving this aim by offering e-extension services.

The second report focused on digital extension practices and on how to implement the e-extension features to be integrated in the KIAMIS. More specifically, it reviewed: i) the services and processes of the farmers' call centre hosted at the Agricultural Training Centre in Nakuru (to better understand their communication needs and workflow); ii) e-extension features of the Zambia Integrated Agriculture Management Information System (ZIAMIS), which FAO has also funded and which is considered a successful platform; and then iii) developed specifications relating to the future extension services of KIAMIS. The research involved exchanges with county officials in the Uasin Gishu and Nakuru counties, observations of operations of the Nakuru Farmers' call centre, exchanges with users and officers responsible for the implementation of the ZIAMIS platform in Zambia.

In Nakuru, the call centre, launched in 2018, operates more call services than digital services, though it owns and exploits a Twitter and Facebook accounts as well as a website. It strongly uses WhatsApp and bulk SMS to interact with farmers and provide them with various support services. Messages are exchanged in Kiswahili and English. About 34 000 farmers have been benefiting from its services. Farmers support the cost of calls (there is no toll-free service).

Exchanges in Uasin Gishu County centred on the upscale of the KIAMIS and on understanding the digital agriculture initiatives of the county, in order to better grasp needs. 23 000 farmers have been registered on the platform by the county. Face-to-face provision of extension services are becoming a challenge because of the low officer to farmer ratio. The use of some ICTs by some agriculture officers (notably WhatsApp for example to disseminate group information) as well as e-extension services leveraging digital tools (offered by the digital services' providers such as Kuza, Digi Cow, and Digital Green) have been useful but remain limited in scale and impacts. Hence, the request of the county that e-extension services are provided through KIAMIS and that the possibility to link farmers to markets using features of the platform is considered. The county has established more than six ICT centres equipped with workstations and free internet. The DVI can contribute to enhancing or providing agriculture services to these centres, using models such as the Kenya government Huduma Centers.[7]

The review of ZIAMIS has illustrated has considered several elements and modules including the use of call centre management technologies and software, bulk SMS and interactive voice response. Based on this, strategic and technical recommendations have been made regarding the KIAMIS e-extension features, covering the technical design of the features, choice of the right technologies to be used, the relevant of tools for the farmers, costs and sustainability issues, human resources, partnership needs, etc.

7 "Huduma Kenya Programme is a Government of Kenya initiative whose aim is to turn around public service delivery by providing efficient and accessible Government services at the convenience of citizens through various integrated service delivery platforms". Huduma centres function as "one stop-shop citizen service centres that provide National and County Government Services from a single location".

The procurement of digital equipment to counties was also planned to help them support digital agriculture service provision.

10.1.2. Field activities in Senegal

The DVI pilot activities in Senegal were anchored in existing FAO programmes, namely farmer field schools and the SAIDA pilot initiative conducted with ANCAR and its extension agents.

Two clusters of villages were targeted, the first one in the Saloum region with direct beneficiaries from the SAIDA pilot, and the second in the Niayes region where 80 percent of the country's vegetable production comes from.

Four villages were chosen with five beneficiaries in each, totalling 20 producers benefiting from the full initiative, including SAIDA, E-Tolbi and Senlouma. An additional 300 beneficiary producers and cooperative representatives were trained on SAIDA and Senlouma platforms but were assisted in opening shops for their associations on Senlouma's website.

The digital technology adoption by producers proved easier than previously thought, as they appreciated the positive impact in their production as well as the revenues they were able to generate. The previous experience with SAIDA contributed greatly to the ease of adoption of the DVI initiative's new services as producers already experienced its benefits, especially the weather forecasting services, according to them. The choice of farmer field schools also ensured that beneficiaries were already versed in adopting new practices and that they had permanent access to trainers.

E-Tolbi technology allows farmers to receive personalized daily interactive voice response messaging advice in their local languages for their fields, while different levels of access within the platform were designed for ANCAR agents consistent with their responsibilities. Extension agents in cluster villages today can visualize the satellite images of their producers' field illustrated by artificial intelligence-driven interpretation and advice on the water, fertilizer and health needs of the plants. This allows agents to advise a greater number of producers while providing a long-desired solution to their limited human resources. ANCAR headquarters have the same access but for all clusters.

Given the importance producers placed on marketing and the different obstacles they highlighted during workshop discussions, it became evident that it was best to open online shops for associations rather than individual producers. Grouping products under cooperatives' online shops is more efficient in advertising and logistics costs, farmer enrolment and shop management, and provides a way to ensure product quality control by peers.

Those discussions also brought up the need to include other main actors in the agricultural value chain into the e-commerce platform such as input providers, financial institutes, insurance companies, major distributors as well as more start-ups.

Market garden producers in Saloum have decided to organize themselves into a large cooperative (proposed name: Union des Producteurs Horticoles du Saloum) in the Niayes region to secure their access to inputs, benefit from better prices by pooling their purchases, modernize the horticultural value chain and diversify their financial partners.

Representatives of livestock breeders' associations in the Saloum region find the project beneficial because breeders encounter many difficulties in selling either milk or meat. However, they stress the need to address the problems of conservation. Solar energy solutions could help remedy these conservation problems. The problem of livestock theft also stagnates the progress of the profession as it discourages investment. The installation of digital livestock tracking systems could help in the fight against livestock theft.

ANCAR encountered difficulties in funding the dissemination of SAIDA platform messages in the past given the high cost of SMS messages

in Senegal. Discussions with ANCAR resulted in considering incorporating local start-ups that specialize in agricultural producers' training and information dissemination. Such an addition would involve allowing access to the information after paying a small fee.

Those discussions also brought up the need to include other main actors in the agricultural value chain into SAIDA activities as well as the e-commerce platform, including input providers, financial institutions, insurance companies, major distributors and more start-ups.

The additional start-ups would play the following roles in making the initiative more efficient and sustainable:

- participate in producers' enrolment and training
- assist managing Senlouma's online platform and social media advertisement needed to promote products on sale
- handle the logistics aspects of product pick-up and delivery, which require specialized equipment and management skills
- improve SAIDA message generation and dissemination, which may require making the system an affordable but overall profitable paying system for the producers

Besides market access, water control also came up as a crucial challenge for producers. Digitalization of water management (automated watering) could be a great benefit to growers Thanks to the DVI activities, the number of users registered in the SAIDA platform reached 300 000 in 2022.

10.1.3. Field activities in Somalia

The pilot activities in Somalia were linked to initiatives FAO has been implementing with farmer field schools and VSLAs, respectively aimed at improving knowledge on agriculture production and expanding access to finance for the beneficiaries. Information delivery was done using digital (WhatsApp, SMS, voice messages, and radio accessed via mobile phones) and non-digital (basic radios) communication platforms, considering the sociotechnical conditions of farmers targeted.

Village clusters targeted and beneficiaries

The targeted location of the services is Baidoa District in south-central Somalia, a region regarded as Somalia's sorghum breadbasket. It is the capital city of the South West State of Somalia, situated within the Bay region, which is known as the main sorghum belt for Somalia and an important and productive region.

Beneficiaries comprise 192 female and 84 male VSLA members (13 groups), and 217 female and 93 male members of farmer field schools (20 groups), who were reached with the communication channels and reside in nine villages. Thousands of listeners within the reach of the radios involved in the activities have also benefited from the knowledge shared.

VSLA and farmer field schools

The promotion of savings groups including the VSLA model has become a transformative approach, with great impact on low-income and vulnerable communities. As a result of its replicability, the model facilitates easy mobilization of individuals and creation of social capital and financial support. The methodology promotes a space to build capacity as they receive basic financial education training and practical guidance to savings and lending. For the most excluded, VSLAs have become the first gateway to financial conversations and the bridge between formal systems of finance and the informal moneylending options they rely upon for assistance.

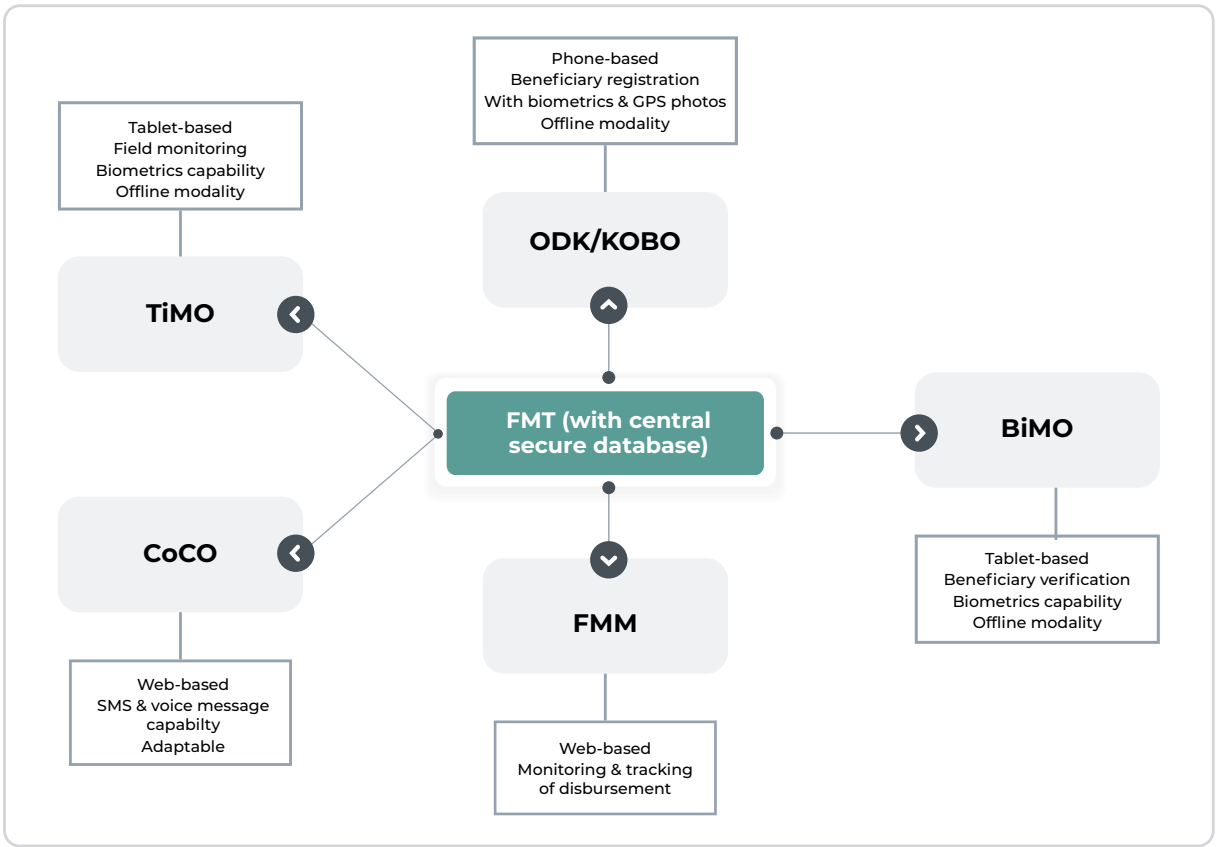
Farmer field schools, described as "schools without walls", support farmers through the provision of agricultural education and extension. Farmer field schools empower farmers using experiential and participatory learning techniques for the purpose of providing farmers with specific technical,

organizational and analytical skills, which improve farmers' decision-making capacities, develop problem solving capacity and stimulate local innovation.

Improvement of the FAO Somalia digital platform

FAO has been using digital platforms to encourage two-way communication with beneficiaries in the district since 2014. It has created an ecosystem of digital platforms, which it uses to manage the activities offered and support provided to the farmers. This ecosystem of tools is introduced in Figure 10. In the image is the Form Management Tool – of which the e-platform is a central part – as well as other modules such as the Financial Management Module or the CoCO module (to disseminate SMS and voice messages and manage compliance and complaints).

Figure 10. E-Platform operated by FAO Somalia



Notes: FMM = Financial Management Module; FMT = Form Management Tool; ODK = Open Data Kit; BIMO = Beneficiary Information Management System; CoCo = Compliance Complaints and Feedback System; TiMO = Third Party Monitoring.

The DVI's operations in the country leverage that platform. As part of the pilot's activities, the CoCO module has specifically been improved to better manage the large-scale dissemination of SMS and voice messages (good agricultural practices and financial literacy information). The strengthening of the platform gave the opportunity to better manage the delivery of more relevant, useful and timely information to more grassroots community members.

FAO Somalia has collaborated with local telecom service providers to procure credits for the dissemination of messages. This collaboration has not worked fluently or in a timely manner, but eventually a way out was found and services offered to communities.

PRODUCTION AND DISSEMINATION OF AGRICULTURE AND FINANCIAL INFORMATION

Existing information and new content produced on good agricultural practices and financial literacy was disseminated to communities, largely through radios but also through SMS and voice messages. Indeed, FAO was able to air 40 sessions of programmes relating to the management of VSLA, financial literacy and good agricultural practices. There were eight VSLA topics and eight repeat sessions as well as 12 good agricultural practice sessions with similar numbers of repeat sessions.

The good agricultural practice topics covered: crops production; integrated soil fertility management; irrigation, water use and management; integrated pest management; harvest and post-harvest management; climate-smart agriculture and relevance to water use efficiency. The content shared also covered the management of farmer field schools.

The use of local radio stations to disseminate this knowledge was judged as a first choice.

The activities were well received by beneficiaries. As confirmed by a monitoring and evaluation exercise, they enhanced knowledge uptake leading to adoption, change of behaviour and practices.

With the introduction of VSLAs as part of its 1 000 Digital Village Initiative, FAO Somalia intends to promote the adoption of digital money and innovative technologies that accelerate access to finance, efficiency and economic inclusion of rural communities.

FAO Somalia is currently working on research mobilization to secure funding for a full launch of DVI, which will build on learning from these initial activities.

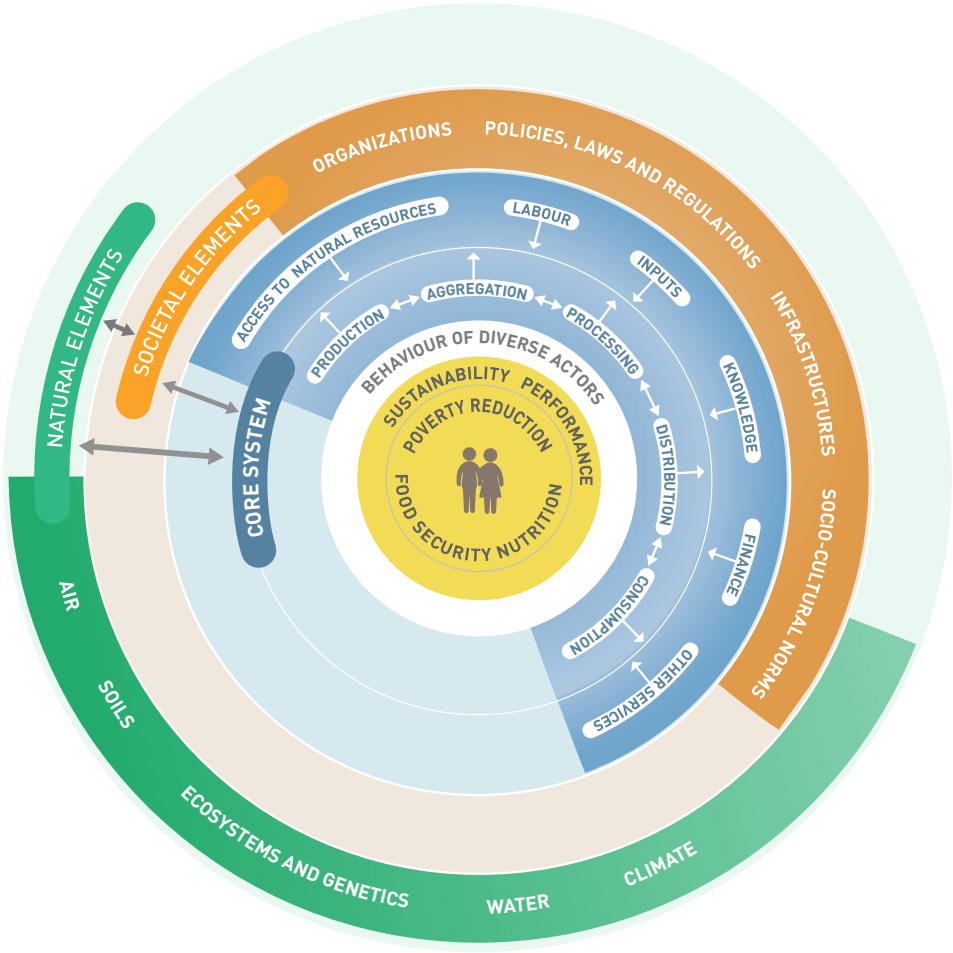
10.2. Key DVI success factors

Several key factors must be articulated for successful implementation of the DVI. Discussed in this chapter, they constitute critical elements of its theory of change.

10.2.1. Synergy with the local development priorities

It is a vital prerequisite that the DVI is implemented in full synergy with the local agriculture and socioeconomic development strategic frameworks, and that it responds to priorities set out by the national and local authorities. If led by a non-state actor, its design must be carried out in consultation with the local authorities, including but not limited to local agricultural development agencies. The selection of villages to be involved in the DVI will be made in close liaison with authorities. According to some stakeholders met during the scoping assessment exercise, while the existence of multiple public stakeholders (with different responsibilities) will help harness their expertise and the opportunities they can enable, it may present priority-setting and coordination challenges in some cases. These cases may arise in countries with central and local governments and/or where agriculture development is a devolved function. These issues will need to be addressed strategically. SDGs as promoted by the countries will also be taken into account. The full engagement of local authorities in the design of services and the insertion of DVI in the local development strategy is a key factor for its sustainability. It is also a driver of trust in DVI for farmers and other local stakeholders.

10.2.2. Continuous improvement of the local agrifood system



Source: Nguyen, H. 2018. Sustainable food systems: Concept and framework. Rome, FAO. https://www.fao.org/publications/card/fr/c/CA2079EN/

The continuous improvement of the local agrifood system in which the DVI is inserted will be indispensable for its long-term successful implementation. Agrifood systems are apprehended as the full web of stakeholders, relationships and activities along the food value chain, including the needed conducive policy environment, the related social environment, norms and technological conditions (International Food Policy Research Institute, 2020).[8] This may be illustrated in the graph above depicting a food system wheel framework, proposed by Hanh Nguyen (2018).

Indeed, the services to be offered by the DVI for the benefit of rural stakeholders will be delivered

8 The International Food Policy Research Institute defines food systems as "the sum of actors and interactions along the food value chain - from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal. Food systems also include the enabling policy environments and cultural norms around food".

in settings of which deficiencies will eventually undermine the DVI's effectiveness. For instance, the use of a web or social media e-commerce platform may be irrelevant if the producers cannot produce the quality or quantity of crops that the market needs. Poor rural transport or cold storage facilities may generate high post-harvest losses and economic disaster for a producer organization even if they can access advisory services via mobile phone. Energy supply failures or the lack of trust in a value chain may generate the same damages. While it should not be expected that all these structural problems are fully solved before establishing DVI services, the continuous improvement of the agrifood systems will ensure long-term results for the initiative.

10.2.3. Suitable and affordable rural digital connectivity

Two epitomizing constraints that rural inhabitants in sub-Saharan Africa have encountered (in fully enjoying the benefits of digital technologies) include the poor telecommunication infrastructure as well as the unaffordability of user connectivity resources. The material access barriers comprise the weak mobile network coverage, the low internet bandwidth or its flaws, or the erratic power supply in remote areas. The unaffordability of the technology for farmers includes the high cost of access devices such as computers, smartphones and tablets. Rural institutions, particularly those in charge of agricultural development, also face budgetary constraints to acquire these resources. Important, progressive but deliberate investments in telecommunications, data centres and electricity infrastructure (including off-grid energy facilities) are required to fulfil the promises of digital agriculture in these remote localities.

In some cases, and as a short-term measure in order to promote equity in the community, DVI may opt to subsidize technology accessibility costs. This can include subsidizing data charges or fees payable to providers of services deemed critical for economic empowerment of actors. Subsidies may include part payments of solar power kits for poor farmers without main electricity grid connectivity or affordable plans for smartphones.

In some cases, as ownership of the required digital device (for example a computer connected to broadband) will not be possible for many farmers or farmer organizations, the establishment of well-equipped community multimedia access points may be required so that rural stakeholders may enjoy the DVI's benefits. It will be important that these community facilities are managed professionally to ensure their sustainability. Fully-fledged community access points will not be needed, and existing facilities such as rural libraries, schools, youth centres, agricultural faculties, agribusiness development organizations and private mobile-money establishments may be involved in the provision of DVI services. The DVI stewards will have to carefully study and learn from challenges and failures met in the management of rural telecentres and public access points since the early days of the insertion ICTs in rural areas in Africa in order not to replicate past errors.

10.2.4. Digital agriculture awareness creation and capacity building

In sub-Saharan African rural localities, the digital skills gap is notorious, suggesting the need for DVI implementation to make major investments in enhancing such skills. Digital agriculture still being a novel concept and not always of clear resonance for many people, particularly in rural areas, creating awareness regarding its potentials and limits is a needed undertaking. Digital agriculture solutions such as those concerning digital climate advisory services, the monitoring of soil moisture and nutrients through remote sensing (including the use of drones), the use of e-commerce platforms, advanced use of social media platforms such as WhatsApp, or even simple use of SMS or Unstructured Supplementary Service Data (USSD) to benefit from advisory services require some capacity building. As a matter of fact, contrary to immediate perception, farmers are not the only stakeholders

at this level where such capacity is weak. Even extension officers, agriculture development officers, policymakers, the personnel of rural associations and other stakeholders need digital agriculture awareness creation and digital upskilling at different levels. DVI managers will also need to enhance their skills as well.

To ensure that digitalization benefits farmers, a solution involves using rural youth who are digitally savvy (including farmers' family members), digital intermediaries such as digital village advisers, field agents and agrodealers as connectors. Awareness creation channels may include group-based demonstration and sensitization alongside hand-holding the primary users.

Digital technologies are evolving at high speed. For example, following the internet's first generation (Web1 in the 'dot com era'), second generation (Web 2.0 in the era of social networks), its third generation (Web3) ushered in the era of distributed services and blockchain technology, and is currently growing at a great pace around the world. It will require training at all levels even in higher educational institutes for their use to spread and for African agriculture to take advantage of them.

10.2.5. Supporting the delivery of compelling digital agriculture services

From the early years of digital agriculture in Africa to the present, farmers and agriculture stakeholders have complained that the digital solutions that are developed, particularly by young innovators, have been not relevant to their needs and sociotechnical profiles. A common mismatch has been the development of solutions for smartphones or requiring important mobile data consumption. At the same time, most farmers that own a mobile phone only enjoy the basic phone and have limited financial resources to pay for the required mobile credit. The illiteracy of farmers, in the face of content that is only available in international languages, have also been a key issue. Many solutions have covered a single feature (such as isolated agronomic tips or market prices) despite farmers' needs being more diversified and intertwined, involving a concomitance of agronomic tips, weather information, access to inputs and outputs markets, and more. The lack of knowledge on agricultural value chains as well as the lack of application of farmer-centred design methods have led to such discrepancies. The situation is progressively changing as the ecosystem of digital agriculture is getting mature, but instances where irrelevant solutions are proposed to farmers persist.

While digital platform developers' lack of knowledge of the agriculture sector has been often highlighted as the cause of many mismatches, the lack of expertise in digitalization by agriculture officers may also lead to the selection or design of irrelevant services.

The solutions also need to be relevant to the selected value chains and their production cycles, may be delivered in local languages as needed, and some services may also be channelled through community radios. Currently in Africa, many solutions are not yet matured and still need improvement. In that case, even if they are offered free of charge by Government agencies with the involvement of key national or international stakeholders, they will not be adopted.

Moreover, some farmers during the scoping assessment exercises indicated that they are sometimes too busy to invest time in learning about new digital initiatives, particularly when the services proposed are not easily understood. For instance, crop and livestock insurance services faced a lukewarm response among many farmers as their value proposition was not easy to appreciate. Sometimes, the timing of learning and sensitization activities organized by the digital initiatives are not always incompatible with the schedule of farming activities. Assembling and coordinating compelling value to farmers and other targeted DVI actors is thus critical for ensuring that the solutions are adopted.

Applications built in a foreign country have been observed to face extreme difficulty in some African environments, because they are not always adapted

to local needs. It is therefore important to seriously work on their adaptation/localization as relevant and support local effective start-ups so that solutions are better tailored to local stakeholders' needs. Collaboration between local start-ups and extension agents, community leaders and the DVI stewards may be indispensable.

10.2.6. Support the delivery of complementary rural transformation services

Apart from its first and second pillars of activities articulated around digital agriculture services provided to the farmers, the DVI concept has rightly integrated a third pillar that aims to facilitate rural transformation services relating to health, education, jobs, welfare, ecotourism and agritourism. As DVI's ambitions include holistically combatting hunger, poverty and inequality in rural areas and helping to achieve the SDGs, it can directly or indirectly assist the farmers and community to address their sustainable livelihoods needs. As a matter of fact, because of the multifaceted challenges faced by rural farmers, including the lack of socioeconomic opportunities in rural areas, offering compelling services to rural farmers should also consider their non-farm livelihoods needs. Some of them, such as those relating to the interplay of health and nutrition alongside agricultural concerns, are illustrated in the One Health approach. Ecotourism and agritourism activities may provide important opportunities to farmers. Similarly, supporting holistic socioeconomic transformation of the entire village, through the promotion of rural education, economic diversification and job creation schemes, which may be enhanced by digitalization, will strengthen DVI's ecosystem, impacts and perspectives.

Considering its mandate and limited resources, FAO is not in a position to directly facilitate all these services. However, they may be addressed through partnerships, such as the one being discussed on DVI with the United Nations Population Fund in Nigeria, or the existing collaboration with International Telecommunications Unions in Niger around the SVP.

10.2.7. Strengthening engagements with rural youth and women

Addressing the youth bulge and promoting the fulfilment of economic opportunities for the rural youth population are critical socioeconomic and political concerns. DVI can contribute to these efforts and also benefit from them. Youth are generally technology savvy, often desire to work with technology, and often make up the enablers of any digital revolution. Young farmers are also generally early adopters or serve in formal or informal roles to support less tech-savvy farmers in using these technologies. DVI has the potential to attract youth in agriculture, contribute to reducing rural-urban migration and incentivize youth to contribute to agricultural development and rural transformation. Rural youth and rural entrepreneurs who can develop and offer digital services to the agriculture sector may also contribute to enhancing DVI.

Addressing gender inequality and empowerment appears as another promising strategy for DVI's success. On average, women represent 50 percent of the agriculture workforce in Africa, and they are engaged in all agrifood systems activities. However, they are not sufficiently benefiting from assets (inputs, lands, finance, etc.) and opportunities (advisory services, training, etc.) that will help them enhance their contribution to the performance of the sector and improve their livelihoods. Key informants and FGD participants proposed the incorporation of strategies to meaningfully engage and empower women as an essential design aspect of DVI. Considering value chains or commodities in which women are mostly engaged can help successfully engage them in DVI activities. For instance, according to some stakeholders, in some Kenyan communities, commodities such as poultry and dairy have been associated with women while fish, avocadoes and coffee are associated with men. Selection processes for community-based agents, farmers and other key participants in DVI that deliberately favoured the participation and empowerment of women in the project are considered essential. These women empowerment strategies will be more effective if carried out in collaboration with women farmers and rural groups.

10.2.8. Embedding sustainability in the design of digital agriculture services

While FAO and governments are promoting DVI as public actors, it is crucial to design economic sustainability in these facilities to avoid their functioning becoming exclusively dependent on public national or international financial resources. As most African countries seem currently in need of development assistance, and as international development projects are by nature short-term engagements, addressing sustainability in the design of DVI is a cautious approach, even if public funding may be needed for an initial period. Such strategies can build on public-private partnerships to ensure private funding and/or some revenues are eventually generated.

Africa's history of implementing rural digital technology initiatives is a source of lessons for DVI implementation. Difficulties faced by the Kenyan Government's Pasha Centres, or the Connect a Constituency Project in Malawi (see Chapter 4) must be avoided as much as possible. Such challenges relate to administrative and financial management of the multimedia access points, poorly addressing connectivity constraints or digital skills gaps, and the failure to align with the priorities of target beneficiaries and clients. It is also important to note that, as illustrated by the initial activities of DVI in Africa (i.e. in Kenya, Senegal and Somalia), many services can be provided without the need for a community access point and delivered through mobile phones and directly on the farm (by the use of sensors or drones for example).

As many farmers are reluctant to pay for digital agriculture services, providing them with compelling value through farmer-fit digital services will encourage them to procure such services. Offering bundled digital agriculture services is an important condition for excellent value creation for farmers. Encouraging rural entrepreneurs offering digital services to adopt effective business models (Lohento and Sotannde, 2019) may be an option for some DVIs. The presentation of a variety of solutions to value chain actors bundled as a one-stop-shop or an aggregator platform for digital services in agriculture is beneficial for amplifying their impact. The bundling of services was, for example, the most frequently mentioned suggestion for improvements among farmers across digital agriculture solutions partnering with Mercy Corps' Agrifin Accelerate Program (60 Decibels, 2021). Entities in charge of the stewardship of services for a DVI must also consider the plugging of other services to a digital platform they may be operating.

10.2.9. Leveraging existing FAO's initiatives and assets

In order to assist governments with addressing food security, natural hazards challenges and support effective agriculture development planning, FAO has invested in a number of digital tools that are available for use. These include platforms such as the Hand-in-Hand Geospatial Platform, which is found on the Digital Services Portfolio,[9] as well as other solutions that help to monitor and analyse agrifood data or promote knowledge-sharing, such as Technologies and Practices for Small Agricultural Producers, the Food Loss and Waste Database[10] and the eLocust platform, procured, commissioned, or developed internally. Some of them were initially developed in specific countries, before being adapted or used in others. This is the case with FAO's FMT e-Platform for Mobile Money and Livelihood Assistance in Somalia or the KIAMIS platform developed in collaboration with the

9 The Digital Services Portfolio integrates a suite of mobile applications such as "Weather and Crop Calendar", "AgriMarket Place", "Livestock", and more: https://digital.apps.fao.org/home – The Digital Services Portfolio is called "Services Agricoles et d'Inclusion Numérique en Afrique (SAIDA) in French, and was launched first as an aggregated platform in Senegal.

10 Technologies and Practices for Small Agricultural Producers is an online FAO system that gathers successful agricultural technologies and practices from various partners to facilitate knowledge exchange. The Food Loss and Waste Database provides in-depth information on the type and location of food that is being lost and wasted.

Kenyan Government (KIAMIS builds on the Zambian Government's ZIAMIS platform[11]).

Taking advantage of these solutions to deliver services will provide quick win to the DVI while strengthening the adoption and maturity of these platforms when needed. The use of SAIDA thus forms the cornerstone of services provided by the DVI in Senegal, while FMT was used in Somalia and KIAMIS in Kenya. Other digital platforms promoted by other organizations may also be used in DVI. Senegal has been using Senlouma, an e-commerce platform promoted by the national extension agency ANCAR as well as irrigation services of the Senegalese company Tolbi.

Apart from digital tools, DVI must be strongly associated with and support existing FAO agrifood projects. DVI services have been integrated in farmer field schools and/or VSLA activities in Somalia and Senegal, while in Malawi a collaboration between DVI and the "Marketing capacity building project for smallholder farmers in Mzimba and Kasungu districts" is in place.

Building synergies between these various initiatives will rationalize the use of resources and strengthen impacts.

10.2.10. Nurturing a supportive ecosystem partnership

Establishing effective partnerships is of utmost importance for delivering the value promised by DVI. Rural development, digital agriculture and agrifood systems are complex instances of which fulfilling deployment requires contributions from a multiplicity of players. Major aspects of the ecosystem partnerships that need to be nurtured include maintaining active engagement of local governments, collaborating with farmer organizations, digital service providers and development agencies active in the targeted geographies, and enhancing the involvement of women, rural youth and young entrepreneurs. The paragraphs below elaborate on these partnerships.

i. Strategically involving farmer organizations

Collaborating strategically with farmer organizations offers the double opportunity of effectively involving farmers, the main targets of food security interventions and securing a financially reliable customer segment for the digital agriculture services. Integrating farmers from the outset will favour the co-design of services that DVI will offer and ensure the organic adoption of. In addition, it has been observed that while individual farmers are reluctant to pay for digital agriculture services, farmer organizations – notably cooperatives and entities involved in profitable value chains – are more able to support these costs. Embedding the need to offer services at a cost and make them affordable for users is critical for successfully navigating the road towards sustainability for digital agriculture services in Africa. All types of farmer organizations are concerned here, including livestock farmer groups, fishers, women farmers, young farmers, cooperatives, savings groups, processors, trade associations, and others. Busara and Dalberg (2021) found the use of savings groups as an effective and efficient channel for onboarding farmers to digital agriculture services, especially women.

ii. Civil society organizations and community-based agents

Rural community digital project implementation informs that it has been fulfilling to give responsibilities to civil society organizations and individuals living within the villages or the larger community who may act, under different schemes, as drivers of the uptake of digital services. Examples of organizations that have been very active in rural

11 KIAMS and ZIAMIS help undertake the e-registration of farmers in a central registry, and carry the potential to facilitate other services such as inputs management, e-extension, credit management, etc.

communities on digital agriculture include Mercy Corps in Kenya and Babban Gona in Nigeria. In some countries, individuals acting as mediators are called village-based advisers, community-based facilitators or community-based advisers and may be employed by local organizations. In Kenya, such individuals have been found to be an influential factor for enhancing the use of digital tools in the Digifarm programme. The community-based advisers are argued to provide human contact, not only being essential for addressing technical challenges but also for demonstrating a sense of care to users. As volunteers or employees of a relevant body (agrodealers, digital agriculture start-ups, local government, NGOs, etc.), these agents may be incentivized through various financial and non-financial means, depending on the framework in which their services have been designed. They may be young farmers, young agripreneurs, booking agents (as used by Hello Tractor in Nigeria or Kenya or TROTRO Tractor in Ghana).

iii. Private sector

Collaboration with various types of private sector entities (including agribusinesses, mobile network operators [MNOs], and young digital entrepreneurs) will yield strong value to DVI. MNOs (such as Orange, MTN, Safaricom) have been champions of digital agriculture services in Africa, taking advantage of the communication services they offer to populations including millions of farmers. Many have pioneered these services by themselves or collaborated with governments and other stakeholders to provide them. Examples include the Digifarm services championed by Safaricom in Kenya or services offered by the entrepreneurs of MLouma in collaboration with Orange in Senegal. Other local or international ICT and digital service providers operating in the villages may be engaged. Collaboration with local young entrepreneurs providing digital services may strongly encourage youth involvement in agriculture, strengthen youth businesses and also support job creation.

It is important to note that governments and/or FAO have an opportunity in some countries to implement DVI as a suite of multistakeholder services by creating linkages between digital platforms it has developed and private sector services. This calls for progressive development of an open innovation ecosystem around these platforms. The open innovation approach will generate a unique opportunity to promote data-sharing at the local and national levels among the various players collecting farmers and agricultural data, which will streamline services offered and support the building of national data-driven economies. More about these open innovation and data-sharing approaches are discussed in the box below.

iv. Bilateral and multilateral public institutions

Many governmental bilateral and multilateral institutions have been at the forefront of funding and promoting digitalization and agriculture development in Africa. These include the International Fund for Agricultural Development, World Food Programme, World Bank, African Development Bank, Enabel (Belgium Cooperation), the Foreign Commonwealth & Development Office of the United Kingdom, the German Agency for International Cooperation, the French Development Agency, the United States Agency for International Development (USAID), and of course FAO. To varying degrees, these organizations have been supporting the expansion of digital agriculture solutions and services. Many of them have several ongoing agriculture or digital projects in various local communities as illustrated in the country chapters of this report. Engaging these institutions will create effective linkages with their initiatives and eventually lead to successful resource mobilization for service delivery and nurturing sustainability.

Box 1. Open innovation, data ownership and sharing

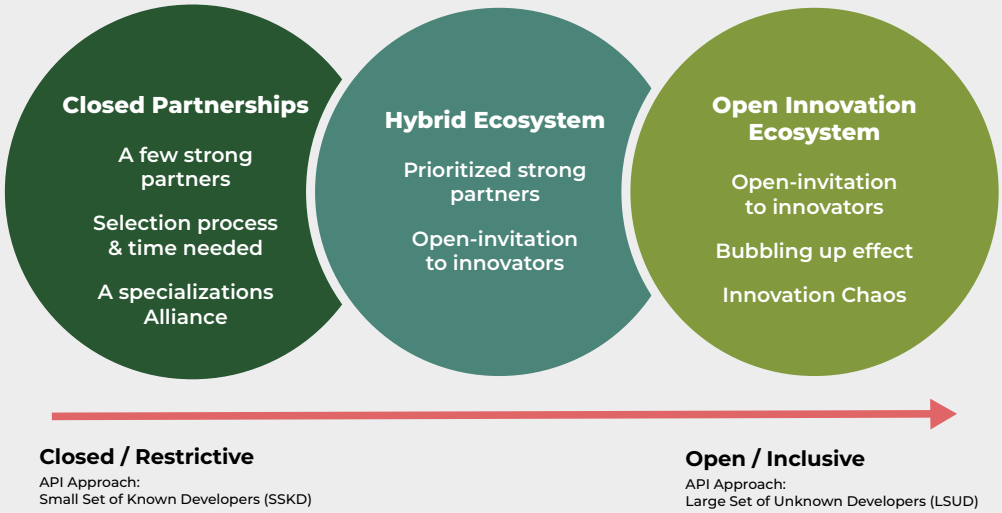
Debates regarding agriculture data ownership and sharing are proliferating in African countries, certainly in line with international trends. Regarding data ownership, farmers and farmer organizations are increasingly expressing concerns regarding the multiplicity of stakeholders, entrepreneurs or development institutions that collect their data, wondering how they are used, while the value of the data collection for the farmers are not always perceived. There are beliefs that the data collected, handled and housed by digital agriculture initiatives belong to farmers, to the extent that the data was identifiable to the actors or was generated through their actions. Many digital agriculture businesses are however of the view that these collected data belong to them by virtue of their investment in its collection, processing and storage.

Strong sentiments were therefore expressed about shared data ownership models being developed and integrated models supporting the sharing of the commercial upsides. Along with the data co-ownership and sharing models came the expectation by farmers and agriculture stakeholders that the digital service providers should provide individual data to the actor upon request for use with other digital service providers when needed. Moreover, many actors require given consent before their data is shared with other forms of third-party entities, including governments (some farmers are reluctant to be involved in data-collection initiatives as they believe governments may leverage them for taxation purposes).

There is thus a need for more discussion on these issues so that a consensus about the value of data collection is more clearly shared across the board.

The importance of data-sharing between all stakeholders involved in the agrifood value chain, including commercial digital service providers, has been mentioned as well. It has been pointed out that to favour the offering of bundled services and promote open innovation, private and public service providers should be involved in collaborative data platform schemes. Governments and international organizations could play a critical role in that framework, especially when they own or co-own digital platforms. It has thus been proposed to onboard third-party digital services on such platforms using an application programming interface (API). This issue has been suggested for example for KIAMIS in Kenya. The platform owners could consider promoting open innovation using various models as proposed in the figure below.

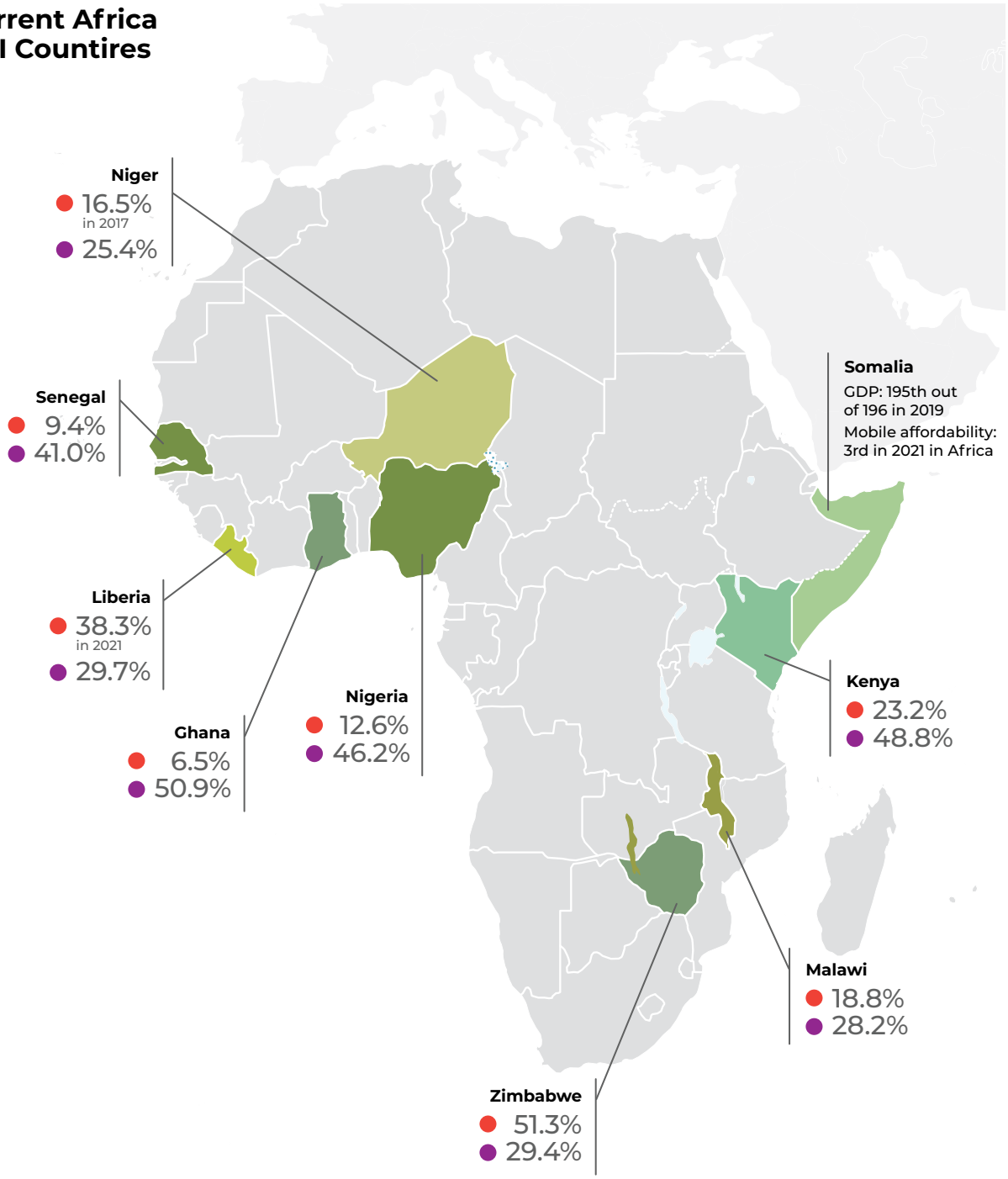
Figure 11. Options for innovation ecosystem development



At the closed end of the continuum, a few strong or immediately relevant partners can be selected through mechanisms compliant with public-private partnership requirements of FAO or governments. This would call for the "small set of known developers" approach to API management. The selection can be made in such a way that no two digital service providers are competing in a specific DVI implementation in what can be considered an alliance of specializations. The closed end of the continuum offered simplicity and convenience in implementation. The open end offered an open invitation to providers of digital solutions for agriculture (DSAs) to plug in through an API framework to provide value-added functionalities relevant to the rural digital transformation demands of the village cluster(s) involved in DVI. This would imply the "large set of unknown developers" approach to API management. Any funding and mobilization support to these private players can be pegged on targets met, as is being implemented with the counties and innovators in the World Bank-funded One Million Farmer Platform in Kenya.

Finally, national or local data-sharing schemes will also help governments to better monitor and plan agrifood system development for sustainable food security and growth achievement.

Current Africa DVI Countires



PoU: Prevalence of Undernourishment (FAO, 2017-2019)

ADI: Agriculture Digitalisation Index (World Bank, 2021)

Source: United Nations Geospatial. 2022. Africa. United Nations. Cited January 2023
https://www.un.org/geospatial/content/africa-2

Field Research in Zimbabwe
© FAO Donald Chidoori

References

60 Decibels. 2021. *Farmer Insights*. Portland, Mercy Corps Agrifin. www.mercycorpsagrifin.org/2021/05/18/agile-impact-series-60-decibels-aggregate-impact-report/

Avelardo Rivera, A.M.-C. 2019. *Digital Agricultural Extension in Malawi: Rollout of the Extension Helper App*. Washington, DC, Feed The Future. https://pdf.usaid.gov/pdf_docs/PA00WHVG.pdf

Ayenor, G.K. (2019). *Review of digital tools deployed in agriculture in Ghana: Leveraging on ICT innovations to modernize agriculture*. Accra, Ministry of Food and Agriculture.

Banda, E. 2021. Products and services. In: *Noble Agriculture Technologies*. Cited 5 December 2022. http://nobleagritech.com/index.php/services/

Busara & Dalberg. 2021. *Gender Impact Study: Final Consolidated Report*. Portland, Mercy Corps Agrifin. www.mercycorpsagrifin.org/wp-content/uploads/2021/05/DigiFarm-AgriFin-Gender-Impact-Study-Final-Report.pdf

Communal Development Plan. 2014. *Communal de la commune rurale de Bagaroua 2015-2019*. Tahoua.

Consultative Group to Assist the Poor. 2016. *Market system assessment of digital financial services in WAEMU. Working paper*. Washington, DC. www.cgap.org/research/publication/market-system-assessment-digital-financial-services-waemu

FAO. 2007. *Technical consultation on agricultural information and knowledge management*. Rome. www.fao.org/fileadmin/user_upload/kce/Doc_for_Technical_Consult/E-AGRICULTURE_-_English.pdf

FAO. 2021. *Strategic Framework 2022-2031*. Rome, FAO. www.fao.org/3/cb7099en/cb7099en.pdf

FAO. 2022. Coordinated Programme of Economic and Social Development 2017–2024. In: *FAOLEX Database*. Rome. Cited 18 November 2022. www.fao.org/faolex/results/details/en/c/LEX-FAOC174137/

FAO & International Telecommunications Union. 2016. *E-agriculture strategy guide. Piloted in Asia-Pacific countries*. Bangkok. www.fao.org/3/i5564e/i5564e.pdf

Forenbacher I., Husnjak S., Cvitić I. & Jovović, I. 2019. Determinants of mobile phone ownership in Nigeria. *Telecommunications Policy*, 43(7): 101812. www.sciencedirect.com/science/article/pii/S0308596118303665

Ghana, Ministry of Food and Agriculture. 2007. *Food and Agriculture Sector Development Policy (FASDEP II). Accra*. https://extranet.who.int/nutrition/gina/sites/default/filesstore/GHA%202007%20Food%20and%20agriculture%20sector%20development%20policy2.pdf

Ghana, Ministry of Food and Agriculture. 2021. *A working draft e-agriculture policy*. Accra.

Ghana, National Development Planning Commission. 2019. *Ghana: Voluntary national review report on the implementation of 2030 Agenda for Sustainable Development. Accra*. https://ghana.un.org/en/19155-ghana-voluntary-national-review-report-implementation-2030-agenda-sustainable-development

Hallberg, D., Kulecho, M., Kulecho, A. & Okoth, L. 2011. Case studies of Kenyan digital villages with a focus on women and girls. *Journal of Language, Technology & Entrepreneurship in Africa*, 3(1): 255–273. www.ajol.info/index.php/jolte/article/view/66724

Haut Commissariat à l'initiative 3N. 2017. *Plan d'action de 2016-2020 de l'Initiative 3N. Niamey*. https://pnin-niger.org/pnin-doc/web/uploads/documents/249/Doc-20200319-072938.pdf

Howdle, D. 2021. The price of mobile/cellphone data in 230 countries in 2021 – winners and losers. *Cable.co.uk*, 14 April 2021. Staffordshire, UK. Cited 18 November 2022. www.cable.co.uk/blogs/global-mobile-data-pricing-2021/

International Food Policy Research Institute. 2020. *Building inclusive food systems*. Washington, DC. www.ifpri.org/publication/2020-global-food-policy-report-building-inclusive-food-systems

International Labour Organization. 2021. Employment in agriculture (% of total employment) modeled ILO estimate) - Somalia. In: *ILOSTAT*. Geneva. Cited 18 November 2022. https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=SO

JoyNews. 2020. *A documentary on the impact of the Zipline Drone service in Ghana* [video]. Cited 18 November 2022. www.youtube.com/watch?v=V9fTWTW2bkM

Kapondera, S. & Chigona, W. 2018. Domestication telecentres by Malawian rural women. *International Journal of Information Communication Technologies and Human Development*, 10(1): 51–64. www.igi-global.com/gateway/article/197882

Karume, S, & Shisoka, D.A. 2017. Factors inhibiting the implementation of digital villages in Kenya. *International Journal of Science Research*, 5(10): 70–78. www.ijsr.net/get_count_search.php?paper_id=ART20162025

Kemp, S. 2021a. *Digital 2021: Niger. Singapore*, DataReportal. https://datareportal.com/reports/digital-2021-niger

Kemp, S. 2021b. *Digital 2021: Somalia. Singapore*, DataReportal. https://datareportal.com/reports/digital-2021-somalia

Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives. 2019. *Digitization and coordination of Kenya's agricultural sector data*. Nairobi. http://kilimodata.developlocal.org/dataset/digitization-and-coordination-of-kenya-s-agricultural-sector-data

Kenya, Ministry of Agriculture, Livestock, Fisheries and Cooperatives. 2020. *Agricultural sector transformation and growth strategy*. Nairobi. www.agck.or.ke/Downloads/ASTGS-Full-Version-1.pdf

Kenya National Bureau of Statistics. 2019. *2019 Kenya population and housing census results*. Nairobi. www.knbs.or.ke/2019-kenya-population-and-housing-census-results/

Kenya National Bureau of Statistics. 2021. *Economic survey 2021 highlights*. Nairobi. www.knbs.or.ke/wp-content/uploads/2021/09/Economic-Survey-2021-Highlights-Final-Presentation-by-CS.pdf

Kieti, J., Waema, T.M., Ndemo, E.B., Omwansa, T.K. & Baumüller, H. 2021. Sources of value creation in aggregator platforms for digital services in agriculture-insights from likely users in Kenya. *Digital Business*,1(2): 100007. www.sciencedirect.com/science/article/pii/S2666954421000065

Koyama, N., Totapally, S., Goyal, S., Sonderegger, P., Rao, P. & Gosselt, J. 2021. *Kenya's digital economy: A people's perspective report 2021*. New York, Dalberg. www.digitaleconomy.ke/assets/download/Kenyas_Digital_Ecomony_Full_report_Aug_2021.pdf

Lohento, K. & Sotannde, M. 2019. *Business models and key success drivers of agtech start-ups*. Wageningen, Technical Centre for Agricultural and Rural Cooperation. https://cgspace.cgiar.org/handle/10568/106010

Mohammed, S. 2018. *The NE Nigeria Resilience Strategy: Situation Analysis*. Maiduguri.

Mugo, A. 2012. Connecting communities in arid lands with knowledge in East Africa. *Knowledge Management for Development Journal*, 8(1): 48–58. www.km4djournal.org/index.php/km4dj/article/view/449

Niger, National Institute of Statistics. 2018. *Annuaire statistique régional de Tahoua 2013–2017*. Niamey. www.stat-niger.org/wp-content/uploads/2020/05/AS_Tahoua_2013_2017.pdf

National Statistical Office of Malawi. 2008. *2008 Population and Housing Census: Preliminary Report*. Zomba. https://unstats.un.org/unsd/demographic-social/census/documents/malawi/malawi_report.pdf

National Statistical Office of Malawi. 2017. *Malawi Demographic and Health Survey 2015-16*. Zomba. https://dhsprogram.com/pubs/pdf/FR319/FR319.pdf

National Statistical Office of Malawi. 2019. *National survey on access and use of information and communications technologies by households and individuals in Malawi 2019*. Zomba. www.nsomalawi.mw/images/stories/data_on_line/economics/ICT/ICT%20Household%20Survey%202019.pdf

News Ghana. 2016. Cashew production in Ghana. *News Ghana*, 8 March 2016. Brong Ahafo. Cited 18 November 2022. https://newsghana.com.gh/cashew-production-in-ghana/

Nigeria, National Information Technology Development Agency. 2020. *Nigeria Digital Agriculture Strategy 2020–2030*. Abuja. https://nitda.gov.ng/wp-content/uploads/2020/11/Digital-Agriculture-Strategy-NDAS-In-Review_Clean.pdf

Nigerian Communications Commission. 2020. *Nigerian National Broadband Plan 2020-2025*. Abuja. www.ncc.gov.ng/documents/880-nigerian-national-broadband-plan-2020-2025/file

Nigerian Communications Commission. 2021. *Personal communication to the consultant*

Ngotho, A. 2020. Kenya has 100 digital agriculture solutions with little value. *The Star*, 9 September 2020. Cited 18 November 2022. www.the-star.co.ke/news/2020-09-09-kenya-has-100-digital-agriculture-solutions-with-little-value/

Nguyen, H. 2018. *Sustainable food systems: Concept and framework*. Rome, FAO. www.fao.org/publications/card/fr/c/CA2079EN/

Partech. 2021. *Africa tech venture capital*. Report. San Francisco, CA. https://partechpartners.com/2021-africa-tech-venture-capital-report/#section1

Regulatory Authority for Electronic Communications and Post. 2020. *Rapport Annuel de l'Autorité de Régulation des Communications Electroniques et la Poste*. Niamey www.arcep.ne/publications.php?sid=26

Saleh, R.A., Mustapha, S.B. & Burabe, B.I. 2016. Analysis of women farmers' participation in agricultural activities in Konduga Local Government Area of Borno State, Nigeria. *American-Eurasian J. Agric. & Environ. Sci.*, 16 (1): 119–125. www.idosi.org/aejaes/jaes16(1)16/13.pdf

Save Somali Women and Children. 2021. *Gender gap assessment: south central Somalia and Puntland*. Nairobi, Oxfam. https://reliefweb.int/report/somalia/gender-gap-assessment-south-central-somalia-and-puntland

Schroeder, K., Lampietti, J & Elabed, G. 2021. *What's cooking: digital transformation of the agrifood system*. Washington, DC, World Bank Publications. https://openknowledge.worldbank.org/handle/10986/35216

Somalia, International Organization for Migration & United Nations Human Settlements Programme. 2020. *Beledweyne urban profile. Working paper and spatial analyses for urban planning and consultations and durable solutions for displacement crises*. Nairobi. https://reliefweb.int/report/somalia/beletweyne-urban-profile-working-paper-and-spatial-analyses-urban-planning

Somalia, Ministries of Posts, Telecommunications and Technology. 2019. *National ICT policy strategy 2019–2024*. Mogadishu. https://moct.gov.so/en/ministry-launches-consultation-process-for-draft-national-ict-policy-strategy/

Techno Brain. 2020. Microsoft-Techno Brain reshape farming in Africa with digital platform. *Techno Brain Group*, August 2020. Dubai, United Arab Emirates. Cited 5 December 2022. https://technobraingroup.com/microsoft-techno-brain-reshape-farming-in-africa-with-digital-platform/

TheGlobalEconomy.com. 2021. *Somalia economic indicators*. Atlanta, GA. Cited 17 November 2022. www.theglobaleconomy.com/Somalia/

Tole, D.M. 2013. *The impact of digital villages in rural ICT development*. Nairobi, Strathmore University. https://su-plus.strathmore.edu/handle/11071/2209

Tossou, S.H., Okou, F.A.Y. & Kpanou, S.B.-V.K. 2020. A systematic review of policy enforcement as a catalyst for digitalizing agriculture in West and East Africa. *Journal of African Development*, 21(1): 68–95. https://scholarlypublishingcollective.org/psup/african-development/article-abstract/21/1/68/262412/A-Systematic-Review-of-Policy-Enforcement-as-a?redirectedFrom=fulltext

Trendov, N.M., Varas, S. & Zeng, M. 2019. *Digital technologies in agriculture and rural areas*. Briefing paper. Rome, FAO. www.fao.org/3/ca4887en/ca4887en.pdf

Tsan, M., Totapally, S., Hailu, M. & Addom, B. 2019. *The digitalisation of African agriculture report 2018–2019: Executive summary*. Wageningen, Technical Centre for Agricultural and Rural Cooperation, and New York, Dalberg. www.cta.int/en/digitalisation/issue/the-digitalisation-of-african-agriculture-report-2018-2019-sid0d88610e2-d24e-4d6a-8257-455b43cf5ed6

Tsan, M., Totapally, S., Hailu, M. & Addom, B. 2021. *The digitalisation of African agriculture report 2018–2019*. Wageningen, Technical Centre for Agricultural and Rural Cooperation, and New York, Dalberg. www.cta.int/en/digitalisation/issue/the-digitalisation-of-african-agriculture-report-2018-2019-sid0d88610e2-d24e-4d6a-8257-455b43cf5ed6

United Nations Conference on Trade and Development. 2020. *Evaluation rapide de l'état de préparation au commerce électronique dans s les pays les moins avancés: Impact Politique et Perspectives*. Geneva. https://unctad.org/system/files/official-document/dtlstict2019d7_fr.pdf

United Nations Development Programme & National Bureau of Statistics of Nigeria. 2021. *The Impact of COVID-19 on Business Enterprises in Nigeria*. New York and Abuja. www.undp.org/nigeria/publications/impact-covid-19-business-enterprises-nigeria

United Nations Industrial Development Organization. 2020. *Somalia financial sector. Technical report*. Mogadishu. https://open.unido.org/api/documents/21185699/download/1_UNIDO_MoCI%20Report%20Financial%20Sector_final.pdf

United Nations Population Fund. 2016. *Housing and Household Assets of the Somali People*. New York. https://www.nbs.gov.so/docs/Analytical_Report_Volume_5.pdf

USAID. 2019. *Engaging youth in agriculture through information and communication technologies*. Washington, DC. www.usaid.gov/documents/15396/engaging-youth-agriculture-through-information-and-communication-technologies

van Dijk, J.A.G.M. 2006. Digital divide research, achievements and shortcomings. *Poetics*, 34(4–5): 221–235. www.sciencedirect.com/science/article/pii/S0304422X06000167

Vodafone. 2021. Digital platforms have an important role in African agriculture. Vodafone, 28 February 2021. Berkshire, United Kingdom. Cited 17 November 2022. www.vodafone.com/news/digital-society/digital-platforms-have-an-important-role

World Bank. 2018. *Rapid growth in mobile money: stability or vulnerability?* Somalia Economic Update Edition 3. Washington, DC. https://documents1.worldbank.org/curated/en/975231536256355812/pdf/REPLACEMENT-PUBLIC-Somalia-Economic-Update-3-FINAL.pdf

World Bank 2020a. Rural population (% of population) - Malawi. In: *World Bank Data*. Washington, DC. Cited 5 December 2022. https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=MW

World Bank. 2020b. *Country partnership framework for the Federal Republic of Nigeria for the period FY21-FY25*. Report No. 153873-NG. Washington, DC. https://openknowledge.worldbank.org/bitstream/handle/10986/35098/Nigeria-Country-Partnership-Framework-for-the-Period-FY21-FY25.pdf

World Bank. 2021a. Malawi Agriculture Commercialisation Project. In: *World Bank Projects*. Cited 5 December 2022. https://projects.worldbank.org/en/projects-operations/project-detail/P158434?lang=en

World Bank. 2021c. *Resilience through reforms*. Nigeria Development Update. Washington, DC. https://openknowledge.worldbank.org/bitstream/handle/10986/35786/Resilience-through-Reforms.pdf

World Bank & FAO. 2018. *Rebuilding resilient and sustainable agriculture in Somalia*. Country Economic Memorandum Volume 1. Washington, DC, World Bank and Rome, FAO. https://documents1.worldbank.org/curated/en/781281522164647812/pdf/124651-REVISED-Somalia-CEM-Agriculture-Report-Main-Report-Revised-July-2018.pdf

Appendix

FAO digital services

FAO has developed a very large number of applications, databases and platforms to support countries around the world. Various digital services are used in the DVI countries and have been referred to in the report. Some of the most referred to are briefly below.

- Digital Services Portfolio: FAO has developed applications, databases and platforms to support the work being carried out in countries around the world. These platforms are sometimes directly managed by governments in collaboration with the organization. The platform used in the DVI countries and referred to as DSP integrates local price data, weather forecast and crop calendars.

  More information: *https://www.fao.org/digital-agriculture/digital-portfolio/en/*

- EMPRES-I: this is the Global Animal Disease Information System of the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) programme. This information system has supported early warning and surveillance of animal disease within the veterinary services in the country

  More information: *https://empres-i.apps.fao.org*

- FAMEWS: through the Fall Army Worm Monitoring and Early Warning System, data on Fall Armyworm can be collected at the farm level and collated for sharing at local, national and global levels to manage the pest, identify priority areas, and foster early warning mechanisms for all stakeholders.

  More information: *https://www.fao.org/family-farming/detail/fr/c/1155315/*

- eLocust app: this is a set of digital platforms FAO has been using for several years for desert locust control. It is highly effective data recording and transmission system for crop pest monitoring. It consists of a robust tablet and custom designed software, which enable field staff to gather data and transfer it in real-time via satellite from the field to their national locust centres, before transmission to the Desert Locust Information Service (DLIS) at FAO Headquarters in Rome.

  More information: *https://reliefweb.int/report/world/elocust3-innovative-tool-crop-pest-control*

Some digital initiatives and services for agriculture in the DVI countries

(Additional initiatives and details are included in the chapters, notably for Malawi and Nigeria)

DSA Provider	Brief Description of Services
Ghana	
Tahmo	The Trans-African Hydro-Meteorological Observatory research project aims to address the lack of meteorological data across Ghana and on the African continent. It seeks to develop and implement a network of weather stations for collecting data that can be used in climate research, weather forecasting, and agricultural planning.
	Website: https://tahmo.org
Esoko	Esoko is a pioneering technology company based in Ghana and serving various countries that provides innovative digital solutions to connect and empower smallholder farmers. The company offers a suite of apps for data collection, dissemination, and analysis to enhance communication, market access, and productivity within the agricultural sector.
	Website: https://esoko.com
MFarms	MFarms is an integrated mobile and web-based application that connects stakeholders in the agricultural value chain. The platform is designed to improve productivity, market access, and communication among farmers, agribusinesses, financial institutions, and agricultural extension officers.
	Website: http://www.mfarms.org
Farmerline	Farmerline is a social enterprise based in Ghana that provides farmers with innovative mobile communication and farm management tools that help them to improve their productivity, access market information, and increase their income.
	Website: https://farmerline.co
CowTribe	CowTribe is a technology company that provides on-demand and subscription-based animal health services to livestock farmers in Africa. The company leverages mobile technology to deliver essential animal health services such as vaccination, treatment, and emergency response directly to farmers in their communities.
	Website: http://www.cowtribe.com
AgroCenta	AgroCenta is a Ghanaian agritech start-up that connects smallholder farmers in the staple food value chain directly to online and offline markets. The platform provides an end-to-end solution for farmers, including access to market information, aggregation of produce, logistics, and access to finance.
	Website: https://agrocenta.com
Trotro Tractor Limited	Trotro Tractor Limited is an agricultural technology company based in Ghana that uses mobile technology to connect farmers who need tractor services with tractor owners. This innovative service provides an on-demand solution for small-scale farmers who require access to mechanization services.
	Website: http://www.trotrotractor.com

DSA Provider	Brief Description of Services
Kuafo	Kuafo, supported by the Council for Scientific and Industrial Research in Ghana, is an e-commerce platform in the agriculture sector.
	Website: http://kuafo.csirgh.com

Kenya

AgroCares	AgroCares uses in-house developed tools to monitor and analyze nutrients in soil, feed and leaves or scouting for insects.
	Company Website: https://www.agrocares.com/
Apollo Agriculture	Apollo bundles everything a farmer needs: financing, farm inputs, advice, insurance, and market access, when possible using satellite data and machine learning enable better credit decisions, and automated operations keep costs low and processes scalable.
	Company Website: https://www.apolloagriculture.com/
Arinifu	Arinifu is a company that offers chicken related e-extension services through their Kuku Smart app. Farmers get farm insights for improved productivity alongside notifications to feed chicks, vaccinate chicks, and clean the coop.
	Company Website: https://app.arinifu.com/
Digifarm	Digifarm is an integrated digital platform that offers farmers access to a suite of information and financial services, including discounted products, customized information on farming best practices, and access to credit and other financial facilities. It collaborates with many digital service providers.
	Website: https://digifarm.io
Digital Green	Digital Green produces videos on topics such as agricultural practices, livestock, agriculture inputs. Digital Green's FarmStack uses secure data sharing and layering digital tools to provide fertilizer and planting date recommendations
	Company Website: https://www.digitalgreen.org/
E-Granary	E-Granary is a digital platform that helps smallholder farmers to increase their yields and income by providing them with various services, including access to quality inputs, credit, and information about best farming practices. The platform also offers a market linkage to ensure farmers sell their produce at competitive prices.
	Website: https://e-granary.com
E-Tinga	E-Tinga is an online based platform that enables farmers to register and order for mechanisation services as groups or individuals using hand gadgets such as mobile phones, tablet or computers.
	Company Website: https://www.e-tinga.com/
iCow	iCow is a mobile phone based agricultural information platform for smallholder farmers to improve their skills through enhanced knowledge. The platform is owned by Green Dreams Ltd.
	Company Website: https://icow.co.ke/

DSA Provider	Brief Description of Services
Synnefa	Synnefa (formerly known as Illuminum Greenhouses) offers smart and comprehensive farming tools with a variety of products to help the modern farmer take the guesswork out of farming. Their services include FarmShield that provides farmers with information on fertigation and irrigation needs of their crop.
	Company Website: https://www.synnefa.io
iProcure	iProcure is the largest agricultural supply chain platform in rural Africa. In addition to complete procurement and last mile distribution services, iProcure provides business intelligence and data-driven stock management across the supply chains.
	Company Website: https://iprocu.re/
Kuza One	Kuza One assists rural agents in providing rural advisory/extension services to the smallholders on one side and facilitates transactions for procuring & servicing quality inputs, mechanization services, credit, market, allied services on the other side.
	Company Website: https://www.kuza.one/agriculture/
One Acre Fund	One Acre Fund is a non-profit social enterprise that supplies financing and training to help smallholders grow their way out of hunger and build lasting pathways to prosperity. They are supporting access to various digital agriculture services.
	Website: https://oneacrefund.org
PlantVillage	PlantVillage uses AI, satellite technology and a unique field force to form the algorithm within the PlantVillage engine that can send out advice via smartphone, SMS, TV or real world social networks to farmers.
	Company Website: https://plantvillage.psu.edu/
Plantwise	Plantwise is a global programme led by CABI, which helps farmers lose less of what they grow to plant health problems.
	Company Website: https://www.plantwise.org/
Pula	Pula is an agricultural insurance and technology company that designs and delivers innovative agricultural insurance and digital products to help smallholder farmers endure yield risks, improve their farming practices, and bolster their incomes over time.
	Company Website: https://www.pula-advisors.com/
RATIN	RATIN is a quick way for farmers, traders and processors to get regional market information anywhere, any time, easily using mobile phones or computers.
	Company Website: https://ratin.net/
Twiga Foods	Twiga Foods bridges the gaps in food and market security through an organised platform for an efficient, fair, transparent and formal marketplace.
	Company Website: https://twiga.com/
UjuziKilimo	UjuziKilimo enables data driven decisions for the world's small holder farmers by collecting and making sense of agricultural data.
	Company Website: https://www.ujuzikilimo.com/

DSA Provider	Brief Description of Services
M-Tiba	M-Tiba facilitates access to affordable healthcare in Kenya using mobile technology; They notably facilitates the management of medical payment services.
	Website: https://mtiba.com
Toto Health	Toto Health is a social enterprise that uses mobile technology to improve child health and reduce maternal and child mortality in underserved areas in Kenya.
	Website: https://www.totohealth.org
Ilara Health	Ilara Health brings accurate and affordable diagnostics to the clinics of Africa's health providers. They partner with global manufacturers to distribute innovative, low-cost diagnostic devices directly to local clinics, overcoming traditional barriers to the latest in medical technology.
	Website: https://ilarahealth.com
Eneza Education	Eneza Education provides accessible, quality education to millions of students in Kenya and Africa using basic mobile technology. Their mobile learning platform offers curriculum-aligned revision material, assessments, and interactive tutorials to enhance the learning experience.
	Website: https://enezaeducation.com
E-limu	E-limu is an educational technology initiative that provides interactive digital educational content for learners in Kenya. It seeks to engage children in the learning process with locally relevant content and innovative teaching methods to improve their learning outcomes.
	Website: https://e-limu.org
Mzalendo	Mzalendo is a non-partisan entity that keeps an eye on Kenyan Parliament with a mission to keep people informed about the activities of their elected representatives. It provides information about parliamentarians, public participation opportunities, legislation, and devolution.
	Website: https://info.mzalendo.com

Niger

SLAPIS	Slapis is a platform for the dissemination of hydrological information in Niger, developed as part of the ANADIA 2.0 project.
	Website: https://climateservices.it/progetto/slapis-platforme-dinformation
RECA Niger	The Réseau des Chambres d'Agriculture du Niger (RECA-Niger) provides various services to the agricultural sector using as well digital tools; these include e-advisory services. The website hosts a diversity of resources, such as agricultural statistics, project reports, and useful links for the farming community in Niger.
	Website: https://www.reca-niger.org
Kaomini	E-commerce platform in Niger; it facilitates as well agri-food product trade.
	Website: https://www.kaomini.ne
Agritech Shop Niger	Agritech Shop Niger is an online store catering specifically to the agricultural sector in Niger. The site offers a variety of agricultural equipment and supplies, ranging from machinery, seeds, fertilizers, and more, aiming to boost farming productivity.
	Website: https://agritechshop.live.ne

DSA Provider	Brief Description of Services
Duddal	Duddal is a digital library that offers technical and educational resources of various kinds in the field of small-scale irrigation and rural development in Niger.
	Website: https://duddal.org/s/bibnum-promap/page/Bienvenue
Last Mile Mobile Solution	The Last Mile Mobile Solution (LMMS) is an initiative of World Vision International that supports beneficiary registration, verification, distribution planning and management, and reporting of commodities and services.
	Website: https://www.wvi.org/disaster-management/last-mile-mobile-solution-lmms
Centre pour la Sécurité Alimentaire et Nutritionelle	The CSAN is an institution supporting farmers and organisations active in rural development in Niger to address challenges related to food security.
	Website: http://www.csan-niger.com

Senegal

Senlouma	e-Commerce platform in Senegal facilitating access to market to producers.
	Website: https://www.senlouma.org
Tolbi	Tolbi is an agritech that develops innovative AI-based solutions for climate smart agriculture in Senegal. They have been involved in the DVI activities in Senegal.
	Website: https://www.tolbico.com
Jokolante	Jokalante offers digital solutions that enable interactions with this Senegalese communities, regardless of their language, type of phone, or geographical location. They have worked consistently with farmers and in rural areas.
	Website: https://jokalante.com
Sooretul	Sooretul is an e-commerce platform that showcases and sells local Senegalese products, particularly those made by women entrepreneurs. It offers a range of products from organic food to cosmetics, promoting local businesses and products.
	Website: https://shop.sooretul.com
Mlouma	Mlouma is an online platform in Senegal that connects farmers, vendors, and consumers to buy and sell agricultural products. It provides information about the availability and pricing of various commodities, aiding efficient agricultural trade.
	Website: https://www.mlouma.com
Manobi Africa	Manobi Africa, via its platform, provides digital services for agricultural and rural development in Senegal and in Africa. It offers services like market information, climate forecasts, and financial services, aimed at improving productivity and income.
	Website: http://www.manobi.com

DSA Provider	Brief Description of Services
Aywajieune	Aywajieune is an online marketplace operating in Senegal that focuses on the sale of fish and seafood. It connects fishermen, fish processors, and consumers, promoting transparent pricing and quality assurance.
	Website: https://aywadieune.com
Georisk Afric	Georisk Afric is a geographic information system (GIS) and remote sensing firm in Africa, which leverages particularly the use of drones. They provide services addressing climate change, disaster risk reduction, and natural resource management.
	Facebook page: https://www.facebook.com/georiskafric
SowIT	SowIT is a technology company that leverages remote sensing technology and AI to provide farmers in France, Morocco, Senegal, and other countries with data-driven insights. Their services aim to enhance agricultural productivity, sustainability, and climate resilience.
	Website: https://www.sowit.fr
CTIC Dakar	CTIC Dakar is a tech hub in Dakar, Senegal, that supports digital entrepreneurship and innovation. They provide various services like incubation, training, and events to nurture the local tech ecosystem.
	Website: https://www.cticdakar.com

Somalia

Saami Online	Saami Online is an e-commerce platform in Somalia.
	Website: http://www.saamionline.com
Aleelo	Aleelo is an e-commerce platform in Somalia.
	Facebook Page: https://www.facebook.com/aleelocom/
SWALIM	The FAO SWALIM platform provides early warning information related to water and land management in Somalia.
	More information: https://www.faoswalim.org/article/el-niño-how-swalim-supported-early-warning-and-preparedness
E-Plaform in Somalia	A Video on the FAO e-Platform used for Mobile Money and Livelihood Assistance in Somalia
	https://www.youtube.com/watch?v=ZSgD1Kj3wTg
Mdalag	MDALAG is an online marketplace for farmers in Somali.
	Website: http://www.mdalag.com
Bulsho Kaab	Bulsho Kaab is an online crowdfunding platform in Somalia.
	Website: https://www.bulshokaab.com
An app for Somali Pastoralists	This article provides information on a UNDP's weather app that supports Somali pastoralists
	https://www.borgenmagazine.com/somali-pastoralists

Food and Agriculture Organization of the United Nataions
Accra, 2023

SBN 978-92-5-137888-5

789251 378885

CC6131EN/1/06.23