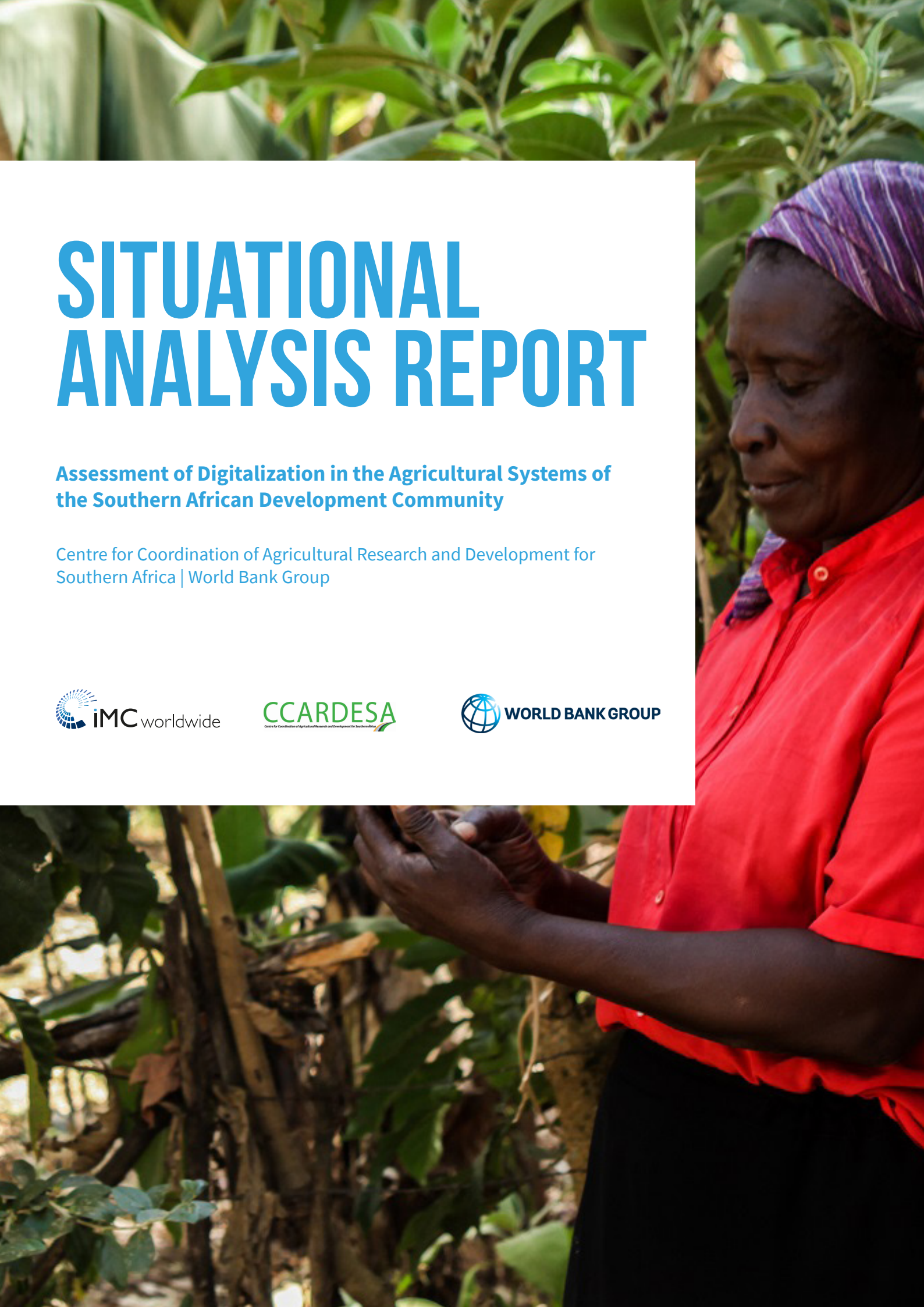

SITUATIONAL ANALYSIS REPORT

Assessment of Digitalization in the Agricultural Systems of the Southern African Development Community

Centre for Coordination of Agricultural Research and Development for Southern Africa | World Bank Group

IMC worldwide

CCARDESA

WORLD BANK GROUP

ASSESSMENT OF DIGITALIZATION IN THE AGRICULTURAL SYSTEMS OF THE SADC REGION

SITUATIONAL ANALYSIS

Centre for Coordination of Agricultural Research and Development for Southern Africa | World Bank Group

2021/2022

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ACRONYMS AND ABBREVIATIONS

ACP	Africa, Caribbean, and Pacific States
AFA	AgriFin Accelerate Program
AFAAS	African Forum for Agricultural Advisory Services
AFTA	African Free Trade Agreement
AI	Artificial Intelligence
AIDI	Africa Infrastructure Development Index
APPSA	Agricultural Productivity Program for Southern Africa
AR4D	Agricultural Research for Development
AU	African Union
B2B	Business-to-Business
B2C	Business-to-Consumer
CCARDESA	The Centre for Coordination of Agricultural Research and Development for Southern Africa
COVID-19	Coronavirus pandemic
DACS	Digital Agricultural Country Study
DAT	Disruptive Agricultural Technology
DE4A	Digital Economy for Africa Initiative
DIAL	Digital Impact Alliance
DRC	Democratic Republic of Congo
EGDI	E-Government Development Index
EU	European Union
FANR	Food, Agriculture and Natural Resources Directorate
FAO	Food and Agriculture Organization of the United Nations
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GFRAS	Global Forum for Rural Advisory Services
GHG	Greenhouse Gas
GII	Global Innovation Index
GIS	Geographic Information System
GNI	Gross National Income
GPS	Global Positioning System
GSMA	Global System for Mobile Communications
HCD	Human Centered Design
ICDL	International Computer Driving License
ICKM	Information, Communication and Knowledge Management
ICT	Information Communication Technology
ICT4AG	ICT for Agriculture

IDIA	International Development Innovation Alliance
IFC	International Finance Corporation
IFPRI	International Food Policy Institute
IMC	IMC Worldwide
IOT	Internet of Things
IS	Information Society
IT	Information Technology
ITU	International Telecommunications Unit
KII	Key Informant Interview
MSMES	Micro, Small and Medium Enterprises
NELK	New Extensionist Learning
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NREN	National Research and Education Networks
OECD	Organization for Economic Co-operation and Development
OSI	Online Service Index
R&D	Research and Development
RCOL	Regional Centers of Leadership
RUFORUM	Regional Universities Forum
SAA	Sasakawa Africa Association
SAAS	Software as a Service
SADC	Southern African Development Community
SARFAAS	Southern African Forum for Agricultural Advisory Service
SME	Small and Medium Enterprise
SMS	Short Message Service
SSA	Sub Saharan Africa
TOR	Terms of Reference
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data

1 INTRODUCTION AND CONTEXT

1.1 IMPORTANCE OF AGRICULTURE IN SADC

The Southern African Development Community (SADC) established in 1992 is an inter-governmental organization to promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper cooperation and integration, good governance, and durable peace and security among the 16 Member States. The members include Angola, Botswana, Comoros, Democratic Republic of Congo (DRC), Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, United Republic of Tanzania, Zambia, and Zimbabwe.

Each country's agriculture sector varies in its gross domestic product (GDP) contribution signaling the varied economic importance of agriculture across the region.

FIGURE 1 THE 16 COUNTRIES IN THE SADC REGION

The agriculture sector is of major social and economic importance in the SADC region, contributing between 2% and 27% of GDP and approximately 13% of overall export earnings[i]. However, the contribution of the sector fluctuates with the impacts of climate and weather over successive years. In the region, agriculture has a major influence on food security, economic growth, and social stability. 70% of the population depends on agriculture for food, income, and employment[ii].

TABLE 1 SHARE OF AGRICULTURE VALUE ADDED TO TOTAL GDP (%), 2009-2019. SADC (2020) SELECTED ECONOMIC AND SOCIAL INDICATORS

SADC Member States	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Angola	6.6	6.2	5.8	6.1	6.5	7.5	9.1	9.8	10.0	8.6	11.3
Botswana	2.8	2.5	2.5	2.7	2.3	2.1	2.2	2.0	2.0	2.0	1.9
Comoros	33.3	19.4	19.2	19.0	19.6	19.2	18.8	18.7	18.5	18.2	17.6
DRC	22.4	21.4	20.9	20.4	19.3	18.6	18.4	18.6	19.7	8.1	9.4

Eswatini	9.3	10.2	9.7	10.2	10.3	9.4	9.5	8.9	8.3	8.2	8.6
Lesotho	5.1	4.8	4.5	4.8	5.0	3.9	3.8	5.6	5.4	4.4	4.3
Madagascar	26.5	22.2	21.8	21.6	20.1	20.2	19.7	20.4	20.7	15.0	14.0
Malawi	30.4	29.6	28.8	29.9	29.9	29.9	28.7	27.9	28.2	27.3	26.9
Mauritius	3.9	3.6	3.7	3.7	3.4	3.3	3.2	3.2	3.1	2.8	2.9
Mozambique	30.0	26.8	25.8	24.9	23.5	23.9	22.9	22.9	25.0	24.6	26.0
Namibia	8.3	8.5	8.1	8.1	7.5	7.7	6.2	6.3	7.1	7.0	6.6
Seychelles	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.3	1.3
South Africa	2.7	2.4	2.3	2.2	2.1	2.2	2.1	2.2	2.4	2.2	1.9
Tanzania	26.5	25.6	25.0	26.6	26.8	25.8	26.7	27.4	28.8	27.9	26.5
Zambia	11.2	9.4	9.6	9.3	8.2	6.8	5.0	6.2	7.2	2.8	3.2
Zimbabwe	12.7	9.6	8.7	7.0	7.1	8.7	8.3	7.9	8.3	7.4	6.5
SADC Region	**7.3**	**6.4**	**6.3**	**6.6**	**6.9**	**7.4**	**7.7**	**8.1**	**8.2**	**6.9**	**7.3**

The core focus for the SADC region's agriculture sector is for greater food security, stable food availability[1], equitable food access[2], and nutritional value and safety for consumers.

1.2 OPPORTUNITIES FOR DIGITAL INNOVATIONS IN AGRICULTURE

Increasing the efficiency of agriculture for smallholder farmers would provide multiple benefits including, increased food availability and freeing up labor to drive more profitable sectors of the economy. The agriculture sector is ripe for innovative solutions to help tackle challenges of food security, hunger, inclusiveness, and sustainability at national, regional, and international levels. Digitization is expected to play an increasingly significant role in achieving global food security, improving livelihoods in rural areas, and is undergoing expansion at an exponential rate.

A recent high-level report entitled 'Charting Pathways for Inclusive Growth' by the Pathways for Prosperity Commission identifies five possible pathways for prosperity being unlocked by technological innovation, the first of these is to raise value from agriculture. Advancements in data analytics, biotechnology and communications will drive growth by improving yields on the farm and by enabling more efficient services and logistics. Agriculture will be a key pillar for inclusive development as many tasks cannot easily be automated. The implications of which suggest continued demand for low-skilled workers and improved terms for trade for farmers, as costs and prices in other more easily automated parts of the economy fall more quickly.

Digital innovations and technologies have the potential to transform agri-food systems by accelerating and integrating stakeholders and their work across the value chain. The use of digital tools by governments for distributing subsidies or managing inventory of emergency food reserves are strategies already being utilized in Africa. These tools, when part of an integrated and national effort, could raise incomes for smallholder farmers, increase their crop production, and enhance food security.

Governments can play a significantly vital role in supporting policy and data infrastructure that encourages the private sector to invest in digital tools. Together with development partners, a valuable digital agricultural transformation can be deployed in partnership with the private sector. Also notable is the impact of the Covid-19 crisis, which has forced many governments to deliver more real time data to help inform the state of food and agriculture during lockdowns, more data sharing between public and private sectors, and beginning momentum to transform the agri-food system across the region. Governments also have a special role in navigating through uneven digital access, digital literacy across populations, low data accuracy and usability, and limited tailoring of content for local contexts. They also suffer

[1] Consistent local supply of appropriate food types, either imported or produced locally.
[2] Local population have the means to purchase or barter for the food they require for appropriate diet and nutrition. Availability and accessibility of food should be of sufficient nutritional value and safe to consume.

as challenges are particularly acute in the public sector, including the shortage of digital talent and aligning digital use cases with manual systems and succeeding in the interoperability continuum.

Over the past ten years, digital agriculture solutions have reached sufficient scale in some parts of the world to become commercially attractive and provide tangible impacts for smallholder farmers such as, Hello Tractor, WeFarm, and Viamo. However, the digital agriculture sector is still in its infancy. Donor financing remains critical to the development of the sector, particularly in some SADC member states (not South Africa) that lag parts of East Africa (Kenya, Rwanda) and West Africa (Nigeria, Ghana) where commercial finance is more accessible. There is a very broad range of digital agricultural tools; from agricultural advisory services to the use of satellite geodata, sensors and machine learning to understand and make sense of big data analytics. Together all can help build more profitable agricultural livelihoods, ensure more climate smart efforts to combat climate change effects, encourage conservation of biodiversity and a diversification of foods as part of changing and emerging diets. Whilst there have been some notable successes, smallholder farmers are still to experience widespread benefits.

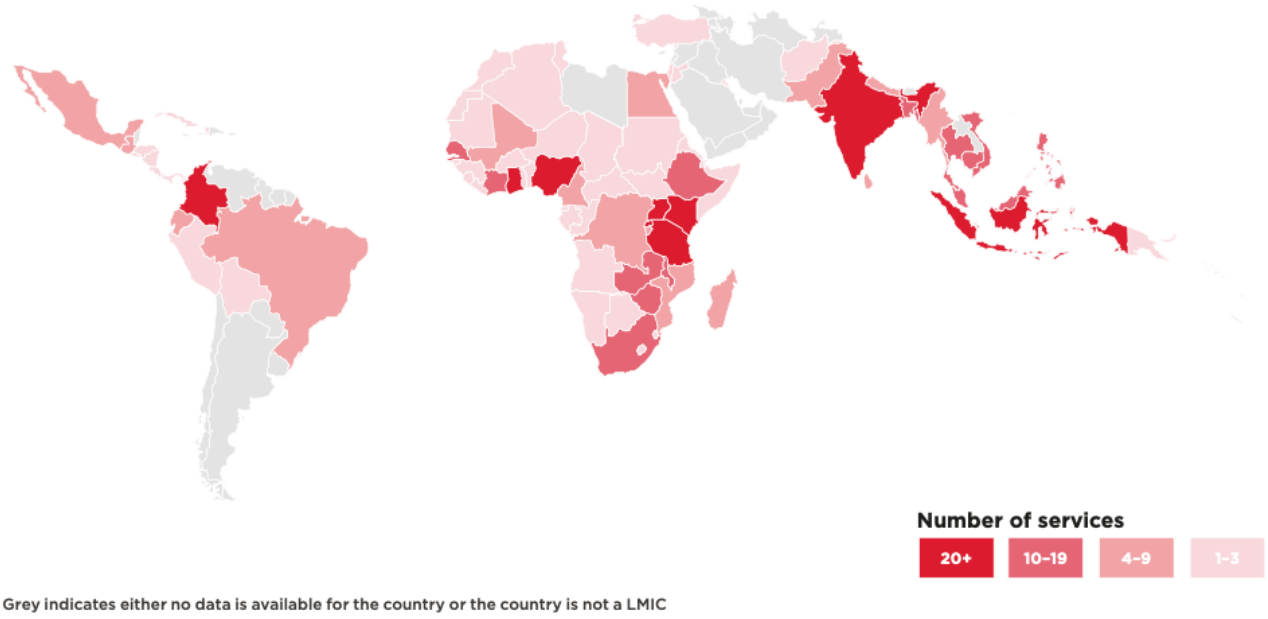

FIGURE 2 GLOBAL MAP OF ACTIVE DIGITAL AGRICULTURE SERVICES. GSMA (2020) DIGITAL AGRICULTURE MAPS

Global System for Mobile Communications (GSMA) AgriTech Digital Agriculture Maps provides a valuable insight into the large numbers of innovations already present. Their global dataset for 2020 illustrates over 700 active digital agriculture services globally in 2020, with a 92% increase since 2009. In Sub-Saharan Africa (SSA) 437 services were tracked by GSMA's AgriTech mapping exercise, with SSA seeing the largest growth in the update of digital agriculture tools. Digital financial services have experienced considerable growth, predominantly through mobile money. The GSMA framework for use cases, and the subsequent 24 sub-use cases identified, address five key challenges including the agricultural knowledge gap, network and internet connectivity, financial exclusion, poor access to markets and climate change. This versatile framework has guided the use cases in this study and is illustrated in figure 4 in section 3.3.

DIGITAL SKILLS AND AGRICULTURE

The African Union (AU) has already recognized the importance of human capital investment, particularly in digital skills. In February 2020, the AU adopted the Digital Transformation Strategy for Africa, which seeks to harness digital technologies and innovation to transform Africa's economies, generate inclusive economic growth, and stimulate job

creation[3]. The pandemic has accelerated the need to enable digital skills advancement across the board from enhancing the capacity of the general consumer population to specialized skills for business, industry, and agriculture.

While the importance of digital skills has been recognized, there has been less of a focus—particularly in emerging markets—on the scale of demand for these skills, and the models that can be used to teach them. The number of emerging studies examining the demand for digital skills in SSA are an important step in beginning to address that gap. It is important to recognize that digital skills are challenging globally, according to the European Commission (2020) as many as 42% of citizens in Europe are without basic digital skills even though most jobs require such skills. Some 37% of people in the labor force – farmers, bank employees and factory workers alike – also lack sufficient digital skills despite the increasing need for such skills in all jobs. In contrast, the Annual Global CEO Survey (2021) by PWC suggests 79% of Chief Executive Officers are concerned about the availability of key digital (Fourth Industrial Revolution) skills, and in Africa that figure jumps to 87%.

The International Finance Corporation (IFC) (2019) in Digital Skills in Sub-Saharan Africa, suggests that digital skills are essential to the future workforce in Africa. By 2030, over 230 million jobs in Africa will require digital skills, which will result in 650 million training opportunities[iii]. Digital skills are not only critical to finding or keeping jobs. They are also critical to closing the digital divide. According to the International Telecommunications Unit (ITU) Digital Skills Insights 2019, in developing countries, 53% of the population is offline, and in least developed countries almost 80% of the population is not using the Internet. This stands in stark contrast to the highly digitized economies and societies in middle- and higher- income countries. It is often wrongly assumed that the lack of internet services in remote areas is the main reason for the gap in internet use. Most of the global population (93%) lives in an area that is covered by at least a 3G mobile signal or service (82 % covered by a 4G signal), based on data provided by national telecom operators. Hence, there are other reasons why many people do not use the internet. These include quality of the connection, cost of the data packages, cost of devices to access the internet, and lack of education and skills.

A recent report by the IFC (2021), Demand for Digital Skills in Sub-Saharan Africa, looking in detail at five countries in SSA including Côte d'Ivoire, Kenya, Mozambique, Nigeria, and Rwanda quantified the demand for digital skills in each country, assessed the market opportunity presented by that demand, and identified successful emerging training models for the provision of digital skills. Demand for digital skills training **will surge in the coming decade**, as jobs that previously did not require digital skills will begin to do so. The Covid-19 pandemic has accelerated the speed of change. By 2030, some level of digital skills will be required by 50-55% of all jobs in Kenya, 35-45% of all jobs in Côte d'Ivoire, Nigeria, and Rwanda, and 20-25% of jobs in Mozambique. Most of the demand for digital skills will be from occupations outside ICT specialties and will be generated by enterprises adopting digital technologies. Seventy percent of demand is expected to be for foundational skills, followed by 23% for non- Information Communication Technology (ICT) intermediate skills.

In combining the opportunities for Agriculture and the need for employees with digital skills, it is clear that a global digital revolution is underway. This is epitomized by farmers in need of dynamic digital information on the prices of different commodities, the acceleration of online e-commerce and increasing use of Internet of Things (IoT) and robotics in all sectors including Agriculture. Part of this will require retraining the workforce as part of the commonly referred to Fourth Industrial Revolution, and deftly described in the 2019 edition of the World Development Report, where technology is generating jobs and influencing the nature of markets. This important publication highlights why governments should get involved in building human capital, that workers will engage in life-long learning, that learning will persist outside the workplace, the importance of tertiary education will rise exponentially, where

[3] As part of the strategy's implementation, the World Bank established the "Digital Economy for Africa Initiative (DE4A)" with a goal of ensuring that every African individual, business, and government is digitally enabled by 2030.

informality and creating new social contracts will become more important and persist. The jobs of the future will require specific skills such as know-how, problem solving and critical thinking but also perseverance, collaboration and empathy, the softer less formal skills.

THE CHALLENGES AND OPPORTUNITIES FOR AGRICULTURE AND THE FOOD SYSTEM

Agriculture is subject to frequent and persistent droughts, prolonged dry spells, floods, cyclones, wildfires, pests and diseases, fluctuating input prices, periodically imposed export and import restrictions, and human and wildlife conflicts which all affect the stability and supply of nutritious food. The Covid-19 pandemic has caused major disruption in daily food supply chains within the region and has forced a rethink as to the resilience of these supply chains. The pandemic has also forced an acceleration of food distribution and food retailing online to stabilize these supply chains. Grassroots food deliveries emerged during periods of lockdowns where restrictions on the free movement of consumers were in force. Concurrently, the breakdown of supply chains of food and the combination of Covid-19 have created the conditions for political skirmishes, interruptions in food supply and consequently civil unrest in both South Africa and Eswatini, signaling the fragility and lack of resilience in some parts of the regional food system.

Agricultural methods are labor intensive, low skilled, involve poor transmission of information and retained knowledge, driven mainly by smallholder farmers cultivating small plots of land that are distributed over a wide area, and with significant fragmentation and barriers to obtaining access to high quality, relevant inputs, and profitable output markets. The production system has large inefficiencies, with heavy consumption of land, use of water, lost production, and wasted food products, which highlights the unsustainable nature of the sector. Farmers are dependent on information to help them to apply good agricultural practices and raise their productivity. A lack of access to this information creates deep and damaging inequalities in the sector and contributes to cycles of poverty, hunger, and overuse of natural resources.

The Regional Food Security Update 2019/20 issued by the SADC Food Agriculture and Natural Resources Directorate predicted the continuing major impact of Covid-19 on food and nutritional security, and agricultural livelihoods. It suggested 43 million people in the region could be food insecure and called for urgent resourcing and scale up of interventions by SADC governments and their humanitarian partners[4]. There was also poor seasonal rainfall dampening overall harvest prospects which was then exacerbated by excessive flooding in the North-Eastern parts of the region. Despite this, crop production estimates for Malawi, Namibia and South Africa were predicted to increase in most crops, including maize the main staple. African migratory locust outbreaks were recorded in Botswana and Namibia and Fall armyworm and foot and mouth disease remained challenges in the region, all putting strains on the food system.

It is also important to recognize that the food system itself is complex and has many different stakeholders who exchange vast amounts of information and supply inputs including seeds, fertilizers, agrochemicals, farm machinery, crop and livestock health services, crop and livestock insurance, and finance amongst many other areas including marketing, logistics and retail. These latter components of the food system can play a significant role in building up a vibrant and functional ecosystem for food in the SADC region. Furthermore, Youth are more attracted to combining elements of the agricultural commodity value chain than simply restricting themselves to on-farm production alone. The opportunity to drive enterprise and provide products, services, knowledge, and information is more attractive

[4] This is about 61% higher than the previous season and 42% above the past 5-year average according to the 2019 Regional Vulnerability Assessment and Analysis Synthesis Report. The impact of the reduced crop production on household food security will be more severe in those areas which were already experiencing high numbers of food insecure populations the previous seasons (SADC Food Security Quarterly Update 2019/20, Issue 3, April 2020 FANR, SADC).

than farming the land itself and they can see a future in it based on service provision and the development of products that meet farmers' needs. Furthermore, youth are more likely to have the mindset that ecosystems exist to mobilize and incentivize diverse participants to collectively address the end-to-end needs of consumers, the very things that typify a successful digital ecosystem.

A recent World Bank report, Future of Food: Harnessing Digital Technologies to Improve Food System Outcomes, suggests that as countries generate wealth, per capita expenditure on food rises and diets also change. The Food and Agriculture Organization of the United Nations (FAO) (2017) The Future of Food and Agriculture: Trends and Challenges report suggests that the share of income spent on cereals declines relative to higher consumption of meat, fresh fruits, vegetables, and processed and convenience foods. With the increasing demographic shift from rural to urban, the nature of supply and demand and patterns of food consumption are changing in scale and nature simultaneously. These changes not only lead to transformation and value addition beyond the farm but have multiplier effects in creating new enterprises and jobs in the broader food system. Urban consumption patterns favor food products with large amounts of labor embedded in them, such as fast food, retail-bought convenience food, and foods prepared by street vendors. Within these ecosystems, actors are more likely to integrate parts of the value chain to capitalize on these changes in consumer habits.

Whilst farming or agriculture employs more people than any other sector, the food system also accounts for a large share of manufacturing and service jobs. In Malawi and Tanzania, food and beverages account for more than 40% of total manufacturing employment[iv]. Even in the European Union (EU), the food and beverage industry represent a larger share of employment than other sectors such as fabricated metal, machinery, equipment, and automotive[v]. Also highlighted is the integration of digital technologies within a company which requires significant investment but also sees increases in output and in employee numbers.

With the recent attention to global agricultural production practices and their unsustainable nature, the greenhouse gas (GHG) emissions from agriculture and land use are broadly accepted to represent 70% of total allowable emissions from all economic sectors to limit global warming to 1.5°C by 2050[vi]. The inability to manage this rise in temperature will continue to drive further droughts (projected to rise by 40% in some regions)[vii] and create greater volumes of food loss and waste claiming a significant proportion of agricultural output while also exacerbating the contribution to GHGs. Accompanying the need for increased productivity is a degradation and loss of biodiversity, and the spread of transboundary pests and diseases of plants and animals which are increasingly resistant to antimicrobials. Furthermore, the incidence of zoonoses is predicted to rise and spread globally as we have seen with the recent pandemic.

1.3 YOUTH UNEMPLOYMENT AND THE AGRICULTURE SECTOR

The potential for the agriculture sector in the region has already been stated in the sections above, but to unleash this potential the sector needs a thriving labor market that integrates the youth. Some of the SADC countries have a persistent youth unemployment rate that can be addressed through the opportunities within the agriculture sector.

Table 2 highlights the youth unemployment rate in the SADC member states, which is persistent over the ten-years of readings.

TABLE 2 YOUTH UNEMPLOYMENT RATE (% AGES 15-24) (%) IN SADC, 2008-2017

SADC Member States	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Angola	33.7	28.1	22.8	16.9	17	17	17	16.9	18	19.1
Botswana	32.5	32.6	35.2	35.2	35.4	35.6	35.4	35.3	35.7	35.7
Comoros	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	10

DRC	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Eswatini	53	53.1	53.1	53.1	53.3	53.4	53.5	53.5	54.1	54.8
Lesotho	47.7	46.2	36.3	28.9	32.9	34.5	34.9	38	39	38.5
Madagascar	5.5	5.9	6.4	3.8	1.0	1.5	2.0	3.0	3.0	3.0
Malawi	9.6	9.2	8.9	8.6	8.2	7.8	7.9	7.8	7.9	8.0
Mauritius	18.9	21.8	23.2	22.1	24.4	23.4	24.6	26	23.6	23.3
Mozambique	38.5	38.5	38.5	38.5	38.6	39.8	43.2	43.2	43	42.7
Namibia	46.1	46.6	45.3	42.6	34.3	40.8	38.7	40.1	45.2	45.5
Seychelles	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
South Africa	45.6	48.4	51.2	50.3	51.7	51.4	51.3	50.1	53.4	57.4
Tanzania	6.9	4.9	5.9	7.1	6.5	5.8	3.7	3.7	3.8	3.9
Zambia	15.5	20.9	26.8	20.1	15.3	15.3	15.3	15.2	15.3	15.4
Zimbabwe	7.9	8.2	8.4	8.5	11.5	11.5	11.4	11.4	11.4	11.4

The World Bank predicts that there will be two billion Africans south of the Sahara by 2050; 330 million new entrants to the labor market by 2025[viii]. These people the World Bank says have already been born. In Scaling Up Disruptive Agricultural Technologies in Africa, it is suggested that the agri-food system is the only sector capable of absorbing about 70% of these new entrants [ix]. However, for this to happen an integration and a functional ecosystem of actors including input suppliers of seed, fertilizer, finance, or advisory services must integrate into an ecosystem in ways that low-skilled men and women, often slightly aging and isolated, can engage. Furthermore, with limited connectivity and access to information and markets, the barriers remain high.

1.4 ACCELERATION OF DIGITALIZATION AND DIGITAL AGRICULTURE AND THE RECENT IMPACT OF COVID-19

The United Nations (UN) Secretary-General's Roadmap for Digital Cooperation (2020) emphasizes the importance and the risks of digital technologies in general: *"As the world grapples with the coronavirus disease (Covid-19) pandemic, it is witnessing first-hand how digital technologies help to confront the threat and keep people connected. Digital technologies do not exist in a vacuum – it has enormous potential for positive change but can also reinforce and magnify existing fault lines and worsen economic and other inequalities".*

Digital agricultural innovations have also increased due to the impact of Covid-19, which has highlighted the systemic challenges faced by smallholder farmers. The disruptions in food supply have caused major impacts on the finances and food security of both commercial and subsistence farmers in all regions of the world and limited their ability to plan effectively.

A recent and rapid survey, Feed the Future: Results of a Rapid Analysis of Digital Solutions Used by Agriculture Market System Actors in Response to Covid-19, conducted of United States Agency for International Development's (USAID) digital agriculture innovations suggests that few new digital solutions have been launched specifically in response to the pandemic except for a few newly launched e-commerce platforms. However, many digital service providers and agribusinesses have accelerated, adapted, and increased their digital services. Some who work with producers to buy and trade have accelerated the launch of new functionalities on their business-to-business (B2B) platforms. Digital advisory service providers have adapted their Short Message Service (SMS) to include new information on the locations where inputs could be purchased or marketplaces that could be accessed. Market actors also increased their use of digital solutions and in some cases adopted them for the first time, using services such as WhatsApp and digital payments.

The Commonwealth Secretariat's 2021 survey assessed the economic response to Covid-19. The pandemic has disrupted global trade, the investment environment and resulted in border closures, lockdowns, travel bans and

working from home. Policy makers recognize the need for greater and deeper digitalization to adjust to the 'new' economic landscape, among other things. The survey identified the following key points:

- Many countries had previously prioritized using technology and enhancing physical connectivity, digital connectivity, regulatory connectivity, B2B connectivity, and supply side connectivity. They were advancing the business environment, digital policies, digital infrastructure, sectoral policies, and regulatory policies and boosting trade and investment by integrating technology. Some of these countries have developed a clear roadmap for the development of their digital ecosystems, others have not.

- The survey highlighted the changing macroeconomic environment due to the pandemic and reinforced the importance of digitalization to sustain economic development and catalyze an economic, sustainable, and inclusive recovery. Low speed of the internet and lack of training for the public to use online platforms were significant barriers. Private sector focus has shifted to capacity building and training to use digital technologies, and the need to access financing for digital infrastructure. Government priorities have shifted to investment in basic and digital infrastructure, microfinance assistance for micro, small and medium enterprises (MSMEs), capacity building assistance and reviewing relevant policies. The survey revealed a need to review trade and investment policies to incentivize MSMEs to thrive in a digitally conducive investment environment. Employment levels have declined due to the pandemic across sectors and remittances have also fallen. The gender digital divide is even more apparent.

- Countries require basic and digital infrastructure, enabling policies and regulations and strengthened coordination of sectoral interventions on digitalization for post-Covid-19 economic recovery.

2 NATURE OF THE STUDY

2.1 INTRODUCTION TO CCARDESA AND APPSA

The Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) is a sub-regional organization that was approved by the Council of Ministers of the Southern Africa Development Community (SADC) in 2010 and launched in 2011.

CCARDESA promotes innovative research, technology generation and adoption of sustainable agricultural development through partnership and capacity development. CCARDESA also coordinates the Agricultural Productivity Program for Southern Africa (APPSA) a regional program supported by the World Bank to promote collaboration and to encourage technology generation and dissemination across national borders of participating countries of SADC. Originally this program operated in Malawi, Mozambique and Zambia and was launched in 2013. In 2019 Lesotho and Angola joined the program and will be implementing it to 2025.

APPSA supports the objectives of the World Bank's Africa Action Plan, which identifies regional integration as an important element for achieving higher economic growth and poverty reduction. Specifically, APPSA aims to increase the availability of improved agricultural technologies in participating countries in the SADC region through Regional Centers of Leadership (RCoL) for specific regional commodities, regional collaboration in agricultural research, technology, and innovation:

- Establishing RCoL on commodities of regional importance.
- Supporting regional collaboration in agricultural research, technology dissemination, and training.
- Facilitating increased sharing of agricultural information, knowledge, and technology among participating countries.

APPSA has a World Bank IDA grant component for CCARDESA and in collaboration with the Food, Agriculture and Natural Resources Directorate (FANR) of the SADC Secretariat, CCARDESA has appointed IMC Worldwide to carry out a situation analysis of the status of digitalization in the agricultural systems of SADC region and assist CCARDESA and SADC to establish a digital platform for networking amongst its stakeholders.

2.2 PURPOSE, SCOPE, AND TERMS OF REFERENCE

CCARDESA is a key player in Agricultural Research for Development (AR4D) activities and wants to take the AR4D agenda forward by ensuring that Agricultural Transformation embraces digitalization because it has the potential to provide productivity and sustainability gains for the whole agricultural sector. Significant changes in agricultural systems are anticipated because of the convergence of new digital technologies which have the potential to change farming along whole value chains. The demand for region-specific digital technologies for agricultural innovations, coupled with a conducive enabling environment, calls for a systematic assessment of levels of availability of relevant digital systems and the extent to which such technologies are accessible in each of the SADC countries.

The purpose of this assignment is to undertake a stocktaking analysis of the status of digitalization in the agricultural systems of the SADC region paying special attention to agricultural research for development, agriculture education, agriculture extension and market linkages.

The specific objectives for the assignment based on the Terms of Reference (ToR) are:

1. Assess the extent to which the national and regional policies and regulatory frameworks of the SADC countries provide a conducive environment (policy space) for agricultural digital innovations.
2. Provide a tool (digital or analog) to identify the policy opportunities and gaps that need to be addressed if the SADC region is to fully take advantage of the digital transformation. This tool should be tailored to help countries to compare and harmonize their policies to allow digital innovations and formation of networking platforms in agricultural systems.
3. Map the various agricultural digital innovations available in each country, and assess their availability, affordability, usability, and potential for scalability by smallholder farmers.
4. Map the various agricultural digital players in each country and identify their roles in the digitalization value chain.
5. Evaluate the extent to which the current agricultural syllabi in agricultural Universities and colleges embrace digital agricultural skills, innovations and applications that encourage youths to become digital entrepreneurs.
6. Identify and propose opportunities for establishing an attractive networking platform for the SADC countries.
7. Propose and Develop a Digitalized Agricultural Platform for the SADC member countries (Community of Practice or Tool) to be launched in the region.

According to the CTA definition, digitalization implies **the use of digital technologies, innovations, and data to transform business models and practices across the value chain and address bottlenecks in productivity, post-harvest handling, market access, finance and supply chain management to achieve greater incomes for smallholder farmers, improve food and nutrition security, build climate resilience, and expand the inclusion of youth and women to boost employment**. This definition is the working definition used in this study and differs from the term disruptive agricultural technologies (DATs) used by others such as the World Bank who refer to both digital and non-digital innovations that enable smallholder farmers to leapfrog their current constraints, improve yields, incomes, nutritional status, and climate resilience. These technologies include mobile apps, digital identities for farmers, solar applications for agriculture, portable agriculture devices, and bio-fortified foods. Where there is commonality is that these technologies can accelerate agri-food outcomes three-to-five times by cutting out middle actors or obtaining more efficient agri-food outcomes.

While digital transformation comes with the promise of positive outcomes, such as efficiency, cost savings, convenience, and increased safety of remote transactions, it also brings barriers and risks that could negatively affect the adoption of digital solutions, such as cyber threats, cyberbullying, fraud, exclusion of marginalized populations, lack of emphasis on sustainability and biodiversity that are unable to access and use these digital solutions.

Although the pandemic has exposed the shocking realities of inequality in access to and use of the internet and the affordability of digital services in their many forms, there is widespread support for the potential that digitalization can change farming along whole value chains at regional level. The African Free Trade Agreement (AFTA) provides drivers for greater trading between African nations. There is recognition that regionally specific digital innovations, and a conducive policy environment as well as an understanding of digital and entrepreneurial skills development will enable digital technologies to play their part.

Digitalization is a gradual process that builds a functioning, yet dynamic and evolving digital ecosystem. The process requires a broadly established and well-understood internal rationale, changes to organizational mindsets and behaviors, some surrender of control so that different actors can engage with one another easily to align structures,

processes, and staff with the appropriate investment of time and resources. It also requires a strategy to address the current pain points in a system, as well as its limitations, and needs to maintain a humility as to the human-based nature of consumers and operators in the system. This principle will be important as some of the elements, policies, innovations, and digital skills are considered in this report.

2.3 STRUCTURE OF THE REPORT

This following report is structured as follows:

Section 1: Provides an introduction and presents the context of the SADC region, the importance of agriculture to the member states, the opportunities and challenges within the agriculture sector and food system, and the recent impact of Covid-19.

Section 2: Presents the nature of the study and provides background on the Client, outlines the ToR and the purpose of the study, and defines the term digitalization.

Section 3: Provides an explanation and justification of the methodology followed by the study team. Outlined in this section is the general framework, which follows the GSMA framework of use cases, the ecosystem approach that informed the study, further information on the tools and team involved in the data collection, and the limitations of the study are also included.

Section 4: Presents the results of the Broader Policy Environment element of the study. Background is provided on the benchmark assessment and the results of the benchmark are put into context for the study. This section also includes the results of the policy and legislation stock take, and the stakeholder interviews.

Section 5: Presents the results of the Digital Agriculture Innovations element of the study.

Section 6: Presents the results of the Digital Agricultural Skills and Entrepreneurship Training element of the study.

Section 7: Provides a discussion on the results of each of the three elements. Key reflections and broader areas of study are presented. This section also highlights potential opportunities for CCARDESA in establishing, coordinating, and encouraging the growth of an emerging digital agricultural ecosystem in the SADC region.

Section 8: Provides a conclusion which addresses the state of agricultural systems currently and prepares a pathway for some possible next steps.

3 METHODOLOGY

3.1 GENERAL FRAMEWORK

IMC Worldwide, CCARDESA, and the World Bank agreed to the framework, approach, and methodology for the assessment during induction meetings held in March and April 2021. CCARDESA facilitated introductions to 14 Information, Communication and Knowledge Management (ICKM) Focal Points in the 16 SADC member states. There were no ICKM focal points for Comoros and Madagascar at the time of the study. The study team worked with 16 experienced national consultants with specialisms in agriculture and digitalization in each of the countries.

To deliver on the objectives of the assignment, the work was divided into four core deliverables across all 16 countries:

1. Establishing knowledge and information on available public national and regional policies, identifying opportunities and gaps, and a benchmarking tool for the region.
2. Mapping various agricultural digital innovations and actors available in each country including factors related to roles, access and use of services, affordability, and scalability.
3. Mapping extent to which the current agricultural syllabi in agricultural universities and colleges embrace digital agricultural skills, including incubators that encourage youths to become digital entrepreneurs.
4. Creation of a Digitalized Agricultural platform that will strengthen the role as a coordinator for CCARDESA in the digital agriculture ecosystem and to facilitate taking along all stakeholders together.

3.2 AN ECOSYSTEM APPROACH

Achieving and sustaining any agricultural development outcome often depends on the ability of multiple interconnected actors to work together. A digital ecosystem comprises stakeholders, systems, and an enabling environment that empowers communities to use digital technology to access services, engage with one another and drive economic advancement. The recent USAID digital strategy explains this in more detail.

Key actors within an ecosystem include governments, civil society, private sector, universities, individual entrepreneurs, and innovators to work effectively together. For innovations to be successful, they must be efficiently generated, developed, tested, reiterated, refined, and ultimately scaled for development impact. The ecosystem in which innovation exists requires coordination, collaborative action, and resources to ensure that it can operate at multiple levels - local, national, and regional - and inclusive of relevant sectors. Adopting an ecosystem approach recognizes the different actors, relationships and resources that have important roles in taking good ideas to scale. It also demands effectiveness in each part of the innovation system which is moderated by other parts of the system (e.g., innovators being able to access capital) and an understanding that a change in one part of the ecosystem leads to changes in other parts of the system (e.g., increases in internet connectivity will accelerate testing new technologies).

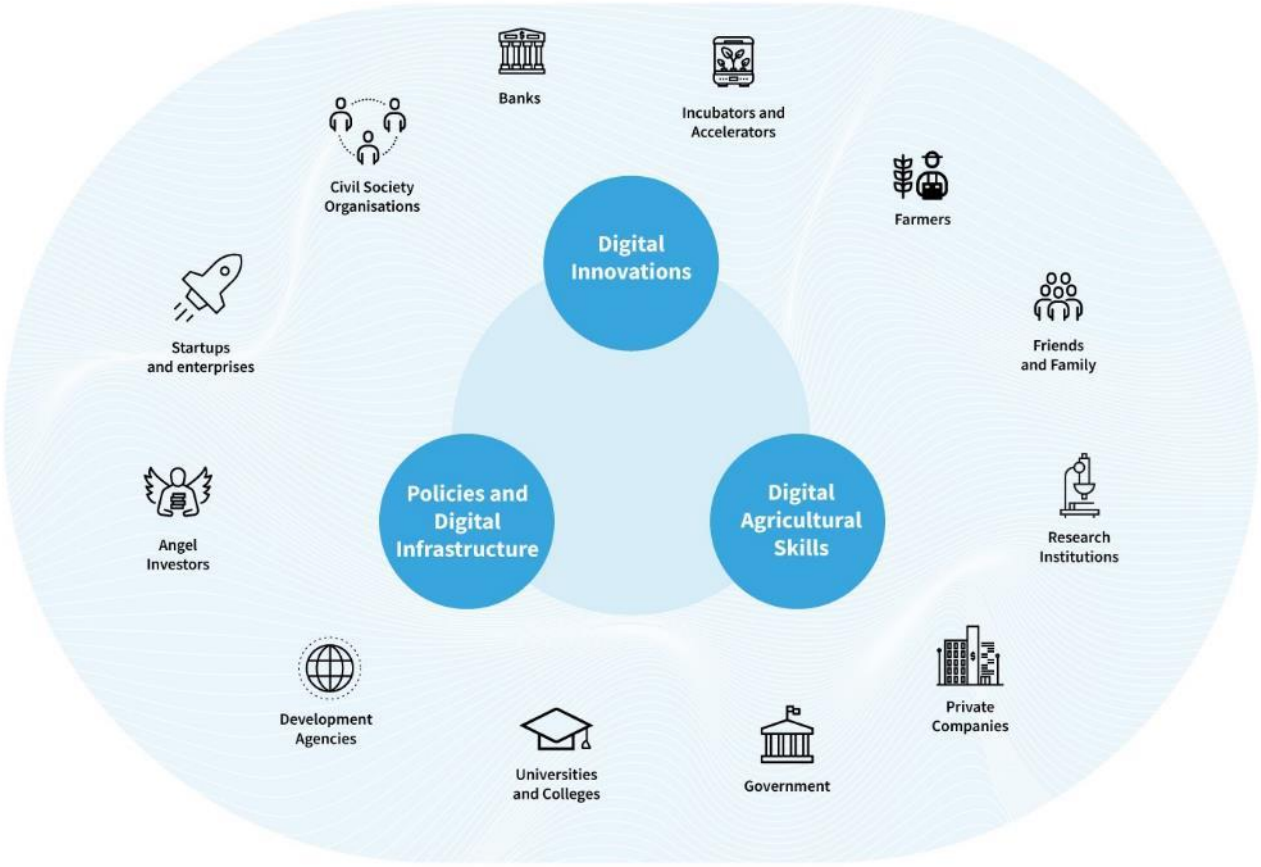

FIGURE 3 DIGITAL AGRICULTURE ECOSYSTEM FOR ASSESSMENT (CREDIT: ICONS FROM THE NOUNPROJECT)

Within the scope of the regional assessment, eight countries were pursued in further detail and termed “Deep Dives” where further time and resources were focused. The selection included a Lusophone, Francophone and Anglophone country, an island nation, and those countries in which the greatest number of innovations could initially be identified.

3.3 OVERALL METHODOLOGICAL APPROACH

TYPOLOGY

The agreed framework used to characterize digital innovations for this study is based on the GSMA framework presented in Digital Agriculture Maps: 2020 State of the Sector in Low and Middle-Income Countries. The framework is based on five key use cases, illustrated in figure 4. The digital technologies effectively mitigate the challenges facing farmers and address the pain points within the value chain for actors in the agricultural sector. This more inclusive model combines the main use cases of the technology, the increased attention and importance of finance and mobile money as a driver of digital agricultural innovation, and the challenges farmers are facing. Other models have characterized use cases based on single domains but less on a vibrant ecosystem of services.

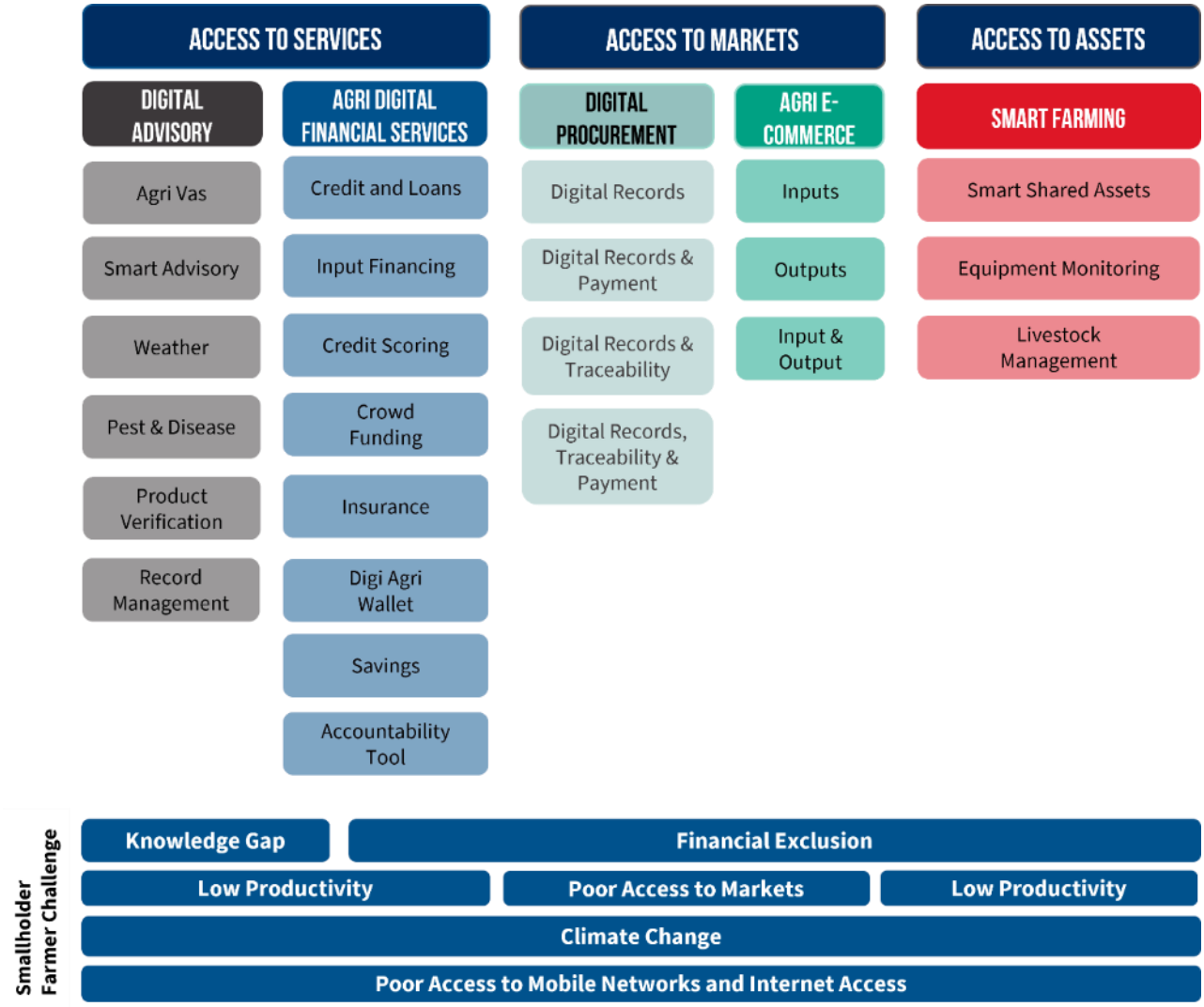

FIGURE 4 USE CASE MODEL BASED ON GSMA FRAMEWORK

TOOLS

The overall approach to this study is based on a systematic and multi-step process which utilized a series of data collection and compilation efforts both quantitative and qualitative that are described below.

a) Qualitative semi-structured interview guides to understand the relevant policies, digital agricultural innovations and digital skills training in Universities and Colleges across the region, through discussion with CCARDESA ICKM Focal Points (Key Informant Interview (KII) Guide for ICKM focal points can be found in Annex 6).

b) Desk and in-country research to identify and verify appropriate innovations and identify contact points for a quantitative survey (Full list of identified innovations can be found in Annex 5).

c) Quantitative survey tool administered to provide further detailed information on digital agricultural innovations at a national and at a regional level and translated where necessary into French and Portuguese (Innovators Survey can be found in Annex 7; KII Guide for Innovators can be found in Annex 11 and 12).

d) Quantitative survey tool to collect data on the digital skills training at Universities and Colleges in each SADC country in the region though collaboration with Regional Universities Forum (RUFORUM) Where

challenges were faced with response rates, the survey tool was administered verbally through key informant interviews and the results supplied into the survey data set with the respondent's permission (Digital Skills and Syllabi Survey can be found in Annex 8; KII Guide for Universities and Colleges can be found in Annex 10).

e) Qualitative semi-structured interviews with incubators and accelerators to assess training and entrepreneurship efforts in different countries (KII Guide for Incubators can be found in Annex 9).

f) Qualitative semi-structured interviews with other stakeholders, where appropriate (Stakeholder KII Guide can be found in Annex 13; Full list of interviewed stakeholders can be found in Annex 2).

GENERAL ECOSYSTEM

The study team collected key digital ecosystem statistics for each country through a desk review of country reports and stakeholder websites (World Bank, ITU, GSMA, etc.). Using this information, a benchmark assessment was conducted based on foundational pillars identified from the Kenyan Digital Economy Blueprint. The general methodology and indices was informed by a similar benchmark study produced by Smart Africa and the Digital Impact Alliance. The assessment elucidated the progress SADC countries are making in unlocking a functioning digital economy and was used to provide a context to the wider findings of this study. This regional reflection of the results and insights obtained across the SADC region is complemented by a series of 16 supplemental Digital Agricultural Country Studies (DACS), each providing an early baseline reflecting what was available in the policy, digital innovation, and skill training areas for possible further study.

POLICIES

For the broader policy section, the study team identified available public policies, strategies and legislation around ICTs, digitalization, data, cybersecurity and privacy, e-commerce and transactions, and agricultural sector policies through desk-based research and discussions with in-country consultants. The team undertook qualitative semi-structured interviews with CCARDESA ICKM focal points to identify additional policies, including draft versions that may be inaccessible online, and to understand practical challenges around the policy environment within ministries and the barriers in implementing digital solutions in agricultural systems. A full list of all ICKM focal points interviewed can be found in Annex 1.

Available policies were reviewed to understand their complexity, basic goals and strategies, and the relationship with agriculture within the public sector. The team also took stock of relevant digital laws, although the list included in this report is not exhaustive but focused mainly on electronic transactions, electronic commerce, cyber security, data protection, and open data. Findings from stakeholder interviews were then analyzed to provide a deeper understanding of the challenges faced within the public sector and to what extent digitalization is being prioritized by governments.

INNOVATIONS

National consultants validated identified innovations (national and regional) and presented where possible contact information for potential survey respondents. The survey tool was tested with ten innovators in Zambia prior to deployment and refined based on their feedback to ensure it was working. All identified innovators were invited to complete a voluntary digital survey in English, French, or Portuguese. To ensure a good proportion of responses to the survey, all innovators were rigorously followed up by consultants either in-person or by telephone for several weeks. A full list of identified innovations can be found in Annex 5.

Self-reported survey results were cleaned by removing duplications, clustered where there were open answers, and names were systematized across the region. Responses were then coded for data analysis. Data was analyzed in Excel. All innovations received a unique number and were uploaded to a database. The database forms the basis for the interactive part of the web portal of CCARDESA and the detailed information is presented in a separate needs assessment and requirements report submitted to CCARDESA (further information can be found in Annex 15).

Qualitative semi-structured interviews with innovators and other relevant stakeholders complemented data from the surveys with additional effort in deep dive countries. In deep dive countries **further information on the breadth and depth of the innovations** being applied, their benefits, results, scale, costs, challenges, inclusivity, and value for money were pursued. Interview respondents were selected based on sampling across the scale stage of the technology, geographic location, and type of intervention. The KII Guides for all interviews can be found in the attached annexes (Innovators, Annex 11 and 12; Stakeholders, Annex 13) and the list of stakeholders interviewed can be found in Annex 2. It is anticipated that the interactive web presence will require active and on-going content management, maintenance, updating of new content and monitoring the functionality of the network once it is live.

The DACS contained digital innovations identified using the GSMA framework (in figure 4). These were presented individually by country and have been consolidated for this regional situational landscape.

In graphs and tables, the following color coding was used to illustrate the different use-cases.

DIGITAL SYLLABI

Digital and entrepreneurial skills training was assessed through a voluntary quantitative Survey Monkey tool sent to 54 Universities and Colleges in the region (a total of 58 different faculties were contacted). To encourage larger participation, some institutions had multiple contact points. A full list of all Universities contacted can be found in Annex 3 and the survey circulated can be found in Annex 8. The majority of those contacted were the Faculties of Agriculture contact points facilitated via collaboration with the RUFORUM members in the SADC countries. However, some additional Universities were contacted through networks within the IMC study team and not all of these were strictly agricultural faculties but aimed to provide good representation amongst the SADC member states. Where there were challenges in response rates, qualitative key information interviews were supplemented via networks of the IMC study team. The study team also carried out key informant interviews with representatives of faculties of agriculture at selected Universities and Incubators to complement the survey results. The KII Guide for Universities and Colleges can be found in Annex 3. Seventy-one (71) incubators and accelerators were approached by the IMC study team to take part, a full list of incubators approached can be found in Annex 4. Semi-structured interviews were also conducted with incubators and accelerators to identify digital skills training and training for entrepreneurship and digital innovators. The KII Guide used with the incubators can be found in Annex 9 and the full list of all stakeholders interviewed can be found in Annex 2.

LIMITATIONS TO THE METHODOLOGY

The planning, data collection, analysis and reporting of this study was completed between April to December 2021. Due to the Covid-19 pandemic much of the data collection and delivery of this assignment was completed remotely

across the 16 SADC member states. The inability of some national consultants to conduct in-person meetings or interviews, and restrictions around national travel due to Covid-19 protocols limited the data collection and led to delays in some areas. Furthermore, the scope of this assignment was extremely broad covering digital agricultural policies, innovations and skills and syllabi, which meant that the study team had to prioritize the research accordingly. The digital ecosystem is highly variable across the SADC member states and therefore in those countries where the digital environment may be at the embryonic stages, there is little data to be collected specific to agricultural systems.

Delays in meeting the previous CCARDESA ICKM focal points for South Africa and the focal point for Tanzania hampered the progress of the study in those two countries. For Tanzania, formal letters were requested to facilitate the meeting and the cooperation of the focal points which created a considerable delay.

Whilst every effort was made to carry out a systematic assessment, there were several delays to the data collection which may have been due to several reasons. A lower-than-expected response rate to voluntary data collection tools required frequent follow ups, more than was originally anticipated as part of the work plan. The impact of the Covid-19 pandemic more generally resulted in consultants and innovators taken ill at different times. There was also significant insecurity in two of the countries over the course of the study period. Every effort was made to collect data to provide information on the stages of innovations, the accessibility of innovations to farmers, how many farmers were engaging, and the potential of these innovations for scalability. However, this data is all self-reported and as such must be interpreted with some caution.

The methodology pursued to identify policies sought to provide an audit of the policies in the public domain illustrating to what extent digitalization is embraced by governments, and the relationship and implications for the agriculture sector. The report did not seek to analyze the content of policies or strategies or assess whether they are effective or have achieved their objectives. There were several challenges in obtaining the documents and determining if they were accurate, final, or implemented. The impact of the pandemic has affected the priorities of governments and their implementation of related policies. The lockdowns associated with the pandemic have constrained open and full consultation of policies that have been drafted and may have delayed their finalization. Additionally, much of the documentation the team found is split between ministry websites and illustrates the siloed nature of policy formulation in this space. Documents and assessments produced by development partners were scrutinized but did not form part of the stock take itself.

The current regional digital agriculture picture is a snapshot in time, as new digital innovations are being created at a rapid pace some may also be declining because of the Covid-19 pandemic or for other reasons. Due to Covid-19 restrictions in the country, physical meetings could not take place. People had to work from home, which significantly affected their ability and willingness to participate in online interviews and in survey instruments. The efforts of the national consultants to convince innovators to participate in the survey required significant energy and effort taking longer than expected and caused some delays in the data collection phase. Many innovators were very busy and mentioned that participating in another survey or interview did not equate to new opportunities for their innovation. There was also suspicion and caution by innovators and public sector stakeholders to engage with local consultants. The data collected provides a reasonable overview of the current landscape, but this overview is not exhaustive and must not be interpreted as such. Furthermore, in some countries the violent exchanges and political uncertainty, as well as the toll of the Covid-19 pandemic was significant, and this correlated with a significant decrease in the willingness of people to participate in the study and the challenges they faced to dedicate their time to work that was unpaid whilst simultaneously juggling childcare, home schooling and illness in their families.

Across the region, the response rate of universities to the survey tool and interviews was 47% which was a reasonable response rate. However, the response rate is variable between countries and the number of participating universities

in some countries was much lower than expected given their diversity and maturity and contrasted highly with much smaller nations in the region. Survey participation was voluntary and self-reported. A number of Universities declined the invitation to fill out the survey. The lower-than-expected response is believed to be due to the enormous additional workload on staff as a direct result of the pandemic forcing many to move all activities online and the time and pressures this entailed. As a result, University staff struggled to find available time for the survey. The level of digital skills represented therefore is believed to be much lower than the reality for the region. During the key informant interviews it was also established that some Universities and Faculties struggled to see their role as part of an ecosystem actor in digital innovations. This aspect is worthy of further investigation, as Universities may be invited to engage and participate as part of an ecosystem where they can shape their roles and relevance.

The stakeholders engaged in this study are not intended to be considered exhaustive. All data collection tools that required stakeholder participation were voluntary and there were cases where the study team did not receive a positive response in participating in the study. **The data collected for this study is intended to provide an early baseline of information on these dynamic topics that can be used for possible further study and are intended to provide an indication of some of the trends present in the region around digitalization in agricultural systems**.

The digital agricultural space is highly competitive, crowded and most innovators struggle to employ profitable business models and reach levels of scale that make them sustainable. An understanding of these issues including availability, accessibility, affordability, usability, and potential growth were pursued through self-reported data or data collected through interviews. It is important to understand that bias will likely arise in such circumstances and that the data reported may be less accurate and sometimes inflated to provide a positive reflection on the innovation or company. Whilst the research team have made every effort to triangulate the data collected, there are limitations to the accuracy of some of the more commercially sensitive data and instances where this data was not willingly shared by some of the innovators and entrepreneurs due to its sensitivity and confidentiality. Not least, the impact of the pandemic has created greater reliance on digital agriculture and therefore figures which may seem high may not be sustained into the future, or alternatively if the pandemic has impacted digital agricultural tools and innovations negatively, these may arise and grow again in the future. Finally, as digital innovations mature, they may have to employ different business models at different stages or a combination of business models to create sustained value and to attract investment. It is important that CCARDESA appreciate that the reports compiled under this study will be snapshots in time and that this picture will change over time. If other parts of the world are an example, this is likely to be at a rapid rate and therefore building an ecosystem of very diverse actors will not only require time but resources to ensure that the ecosystem adds value to all the actors and is advancing economic opportunities for all of them.

COMPLEMENTARITY AND SUPPLEMENTATION

The study team included other organization's research where available, to avoid duplication and to reflect ongoing work within the SADC region. As such the following organizations were approached to share their digital landscape information which is reflected in the overall output of digital innovations in the SADC region. These sources include:

- GSMA's Digital Agriculture Maps of 2020 in the SADC countries.
- The World Bank database on "Disruptive Agricultural Technologies"
- CTA Database (2019) Digitalization in Agriculture Report and Wageningen University Knowledge Hub
- Cornell University's Database of Agriculture in the Digital Age which provides evidence of specific innovations and the effects on smallholder farmers.

4 THE BROADER POLICY ENVIRONMENT

4.1 THE GENERAL DIGITAL ECOSYSTEM

In 2020, the AU adopted the Digital Transformation Strategy for Africa (2020-2030) which presents a vision of an integrated and inclusive digital society and economy in Africa. It recognizes the digital economy as a key factor in stimulating economic growth and jobs, reducing inequality, and promoting sustainable growth. The Strategy, illustrated in figure 5, is based on foundational pillars, critical sectors to drive the digital transformation, and cross cutting themes to support the digital ecosystem.

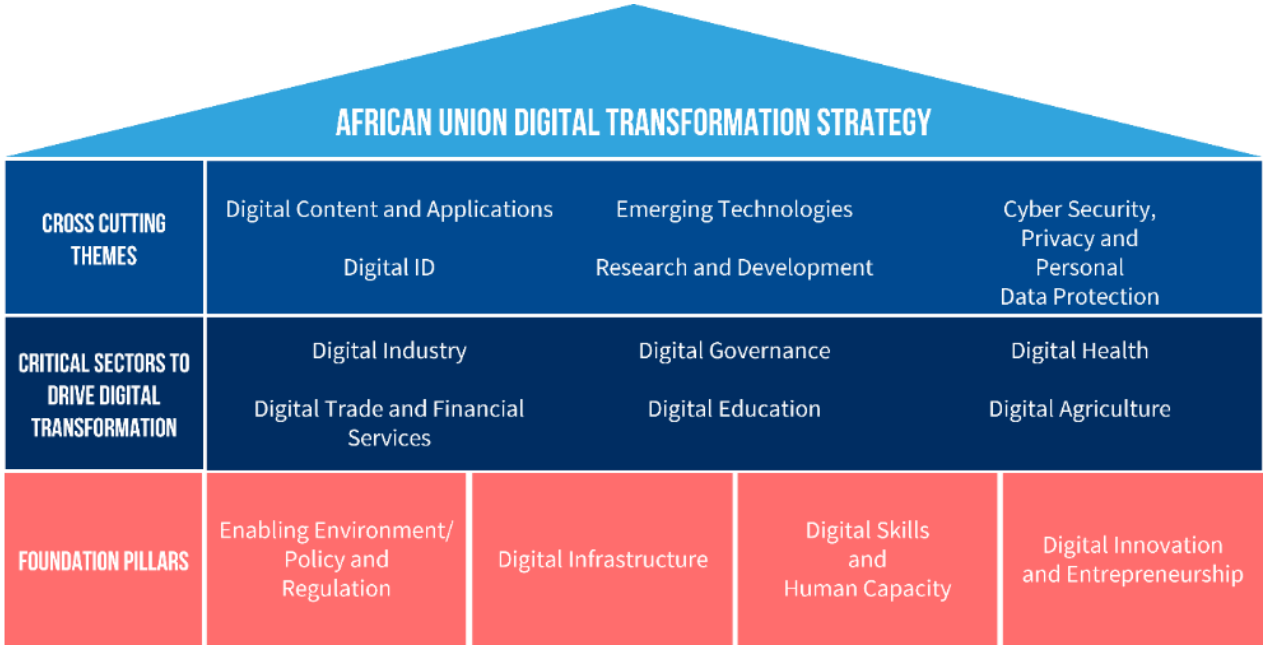

FIGURE 5 OVERVIEW OF AFRICAN UNION (2020) DIGITAL TRANSFORMATION STRATEGY FOR AFRICA

The transition to, and importance of, a digital economy is illustrated in the prevalence of this agenda within regional institutions, donors, and multilateral organizations. Where agendas previously focused on ICTs, providing hardware and universal access, the focus is now on enabling a digital economy with a more holistic view of digital and ICTs. The digital economy considers sectors beyond the Information Technology (IT) industry and encourages a whole-of-government approach to have more emphasis on the overall ecosystem and economy[x].

This is embodied in the OECD Going Digital Integrated Policy Framework and Toolkit with promotes a holistic approach that seeks to balance opportunities and risks of digital transformation across the economy and society. The Toolkit is focused around seven policy dimensions:

1. **Access** to communications infrastructure, services and data
2. Effective **use** of digital technologies and data
3. Data-driven and digital **innovations**
4. Good **jobs** for all
5. **Social** prosperity and inclusion
6. **Trust** in the digital age, and
7. **Market openness** in digital business environments

These policy dimensions cut across the economy and society with several themes: data and data flows, development, digital government, digital technologies, gender, growth and well-being, information industries, productivity, skills, and SMEs. These dimensions and themes should not be considered in isolation but require coordinated policy action across-government and the economy. The OECD approach in Measuring the Digital Transformation, is heavily reliant on available data, statistics, and indicators to inform future policies that are fit for digital transformation. As digital transformation and the concept of a digital economy is relatively young, many countries will struggle to have sufficient data and indicators that are applicable to such an advanced framework.

ASSESSING A DIGITAL ECONOMY

The World Bank identifies two approaches on how to assess a digital economy: top-down approach or bottom-up approach[xi]. A top-down approach measures the economic activities undertaken using technology in areas such as consumption, investment, government spending and by three key stakeholders: government, citizens, and businesses. This approach is similar in nature to measuring a national economy but is feasible due to the availability of economic data on technology. Instead, the World Bank suggests that a bottom-up approach is more suitable. The trade-off with a bottom-up approach is that it may not assess the entire digital economy but focuses only on the enabling foundations or pillars that help to advance a digital economy. If these foundational enablers are in place and good, then it is likely that a country is on the path to developing a successful digital economy.

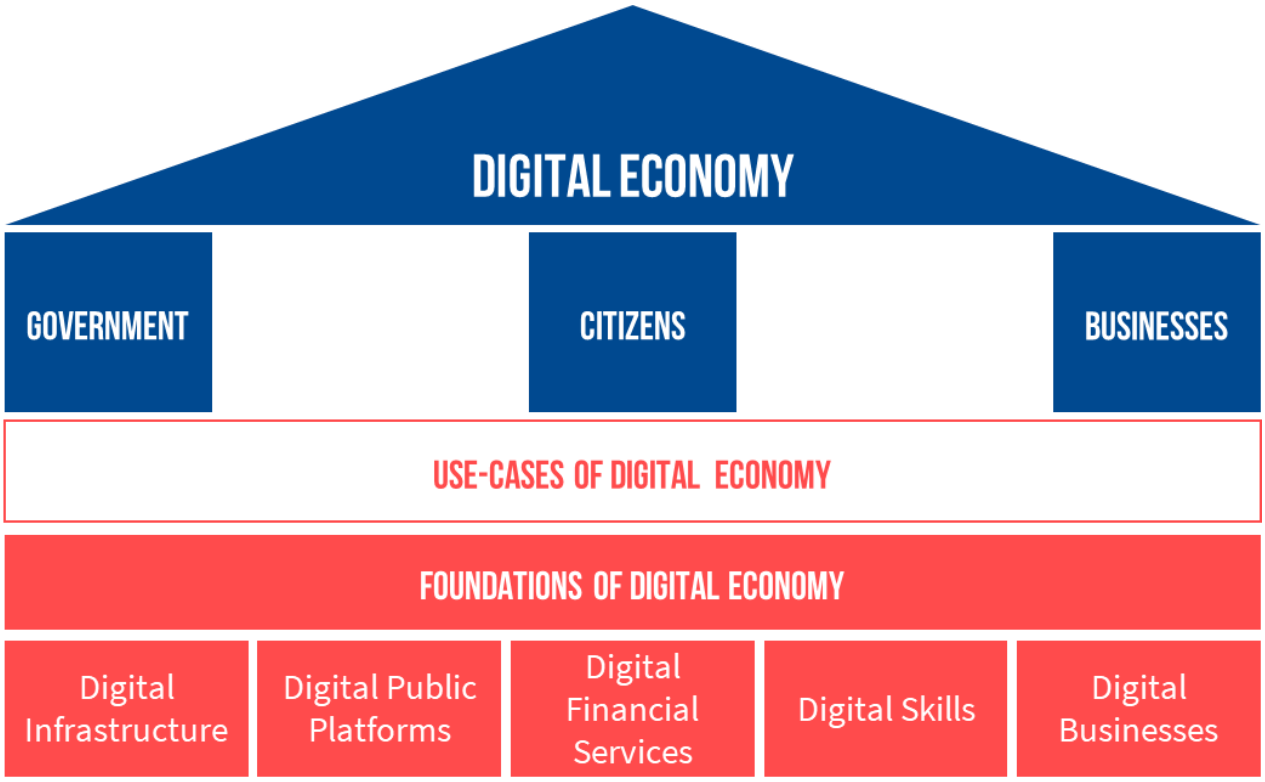

FIGURE 6 WAYS OF ASSESSING A DIGITAL ECONOMY AND WORLD BANK DE4A INITIATIVE FOUNDATIONS

Under the World Bank Digital Economy for Africa Initiative (DE4A), this bottom-up approach has been followed with a focus on five key foundational areas for assessment: digital infrastructure, digital public platforms, digital financial services, digital business, and digital skills. Several cross-cutting areas are also identified: digital economy regulation, competition policy, gender, cybersecurity, consumer protection and data protection. Figure 6 presents the two approaches suggested by the World Bank, top-down in blue and bottom-up in red; the foundational pillars used for

DE4A are also illustrated. The DE4A initiative builds and supports the work of the AU's Digital Transformation Strategy for Africa.

The Pathways for Prosperity Commission has also produced a Digital Economy Kit which intends to promote and assist in building a holistic national vision that harnesses digital technologies throughout the economy and helps prepare countries to be digitally ready. The Kit aims to support countries in building a shared national vision and prioritizes four key pillars: infrastructure, people, finances, and policy and regulation. These pillars are interconnected through sector ecosystems, technologies, and business models and are necessary for the next stages of inclusive digitally led growth.

KEY PILLARS FROM PATHWAYS TO PROSPERITY DIGITAL ECONOMY KIT			
INFRASTRUCTURE	**PEOPLE**	**FINANCES**	**POLICY AND REGULATION**
- Electricity and physical communications infrastructure - 'Soft' infrastructure of foundational digital systems, including ID systems, digital finance, and e-government. - Effectiveness of policy and regulation in generating competition among infrastructure providers and enhancing affordability. - Fair coverage of infrastructure (urban vs. rural). - International interoperability of national infrastructure.	- Addressing gaps in capabilities for users, providers, and government (i.e. building capacity of digital skills in individuals). - Labour markets able to absorb digital transformation through policies and regulation. - Social protection systems to cushion transitions.	- Inclusive financial intermediation will be critical as households, businesses and governments upgrade and innovate with digital technologies. - Households will need affordable digital products. - Businesses will need access to finance. - Governments will need to finance public goods.	- Competition policy - Taxation - Intellectual property - Data standards and interoperability. - Cybersecurity and data protection.

FIGURE 7 KEY PILLARS OF DIGITAL ECONOMY KIT FROM PATHWAYS TO PROSPERITY

These frameworks, kits, and initiatives presented are all underpinned by digital transformation and highlight foundational pillars that enable a digital economy. While their uses vary there is a clear pattern that emerges of certain themes or areas that are deemed most critical for digital preparedness and the importance of the three stakeholders: government, businesses, and citizens.

This study does not assess the digital economy of the sixteen SADC member states which is beyond the current scope but identifies an assessment tool that provides an overview on the progress or level of development towards a digital economy to provide context to the results of the study and which could be shared across the region.

4.2 THE BENCHMARK ASSESSMENT

To determine the degree to which SADC member states are unlocking a digital economy, a benchmark assessment was conducted. The approach was adapted from Unlocking the Digital Economy in Africa: Benchmarking the Digital Transformation Journey by SMART Africa and the Digital Impact Alliance (DIAL). SMART Africa's mandate is to

encourage Africa's transformation into a knowledge economy through the usage of ICTs, and therefore this assessment would be most compatible to the SADC Region. The assessment areas in the report are based off the five foundational pillars of the Kenyan Digital Economy Blueprint, illustrated in figure 8, and are similar in nature to the African Union's Digital Transformation Strategy foundation pillars (Enabling Environment; Policy and Regulation; Digital Infrastructure; Digital Skills and Human Capacity; Digital Innovation and Entrepreneurship).

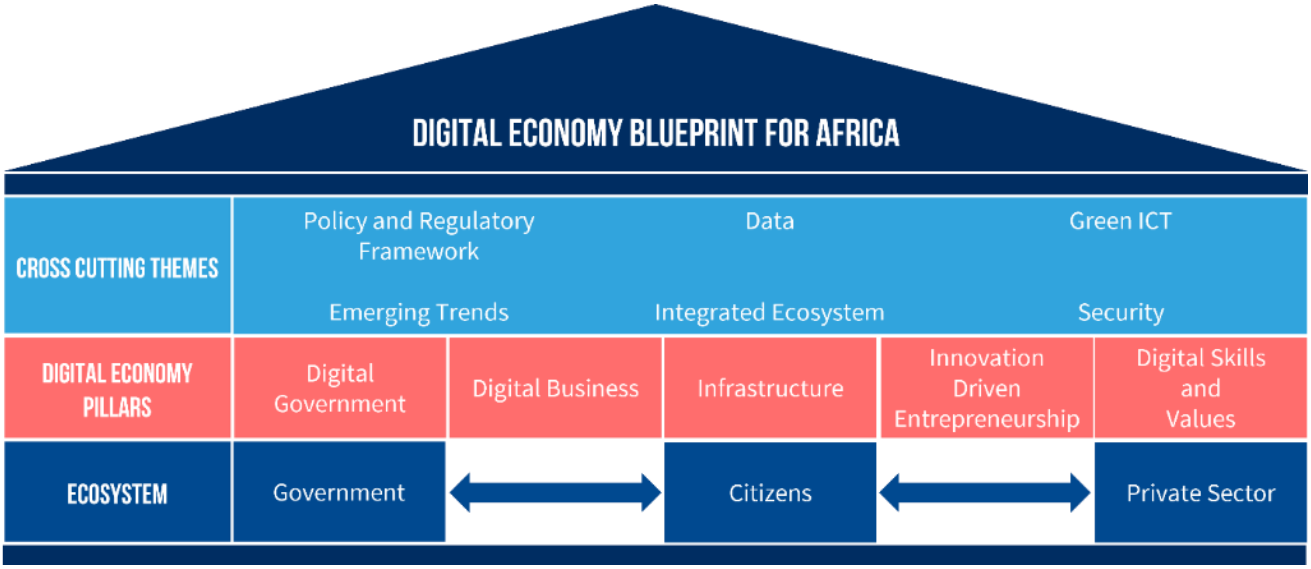

FIGURE 8 OVERVIEW OF KENYAN DIGITAL ECONOMY BLUEPRINT

A sixth pillar was added to the benchmark to include Policy and Regulatory Frameworks to align it with this study and as a regular cross-cutting area mentioned in other frameworks. These six pillars are presented in table 3.

TABLE 3 PILLARS FOR THE BENCHMARK ASSESSMENT

Digital Government	Digital Business	ICT Infrastructure	Innovation Driven Entrepreneurship	Digital Skills	Policy and Regulatory Frameworks
The presence and use of digital services and platforms to enable public service delivery.	The development of a robust marketplace for digital trade, digital financial services, and digital content.	The availability of affordable, accessible, resilient, and reliable infrastructure.	The presence of an ecosystem that supports homegrown firms to generate world-class products and services that help to widen and deepen digital economic transformation.	The development of a digitally skilled workforce that is grounded on sound ethical practices and socio-cultural values.	The presence of policies and regulations that are dynamic, flexible and promote the digital economy.

To measure the level of each pillar and provide a whole picture of each SADC country, specific indicators were selected for the benchmark assessment. Whilst the indicators were based on the SMART Africa/DIAL report, adaptations were made to some of the indicators for a more specific focus on the digital elements. For example, the ICT Infrastructure pillar uses the ICT Composite Index score, rather than the general Infrastructure indicator from the Africa Infrastructure Development Index (AIDI) that included elements such as roads. For the Digital Skills pillar, only the digital skills among active population score was used for this benchmark rather than the general Skills score in the Global Competitiveness Index (GCI) which includes factors not related to digital. The indicators and data stream used and the maximum score available is illustrated in table 4.

TABLE 4 INDICES USED FOR THE BENCHMARK ASSESSMENT

Benchmark Pillar	Index	Data Stream	Maximum Score
Digital Government	E-Government Development Index (EGDI) 2020	Online Service Index (OSI)	1
Digital Business	GCI 2019	Business Dynamism Component	100
ICT Infrastructure	AIDI 2020	ICT Composite Index	100
Innovation Driven Entrepreneurship	Global Innovation Index (GII) 2021	N/A	100
Digital Skills	GCI 2019	Digital skills among active population	100
Policy and Regulatory Frameworks	ITU G5 Benchmark 2021	N/A	100

Each SADC country received a total score based on the specific scores of each pillar, outlined above. These figures were then compiled into an index (this was done by dividing the scores by the maximum possible score). Angola is provided as an example in table 5 below of how the scoring and adjustment was made. Detailed results of the benchmark assessment can be found in Annex 14.

TABLE 5 BENCHMARK ASSESSMENT RESULTS FOR ANGOLA (PROVIDED AS AN EXAMPLE)

Angola	Score	Index
Digital Government (OSI, 2020)	0.488	0.49
Digital Business (GCI, 2019)	36.72	0.37
ICT Infrastructure (AIDI, 2020)	9.934	0.10
Innovation Driven Entrepreneurship (GII, 2021)	15	0.15
Digital Skills (GCI, 2019)	24.094	0.24
Policy and Regulatory Frameworks (ITU, 2021)	44.5	0.45
Total		**1.79**

The benchmark is based on a mix of indicators from 2019-2021, outlined in table 4. Some data was not available for all assessment areas for Comoros, the DRC, Eswatini, Lesotho and Seychelles. This was accounted for and adjusted when ranking the countries.

4.3 BENCHMARK ASSESSMENT FINDINGS

The benchmark identified where SADC countries are making progress, and where they may be behind. The results of the benchmark and the subsequent ranking do not provide much insight alone, but when this information is coupled with other key identifiers, such as the percent of the population working in agriculture and the contribution that agriculture makes to GDP, there are notable findings.

TABLE 6 OVERALL BENCHMARK ASSESSMENT RESULTS AND RANK FOR THE SADC MEMBER STATES

Country	Benchmark Index Score (Adjusted)	Overall Benchmark Ranking
South Africa	0.5891	1
Mauritius	0.5839	2
Seychelles	0.5155	3
Global Median	0.5064	
Eswatini	0.4222	4
Tanzania	0.4138	5
Botswana	0.4114	6
Zimbabwe	0.3895	7
Namibia	0.3809	8
Lesotho	0.3802	9
African Median	0.3595	
Zambia	0.3506	10

Malawi	0.3483	11
Madagascar	0.3005	12
Angola	0.2985	13
Mozambique	0.2919	14
Democratic Republic of the Congo	0.2782	15
Comoros	0.2497	16

The top ten countries that ranked highest in the benchmark all have an agriculture sector that contributes less than 10% to GDP, except for Tanzania (27%). The top two, South Africa and Mauritius, also employ less than 5% of their population in the agriculture sector. It suggests that the countries that are predominantly agriculture based have made slower progress to unlock the digital economy, although this is only less than half the SADC countries and could also be explained by some unavailable data for the bottom two countries, DRC, and Comoros. These top ranked countries could provide a good example of what is relevant and necessary as they score well in the benchmark. Many of these countries also have relevant digital strategies and policies published but there is also a limitation in that the share of agriculture in the economy or for employment is significantly less than the rest of the region.

Unsurprisingly the top three ranked countries are the richest in the region, appearing in the top four for Gross National Income (GNI) per capita in table 7. The benefits that could be achieved if the digital transformation agenda is directed towards the agriculture sector in these countries is evident as many of these countries rely on the sector for food security, employment, or economic growth. However, the challenges in achieving a fully developed digital economy are also apparent when most of the population is employed in agriculture which is likely located in rural areas with low connectivity and low digital skills levels.

TABLE 7 BENCHMARK ASSESSMENT OVERALL RANKING RESULTS

Ranked SADC Countries	% GDP (Agriculture)	% Employment (Agriculture)	GNI per capita (USD)
1. South Africa	2%	5%	12,640.00
2. Mauritius	3%	6%	26,800.00
3. Seychelles	1%	N/A	29,840.00
4. Eswatini	9%	12%	8,080.00
5. Tanzania	27%	65%	2,760.00
6. Botswana	2%	20%	17,100.00
7. Zimbabwe	7%	66%	3,800.00
8. Namibia	7%	22%	9,810.00
9. Lesotho	4%	44%	3,190.00
10. Zambia	3%	50%	3,560.00
11. Malawi	27%	76%	1,090.00
12. Madagascar	14%	64%	1,620.00
13. Angola	11%	51%	6,320.00
14. Mozambique	26%	70%	1,310.00
15. Dem. Rep. of Congo	9%	64%	1,100.00
16. Comoros	18%	34%	3,200.00

The results of the benchmark identified that there are two clear front-runners within the SADC region that are at a higher level in unlocking the digital economy. The role of the agriculture sector economically is much smaller in these two countries and distinguishes them from the rest of the sixteen SADC countries.

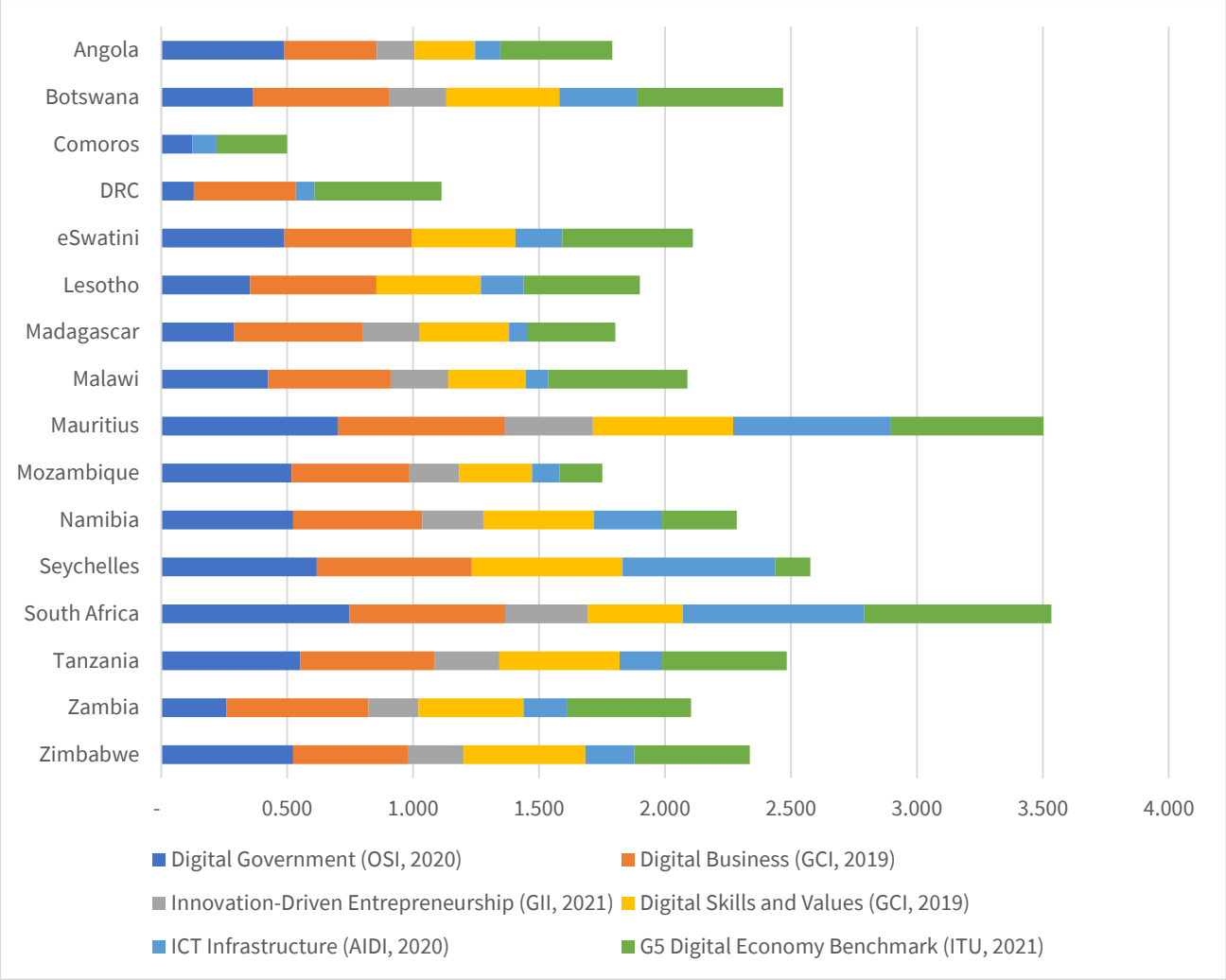

FIGURE 9 BENCHMARK ASSESSMENT SCORES[5]

Figure 9 illustrates the total scores for each country and the split between the foundational pillars[6]. The calculation for the total score is explained briefly in table 5 and the results from the benchmark assessment for each country can be found in Annex 14. The maximum score available on the benchmark is 6.

Figure 10 illustrates the total score only, and not the split between the different pillars. This is the same information as in figure 9, but it is now adjusted to factor in the missing or unavailable data for some countries. The total scores in figure 10 inform the ranking of the overall benchmark in table 6. The adjusted figures provide a better benchmark for the range of the information included. While there is some variation in the clustering of countries to figure 9 before, the general pattern is still present.

Figure 10 shows the variation within the region and highlights how far ahead South Africa and Mauritius are, scoring highest in the benchmark. However, the variation among the remaining SADC countries presents five clear clusters. South Africa, Mauritius and Seychelles all score between 0.5-0.6. Eswatini, Tanzania and Botswana score between 0.4-0.5. Zimbabwe, Namibia, Lesotho, Zambia, Malawi, and Madagascar score between 0.3-0.4. Angola, Mozambique, and the DRC score between 0.2-0.3. Comoros is an outlier coming last at 0.166.

[5] Figure 9 is representative of the score that the countries achieved under each assessment area. They have not been adjusted to account for unavailable or missing data for some countries.
[6] The total score is made up of the combination of scores from all six pillars, where available.

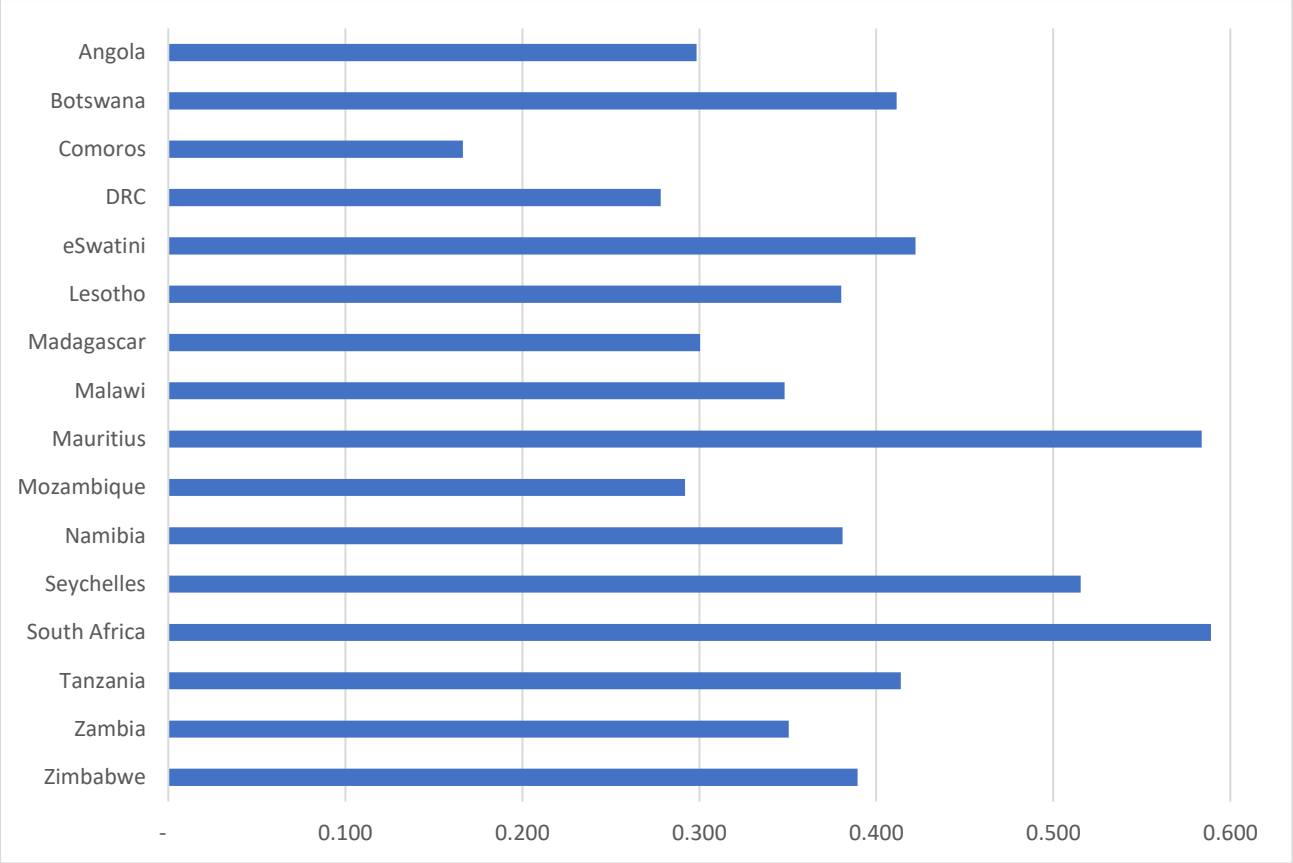

FIGURE 10 BENCHMARK ASSESSMENT SCORES ADJUSTED FOR MISSING OR UNAVAILABLE DATA

The results of the overall rankings in table 6 provide valuable insights as to where potential best practices in the policy arena may lie in the region. Going a step back and looking at each foundational pillar individually identifies further notable findings. The rankings in table 8, for each pillar, are based on the scores each country received under that specific indicator (see table 4 for details of indices).

TABLE 8 BENCHMARK ASSESSMENT PILLAR RANKINGS

Rank	Digital Government	Digital Business	Innovation Driven Entrepreneurship	Digital Skills	ICT Infrastructure	G5 Digital Economy Benchmark
1	South Africa	Mauritius	Mauritius	Seychelles	South Africa	South Africa
2	Mauritius	South Africa	South Africa	Mauritius	Mauritius	Mauritius
3	Seychelles	Seychelles	Tanzania	Zimbabwe	Seychelles	Botswana
4	Tanzania	Zambia	Namibia	Tanzania	Botswana	Malawi
5	Namibia	Botswana	Botswana	Botswana	Namibia	Eswatini
6	Zimbabwe	Tanzania	Malawi	Namibia	Zimbabwe	DRC
7	Mozambique	Madagascar	Madagascar	Zambia	Eswatini	Tanzania
8	Angola	Namibia	Zimbabwe	Lesotho	Zambia	Zambia
9	Eswatini	Eswatini	Zambia	Eswatini	Lesotho	Lesotho
10	Malawi	Lesotho	Mozambique	South Africa	Tanzania	Zimbabwe
11	Botswana	Malawi	Angola	Madagascar	Mozambique	Angola
12	Lesotho	Mozambique		Malawi	Angola	Madagascar
13	Madagascar	Zimbabwe		Mozambique	Comoros	Namibia
14	Zambia	DRC		Angola	Malawi	Comoros
15	DRC	Angola			DRC	Mozambique
16	Comoros				Madagascar	Seychelles

The top five ranked countries in each pillar are an unexpected mix of ten countries and is less consistent than the top three which tends to be between Mauritius, Seychelles, and South Africa. The top five ranked countries are presented

below in table 9 as they may be useful to examine for possible learnings. Further information for each country is included in the DACS Annexes produced for all sixteen SADC countries alongside this report.

TABLE 9 BENCHMARK PILLARS, TOP FIVE RANKING

Rank	Digital Government	Digital Business	Innovation Driven Entrepreneurship	Digital Skills	ICT Infrastructure	G5 Digital Economy Benchmark
1	South Africa	Mauritius	Mauritius	Seychelles	South Africa	South Africa
2	Mauritius	South Africa	South Africa	Mauritius	Mauritius	Mauritius
3	Seychelles	Seychelles	Tanzania	Zimbabwe	Seychelles	Botswana
4	Tanzania	Zambia	Namibia	Tanzania	Botswana	Malawi
5	Namibia	Botswana	Botswana	Botswana	Namibia	Eswatini

Some notable findings from these top five rankings include:

- **South Africa**, which ranks highest overall in the region, only features in the top five rank across five individual pillars. It scored poorly on digital skills and comes tenth in the ranking for this pillar.
- **Botswana** which ranked sixth overall features five times in the top five rank across the individual pillars, coming third in the G5 benchmark, fourth in ICT infrastructure, and fifth in digital business, innovation driven entrepreneurship and digital skills.
- **Seychelles**, which came third overall, maintains a top three rank in all the pillars except the G5 benchmark where it ranked last. Data was not available for the innovation driven entrepreneurship pillar.
- **Tanzania**, which ranked fifth overall, featured in the top five rank in three individual pillars: third in innovation driven entrepreneurship, fourth in digital government and digital skills.
- **Malawi**, which ranked eleventh overall, ranked fourth in the G5 benchmark.
- **Zambia**, which ranked tenth overall, ranked third in the digital business pillar, its only presence in the top five rank of individual pillars.
- **Zimbabwe**, which ranked seventh overall, ranked third in the digital skills pillar, its only presence in the top five.

The benchmark assessment identified four clusters of countries:

Group 1: South Africa, Mauritius, and the Seychelles.
Group 2: Eswatini, Tanzania and Botswana.
Group 3: Zimbabwe, Namibia, Lesotho, Zambia, Malawi, and Madagascar.
Group 4: Angola, Mozambique, the DRC, and Comoros.

The benchmark assessment and the overall rankings illustrate some key front-runners in the region that are perceived to have better foundational pillars required for a digital economy. Most of these front-runners are less dependent on agriculture for economic growth, and to some extent employment. These countries are mostly present in Groups 1 and 2.

However, the pillar rankings in table 7 suggest that learnings for some of these themes around digitalization will come from a mix of countries rather than just the top two groups. This is illustrated well in figure 11, where South Africa,

Namibia and Mozambique are directly compared. These three countries are selected because South Africa ranked first in the overall ranking, Namibia ranked in the middle, and Mozambique ranked last (with a full set of indicators) [7].

Figure 11 intends to show the disparity across foundational pillars within the region. For example, South Africa above, scores lower than Namibia in the benchmark on Digital Skills. The only country that scored highly in all assessment pillars and exceeded the Global and African medians in the benchmark (see figure 12 below) was Mauritius.

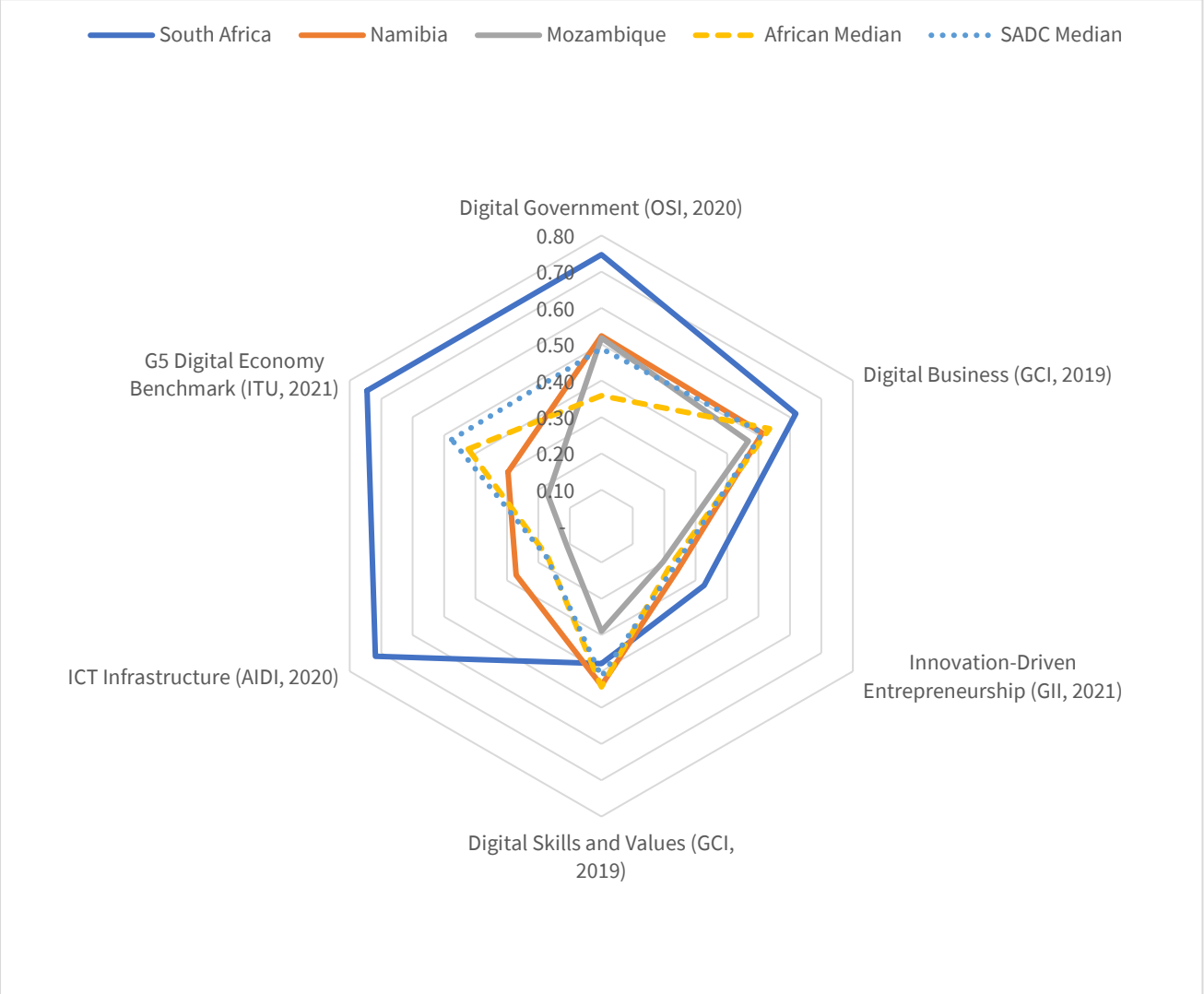

FIGURE 11 BENCHMARK ASSESSMENT RESULTS FOR HIGHEST, MIDDLE AND LOWEST RANKED SADC COUNTRY

Mauritius could provide some best practices but there are limitations due to the contextual factors that differentiate it from the rest of the region, such as its low engagement with the agriculture sector, its high import rate of food, the fact that it is an island state and one of the richest nations in the SADC. Therefore, the wider region should be considered when looking for learnings, collaboration, or examples as there may be similarities shared between neighboring countries with similar country contexts to enable more efficient implementation.

[7] In the benchmark ranking the DRC and Comoros follow Mozambique but both countries had unavailable data for more than one indicator so for illustrative purposes Mozambique was selected for the figure.

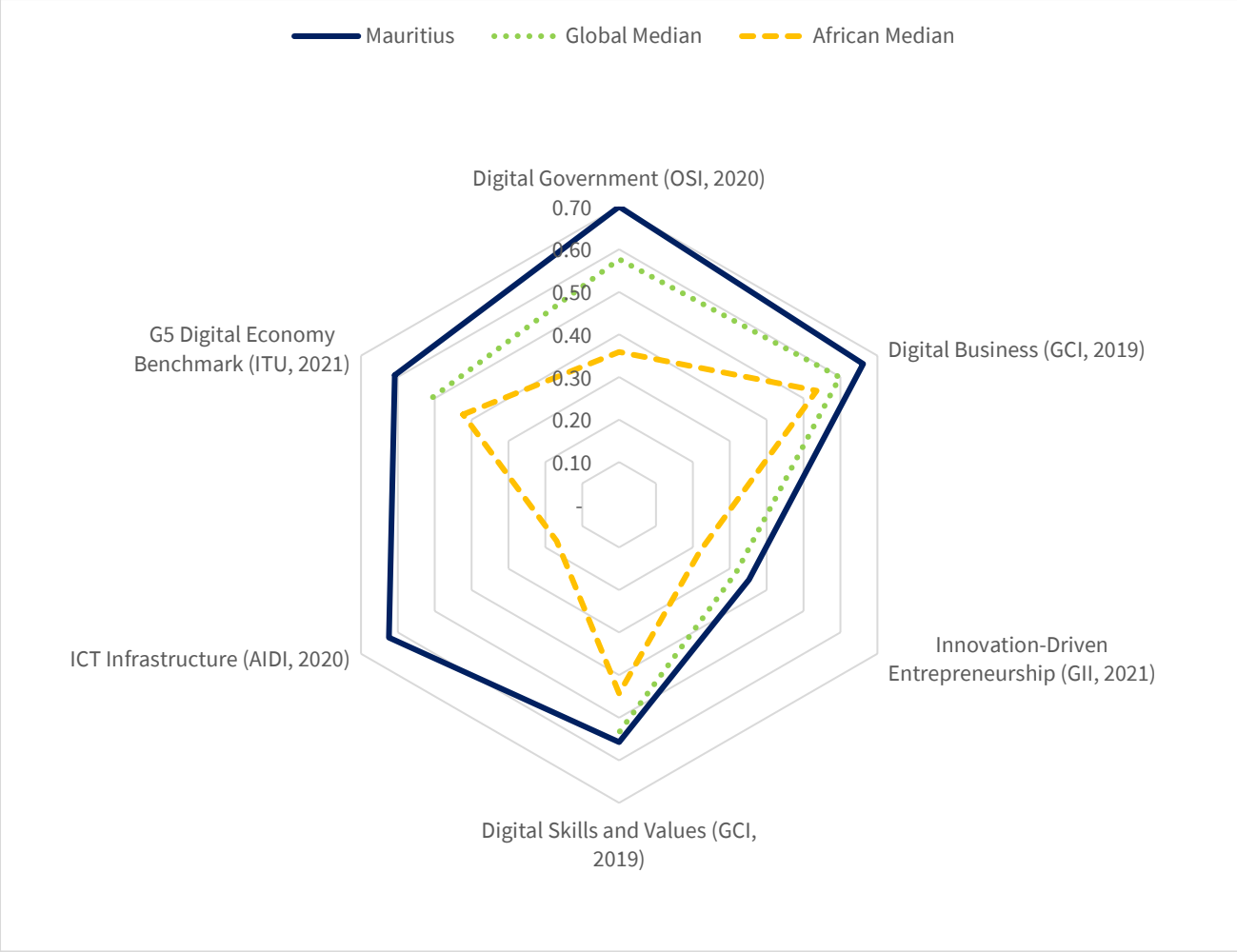

FIGURE 12 MAURITIUS BENCHMARK ASSESSMENT RESULTS

Another key observation made apparent through the clustering is that the countries towards the bottom of the ranking, such as Group 4, are not Anglophone countries. The findings from the benchmark cannot provide any justification, but it is a theme that should be revisited in the following section to understand what the broader policy and legal environment is like across these groupings.

4.4 STOCKTAKE FINDINGS

GENERAL DIGITAL POLICIES AND STRATEGIES

Governments across the SADC region are embracing the digitalization agenda. However, the breadth and depth of this varies among the sixteen countries. The clustering of the policies and strategies obtained for the study in Table 10 is broad and does not provide detail on when these documents were published or their intended implementation time periods. It also does not include national strategies or development plans, which for some countries do speak to a Digital Economy or plans for data or security policies. However, it does provide an overview of what was relevant from the research conducted.

TABLE 10 STOCK TAKE FINDINGS OF AVAILABLE GENERAL DIGITAL POLICIES AND STRATEGIES

Country	ICT / Information Society	e-Government	Broadband	Security	Data	Digital Economy
Angola	✓	✓				
Botswana	✓	✓	✓	✓		
Comoros						✓
DRC	✓					✓
Eswatini	✓	✓		✓		
Lesotho	✓					
Madagascar						
Malawi	✓	✓	✓	✓		✓
Mauritius	✓	✓	✓	✓	✓	✓
Mozambique	✓	✓				✓
Namibia	✓	✓				
Seychelles	✓					✓
South Africa	✓	✓	✓	✓	✓	
Tanzania	✓	✓				
Zambia	✓		✓	✓		✓
Zimbabwe	✓					
Total ✓	14 / 16	9 / 16	5 / 16	6 / 16	2 / 16	7 / 16

The stock take of available policies, strategies, roadmaps and legislation identified that almost all the SADC countries have a version of an ICT or Information Society (IS) policy. Only Comoros and Madagascar did not have an available ICT policy for review, but Comoros did have the newer "generation" of ICT document in the form of a Digital Economy Strategy. In addition to Comoros, five other countries had a specific Digital Economy Strategy or Policy in place. Most ICT or IS policies focused on infrastructure, universal access, increased competition, and investment from the private sector through improved regulatory or legal frameworks, encouraging the local ICT sector to reduce reliance on imports of software and hardware, and improving human capital. Many of the first iterations of the policies would also include the objective of becoming an ICT hub for the region but this agenda tended not to be re-included in other documents or updated iterations of similar policies. The exception is Mauritius, which regularly cites an ambition to become a hub for the region, and Tanzania, which considered the objective successful in their second ICT policy as they now serve neighboring landlocked countries with the benefits of high-capacity submarine cables due to their broadband network roll out[xii].

E-government strategies were the next most common document identified across the region with examples in nine countries. As with all the findings for the broader policy environment, these are not exhaustive, and it is likely that there are more policies or strategies in existence that have not been made available digitally. It should also be recognized that most of the general ICT policies include elements of e-Government, broadband and connectivity plans, and to some extent sections on cybersecurity. Therefore, a lack of some of these strategies does not necessarily mean that these areas are completely omitted in plans.

Assumptions should not be made based only on the presence of a policy or strategy as the study did not assess or determine whether the policies were implemented effectively or what outcomes resulted from them. The stock take aimed to determine to what extent a government prioritizes digitalization in strategies and plans and whether the breadth of this agenda extends across economic sectors, including agriculture.

LEGISLATION

The legal landscape across the region is presented in Table 11, but only includes legislation that has been enacted or published formally at the time of the study, and not draft bills. Where draft bills were present these

have been noted in the table but do not count towards the total score.

TABLE 11 STOCK TAKE FINDINGS OF AVAILABLE LEGISLATION RELEVANT TO STUDY

Country	E-Commerce Law	Cybersecurity Law	Data Law
Angola	✓	✓	✓
Botswana	✓	✓	✓
Comoros			
DRC			
Eswatini	DRAFT	DRAFT	DRAFT
Lesotho	DRAFT	DRAFT	✓
Madagascar	✓	✓	
Malawi	✓	✓	DRAFT
Mauritius	✓	✓	✓
Mozambique	✓		
Namibia	✓		
Seychelles	✓		✓
South Africa	✓	✓	
Tanzania	✓	✓	
Zambia	✓	✓	✓
Zimbabwe		DRAFT	DRAFT
Total ✓	10 / 16	8 / 16	7 / 16

The stock take identified that around half of the countries in the SADC region had available legislation on the three key focus areas related to the topic of digitalization and which would have the largest impact on innovators: **e-commerce, cybersecurity, and data laws**. E-Commerce Law encompasses legislation related to electronic communications and transactions which was present in most of the SADC countries.

Most countries had some form of cybersecurity law or data protection law in place even if there was no specific policy or strategy available. Although it should also be noted that some countries had legislation in place for these two areas that are quite old and are likely in need of updating. Only two countries lacked any available relevant legislation, Comoros, and the DRC. Zimbabwe also lacked available relevant legislation, but two draft bills were identified for cybersecurity and data protection.

Mauritius is the only country to have available examples for all researched documents (**policies, strategies, or legislation on ICTs, communication, information societies, e-Government, broadband, cybersecurity, data protection or open data, or a digital economy**). This illustrates a strong relationship between the presence and availability of these documents with the benchmark assessment where Mauritius scored consistently in the top two for all assessment pillars.

Table 12 presents the ten countries that ranked in the top five of each of the assessment pillars in the benchmark assessment. While the table does not provide a clear or direct relationship between the presence of policies and legislation and the benchmark assessment, it does present the five countries that had the most complete "set" of documents that were reviewed for this study: Botswana, Malawi, Mauritius, South Africa, and Zambia. The table illustrates that this relationship evident in Mauritius is not replicated in the other countries that scored well in certain criteria. Seychelles ranked in the top five for the digital government pillar and the ICT infrastructure pillar but lacks a specific policy or strategy on e-Government or Broadband. It is not imperative for there to be several specific sector strategies as it is likely that some of these elements were included in the ICT Policy or other National Strategies or Development Plans. However, the role of government and policies for digitalization, and subsequent strategies or roadmaps, is to facilitate the creation and implementation of innovative digital initiatives, reduce the obstacles in regulatory and legal frameworks for digital tools and the data they generate, and respond to the needs and demands of communities through research and development or educational systems to improve skills[xiii].

The presence of a document or piece of legislation does not suggest that a country has a more mature digital economy. The presence of policy, regulatory or legal frameworks may not always translate into awareness, effectiveness, or enforcement of these frameworks. Policies provide one part of the wider ecosystem needed for enabling innovations. Concurrently, a lack of policies or legislation does not inhibit the creation of digital innovations, technologies, or greater digitalization.

TABLE 12 STOCK TAKE FINDINGS OF AVAILABLE DOCUMENTS ACROSS THE TOP FIVE RANKED COUNTRIES

	Botswana	Eswatini	Malawi	Mauritius	Namibia	Seychelles	South Africa	Tanzania	Zambia	Zimbabwe
Policies and Strategies										
ICT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E-Government	✓	✓	✓	✓	✓		✓	✓		
Broadband	✓		✓	✓	✓		✓			
Cybersecurity	✓	✓	✓	✓			✓		✓	
Data				✓		✓	✓			
Digital Economy			✓	✓		✓				✓
Legislation										
E-Commerce	✓	DRAFT	✓	✓	✓		✓	✓	✓	
Cybersecurity	✓	DRAFT	✓	✓			✓	✓	✓	DRAFT
Data	✓	DRAFT	DRAFT	✓		✓			✓	DRAFT
Total ✓	7 / 9	3 / 9	7 / 9	9 / 9	4 / 9	4 / 9	7 / 9	4 / 9	5/9	2 / 9

DIGITAL IN AGRICULTURE POLICIES OR STRATEGIES

The stock take findings present a region that is in transition. Despite the variation across the 16 countries in the benchmark assessment and the mixture in the maturity and content of the policies, strategies, and legislation it seems that most of the SADC countries are slowly including digitalization, and in some more advanced cases embedding it in national plans. However, no SADC country has published a digital agriculture strategy or roadmap. There are good examples in the region where some integration has occurred although it is not always clear who is leading on the agenda, whether it's a collaboration of ministries or not. Even for countries where the agriculture sector contributes less than 3% to GDP, such as Mauritius, effort has been made to integrate agriculture into innovative and emerging technology strategies or vice versa. From reviewing documents and receiving feedback from key stakeholders it also seems that there are some further strategies, policies and legislation in the pipeline that have yet to be published, including for agriculture specifically. It is likely that the Covid-19 pandemic may have delayed some of these projects, but also acted as a further incentive for greater embedding of digitalization within the economy.

The stock take also identified and illustrated where some good examples are within the region and where there is room for shared learnings. There is also some relationship between the scores in the benchmark assessment, the ranking overall and how developed the broader policy environment appears. However, the presence of policies, strategies and legislation does not speak to effective implementation or enforcement of these things. But it can suggest where greater focus and prioritization of digitalization is occurring in the region and signal where some examples can be reviewed for further examination.

There were **no examples available of a digital agriculture strategy or policy in any of the sixteen SADC countries**. Integration of digitalization within available agriculture specific policies or strategies was also limited. However, two notable countries are Tanzania (Box 1) and Zimbabwe (Box 2) which did include examples of **integrating digital into policies and strategies which included examples of ongoing innovations being used, greater emphasis on e-learning, encouraging investment for greater connectivity, as well as extending the use and uptake of ICTs**. What is encouraging about both these countries having agriculture policies that specifically include digital or ICTs beyond just greater use is that Tanzania's agriculture sector makes up 27% of GDP and employs 65% of the workforce. While Zimbabwe's agriculture contribution to GDP is much lower (7%), the sector does employ 66% of the population which is one of the highest in the region. Both countries **also scored in the top half of the benchmark assessment for**

maturity in a digital economy with Tanzania fifth and Zimbabwe seventh. However, in all the examples cited for these two countries under agriculture, digitalization was not fully embedded within the agriculture strategies.

BOX 1 EXAMPLES OF INTEGRATION OF DIGITALIZATION IN AGRICULTURE POLICIES IN TANZANIA (EXTRACT FROM TANZANIA DACS ANNEX)

The Tanzania National Strategy for Growth and Reduction of Poverty II (NSGRP II) 2010, which is not an agriculture specific document but features a whole section on agriculture as a priority sector, recognises the importance and benefit of integrating ICTs within the entire value chain. Specifically, it mentions the benefit of ICTs to provide information on prices, market and advisory services, and climate-smart solutions. The Tanzania Agricultural Sector Development Programme (ASDP) 2006 which predates the NSGRP II includes a section on information and communication and states that a "critical component in the provision of improved agricultural services involves the integration of [ICTs]". The focus within the ASDP features heavily in improving extension services and the management of information systems.

The Tanzania Agricultural Sector Development Programme Phase II (ASDP II) 2017 is the most comprehensive document reviewed in Tanzania that makes reference to ICTs and modern technologies. Many of the practical mentions of modern ICTs are to facilitate greater dissemination of information on agricultural practices and livestock information. Similar to ASDP, there is a focus on e-extension services but this is also extended to e-learning, market information, and developing innovative ICT-based approaches to financial advisory services. There is a much more holistic approach to "leveraging ICT tools and methodologies" in ASDP II that will support:

- The development and implementation of the ICT system and its backbone architecture (comprehensive agricultural data, network services and integrated and optimised solutions). This backbone would include:
    - Consolidation of the government's current agricultural data centres into one state-of-the-art facility
    - Provision of the improved ICT infrastructure and standardised security services to external suppliers (i.e. firms) of e-services such as e-voucher and e-wallet
    - Intercommunication between integrated solutions
    - Data collection, processing and cataloguing
- The equipping of agricultural advisors/extension in selected areas with ICT tools (low-cost tablets for advisors, smartphones for lead farmers) and methodologies to enable enhanced access to technical and economic information and relevant information sharing networks.

The most common appearance of digitalization in agriculture occurs in national development plans, general ICT policies or digital economy strategies rather than agriculture strategies. One explanation for this is that for some countries the national development plans were created more recently than the available agriculture policies, but this was not necessarily the case for all. Many of the Ministries of Agriculture in the SADC countries are split into various departments or directorates that work on specific topics or areas, such as agricultural extension or research and development. These departments adopt digitalization strategies independently. For example, in Botswana the Department of Vet Services has a successful and modern traceability system on livestock,[xiv] but this is not evident in other subsectors of agriculture.

Silos within Ministries are problematic and can lead to a lack of sharing of knowledge or solutions, duplication of efforts, or a confusion on the overall goal. One example of siloed work is in **Zambia,** which has a clear and comprehensive National ICT Policy (2006) based around 13 pillars, one of which is Agriculture. The policy makes commitments to improve infrastructure in rural areas, institute policy measures to integrate and encourage the use of technologies into the sector, increase the competitiveness of farmers and their products using technology, and to promote the development of ICT entrepreneurs at SME level to strengthen the development and application of ICTs in agriculture. Several strategies are suggested to achieve those goals. These strategies go beyond increasing physical

access and connectivity of digital technologies to farmers to other key aims such as increasing information, reducing the knowledge gap, improving skills, and encouraging uptake of technologies by farmers[8].

BOX 2 EXAMPLES OF INTEGRATION OF DIGITALIZATION IN AGRICULTURE POLICIES IN ZIMBABWE (EXTRACT FROM ZIMBABWE DACS ANNEX)

The Zimbabwe National Agriculture Policy Framework 2019-2030 acknowledges that ICTs are being used within the agricultural sector to overcome barriers. Examples of innovations include AGRITEX working on the development of a SMS platform that is able to deliver pre-planting, growing, harvesting, post-harvest and marketing information, and providing agricultural information, financial services, crop insurance and market linkages with ECONET Services through Ecofarmer; and e-Mkambo, Zimbabwe Farmers' Union bulk SMSs, and emails and newsletters. However, it is not without challenges as penetration of ICTs remains low and limited network access in rural areas is a particular hindrance. Encouragingly, the Policy promotes greater collaboration with the Ministry of ICT and Cyber Security to help digitise the entire agriculture sector to improve service delivery. Some additional initiatives mentioned include:

- Public and private investment in soft and hard market infrastructure (feeder roads, structured wholesale and retail markets, cold and dry storage and ICT platforms)
- Modernisation of research facilities, agricultural equipment and ICT equipment
- Institutionalising in-service ICT literacy programmes in all agricultural institutes
- Encourage extension workers and farmers to take part in the development of technologies and platforms.
- Improve access to markets in agricultural value chains by smallholder farmers through the application of ICT
- Invest in ICT permits and levies
- Enhance the capacity of AGRITEX to translate climate information and make use of ICT platforms for farmers.
- Oversee development of subsector strategies (e.g. ICT in Agriculture strategy)
- Build the capacity of government departments, farmer organisations and market players in data collection, analysis, storage and dissemination or exchange.
- Utilise a digital platform to deliver subsidised inputs and set up a flexible electronic voucher system.

This Policy was produced shortly after the National ICT Policy and follows the vision of embedding ICTs within the agriculture sector. Much emphasis is made on agricultural extension services and the ability to digitise them, but the solutions provided lack detail.

Despite the prioritization that agriculture received in the first ICT Policy, this same prioritization is not reflected in the Second National Agricultural Policy of Zambia 2016. It seems that in the Zambian ICT Policy there were ambitious goals and strategies that were specifically adapted to the agriculture sector, but this has not been reflected well or carried over into more recent agriculture strategies and plans in Zambia. This could be a result of departments and ministries working in silos without adequate collaboration, hindering information sharing and resulting in duplication of policies or even a lack of awareness or enforcement of these agendas. There is little mention of the specific benefits that ICTs and digital technologies can bring into the agricultural sector. The only references made are in the general measures to increase agricultural productivity and production. The limited reference to ICTs suggests that it has not been embraced well into the agricultural systems of Zambia despite the focus received in the first ICT Policy.

The case of Malawi illustrates how creating a complete set of policies may not lead to improved application of digital solutions. **Malawi was one of only a few of the SADC countries to have a recent and specific Digital Economy Strategy**[9]. However, **it ranked 11th overall in the benchmark assessment and scored poorly in all pillars except the G5 Digital Economy Benchmark**. Since 2013, Malawi has produced several policies, plans and strategies that

[8] Many of the first iterations of an ICT policy or strategy focus heavily on the IT sector and increasing physical access to hardware, rather than the broader cross-sectoral and digital elements of the new "generation" of digital economy strategies.
[9] Table 11 illustrates seven SADC countries had a digital economy strategy, but the documents reviewed were clustered into groupings under specific criteria. Some of the documents allocated to this pillar therefore are not titled a "Digital Economy Strategy" but their aims are more in line with the general approach that encourages whole of government involvement and across sectors and themes rather than the more traditional and rigid ICT Policies or Strategies that focused largely on the IT sector and achieving Universal Access.

relate to ICTs and digitalization, for a more detailed overview please revert to the separate *Digital Agriculture Country Study Annex for Malawi*. Unlike some other SADC countries, Malawi has not produced updated versions of these documents until the recent Malawi Digital Economy Strategy (2021-2026). The Digital Economy Strategy includes a specific focus on agriculture including the use of innovative technologies such as the IoT, smart farming, open data and making specific references to online platforms.

TABLE 13 MALAWI'S 2026 DIGITAL ECONOMY OBJECTIVES FOR AGRICULTURE

2026 Objective	Actions required
Farmers access high quality inputs and plug into a rich commercial market supported by a variety of platforms	Develop e-verification to ensure quality of inputs distributed through the Affordable Inputs Program
	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 update by farmers
	Subsidize the costs of asset sharing services when delivered to farming cooperatives and associations
Rich and updated data provides the latest view on agricultural activity and supports innovation, monitoring, 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-GIS data repository under National Statistical Office

What sets this strategy apart from the previous ICT and digital plans proposed is the approach to the economy, while recognizing the key priority sectors to the Malawi economy. The agricultural objectives (listed in table 13) look across the entire value chain and have a specific focus on improving the efficiency and productivity of smallholder farmers with clear solutions and technologies, rather than simply stating that greater access to ICTs and digital technologies will result in agricultural efficiencies. The Digital Economy Strategy for Malawi addresses some key foundational concerns such as access, use, and skills, but also extends the focus on digital to wider sectors and functionalities of the economy that have specific and knock-on effects for the agriculture sectors. It also highlights clear partnerships across government and the private sector. This strategy is the most digitally mature and ambitious plan that Malawi has put forward and provides a clear response and solution to unlocking the digital economy, and therefore the digital agriculture economy.

Only seven countries had some form of a digital economy strategy, three of these countries came from Group 4 which consists of Francophone and Lusophone countries. The stock take findings did not provide much evidence to contradict the findings of the benchmark. However, it is curious that countries that seem to have struggled the most in developing the key foundational pillars for a digital economy and lack supporting policies and legislation have published one of these more innovative strategies. One possible explanation for this could be that these countries were significantly lagging behind in digital development and have attempted to leapfrog the previous iterations of digital policies or strategies (e.g., ICT, e-Government, etc.) to focus on the newer agenda and approach to a digital economy that takes on a whole-of-government approach. **Further investigation would be needed to ascertain the incentives of these strategies, but they are an encouraging step for countries that risk falling behind the region**.

4.5 STAKEHOLDER FINDINGS

Despite the variation of scores on the benchmark assessment, the available legislation, and the maturity of strategies or policies, all 16 countries of the SADC region shared common challenges and barriers faced by stakeholders in implementing digital solutions for agriculture. These challenges can be grouped together into six themes that reoccurred in almost all the interviews or were referenced as challenges within the available policies and strategies:

1. Operating in silos across government and within ministries. This challenge was already referenced in section 4.4 as it was evident when reviewing available documents that where strategies were suggested for agriculture in national development plans, they would then not feature in sectoral policies. It is also apparent within Ministries. In South Africa, departments within the Ministry of Agriculture are at risk of working in silos with examples of duplication in preparing the same policy under a different directorate which can then lead to contradictory and misaligned policies. There seems to be limited communication across ministries with most of the ICKM focal points interviewed unaware of more general strategies and whether agriculture was included as part of these plans. It is possible that if this remains unchecked the development of the agriculture sector could fall further behind which would impact half the countries in the region that employ over 50% of their population in this sector.

2. Lack of a guiding policy or strategy. A clear finding from the stock take was that there is no available digital agriculture strategy in the SADC region. For some countries, sourcing general agriculture policies and strategies was a challenge as they were not available online. Others had available documents but were outdated with no updated versions available. For many countries there was limited evidence of an available and usable agriculture strategy that provided a guiding vision or outlined the necessary funding and timelines for implementation. Another common finding from the interviews with the focal points was the struggle for adequate funding for the sector generally, and specifically for digitalization. In Angola, according to the focal point, efforts have been made to implement ICTs within the agriculture faculties but without any guiding policies to sustain them. In Eswatini, during the Covid-19 pandemic, funding has been particularly challenging as agriculture is deprioritized for the health sector and security. In Zambia, the lack of a guiding policy was perceived to be the responsibility of different ministries to support the national plans. A vision or roadmap for the sector allows for greater collaboration with a wider range of stakeholders, clear objectives and aims shared across Ministries and internal departments or directorates and provides justification for sufficient funding and timelines.

3. Poor infrastructure and network coverage, especially in rural areas. The first two challenges are specific to the public sector only, but poor infrastructure and network coverage is a challenge for all agriculture stakeholders. Poor or inadequate infrastructure impacts policymakers and public sector research officials because the systems required are not in place or limit the ability to digitize information, for example. Low network coverage, especially in rural areas, can impact extension officers as was the case for an example from South Africa where extension officers use a “digital pen” which records GPS coordinates and provides other real-time information but is reliant on a linked device, available data, and a stable network connection to work. Another significant barrier is the high cost of data which is felt by innovators, entrepreneurs, beneficiaries, and government officials, and is usually exacerbated by limited or poor infrastructure as a result of low service provider availability. This can provide even further barriers, as with an example from the Seychelles where services such as digital advisory were provided by mobile network operators but due to network availability of that operator, some farmers are not included and therefore were unable to access that information. These connectivity issues are largely outside the remit of the Ministry of Agriculture and require greater collaboration with stakeholders within and across government and in the private sector but are a key barrier to greater digitalization across a country, not just a sector.

4. Low digital skills or training. As with poor connectivity, low digital skills or training is a challenge for all agriculture stakeholders, from the policymakers to the extension workers and to the smallholder farmers. Greater efforts need to be made to provide digital skills and training across all levels of education, the degree to what level is targeted varies from country to country with some targeting school level trainings and others only focusing on tertiary education institutes and policymakers. The focus must be on all levels, but if greater digital intervention is likely then efforts need to be made to educate or train the farming population, the majority of which are over 50 years old.

5. An aging farming population. The two key barriers that come from an aging farmer population are the low digital skills as mentioned above and the knock-on effect this has on uptake of technologies. Radio remains a popular tool to reach farmers of all abilities due to its accessibility but because of the Covid-19 pandemic, examples were shared in Botswana, Lesotho and the Seychelles of some farmers using social networks such as Facebook or WhatsApp to advertise and sell their crops. Although the detailed statistics of the users was not shared, it is likely that the majority of these were urban farmers or younger farmers. However, it does present an opportunity for further exploration in some countries especially Botswana and Eswatini which experienced an increase in younger people joining the sector. This has triggered an increased uptake in digital approaches and greater pressure from the youth to digitalize more works and services generally. Greater involvement of the youth in agriculture could potentially help to increase progress but a barrier remains for some countries to attract individuals to the sector which is seen as unattractive.

6. Lack of security institutions and regulations. The final challenge was cited less times than the other five mentioned above but will become increasingly important as these countries progress into digital economies. In Zimbabwe, innovations are being used for information on weather and climate but currently there are no policies to govern the technologies and the creation of data that results from it. In Mozambique, when asked about any unintended consequences from the use of digital technology, cases of fraud were cited. There is a fear that companies, particularly digital financial services, collect data and can share this information without the user's consent. Access to credit is a key barrier for farmers which could be addressed through digital solutions but requires privacy and security assurances. With greater digitalization more focus should be placed on ensuring trust, privacy and protection of consumers and businesses. Digital technologies, especially more advanced ones, rely heavily on the collection, dissemination, and analysis of data. The stock take identified that data policies, cybersecurity strategies and even legislation related to these topics was much more in the early stages of development across the region or was outdated and needed updating to bring in line with new technologies and risks associated with the Fourth Industrial Revolution technologies. If strategies, standards, and legislation to address issues around privacy and security are not implemented, it risks hindering the growth of the sector and the opportunities that digitalization presents in the agricultural systems.

5 DIGITAL AGRICULTURAL INNOVATIONS

This section provides a landscaping analysis to assess the numbers, scope, trends, and characteristics of digital agricultural innovations in the SADC region. A more detailed assessment of each country is presented in separate DACS Annexes which are supplements to this report. It is important to note that the rapid and dynamic nature of digital innovations is such that the landscape of these actors is in constant flux, and to keep in mind this picture is evolving all the time.

In total 216 innovations were identified in the region; a full list is provided in Annex 5. All identified innovations were invited to take part in the survey. 109 innovations participated in the survey, a response rate of 50% (109 of 216). However, the response rate varied considerably across different countries as did the level of detail provided. The top three countries completing surveys were Lesotho (90%), Malawi (92%) and Mauritius (86%) and the bottom three Tanzania (37%), South Africa (28%) and Comoros (20%).

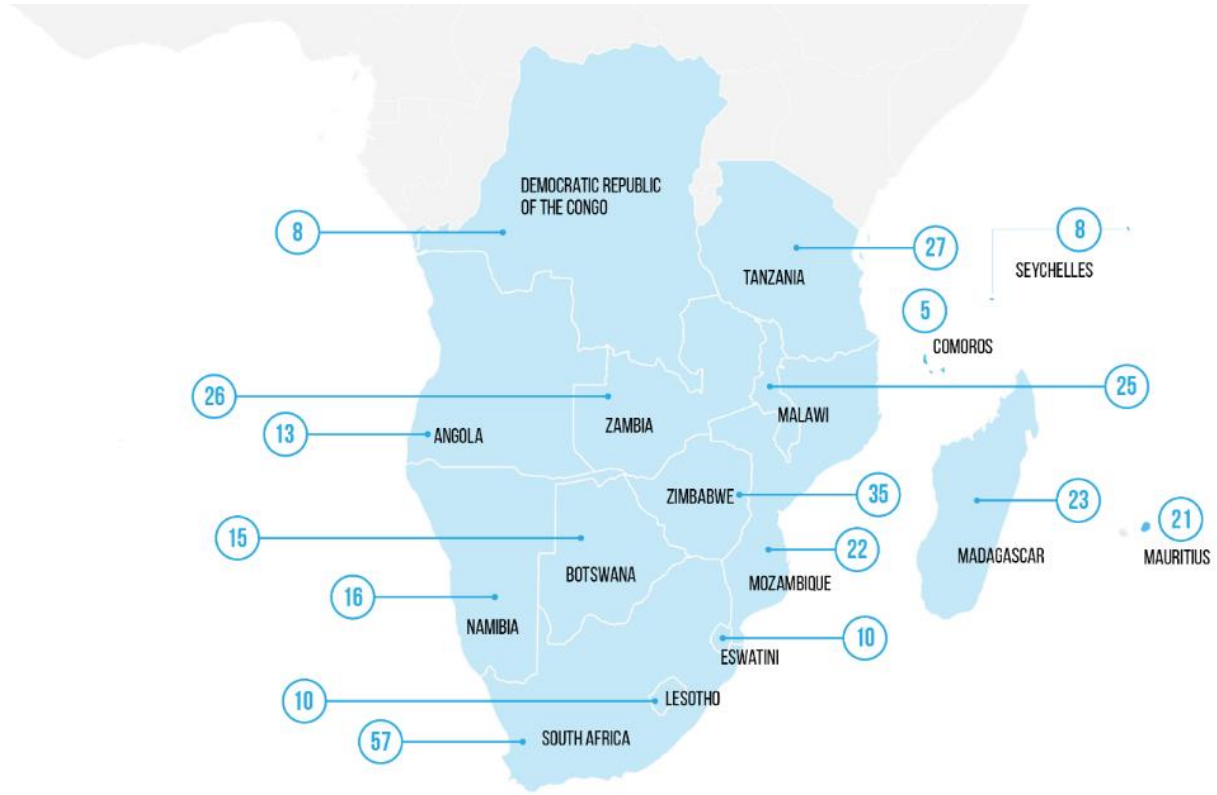

FIGURE 13 OVERVIEW OF ALL DIGITAL AGRICULTURAL INNOVATION IN THE SADC REGION

Figure 13 illustrates the number of innovations identified across the different SADC countries. The countries with the highest numbers of innovations included South Africa (57), Zimbabwe (35), and Tanzania (27).

5.1 MAPPING THE DIGITAL AGRICULTURAL INNOVATIONS

Figure 14 below, illustrates the different use case categories and their frequency represented by the 216 identified innovations. Survey respondents identified the use cases for their innovations and elsewhere desk research or verifications by national consultants enabled the use cases to be assigned. Some surveys were returned but were incomplete, particularly where proprietary data on user numbers and revenue models, or the amount of funding received by the innovation was requested.

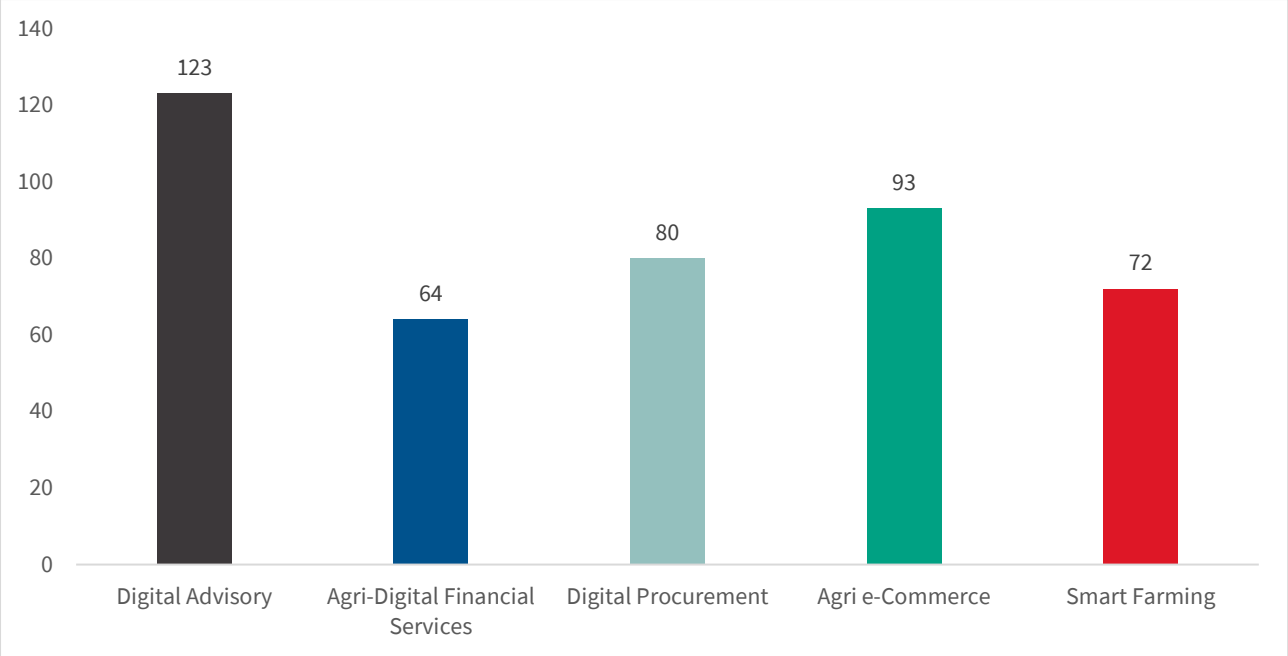

FIGURE 14 USE CASES IN THE SADC REGION

The most common use case was digital advisory, followed by Agri e-commerce and digital procurement. There were fewer innovations observed in the Agri digital financial services use case. This may be due to a higher number of agriculturally focused innovations in the study and a recognition that although the rural population do use digital financial services, it was not possible to quantify how many are using them and whether financial services are used for personal or business purposes. As a result, the proportion of fintech innovations in this study is likely to be slightly underestimated.

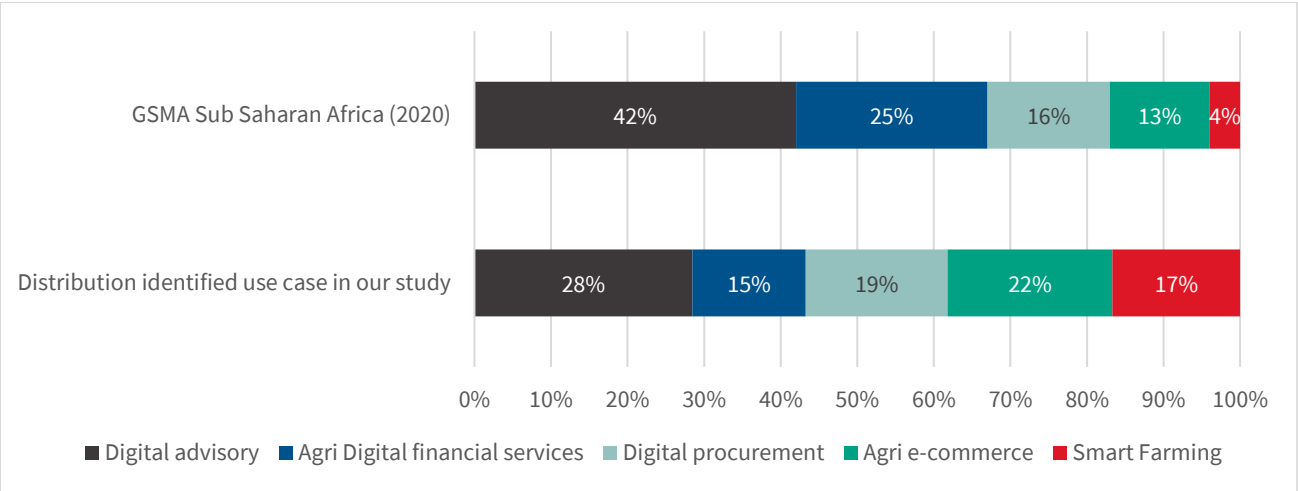

FIGURE 15 COMPARISON DISTRIBUTION OF USE CASES FROM GSMA STUDY (2020) AND THIS STUDY (2021)

The GSMA typology used enabled a comparison of results from the SADC region with SSA results from GSMA's 2020 Agri Maps (see figure 15). Some apparent differences between the two studies are: the higher proportion of smart farming and Agri e-commerce innovations in SADC compared to SSA as a whole, and a lower proportion of digital advisory and Agri digital financial services. Smart farming may be advancing faster than other regions since satellite information and sensors have become more available and accessible. It is also possible that newer smart farming innovations have been launched that were not present in the 2020 data capture calculations carried out by GSMA.

REGIONAL VERSUS LOCAL

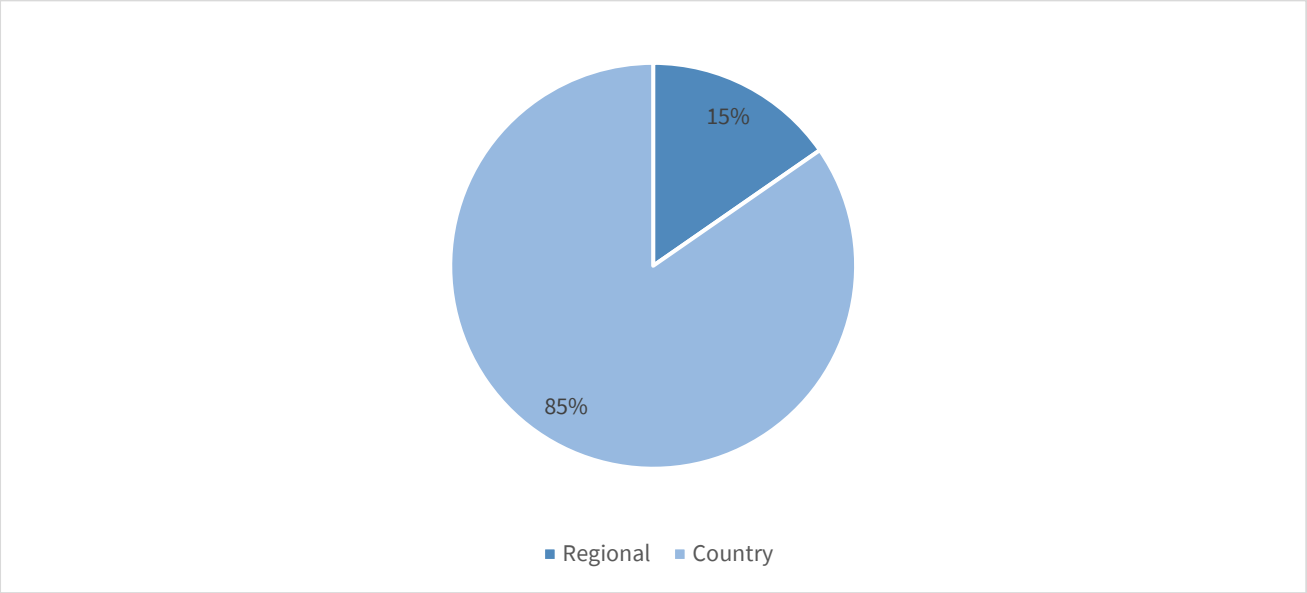

FIGURE 16 SPREAD OF IDENTIFIED DIGITAL AGRICULTURAL INNOVATIONS DEPLOYED IN A SINGLE COUNTRY VS. REGIONALLY

From the 216 digital agricultural innovations identified, most (182) are active in a single country, whilst 34 are regionally deployed (active in two or more countries). Only one innovation is present in all the SADC countries, GeoFarmer, while Smart Farmer is active in eight of the 16 SADC countries.

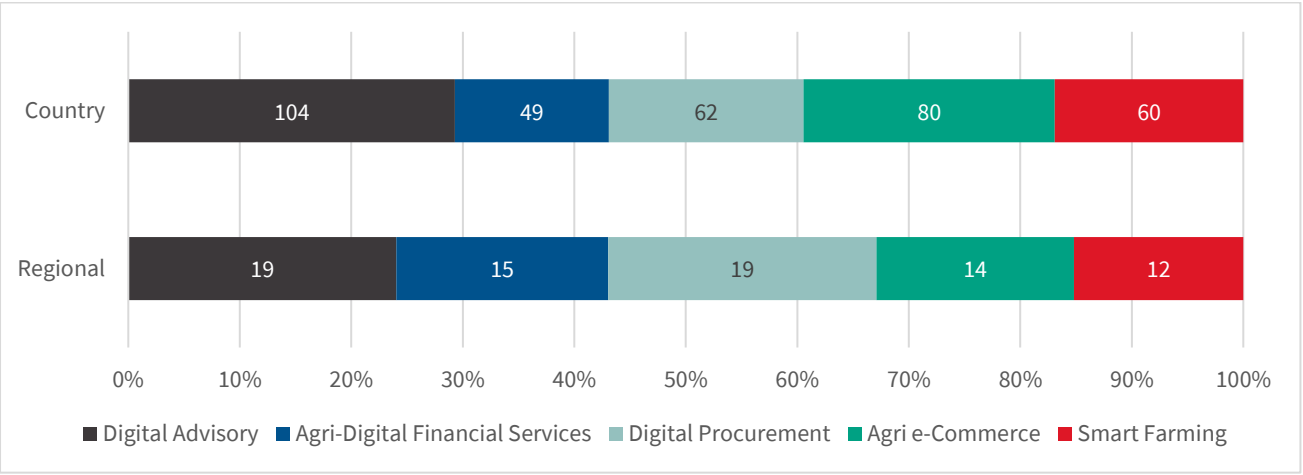

FIGURE 17 USE CASE DIVISION BETWEEN IDENTIFIED INNOVATIONS DEPLOYED IN A SINGLE COUNTRY AND REGIONALLY

Figure 17 compares the relative distribution of all identified innovations that are deployed regionally with those found locally. The regional innovations have a higher proportion of Agri digital financial services and digital procurement than those at a national level.

In figure 18, the distribution of all identified use cases is illustrated through comparison across countries:

- Digital advisory - Malawi (36%), Madagascar (33%) and DRC (33%) emerged at the top. All three countries have a high reliance on the agriculture sector.
- Agri digital financial Services - Comoros (38%), Eswatini (21%), Mozambique (21%) and Tanzania (21%) form the joint top three. Comoros is an outlier as information was compiled from desk research and no survey responses were completed.

- Digital procurement - Seychelles (39%), Mauritius (36%) and Lesotho (28%) form the top three. Island nations appear to have a larger proportion of digital procurement and lower proportion of digital advisory interventions. Madagascar is the exception. Island nations have a higher dependency on imported goods, and digital procurement and e-commerce systems were expected to be higher in these countries.
- Digital e-commerce - Tanzania (25%), Mauritius (24%) and Angola (24%) emerge at the top, but it is difficult to explain this finding based on the available data.
- Smart farming - Botswana (27%), South Africa (26%) and Angola (24%) emerge at the top. The first two were expected, but the result was surprising for Angola, because of their low score in the benchmark assessment. It might be that a Dutch program Geo4AW supporting projects in different countries including Angola might have influenced the result.

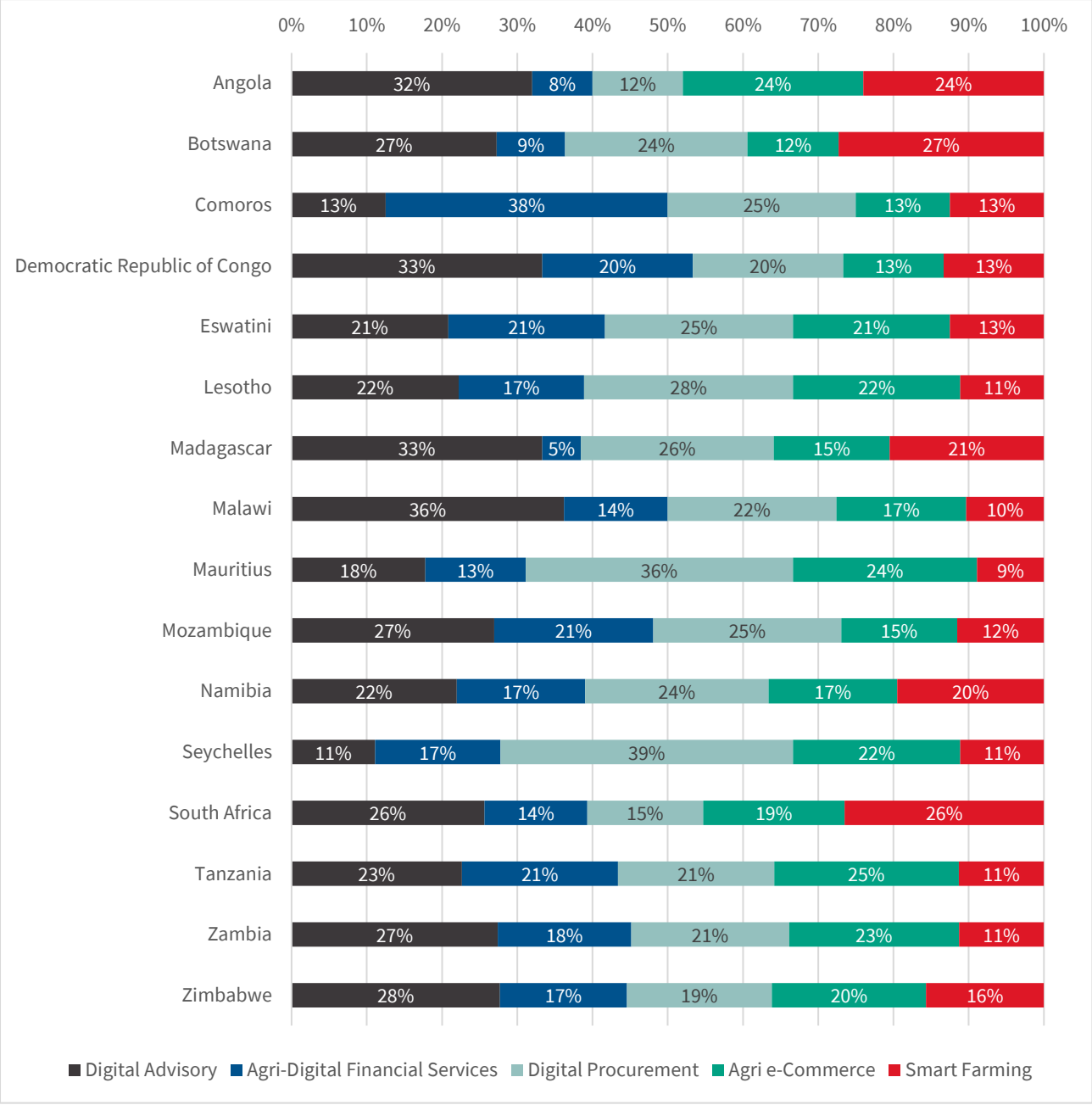

FIGURE 18 DISTRIBUTION OF USE CASE IN IDENTIFIED INNOVATIONS PER COUNTRY

The results of use cases and their distribution across the four country groupings established through the benchmark assessment undertaken in section 4.2 provides further insights.

Group 1: South Africa, Mauritius, Seychelles
Group 2: Eswatini, Tanzania, Botswana
Group 3: Zimbabwe, Namibia, Zambia, Malawi, Lesotho, and Madagascar
Group 4: Angola, Mozambique, DRC, and Comoros (this is an outlier, but still used in the clustering)

Figure 19 illustrates the average number of innovations per country[10] for each group. Group 1 has a much higher number of innovations than the other groups. Group 3 has more innovations on average than group 2, but this might be partly due to the incomplete overview of innovations in Tanzania. Group 4, consisting of Francophone and Lusophone countries, have the lowest average number of identified innovations but this might also due to the incomplete overview in Comoros (see the limitations paragraph in section 3.3) .

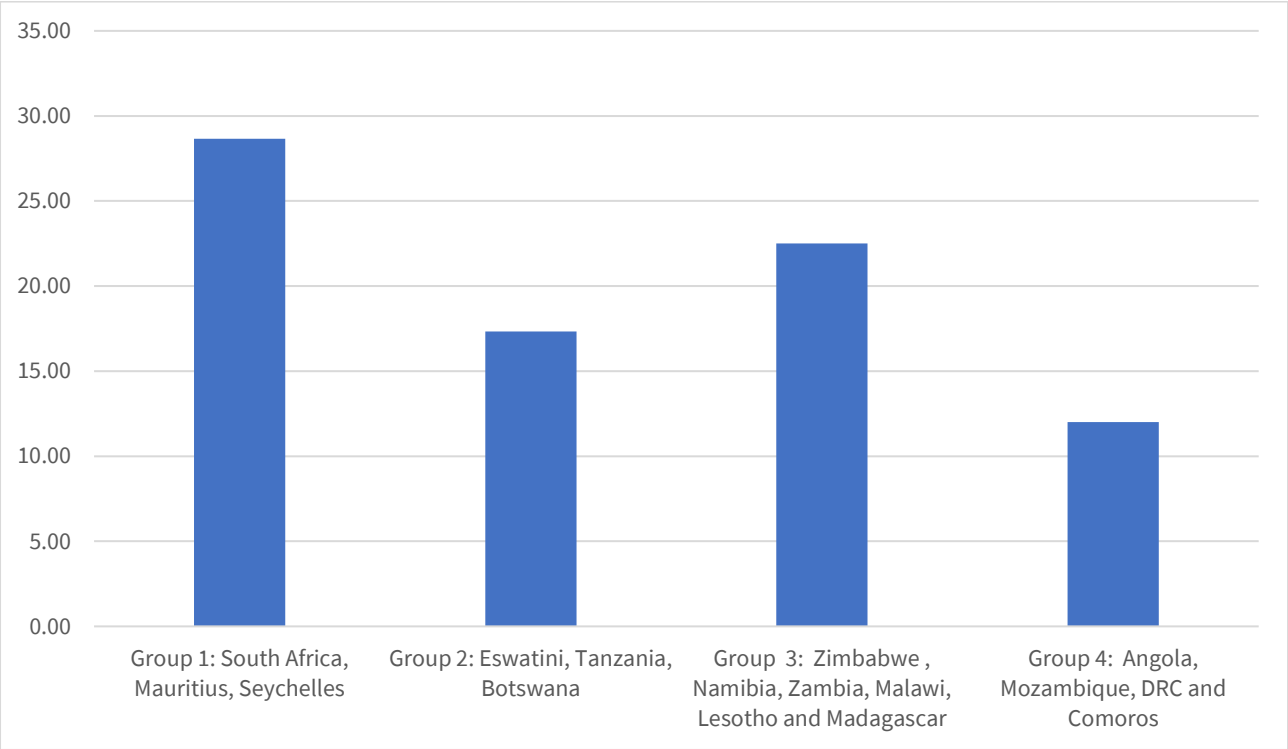

FIGURE 19 AVERAGE NUMBER OF IDENTIFIED INNOVATIONS BASED ON BENCHMARK ASSESSMENT GROUPS

Figure 20 gives the distribution of use cases to each of the four country groups. Based on the distribution the following observations can be made:

- For digital advisory services, group 4 has the highest proportion (31%), followed by group 3. For both groups this is the top use case. Group 1 and 2 have a much lower proportion.
- For Agri digital financial services, there is no clear order between groups, but it is difficult to explain this finding based on the available data.
- For digital procurement, group 1 has the highest proportion, but the other groups don't differ much. For group 1 and 2 this is the top use case.
- For Agri e-commerce, group 1 is again on top followed by group 2, but groups 3 and 4 are not far behind.
- For smart farming, group 2 has the highest percentage, but it is difficult to explain this finding based on the available data.

[10] The average is calculated by taking the total number and dividing by the number of countries.

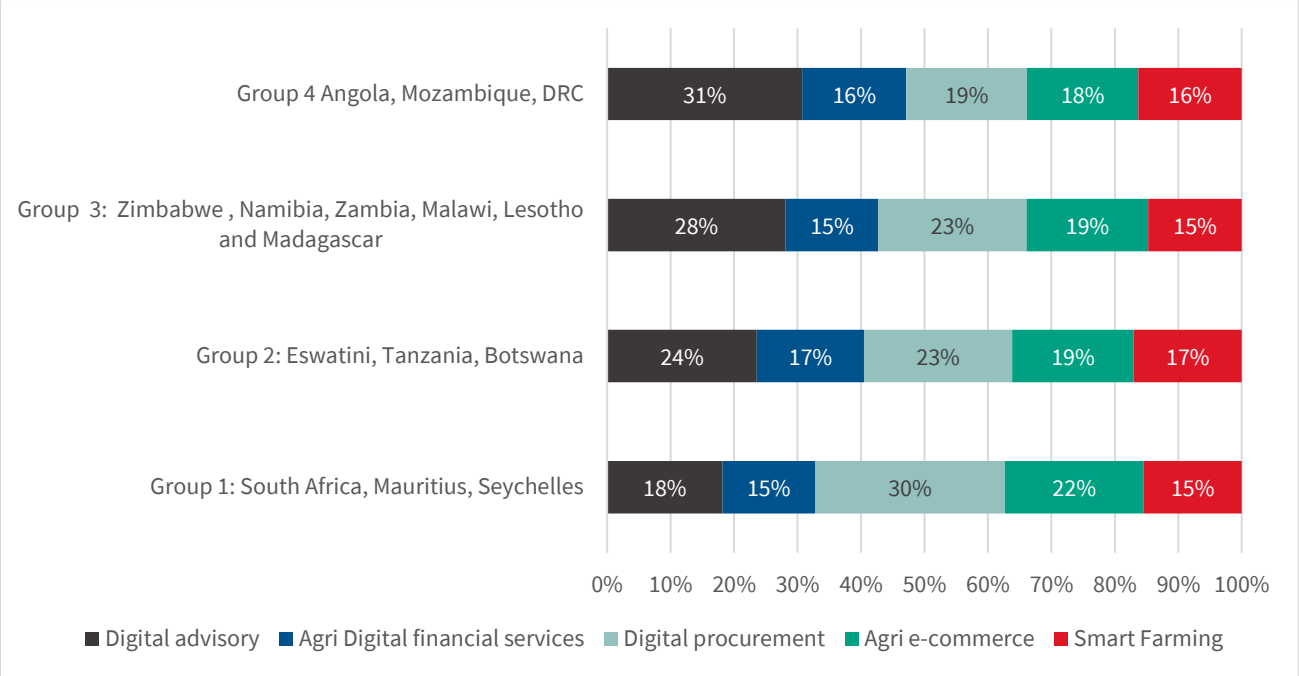

FIGURE 20 DISTRIBUTION OF USE CASES BASED ON BENCHMARK ASSESSMENT[11]

BUNDLED SERVICES

The study illustrates that almost half of the innovations address a single use case and just over 50% address at least two or more use cases. Ten innovations go as far as to address all five use cases in their service, representing roughly 10% of the available innovations identified.

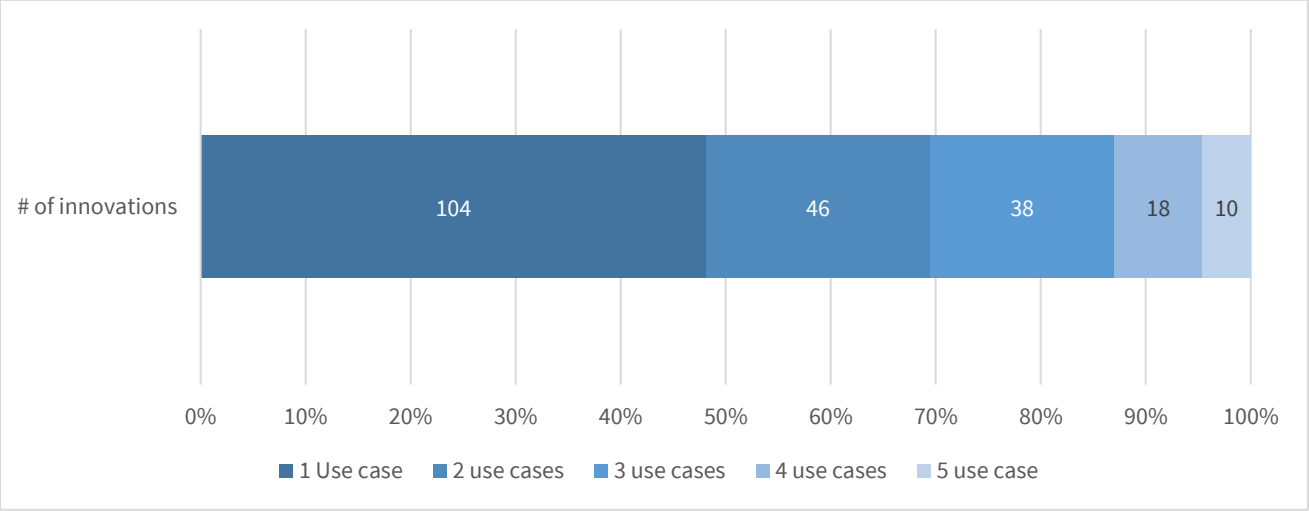

FIGURE 21 PREVALENCE OF USE CASES IN THE IDENTIFIED INNOVATIONS

However, when comparing the distribution across use cases of regional vs local innovations as bundled services, regional innovations have more bundled services than local innovations for three or more use cases. Three of the innovations with five use cases are regional innovations: Agromate, Kres, and Smart Farmer.

[11] Comoros is removed as an outlier from group 4

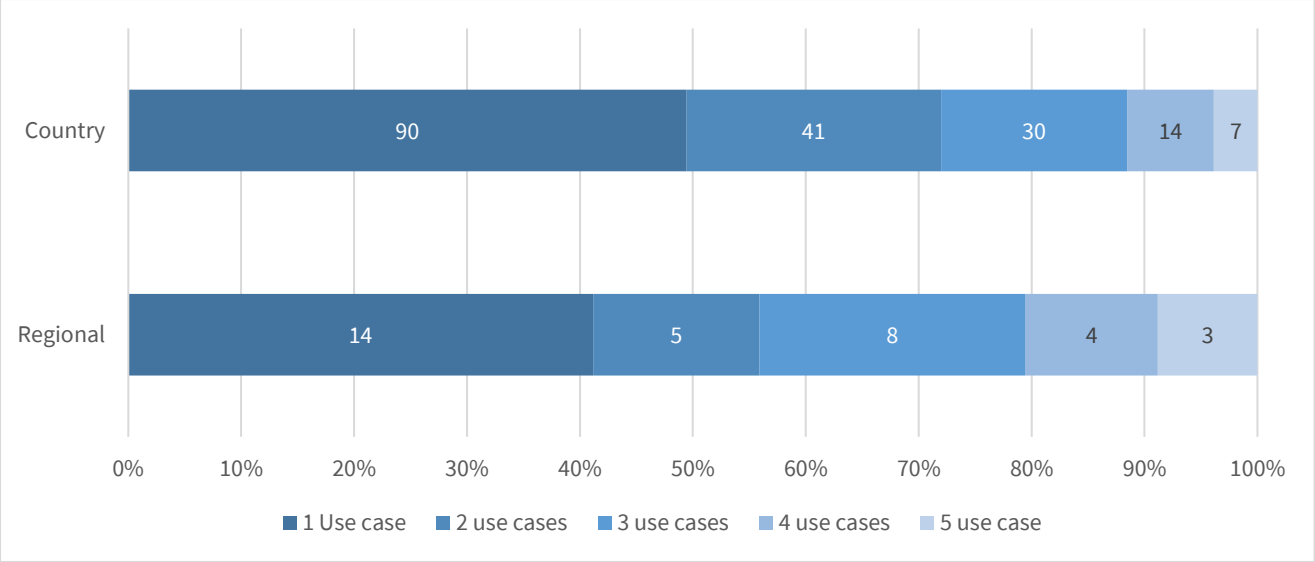

FIGURE 22 DIVISION OF PREVALENCE OF USE CASES IN THE IDENTIFIED INNOVATIONS DEPLOYED IN A SINGLE COUNTRY VS REGIONALLY

LANGUAGE

The surveys deployed were created in English and translated into French and Portuguese to be deployed where appropriate to ensure that respondents gave as accurate information as possible. If we apply language across the SADC country results (See figure 23) the Francophone and Lusophone countries have fewer innovations, but the distribution among use cases is relatively consistent. In general, the Francophone and Lusophone countries have a high dependency on agriculture and exhibit higher proportions of Digital Advisory use cases. Anglophone countries have a higher proportion of Agri e-commerce use cases. Francophone countries have a higher proportion of Digital procurement use cases, as highlighted previously for the two island nations which are part of this cluster.

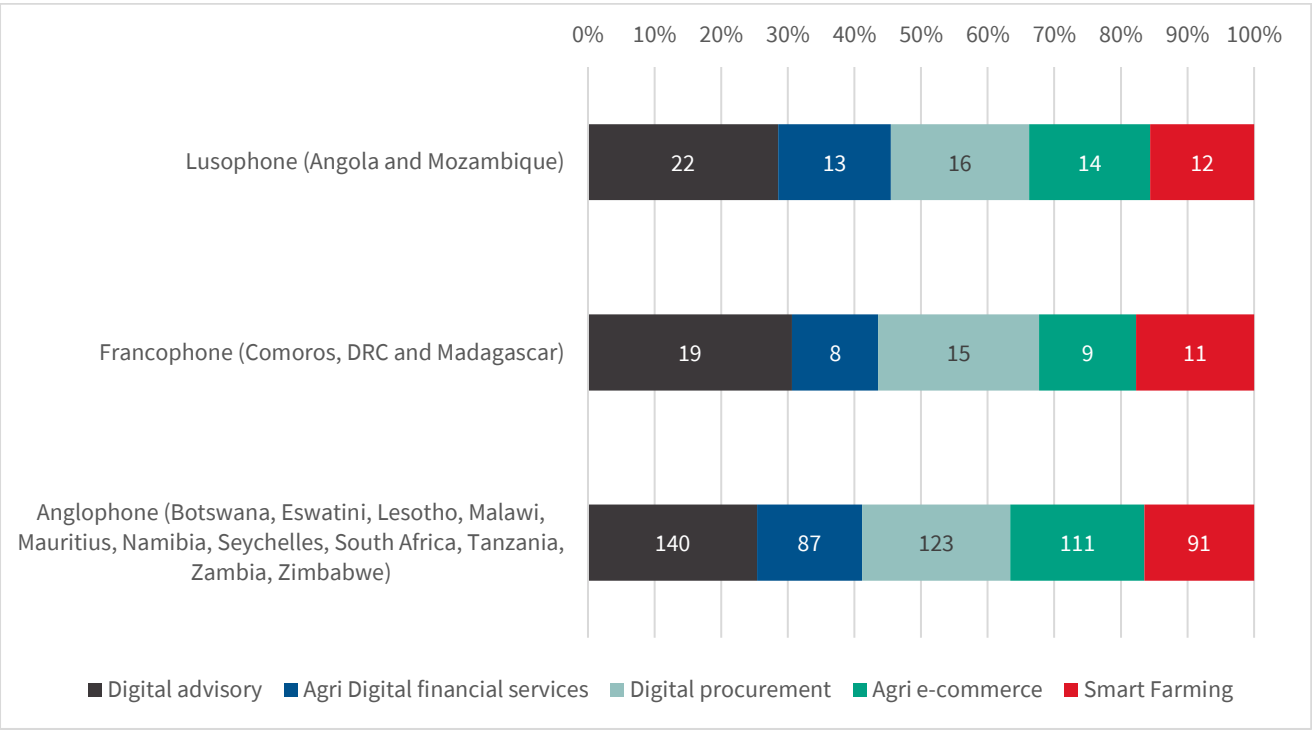

FIGURE 23 DISTRIBUTION OF USE CASE IN ANGLOPHONE, FRANCOPHONE AND LUSOPHONE COUNTRIES

5.2 SURVEY RESULTS

The graphs above present trends and findings from all identified innovations. The following section presents results from the 109 survey respondents.

SUB USE CASES

The GSMA use case model is further subdivided into sub use cases in Figure 24. The five most frequent sub use cases cited in the surveys are digital records (55) under digital procurement, Agri Vas (44) under digital advisory, outputs (43) under Agri e-commerce, smart advisory (38) under digital advisory, and inputs (36) under Agri e-commerce.

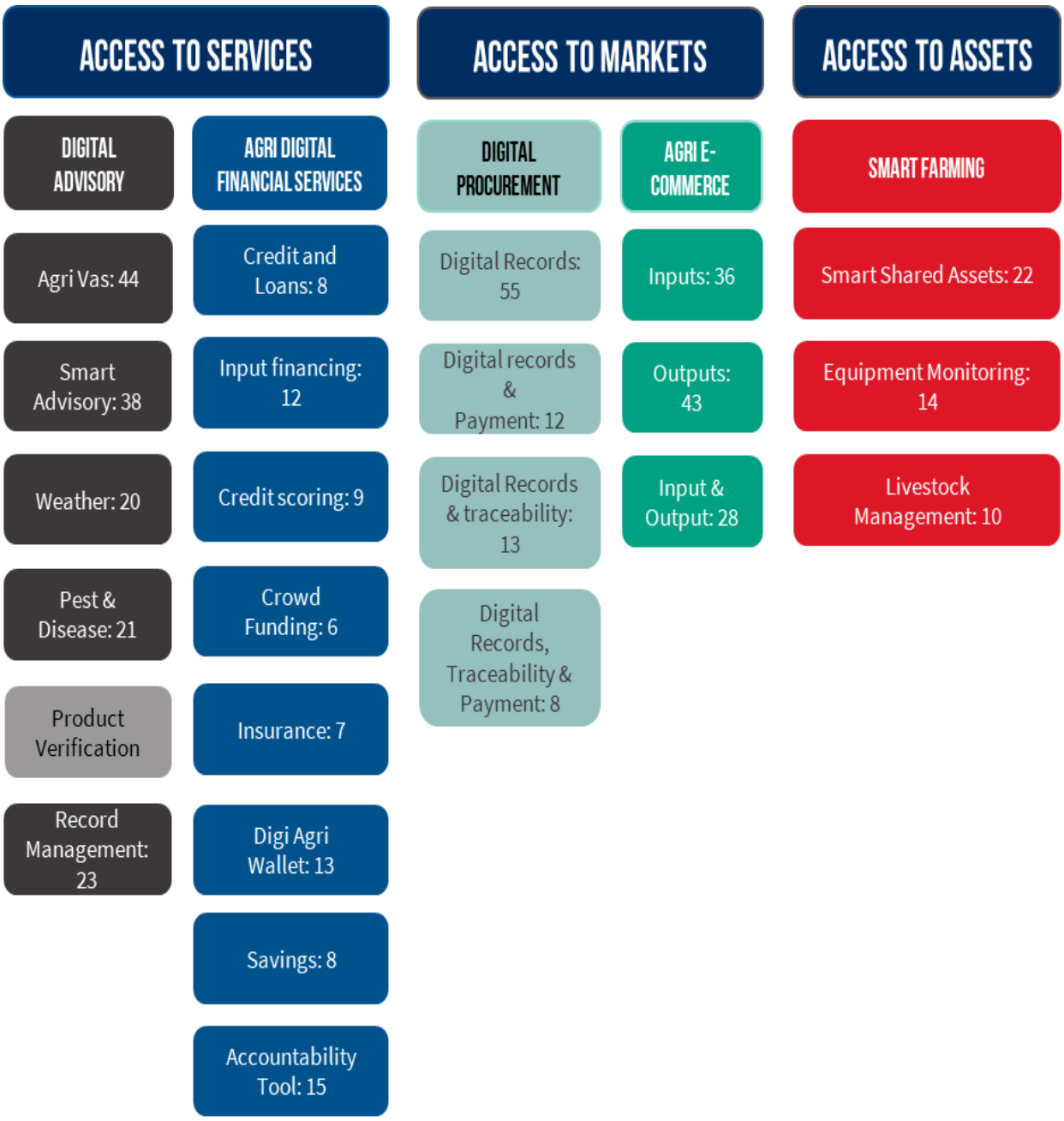

FIGURE 24 SUB USE CASES IDENTIFIED BY SURVEY RESPONDENTS BASED ON THE GSMA FRAMEWORK

Among the survey respondents there is a slightly higher proportion of respondents sharing information on regional innovations (20%) than in the total identified innovations (that had only 15% regional innovations). This is illustrated in figure 25.

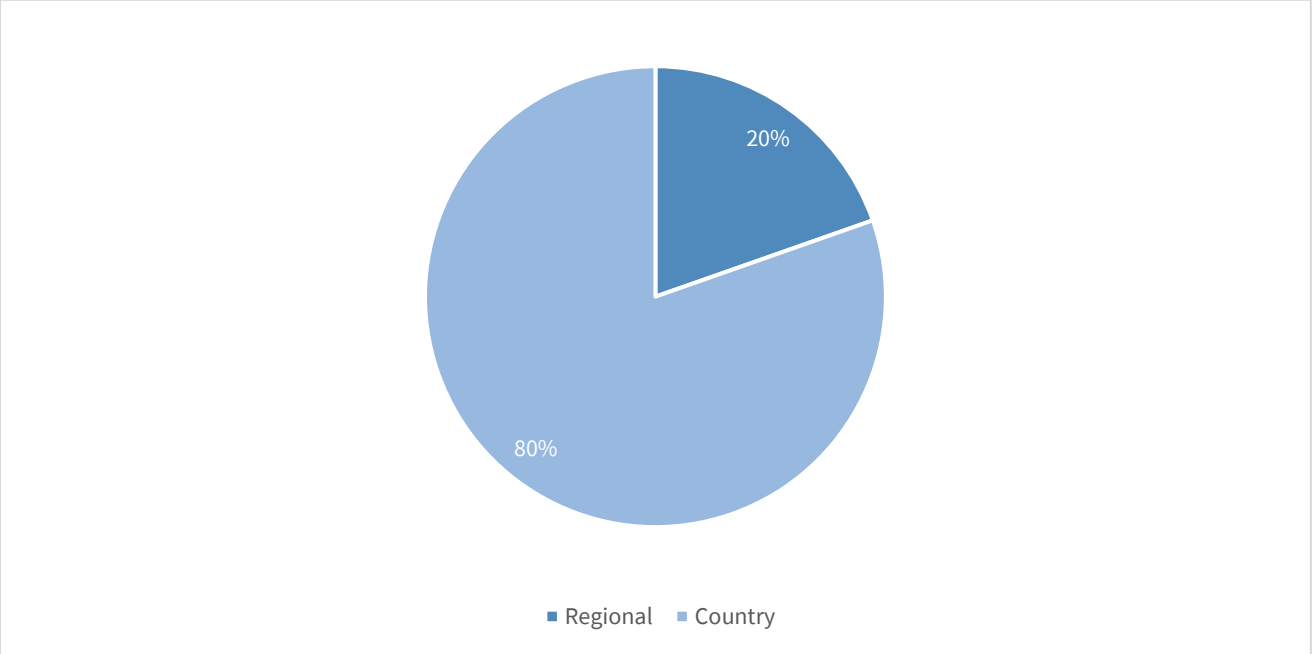

FIGURE 25 LOCAL VS REGIONAL INNOVATIONS AMONG SURVEY RESPONDENTS

LAUNCH YEAR

The innovations in the SADC region are relatively young. More than 60% were developed in 2018 or later (see figure 26).

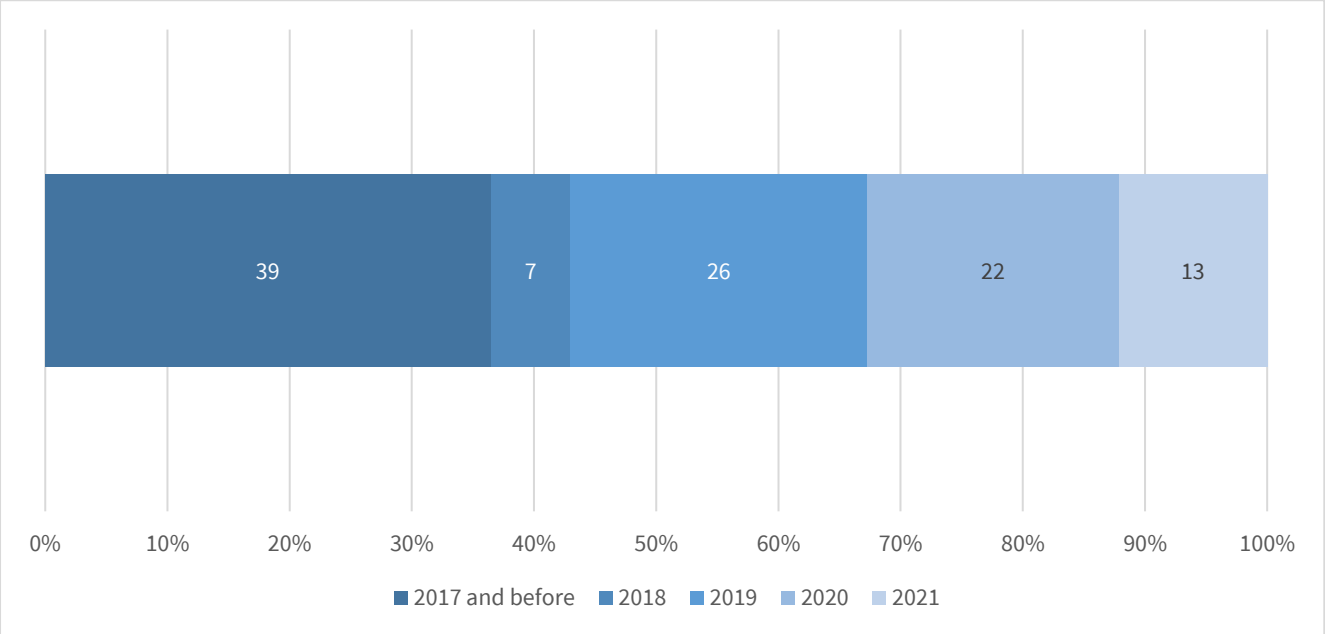

FIGURE 26 ILLUSTRATION OF NUMBER OF SURVEYED INNOVATIONS LAUNCHED PER YEAR

TYPES OF ORGANIZATION THAT DEVELOP INNOVATIONS

The biggest group of survey respondents are from the private sector who are the predominant driving force creating innovations. Governments and Non-Governmental Organizations (NGO) follow at some distance but are often partners, consumers or users of the innovations. This is illustrated in figure 27.

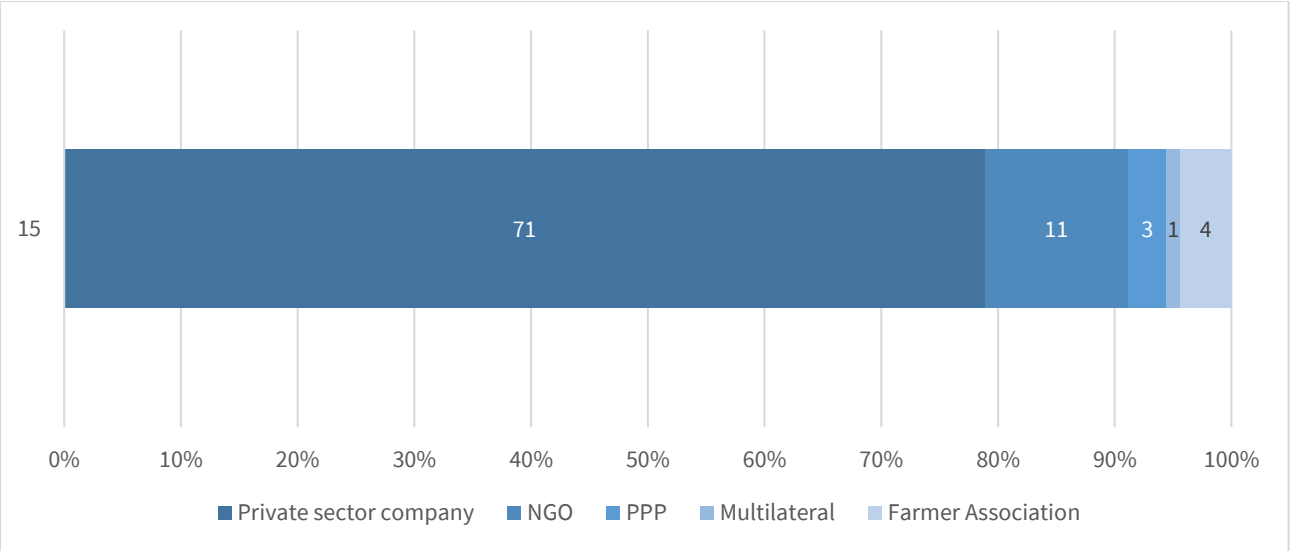

FIGURE 27 THE TYPE OF ORGANIZATIONS RESPONSIBLE FOR INNOVATIONS AMONG SURVEY RESPONDENTS

CHALLENGES ADDRESSED

The survey respondents identified the agricultural challenges their solutions were addressing (see figure 28), with the most common addressing knowledge gaps. This correlates with the highest proportion of innovations providing digital advisory solutions. Low productivity and poor access to markets were the next most frequent challenges being addressed by innovations.

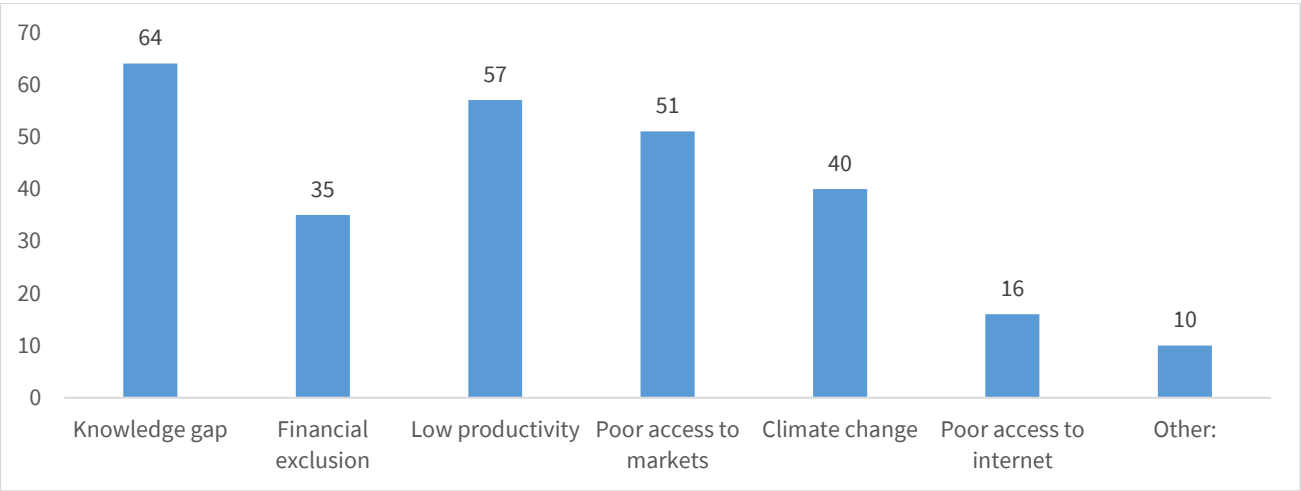

FIGURE 28 AGRICULTURAL CHALLENGES ADDRESSED BY SURVEYED INNOVATIONS

Survey respondents also relayed the challenges they faced during the deployment of their innovations (presented in table 14). The most frequent challenge cited was struggling with the level of digital literacy in users of their innovations. This constrains the ability of innovators to scale-up their solutions. If farmers are not digitally literate, they cannot consume digital channels, tools, and instruments. This then affects the second most cited challenge: farmer uptake.

TABLE 14 CHALLENGES FACED BY SURVEYED INNOVATORS WHEN APPLYING THE INNOVATION

Which of the following challenges have you faced in applying this innovation within your agriculture work?	
Digital literacy	65
Farmer uptake/use/behavior change	47
Operational constraints	36
Lack of mobile network coverage	35
User affordability	29
Access to device (sharing with family with others)	28
Understanding the market and user needs	27
Data collection issues (High cost of collecting data and skills and processes to collect and process data)	27

Survey respondents elaborated further on the additional challenges they faced, including the cost of localization (contextualization and translation) of content. Content is more often available in English and in academic formats that may be difficult for farmers to understand. To deliver actionable and understandable content to farmers is an expensive undertaking. A further factor that hinders rapid growth is farmer on-boarding. Collecting farmer profiles, especially geo data of their farms, is an expensive process (time, labor, and money). Innovators' opportunities are greatly enhanced by platforms where they can offer their services to farmers that have already invested in creating profiles for themselves.

INNOVATION ALONG THE VALUE CHAIN

The innovations are not equally distributed along the value chain. Storage, Post-Harvest Processing and Transport are less common in the digital innovations surveyed than the other parts of the value chain. Most innovations have targeted more than one part of the value chain, illustrating that many commodity value chains are fragmented in more than one place.

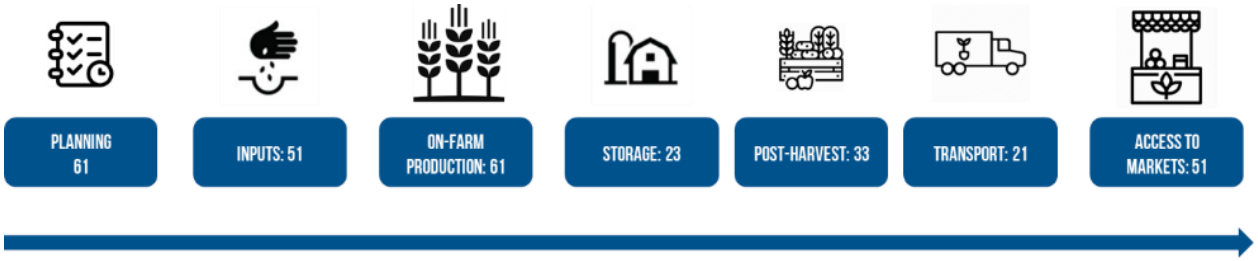

FIGURE 29 DISTRIBUTION OF SURVEYED INNOVATIONS OVER THE VALUE CHAIN

SCALING INNOVATIONS

The study shared the six stages of a scaling innovation model from the International Development Innovation Alliance (IDIA) Insights with survey respondents. They were asked to determine which stage their innovation relates to best, based on a description of each phase as illustrated below (Figure 30).

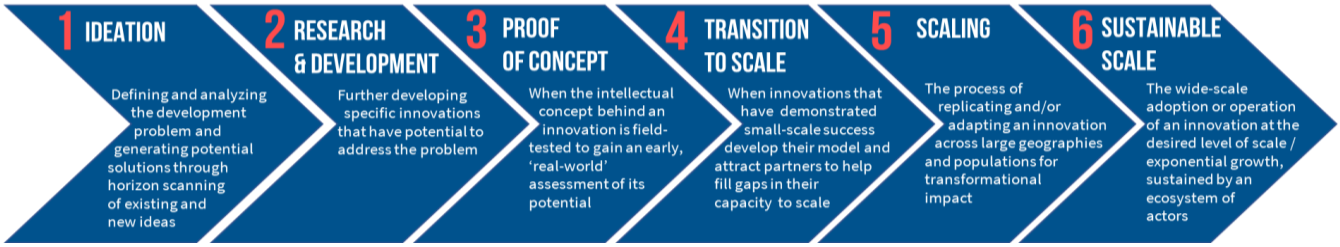

FIGURE 30 SIX STAGES OF SCALING MODEL

The results showed that regional innovations are at a more advanced stage in scaling. For regional innovations more than 50% have reached the Scaling phase (stage 5 in figure 30), while for local innovations this was just above 30%.

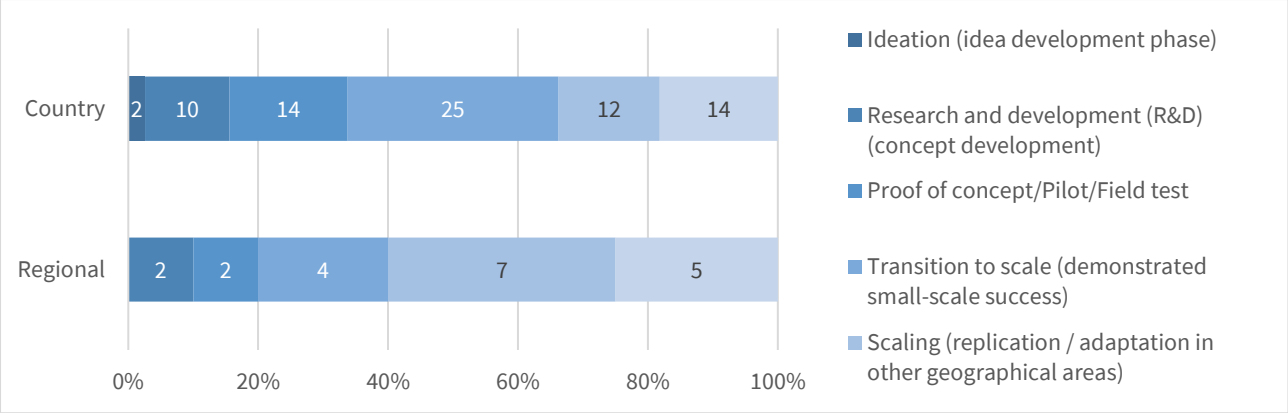

FIGURE 31 SCALING STAGES IDENTIFIED BY SURVEYED INNOVATIONS DEPLOYED IN A SINGLE COUNTRY VS REGIONALLY

Innovations that have reached sustainable scale have more users than those at earlier stages. These findings are tentative because a relatively large number of survey respondents failed to complete this question fully[12]. Interestingly, innovations in the Research and Development stage had on average more users that those at the Proof-of-Concept stage. This may be because some innovations may be being tested by existing users of a (different) primary innovation. The big difference between Scaling and Sustainable scale stages may also have been skewed by the large number of registered users of Viamo in the SADC region (8,500,000).

TABLE 15 AVERAGE NUMBER OF REGISTERED USERS IN SURVEYED INNOVATIONS FOR EACH PHASE OF SCALING

At what stage in the scaling process is this innovation?	Average # registered users
Ideation (idea development phase)	0
Research and development (R&D) (concept development)	1,927
Proof of concept/Pilot/Field test	1,383
Transition to scale (demonstrated small-scale success)	8,689
Scaling (replication / adaptation in other geographical areas)	97,791
Sustainable scale (wide scale adoption)	835,465

SUSTAINABILITY AND BUSINESS MODEL

Four revenue models were commonly cited in survey responses, illustrated in figure 32. Most frequently cited was a business subscription fee model, followed by an individual subscription fee model and a transaction fee model. Grant funds from donors were also commonly used to develop digital agricultural innovations.

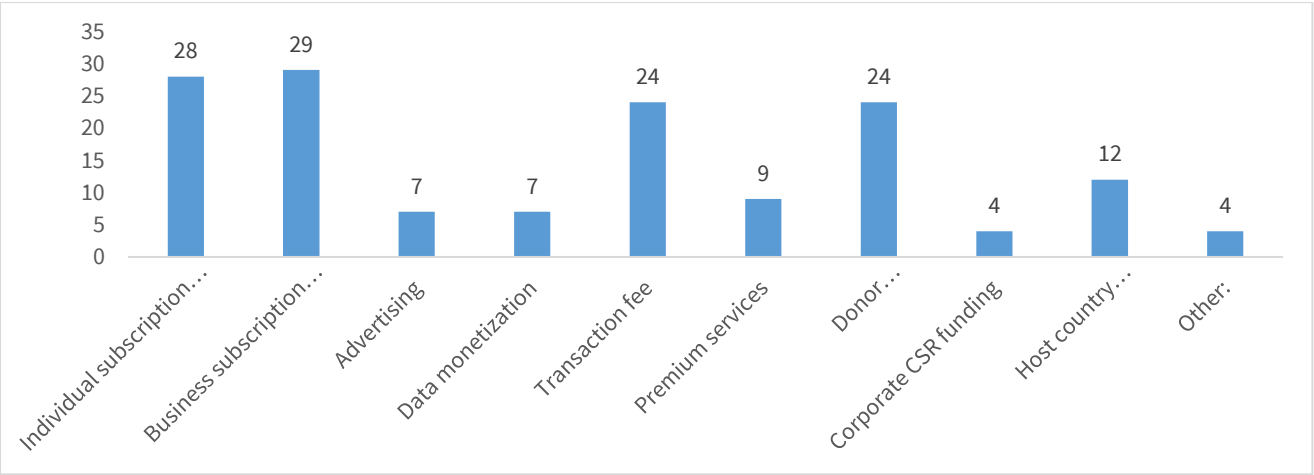

FIGURE 32 REVENUE MODEL FOR SURVEYED INNOVATIONS

[12] Survey respondents may have been unwilling to share proprietary or competitive insights or they had inadequate data to substantiate this.

Figure 33 shows the finance mechanisms used to support the innovations. The figures are based on the average per country (e.g., For Group 2 the average is based on 3 countries and for Group 4 the average is based on four countries).

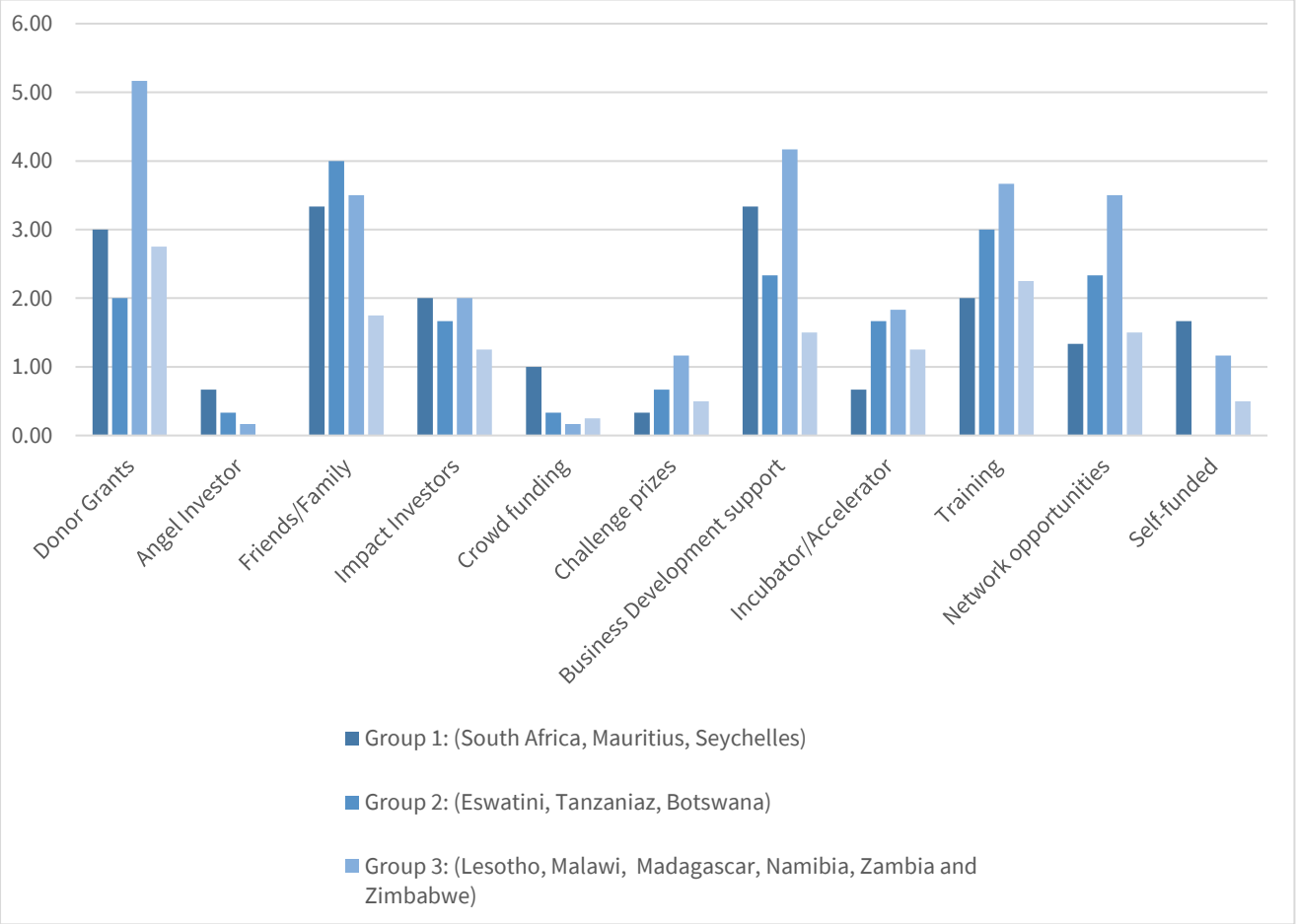

FIGURE 33 FINANCIAL MECHANISMS TO SUPPORT THE INNOVATION

Some observations from figure 33: Group 3 (5.17 average) and Group 4 (2.75) both have donor grants as the most mentioned finance mechanism to support innovations. Group 3 is best able to attract donor funding from all groups. This is exemplified by Malawi who scored highly and has attracted donor grants for several innovations (10), Zambia (7) and Zimbabwe (6) also score highly. For Group 1, Business Development Support (3.33) and Friends and Family (3.33) are the most common mechanism for financial support. For Group 2 this is Friends and Family (4).

All Groups received some support from impact investors, although Group 1 and 3 use impact investors more often than Group 2. Support from Angel Investors is mentioned less by all respondents but featured most in Group 1 responses. Self-funding is also most common in Group 1. Business Development Support, Incubators and Accelerators, Training and Network opportunities are most common in Group 3.

Most of the survey respondents mentioned that their innovation would not be sustainable without further grant funding and only 19% mentioned that they are not in need of further donor funding. From survey respondents within the sustainable scale stage, almost 60% mentioned they are still dependent on grant funding from donors (11). Two (2) of those at the sustainable scale stage that are not reliant on grant funding are digital wallets (Mukuru and t.money), and two are government supported (DAES v1 in Malawi and Seasonal Forecast in Lesotho).

Innovators who are in Transition to Scale, Proof of Concept, Research and Development or Ideation phase received the most support from incubators (75% of incubator support is going to these phases) and they often use self-funding,

funding by friends and family, or they receive challenge prizes (all three answers were 70% of the respondents in the earlier phases) than the Scaling or Sustained Scale phases.

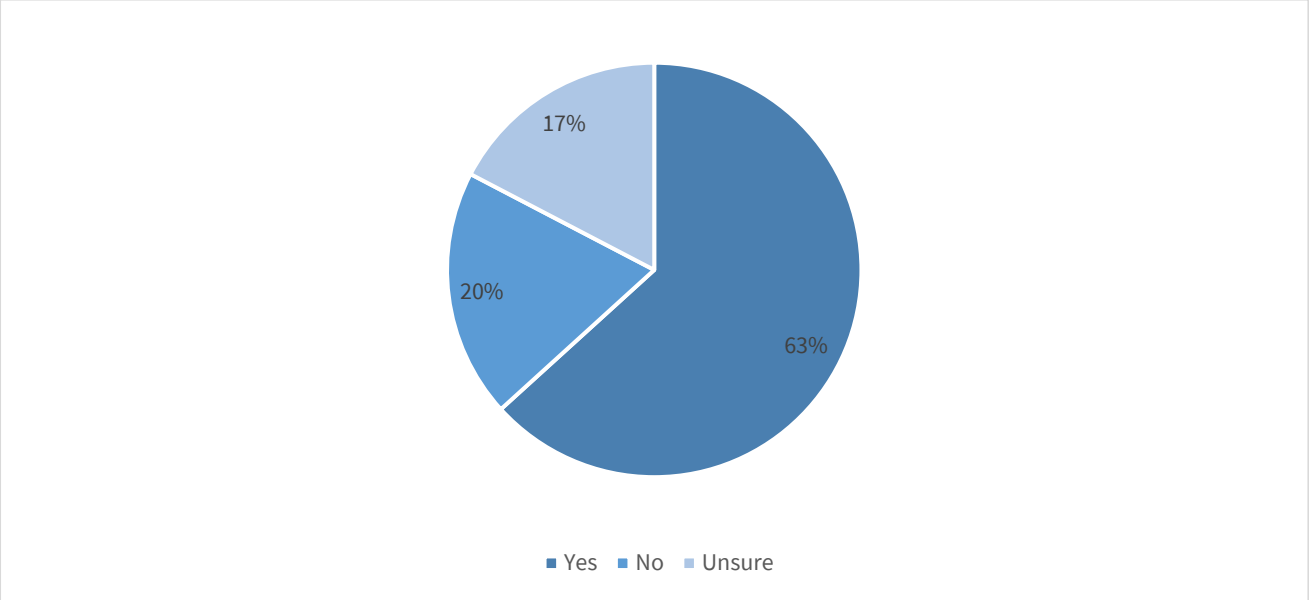

FIGURE 34 SHARE OF RESPONSES FROM SURVEYED INNOVATIONS ON WHETHER FURTHER DONOR GRANT FUNDING IS REQUIRED

Growing beyond the transition to scale stage is more complicated. Evidence in the form of data is a huge deficit for these businesses which enables innovations to successfully obtain finance beyond early stage to later stages to be able to grow and scale further. To move from start-up to scale up stages there is a need for rapid onboarding of new farmers (and hence additional funding) to cover operational costs and become sustainable without further and additional requirements for funding.

TARGET GROUP OF THE DIGITAL INNOVATION

Innovations either use an indirect model to reach farmers through intermediaries such as agribusinesses or target the primary user groups directly. Figure 35 shows the distribution among different target groups. Farmers are mostly seen as primary end users followed by farmer cooperatives and extension workers. Government agencies, agribusinesses and NGO staff are more often seen as intermediaries.

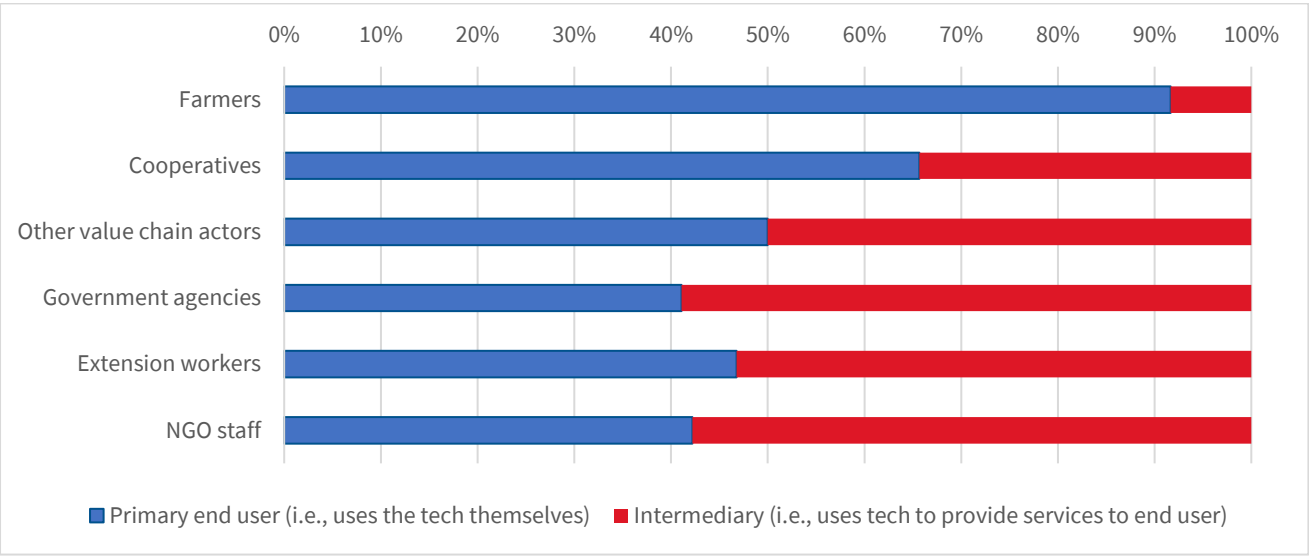

FIGURE 35 TARGET GROUP OF SURVEYED INNOVATIONS (PRIMARY END USERS VS INTERMEDIARY END USERS)

DIGITAL INCLUSION

In the survey, respondents were asked to describe if their innovation was inclusive of women, people with disabilities, the elderly, smallholder farmers and those with low or limited literacy levels. If any explicit actions were recorded, they were predominantly for the inclusion of smallholder farmers and those with low or limited literacy levels. A large group reported no explicit actions towards greater inclusivity.

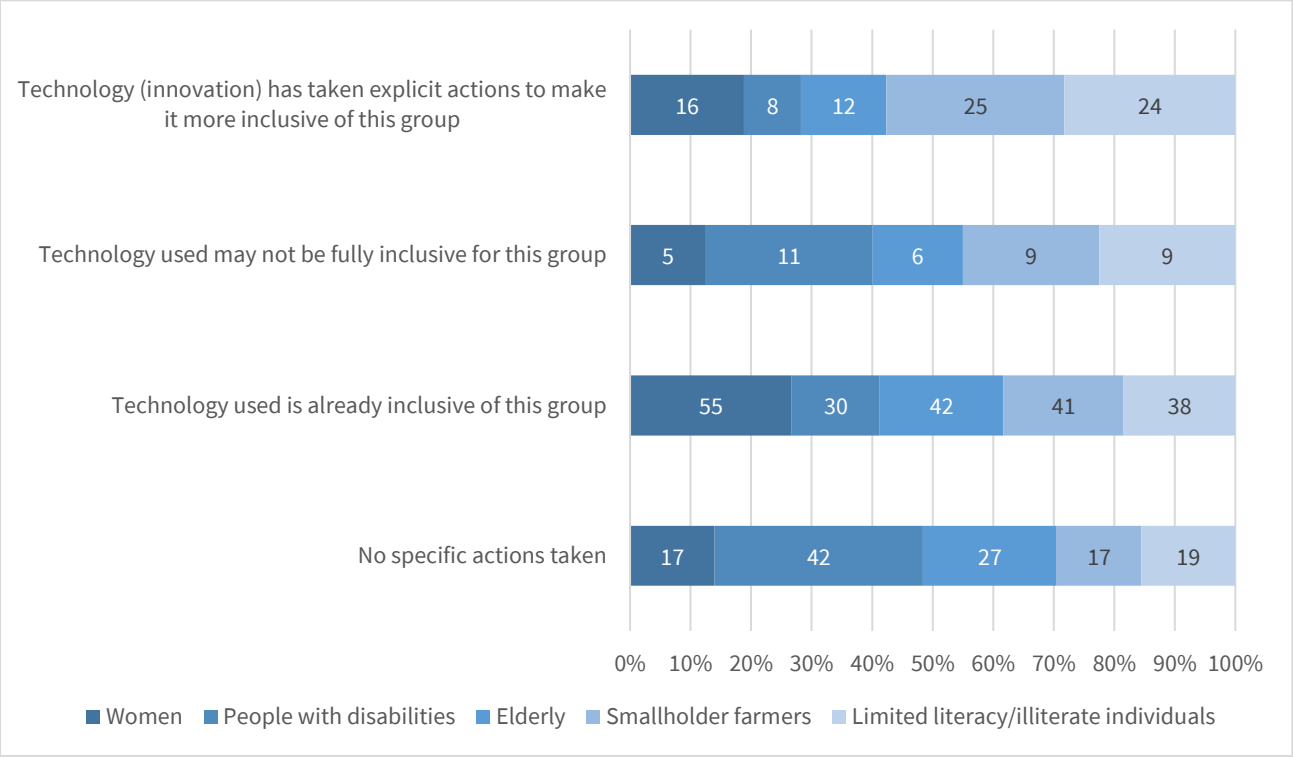

FIGURE 36 MEASURES TO MAKE SURVEYED INNOVATIONS MORE INCLUSIVE

RESULTS

Respondents were asked to share the results of their impact, but many struggled to share information through the survey. Data collection on the ground is a further expense and remote data collection is not yet commonly accepted by farmers (or trusted). To become data driven both in terms of planning ahead and financing requirements, further steps are necessary. Accessing finance is necessary for scaling, particularly to expand beyond borders and facilitate regional trade, commerce, and a regional ecosystem. Impact investors are particularly well placed for this as they understand the need for rapid testing and iteration characteristic of these types of businesses.

6 DIGITAL AGRICULTURAL SKILLS AND ENTREPRENEURSHIP TRAINING

6.1 AGRICULTURAL SYLLABI UNIVERSITIES

Digital and entrepreneurial skills training was assessed through a quantitative Survey Monkey tool sent to 54 Universities, the majority of these were Faculties of Agriculture that are part of the RUFORUM network, but some institutions were contacted that were not strictly agricultural focused to try and provide a complete picture of the region (a total of 58 different faculties were approached). 26 Universities responded to the survey, however 7 Universities responded that they did not teach any digital skills and therefore did not provide further responses. The response rate was 47% which was a reasonable response rate but lower than expected. Some KIIs were also conducted to complement survey responses. Figure 37 illustrates the distribution of the participating universities in the SADC countries that completed surveys. A full list of all Universities and Colleges approached can be found in Annex 3, the relevant survey can be found in Annex 8, and the KII guide can be found in Annex 10.

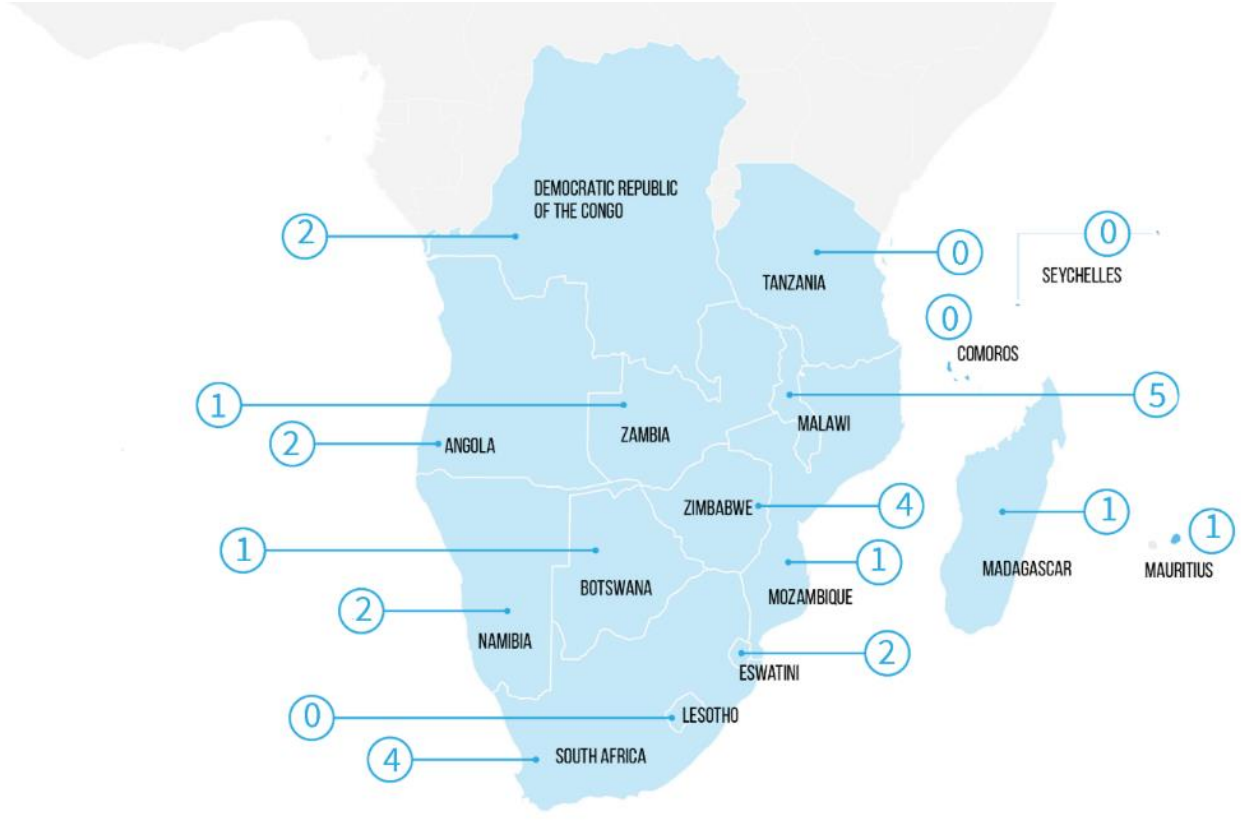

FIGURE 37 OVERVIEW OF UNIVERSITIES THAT RESPONDED TO THE SURVEY

DIGITAL LITERACY SKILLS TAUGHT BY UNIVERSITIES IN THE SADC REGION

Based on data collected through the survey and KIIs, it is evident that the universities in the SADC member states provide digital skills training associated with the International Computer Driving License (ICDL) standard, which was the framework around which the survey was designed due to the familiarity with using it in the tertiary education sector across Africa (Association of African Universities, personal communication). The ICDL is a digital skills standard developed by the ICDL Foundation to raise digital competence standards in the workforce, education, and society. The

ICDL Base Modules that include computer essentials, online essentials, word processing and spreadsheets seem to be taught by most of the universities in the SADC region. The universities also proceed to provide ICDL Standard Modules that cover the use of databases, presentations, online collaboration, and IT security. Advanced ICDL modules of word processing, spreadsheets, databases, and presentations are also taught. Additional digital skills such as graphic design, digital marketing, desktop publishing and mobile technologies did not appear to be part of the mainstream curriculum in most of the universities that responded.

Figure 38 shows the distribution of ICDL modules across the SADC region. Ten of the 26 respondents teach basic skills level modules, seven teach standard skills level modules and only five teach the advanced skills level modules.

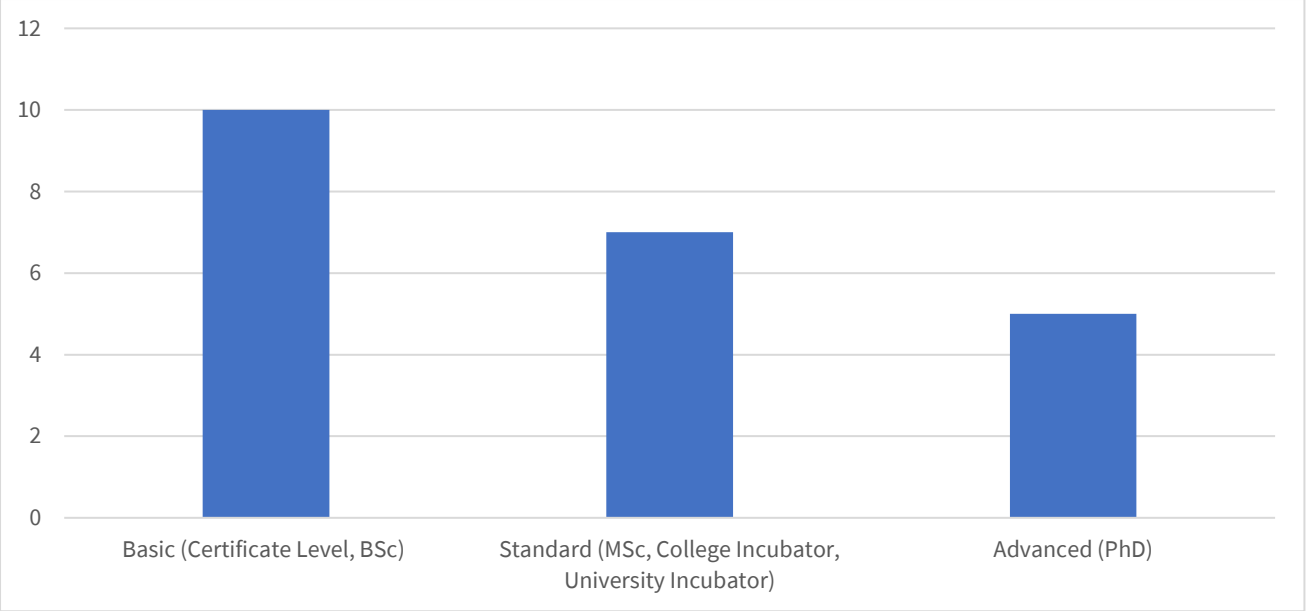

FIGURE 38 DISTRIBUTION OF ICDL MODULES ACROSS THE SADC REGION

HOW THE DELIVERY OF THE DIGITAL SKILLS TRAINING IS ORGANIZED IN SADC UNIVERSITIES

It is important to ensure that the content of the curriculum caters for the different needs of the faculties. Digital skills training is often taught by a central department in most of the responding SADC universities. While this is an efficient way of managing the training, it often misses the specificity that agricultural training requires. For example, the application of databases and spreadsheets might differ between a medical student and an agricultural student. The examples used in delivering the digital skills content must be robust enough and be relevant to specific disciplines. The dynamism of (and continuous changes in) the IT tools and applications also require that students be trained to invest in self-instruction and engage in continuous learning and skills upgrading. **During the discussions with most of the universities it seemed that the agricultural faculties were not assuming direct responsibilities for building the digital skills capacities of their own students but were relying on a central department within the university**.

The university digital skills curriculum could be kept up to date through collaborations with ICDL Africa, a subsidiary of the ICDL Foundation (not-for-profit certifying authority of ICDL). ICDL Africa guides the implementation of the ICDL standards in the African context and manages the accreditation of a network of ICDL Accredited Test Centers. Students could be encouraged to obtain ICDL certification as part of making them work-ready. Collaboration with ICDL test centers would be possible in the following SADC countries that have ICDL Test Centers: Botswana, DRC, Eswatini, Lesotho, Malawi, Mauritius, Mozambique, Seychelles, South Africa, Tanzania, Zambia, and Zimbabwe.

The ongoing health pandemic has led to the growth in the use of online delivery methods for continuous and flexible digital skills training for university students.

DIGITAL AGRICULTURAL SKILLS TRAINING IN SADC UNIVERSITIES

Digital agricultural skills training requires that IT tools or applications be taught using the viewpoint of agricultural needs or relevance. The applicability of fundamental IT literacy for agriculturalists and agricultural development must be emphasized. The relevance of new and emerging skills areas to the agricultural sector must be clearly articulated and demonstrated practically during the delivery of digital agricultural skills training. The digital agricultural skill areas include cybersecurity, IoT, Artificial Intelligence (AI), mobile technologies, digital marketing, desktop publishing, and Big Data.

Figure 39 illustrates that Big Data for agriculture, Internet of Things for agriculture, digital entrepreneurship and coding for agricultural systems are widely taught. Other topics are less common.

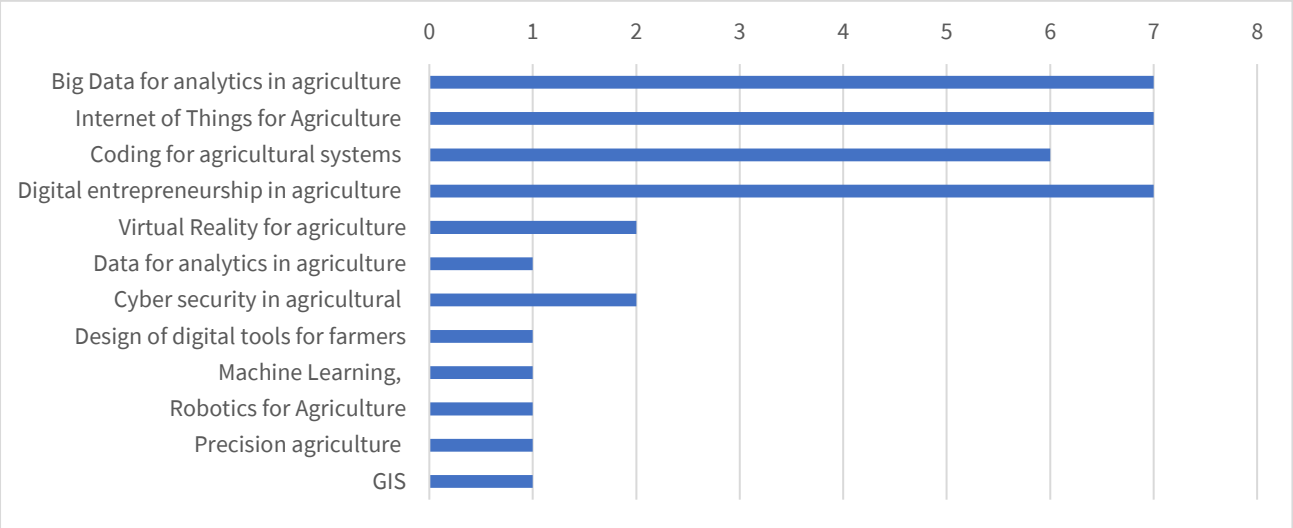

FIGURE 39 DIGITAL AGRICULTURAL SKILLS TAUGHT AT SURVEYED UNIVERSITIES AND COLLEGES IN SADC

Several universities reported that they taught most of these skills, except for Botswana, Comoros, Eswatini, Lesotho, Seychelles, and Tanzania who either did not complete the survey or **were explicit that they did not teach digital skills**. However, it was still unclear from the analysis how the curriculum was structured to accommodate the training of these new skill areas. Some universities (e.g., LUANAR in Malawi and Africa University in Zimbabwe) reported that the digital agricultural skills were taught as part of other courses. There is a clear opportunity for Universities to learn from innovation hubs and incubators and work more closely to support the continuous training of students in new and emerging areas through greater collaboration between the two types of institutions. Online delivery methods also present an important opportunity for continuous and flexible digital agricultural skills training for university students. Furthermore, there are opportunities to develop specialist modules to ensure that skills development can also be tailored for policy makers in digital agricultural fields.

The ICDL Insights modules could be used as a standard for introducing trending and emerging topics such as cloud computing, AI, IoT, Big Data, blockchain and industry 4.0.

COLLABORATING TO IMPROVE DIGITAL AGRICULTURAL SKILLS TRAINING FOR SADC

The responding universities did not mention any national or regional university-to-university collaborations to support the delivery of digital agricultural training. The students' training needs for the new areas require specialized instructors, specialized equipment, the establishment of complex simulated virtual environments, access to specialized and expensive equipment and reliable access to the internet and related devices. Evidently there are opportunities for collaborations among the SADC countries for setting up regional digital agricultural skills centers of excellence, joint resource mobilization, joint curriculum development, staff, and student academic mobilities for capacity development.

DIGITAL ENTREPRENEURSHIP TRAINING IN SADC COUNTRIES

The way that digital entrepreneurship in agriculture is taught must adapt to the new opportunities presented by evolving digital technologies. Digital agricultural entrepreneurship therefore aims to expose students to new agricultural entrepreneurial projects, new agricultural products and services, new ways of generating revenue for agricultural initiatives, new opportunities to collaborate with agricultural platforms and partners, and new areas for agricultural competitive advantages.

Universities in eight SADC countries reported that they were delivering some form of digital entrepreneurship skills training in the areas of E-extension, Smart Farming, Digital Content Creation, ICT-Enabled Advisory Services, Intelligent Agriculture/Geomatics, Digital Procurement, Agri-e-commerce, Agriculture Innovation, Agribusiness Agricultural Extension, Agri Digital Financial Services, Technologies in Sheltered Farming, Precision Farming, Small and Medium Enterprises, and Agricultural Management.

Figure 40 shows the distribution of digital entrepreneurship training with Digital Advisory and Smart Farming as the most common subjects.

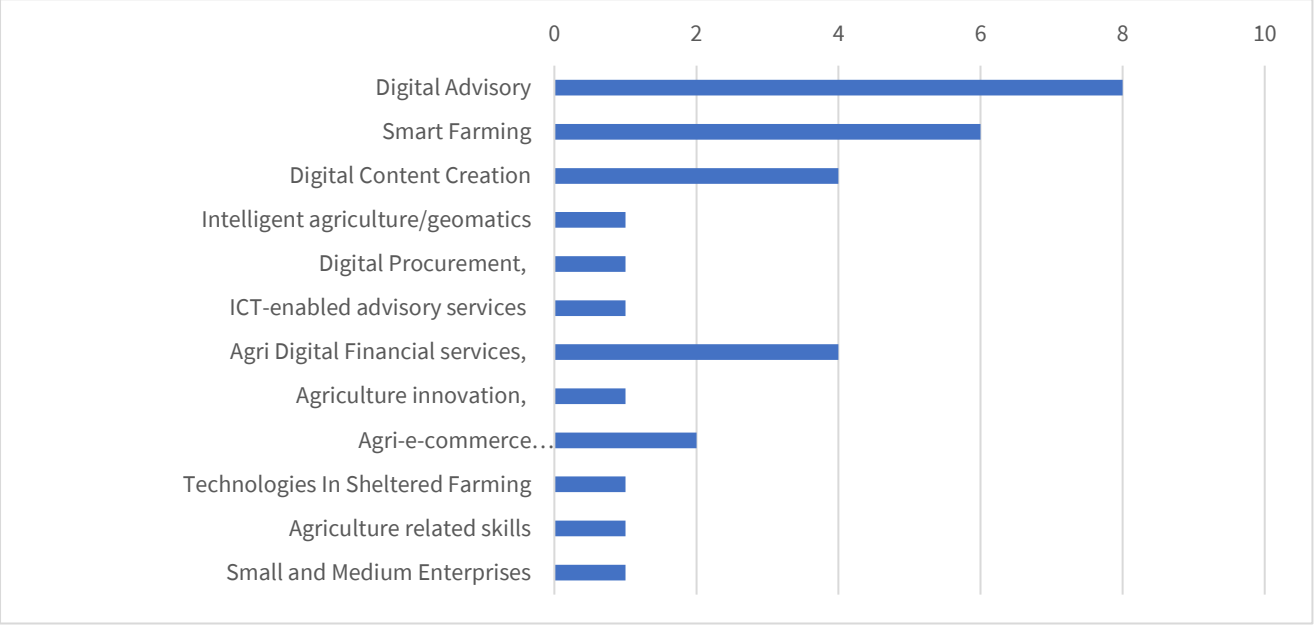

FIGURE 40 DIGITAL ENTREPRENEURSHIP TRAINING COURSES REPORTED AT UNIVERSITIES

Based on the more qualitative discussions with selected universities, **an opportunity for refining the digital entrepreneurship curriculum for agricultural students and practitioners is apparent.** There is currently no standard that is being used to guide training in this area which would be beneficial.

LAST MILE INTERNET CONNECTIVITY SOLUTION FOR UNCONNECTED AREAS

The importance of building strong communications infrastructure for higher education and research institutions in the SADC region cannot be over-emphasized. Such infrastructure is needed to support advanced service digital agricultural delivery through high-speed telecommunications networks. The Research and Education Networks in the SADC member states (NRENs) are key institutions that provide internet bandwidth services, cloud services and other value-added services to research and education institutions at reduced costs.

The development of strong campus networks and the strengthening of NRENs are key so that SADC higher education institutions and innovation hubs can effectively provide all types of digital services for teaching digital agricultural training, digital agricultural entrepreneurship, and advanced research activities. **During the discussion with the responding universities, it was emphasized that CCARDESA could support the appeal to SADC Governments to prioritize the 'last mile' solutions in the SADC countries so that the rural areas have equal access to the internet as those in the urban areas.** Most of the SADC countries have established NRENs but they have not achieved "maturity" status of development because of limited support from their governments.

6.2 INCUBATORS AND INNOVATION HUBS

INCUBATORS, INNOVATION HUBS AND TRAINING CENTERS IN THE AGRICULTURAL SPACE: AN OVERVIEW OF THE SADC REGION

The demand for emerging skills in the current international labor market is fostering the creation of large numbers of business support organizations[13] such as incubators, innovation hubs and training centers or programs. These institutions have the role of preparing young people for future jobs, innovations, entrepreneurial initiatives, and to meet the demand of employers in need of a workforce that can move fluidly across projects, teams, and work locations, especially considering the impacts that the Covid-19 pandemic has created in the international labor landscape. As demonstrated by the ITU Digital Skills Insights 2019, digital skills have been recognized as crucial in the response to the demand of the SSA labor market.

In October 2019, a qualitative and quantitative study by AfriLabs and Briter Bridges, Building a Conducive Setting for Innovators to Thrive, mapped hubs across Africa. They identified 643 different hubs across more than 50 countries which included coworking spaces, incubators, accelerators, and hybrid innovation hubs affiliated with government, universities, or corporates. According to GSMA, the number of identified hubs has grown by 51% over the period 2016-19. Of the 643 identified by AfriLabs, 41% were incubators, 24% innovation hubs, 14% accelerators and 39% co-working spaces.

Within this study, these institutions have also been considered key stakeholders in providing a range of digital skills training for agricultural development, the agribusiness sector and in preparing students, researchers, and entrepreneurs to progress their ideas and aspirations in the current SADC agricultural labor market. Of the 62 Agri-incubators targeted by this study, 29 responded to requests for interview and participated in KIIs resulting in a reasonable response rate of 47%. A full list of incubators approached can be found in Annex 4, the KII guide for

[13] In this study we have referred to these types of business-support organizations as i*ncubators*, with the express acknowledgment that they have differences in targets related to the youth they train/incubate, their management and business models, and the funding available for investment in startups/enterprises.

incubators can be found in Annex 9, and the full list of stakeholders interviewed including incubators can be found in Annex 2.

Figure 41 illustrates the distribution of existing agri-incubators and the number of agri-incubators that participated in a KII[14] (e.g., for Tanzania 7 agri-incubators were identified of which 4 participated).

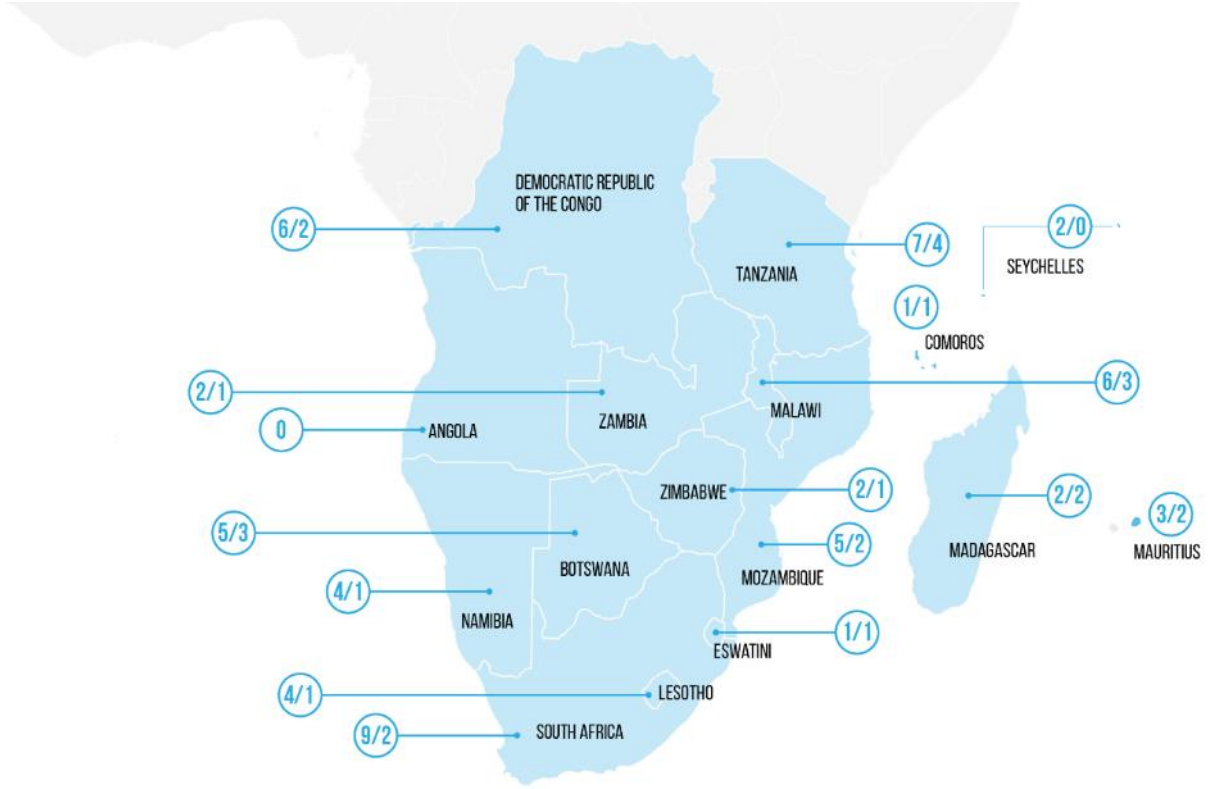

FIGURE 41 DISTRIBUTION OF IDENTIFIED AGRI-INCUBATORS VS PARTICIPATING AGRI-INCUBATORS

Of the 29 agri-incubators examined in nine countries in the SADC region, 48% cited their support came from government, while the incubators belonging to the six remaining countries were independent organizations or initiatives with a dependence both on donors or partner funds, or business models that supported revenue generation to cover their operational costs without the need for additional support from external entities.

There were several different revenue-generating business models mentioned by the agri-incubators including charging fees in the provision of incubation services, delivering trainings and events (hackathons, bootcamps, pitch days, etc.), rental income from co-working spaces or conference rooms, and fee-based consultancy support for studies or market research and other business-related activities.

Regarding the support from government to the incubators, this was not necessarily based only on funds, but other relevant forms of help such as seed funding for the start-ups incubated, the provision of in-kind offices and spaces for the co-working and the provision of land to facilitate the piloting of agri-related entrepreneurial initiatives.

[14] Survey respondents in Botswana and Eswatini universities provided incomplete surveys and as such they are not mentioned in the map since the information provided was limited or they do not provide digital skills.

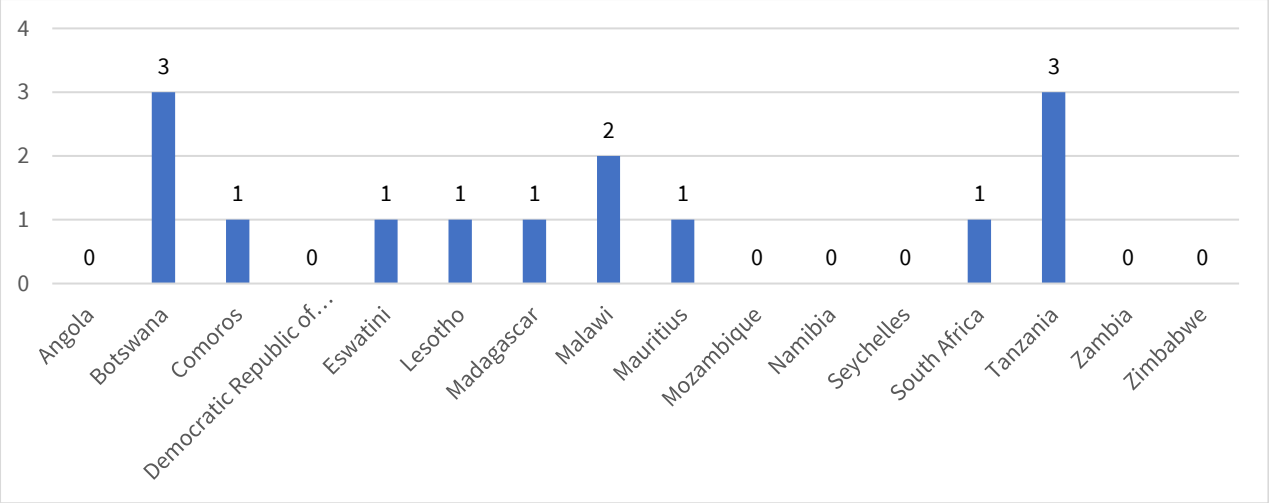

FIGURE 42 AGRI-INCUBATORS SUPPORTED BY THEIR GOVERNMENTS

THE ROLE OF SADC AGRI-INCUBATORS IN UPSKILLING YOUNG PEOPLE WITH DIGITAL SKILLS FOR THE AGRICULTURAL SECTOR

Despite the acknowledgment on the importance of building digital skills for the agricultural sector by most agri-incubators interviewed, the incubation space of the SADC Region is not ideally prepared with the necessary skills and equipment to teach digital agriculture skills. Excluding Angola and Seychelles, of the 14 countries examined, six do not teach digital agriculture skills and some even suggested that they were not familiar with the meaning of *digital agriculture*. With respect to general digital skills training, only four incubators do not teach any digital skills, illustrating how incubators are better equipped with providing expert advice and more general curriculum on IT or digital training rather than tailored digital agriculture skills training.

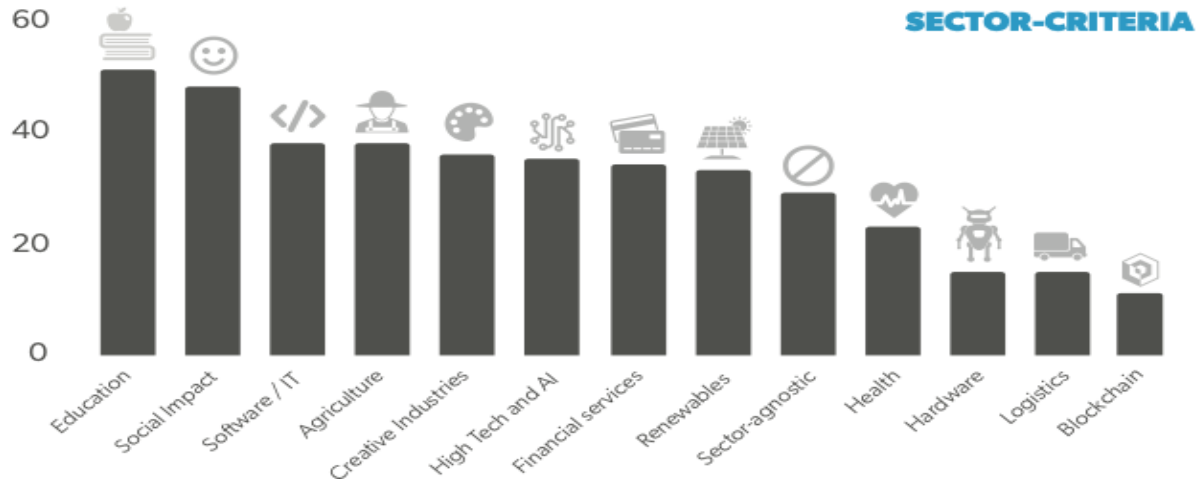

FIGURE 43 GRAPH FROM AFRILABS AND BRITER BRIDGES (2020) REPORT[xv] SHOWING BREAKDOWN OF SECTOR SPECIFIC HUBS

Sectors delivering high social impact in education and agriculture were amongst the highest number of hubs specializing, as identified by AfriLabs and Briter Bridges 2019 report.

Most incubators in countries that teach digital agricultural tools do not provide specific digital agricultural training but tools for incubee businesses are mentioned during wider digital skills training, including those not specifically aimed at agriculture.

Occasionally, specific training courses on precision agriculture or drones for farm management are customized to support a digital agriculture entrepreneur in need of the skills (customized training), but these are rare services provided by a few incubators.

TABLE 16 DIGITAL SKILLS TRAINING AND DIGITAL AGRICULTURAL SKILLS TRAINING ACROSS RESPONDING INCUBATORS IN SADC

	Digital Skills Training	Digital Agri Tools
Botswana	✓	✓
Comoros		
DRC	✓	
Eswatini		
Lesotho		
Madagascar	✓	
Malawi	✓	✓
Mauritius	✓	✓
Mozambique	✓	✓
Namibia		
South Africa	✓	✓
Tanzania	✓	✓
Zambia	✓	✓
Zimbabwe	✓	✓

In general, both digital skills and digital agriculture tools are taught by external consultants or partners of the incubators who provide a digital training portfolio or organize specific masterclasses on digital agriculture.

None of the incubators interviewed have internally dedicated digital agriculture experts but do have IT developer staff or digital experts to assist youth with general digital skills.

TABLE 17 CURRICULAR COMPONENTS OF THE DIGITAL SKILLS TRAININGS AND DIGITAL AGRI TOOLS TAUGHT IN THE AGRI-INCUBATORS INTERVIEWED

	Digital Skills Training	Digital Agri Tools
Botswana	Capacity building sessions like Robotics and Coding, Online marketing, Communication (ex. Video production), social media, ICTs for production records and finance, ICT for record keeping	Digital Advisory Agri-e-commerce Smart Farming Digital Procurement
Comoros	None	None
DRC	Website development, Digital marketing, FinTech, IT tools to manage the business	None
Eswatini	None	None
Lesotho	None	None
Madagascar	Use of the internet, social media, and data collection to sell products, Digital communication and marketing, Multimedia	None
Malawi	Climate change adaptation enterprises through ICTs, Digital marketing, Product development for prototype development, digital marketing, 3D/2D Design, Software languages (machine learning, phyton, etc.), Hardware engineering, ICT for biomedical	Digital Advisory Agri Digital Financial services Digital Procurement Agri-e-commerce Smart Farming
Mauritius	On Demand (e.g., IoT training), Digital Marketing Workshops, Modern technologies for SMEs in the agricultural sectors	Digital Advisory
Mozambique	Digital transformation trainings: -Registering farmers info -Capturing geolocation in the field -Registering trainings into digital platforms -Surveys to capture information Digital marketing	Digital Advisory Digital Procurement

Namibia	None	None
South Africa	Business resources and tech tools, Digital marketing skills, Coding academy, Robotics, 3D printing, hardware, chatbox, Mobile and web development	Digital Advisory Agri Digital Financial services Digital Procurement Agri-e-commerce Smart Farming
Tanzania	ICT for Financial records, impact tracking and access to market, Agri technical mentorship, Prototypes Design, Digital marketing, IoT, Programming, Data Science/AI, Mobile and web development, Use of Apps for agriculture, Design of solutions for farmers, Digital Literacy, SEO / web marketing / social media, TAHA: how to join this web platform (www.taha.or.tz), Marketing Intelligence	Digital Advisory Agri Digital Financial services Digital Procurement Agri-e-commerce Smart Farming
Zambia	Financial management for SMEs, Financial management software	Agri Digital Financial services Digital Procurement Agri-e-commerce Smart Farming
Zimbabwe	AI/machine learning, SEO trainings, Business and market strategies in the digital space, Coding, mobile app design and monetization of digital content, e-commerce, cloud technologies marketing, social media management, digital payments, digital systems for invoices records, online processes, legal contracts, Content management (WordPress), Digital market Analysis, social media	Digital Advisory Agri Digital Financial services Digital Procurement Agri-e-commerce Smart Farming

7 DISCUSSION

7.1 THE BROADER POLICY ENVIRONMENT

KEY REFLECTIONS FROM BENCHMARK ASSESSMENT, STOCK TAKE AND CHALLENGES WITHIN THE AGRICULTURE SECTOR

The focus on the broader policy environment for this study has identified three key focus areas, also referenced in the findings. These focus areas result from the benchmark assessment, the stock take of policies, strategies and legislation, and the challenges identified by stakeholders in the agriculture sector more specifically.

The benchmark assessment is an effective tool to measure progress within the region and identify countries that may require greater intervention in specific policies or legislation to accelerate digital transformation in agricultural systems.

The benchmark assessment enabled the identification of countries within SADC that are unlocking positive pathways towards a digital economy and a vibrant ecosystem of different actors. Four clusters of countries at different points in their progress were identified in applying the benchmark:

Group 1: South Africa, Mauritius, and the Seychelles.
Group 2: Eswatini, Tanzania and Botswana.
Group 3: Zimbabwe, Namibia, Lesotho, Zambia, Malawi, and Madagascar.
Group 4: Angola, Mozambique, the DRC, and Comoros.

Countries that have been the most successful to date at advancing their policy and enabling environments all have agriculture sectors contributing less than 10% of GDP and employ less than 5% of their population in productive agriculture. There may be many more people engaged in the food system itself including retail, processing, trade, storage, logistics, marketing, and food preparation. These front-runners provide good areas of potential learning in certain foundational pillars necessary for a vibrant digital economy. The clusters formed through the benchmark help to identify the progress countries have made and where greater efforts may need to be directed.

The benchmark illustrates the variation in the strengths and weaknesses across the region. The specific areas of this diversity were explained in further detail through scrutiny of the foundational pillars making up a vibrant digital economy. An example to illustrate this comes from South Africa which does not offer a strong example for digital skills, despite being ranked first overall, as it ranks tenth under this specific pillar. The value of the foundational pillar breakdown provides an opportunity to see which country provides a good example to learn from in each of the pillars. Some caution is also necessary given the complexity around development because a strong candidate such as Mauritius, which excels in the ranking and is identified as advanced even at a global level, is still unproven because it is at an earlier stage in developing its agriculture sector to build greater self-sufficiency in its national food system.

A whole-of-government approach is necessary for a thriving digital economy that enables engagement of stakeholders in the policy process and can alleviate cross-sectoral challenges, such as connectivity and digital literacy skills. Furthermore, greater efforts are necessary to understand whether the legal and regulatory standards in place for digital commerce, privacy and data fulfil their objectives for all stakeholders.

The policy and legislation stock take clarifies what countries' activities are, and if they are embracing a digital economy. In terms of legislation, half the countries have some form of legislation on e-commerce, cybersecurity, or

data but there is mixed information on the extent to which these are implemented or enforced. It is also possible that these require updating to encompass emerging technologies and modern digital solutions. This is particularly pertinent to the sixth challenge identified by stakeholders in section 4.5; the lack of security institutions and regulations. With greater digitalization more focus should be placed on ensuring trust, privacy, and protection of consumers and businesses. Digital technologies, especially more advanced ones, rely heavily on the collection, dissemination, and analysis of data. More directly related to legislation is the regulation and standards that are currently missing to enable greater interoperability between the private sector, public sector and across regional bodies.

A digital economy strategy enables the private sector to engage in policy formulation and play a role in whether policies are delivering an enabling environment. The observation from our analysis suggests the predominance of a siloed approach by different ministries and departments suggesting gaps, overlaps and inherent inefficiencies. This nature of siloed policymaking hinders the entrance of partnerships with the private sector.

Digital Agriculture policies or strategies were not available in any of the 16 countries within SADC and the integration of digital into existing agriculture strategies and policies was limited. An agriculture sector specific digital strategy and roadmap is necessary with clear objectives, milestones, timelines, and funding requirements to tie in the sector performance with a digital economy advancement.

None of the countries investigated had a clear digital agriculture strategy. A lack of a guiding policy or strategy was a barrier for stakeholders to implement innovations or digital solutions that would be sustainable. The FAO states that "committing piecemeal resources to ICT4Ag on an *ad hoc* basis result in higher costs and lower impacts" and that any effective roadmap will require "a holistic, multi-stakeholder approach as ICTs are also driving other sectors critical for agriculture, namely banking, weather monitoring, insurance, logistics and e-governance"[xvi]. A clear agriculture sector specific strategy or roadmap can address some of the key challenges raised by stakeholders consulted during this study. It is important to recognize adequate funding for the sector will be necessary to implement new solutions and resource the transition to a more digitally aware approach. The OECD notes in Digital Opportunities for Better Agricultural Policies that the estimates for the costs of developing digital tools for policymaking are not insignificant and these actual costs need to be factored into overall budgeting and planning with ongoing skills and management requirements necessary for such a transition.

In addition, the sector specific strategy – and most particularly for agriculture - would need to be adapted to leave no one behind especially those at greatest risk of exclusion. While low digital skills are an issue that needs to be addressed in a digital economy strategy, as it is cross-sectoral, specific and explicit focus will be required for the aging rural farming population that consists largely of women, but also the elderly and those with low literacy levels. One way to achieve this is through hyper-localized relevant content that is translated into working languages or images through gamification approaches tailored to a specific country.

BROADER REFLECTIONS AND FURTHER AREAS FOR DEVELOPMENT

This section presents broader reflections, areas for development, and possible intervention areas where CCARDESA and SADC could play a greater role. The reflections are presented in alignment with different country groups identified by the benchmark assessment. These suggestions are not exhaustive, and some may be relevant and useful in all the SADC countries.

Group 1: South Africa, Mauritius, and Seychelles

Specific focus and investigation should be made to understand what is working within these countries in the implementation of their policies and legislation, how it is working, and the levels of enforcement with regards to the policy and legal frameworks for the purpose of extending learning across the region. Special emphasis should be focused on promoting privacy and data standards to encourage greater engagement by the private sector. Mauritius has an advanced policy environment and could prove a useful example when looking at learnings.

Groups 2 and 3: Eswatini, Tanzania, Botswana, Zimbabwe, Namibia, Lesotho, Zambia, Malawi, and Madagascar

A whole-of-government approach needs to be championed with the development of a digital economy strategy. Focus within the strategy should be on the cross-sectoral barriers such as infrastructure, connectivity, the cost of data and access to data, digital skills more generally at primary and secondary level, and greater integration across sectors to break down the siloed nature of current policy making. Malawi is included in this grouping which already has a good example of a digital economy strategy and so it is likely that much learning could be shared across the other countries clustered. Within these environments heavily dependent on Agriculture, a specific digital agriculture strategy should be formulated, and consultation with public and private sectors should guide that strategy. There should be clear milestones and monitoring to help share learnings across the region.

Group 4: Angola, Mozambique, the DRC, and Comoros

These countries ranked lower down the benchmark, and based on the data collected, appear to be least advanced in the region. However, these countries are in transition and could leapfrog the more conventional stages of policy development as three of these countries had digital economy strategies published which suggests a level of prioritization of this agenda. This shows great opportunity for these countries that are heavily dependent on the agriculture sector for economic growth and employment. The momentum must be continued and directed towards the agriculture sector which may require much investment to support the transition as many of the foundational pillars are underdeveloped. Explicit focus also needs to be on producing hyper-localized content that is relevant to audiences in these contexts and ensuring that innovations and solutions are provided in other languages, especially French and Portuguese or indeed indigenous languages, and with image-based interfaces.

Areas for development for the general digital agriculture ecosystem in SADC

1. CCARDESA can play a valuable role in advancing the digital policy environment in the region by coordinating public and private actors and encouraging a different mindset around the development of a functional digital ecosystem.
2. CCARDESA can convene diverse stakeholders to push for engagement towards the deliberate goal of a digital agriculture strategy in countries dependent on agriculture for GDP and employment and enable them to shape a vibrant and dynamic digital agriculture ecosystem through the development of a clear roadmap. Part of this approach could be to encourage policy makers to create farmer platforms to enable them to engage more with other stakeholders, but the platforms created should be designed to be self-sustaining.
3. Deliberate support to help those countries whose first language is not English should be supported in creative ways. Hyper-localized content and channels in local languages should be advanced to enhance digital extension advisory services.
4. CCARDESA is well positioned to leverage the support of development partners which in turn, have a greater likelihood of being able to work with a ‘whole-of-government’ approach and promoting important principles such as open data, digital data standards, privacy, and continued security.

5. Building digital skills in policy makers is going to be key to advance this agenda by CCARDESA hosting an interactive platform which can connect the supply of these trainings with the demand from policy makers.
6. Furthermore, all digital agricultural innovations in the region must find the balance between human centered design (HCD) principles to meet the needs of end users such as smallholder farmers (to adopt digital innovations), and the need to drive the demand for more digital innovations and digital entrepreneurial jobs to enhance the efficiency in the agriculture sector for commercial and economic gain.

7.2 DIGITAL AGRICULTURE INNOVATIONS

KEY REFLECTIONS ON DIGITAL AGRICULTURAL INNOVATIONS

Digital Agricultural innovations are used in all SADC countries, but the number of innovations and the application in different use cases differs markedly between countries based on their digital maturity.

A total of 216 digital agriculture innovations were identified in the SADC region. They were unevenly distributed across the 16 members of SADC with South Africa, Zimbabwe and Tanzania having the highest overall in number. All 216 identified innovations were distributed across all five GSMA use cases in the typology framework used, illustrating a significant diversity of use cases across the region. Overall, digital advisory was the most common use case among the identified innovations followed by Agri e-commerce and digital procurement. If compared with an earlier study of GSMA (for SSA as a whole), this study shows a higher proportion of smart farming and of Agri e-commerce innovations and a lower proportion of digital advisory and Agri digital financial services.

Four country groups highlighted through the benchmark assessment revealed differences in both the number of innovations per group and the distribution of use case by group. Group 1 (South Africa, Mauritius, Seychelles) had the highest number of innovations in the group, followed by Group 3 (Zimbabwe, Namibia, Zambia, Malawi, Lesotho, Madagascar) and then by Group 2 (Eswatini, Tanzania, Botswana). Group 4 (Angola, Mozambique, DRC, Comoros) has the least number of innovations in the group. Group 1 and Group 2 have digital procurement as the most common use case and have a slightly larger proportion of the innovations in the category of smart farming applications. These use cases focus on more sophisticated users, and B2B business models underpinning their innovations. These business users are generally both more digitally literate and more business savvy. In Group 3 and Group 4 digital advisory services were the most common innovations and are focused on addressing the knowledge gap that is still persistent amongst the most predominant users, farmers.

Digital agricultural innovations are evolving and proliferating at a rapid pace in the region and CCARDESA has an important role in building trust around the exchange of data and data quality in the region to strengthen the nature of the digital agricultural ecosystem and its functionality. This also must be balanced with the observation that many innovators shared information on use cases, the numbers of active, registered, and recurrent users. Actual customer satisfaction levels vary unevenly and with figures that may be questionable. This highlights the value of reliable data and trust within the ecosystem to facilitate collaboration rather than holding on to data for fear of being outcompeted.

Most innovations are active in a single country (84%) suggesting that material improvements in the enabling environment in specific countries are likely to have a greater impact on the advancement of agricultural digitalization in those countries. **CCARDESA could leverage the support of development partners such as the World Bank to help advance progress towards the enabling environment and facilitate work across different government departments.**

In the region, digital advisory and agri e-commerce have the highest number of proportional use cases highlighting the value of a digital ecosystem in each case. For digital advisory, efforts must be made to enable human centered design principles to address the needs of end users such as farmers (B2C); encourage and enable an on-going pipeline of relevant, high-quality content; ensure hyper-localization of content in local languages; and ensure the involvement of input providers and agribusinesses who can supply agronomic inputs to farmers. At the same time, interoperability, privacy and data quality will be important. CCARDESA can also advance agri e-commerce similarly, by crowding in actors with experience in financing digital agricultural enterprises, as well as bringing in those with experience in financial payments and transactions, digital records and receipts, B2B and B2C actors. They can also facilitate engagement by policy makers to enhance the enabling environment and ensure the participation of traders, distributors, processors, aggregators, off-takers and commodity exchanges across the value chain.

Countries with the greatest maturity towards a functioning digital ecosystem were found to have the highest number of innovations. Those with the largest number of innovations identified were generally addressing later stages of the value chain (post-farm production and towards the farm-to-fork end of the food system).

Half the innovations addressed a single use case and half provided multiple use cases suggesting that a proportion of digital enterprises are beginning to address gaps they have identified in the digital agricultural ecosystem already. With such a high proportion of single use cases further iterative cycles of testing and refinement will be necessary to begin to bundle service offerings and establish revenue generating business models. **CCARDESA could facilitate opportunities for those less mature enterprises to learn about pathways for growth and sustainability from digital enterprises who have already made this leap.**

Low digital literacy hinders the adoption of new technologies especially in an aging rural population.

The most common challenge that survey respondents encountered was low digital literacy levels of their users. If farmers have limited access to digital solutions or are unable to use them, because they lack digital skills, further uptake is likely to be significantly impeded. Innovators should be encouraged to take deliberate actions to ensure innovations are inclusive of those with lower (digital) literacy levels to enable both a raised awareness of the benefits of digital agricultural innovations but also to enable their use. This is likely to be significantly easier for young farmers who are more digitally literate. **CCARDESA can coordinate efforts to narrow the gap between digital literacy and skills amongst farmers by working with other departments of government, incubators and accelerators specialized in education to innovate in this space and address the pain points.**

Digital content should be hyper-localized, relevant to local constraints and deployed through channels that facilitate and enable action by farmers.

The content information that digital channels provide should also be locally relevant and actionable by the farmer. Content is still perceived to be too academic, difficult to understand, and in turn less actionable for farmers to use. Knowledge transfer from academic research to pragmatic farming practices is a complex process. Whilst digital solutions are the channels to bridge the last mile, the inclusion of relevant, accurate, and continuously up-to-date content is an expensive and time-intensive process. Most agricultural research content is created in English and approved content is usually only available in a national language, but not all farmers understand either of these. Countries whose first language is not English are likely to be at a real disadvantage in terms of content generation and/or adaptation. Local translation into indigenous languages is complex and expensive. The trick is to design a scalable system that is still able to contain hyper-localized and relevant content about value chains, specific inputs that are available, soils, etc. To use digital agriculture innovations, digital skills are critical. Where digital literacy is low, access to and use of digital agricultural innovations is likely to be lower.

Some respondents overcome the challenge of digital literacy by creating networks along different value chains with local field agents, trusted agro-dealers, or lead farmers with higher digital literacy and smartphone ownership. These valuable intermediates (or agents) can share the information with other farmers. Alternatively, equipping extension officers to build their capacity to serve the large number of farmers can bridge the divide. If feedback channels are available to communicate with farmers, this will help close the knowledge gap and increase on-farm productivity. Donor grants to develop local language content as a public good will make an important contribution to overcoming this challenge and simultaneously help innovations to scale further.

Of some concern, is the observed disparity between Anglophone and Francophone or Lusophone countries, which is worthy of further investigation by CCARDESA. Understanding if this is because these countries are earlier in their digital agricultural journey will be important in understanding how best to address this gap. It is also important to note that results suggested that 60% of innovations were launched in 2018 or more recently, suggesting their relative infancy.

The most significant challenge innovators are addressing are knowledge gaps particularly around low productivity and poor access to markets signaling the dependency of many innovations on appropriate, relevant, and high-quality content. CCARDESA is well placed to facilitate partners that can provide content, especially research institutions and extension divisions, in languages and channels that can be accessed and understood by farmers. A potential farmer database to bring actors together may help, as well as collaboration between public and private sectors especially with departments such as education to enable digitally savvy consumers to drive the demand for digital agricultural innovations. The role of integrating digital into public extension divisions will likely also provide cost efficiencies.

Not all parts of the value chain are equally well resourced from the results obtained across the region. **CCARDESA could facilitate incentives and schemes to encourage more innovative digital solutions in areas such as e-storage, post-harvest processing and value addition, logistics, transport, food standards and safety, marketing, and export opportunities across the region**. They are well positioned to leverage the support from donors and development partners.

There is a missing middle in terms of funding for innovators that move from start-up to scale-up.

Survey respondents use different financial mechanisms to underpin their innovations. Innovators from group 1 countries make more use of angel investors and impact investors than respondents from the other country groups. Most innovations are still not yet fully sustainable. Many innovations are still dependent on donor grants for further investments in new functionalities and services. Respondents report the challenges moving beyond the start-up phase. Especially in being able to access appropriate finance and develop their capacities to expand their users or customer base. On-boarding of new farmers is also expensive and often requires face to face meetings. Even if innovations were at further stages of sustainable scale, they still reported a need for further investment. Another challenge is the cost of accurate, and timely data collection to measure impacts which is a further limitation to accessing further finance. Without evidence of results of their innovations it might be difficult to attract more funding to scale further.

Data on the outcomes and impacts for farmers is patchy and for many digital enterprises the cost of data collection is also significant both in terms of time and financial resources. Investigation on how best to collect and share data to facilitate learning and more commercial financial investment will be closely linked.

Self-reported data suggested that 30% of local innovations are at a stage of scaling where they are replicating or adapting their innovation across larger geographies or a population for transformative impact. Whilst some caution

must be taken in reflecting on this proportion due to biases of self-reported data, there may be more to learn from the 50% of regional innovations at this stage or further. The most predominant business model was business subscription fees (B2B) followed by individual subscriptions (Business-to-Consumer, B2C) and transaction fees, additional business models such as Software as a service (SaaS) could be considered. Sustainability seems to be a more complex picture with most innovations suggesting that they will continue to rely on grants or donations and only 20% no longer needing the support to sustain their operations.

7.3 DIGITAL AGRICULTURAL SKILLS AND ENTREPRENEURSHIP TRAINING

KEY REFLECTIONS ON DIGITAL SKILLS, DIGITAL AGRICULTURAL SKILLS, AND ENTREPRENEURSHIP TRAINING

Existing education providers need to align and expand their offerings to meet the surge in demand for digital skills referenced in section 1.

For traditional providers to keep pace with the speed of technological changes and provide relevant skills, they can partner with dedicated digital skills providers. The unmet training demand provides a significant business opportunity for private local, regional, and global training providers and will require partnerships across the education ecosystem to deliver.

Digital Skills in the Digital Economy supplied by Universities and Colleges

The digital ecosystems of the SADC member states are characterized by differences in the reliability of the associated internet infrastructure, digital policies, digital innovations, and digital skills. Much of this policy implementation relies on appropriate digital skills amongst policy makers. Countries that seem to have the most mature digital economies, including digital policies, have little data on the effectiveness of implementation. Enhanced digital skills and evaluative skills in policy makers is important to ascertain if policies indeed provide the enabling environment for digitalization. From the available data collected, most Universities teach basic and intermediate digital skills (ICDL), a proportion teach standard level digital skills and a smaller proportion teach advanced digital skills. These are taught in central departments of the institution as this appears an efficient way of deploying the teaching. However, Agriculture faculties have not yet embedded this and miss the specificity of the agriculture sector and the solutions necessary.

What are the drivers of digital skills adoption in the SADC countries?

Digital skills adoption in the SADC countries will be driven by activities in the broader economy rather than agriculture *per se*. Skills adoption will also come from the prioritization of investments in improving internet infrastructure, access to devices, and availability of digital skills training programs. According to the IFC (2021) Demand for Digital Skills in Sub-Saharan Africa, the demand for digital skills will be driven by growth in the oil, gas and services sector (E.g. in Mozambique) and is expected to increase digital skills adoption. In addition, the establishment of the Mozambique NREN will increase access to ICT in higher education institutions and this is also likely to boost digital literacy and its acceptance. The agricultural sector in Mozambique is projected to have a 10-15% rate of digital skills adoption by 2030. These drivers will open opportunities to accelerate these skills to benefit the agriculture and food systems sectors in all countries whether they be more mature, highly reliant on agriculture, or looking to enhance and grow their more regenerative agricultural sectors and build more resilience in their food supplies.

The demand for digital agricultural skills in the SADC Region

This same recent IFC study (2021) also revealed that across the five SSA countries (Mozambique, Rwanda, Nigeria, Ivory Coast and Kenya), 57 million jobs will require digital skills by 2030. Foundational digital skills (i.e., web research, mobile communication, online communication, e-learning and e-banking) are expected to account for 70% of the total demanded digital skills by 2030. Interestingly, advanced digital skills would be less in demand because the industries in SSA utilizing advanced skills are still at the infancy of growing these components of their businesses and therefore the demand for them is emerging rather than already established. According to the IFC study there will be a need for about 114 million training opportunities across the five countries resulting from the 57 million jobs requiring digital skills. Extrapolating this evidence across the SADC region suggests a similar trend and that digital skills will be a huge growth area to drive employment across multiple sectors.

The mandate for digital skills training in the SADC region

The training programs that are most needed are the **foundational programs that enable people to use digital tools in their day-to-day activities**. Appropriate training programs that take into consideration the local languages and the local contexts will be a priority particularly for agriculture which demands relevant and local content. Furthermore, it is likely that these programs dealing with low levels of literacy will require image or gamification-based approaches to enhance understanding of information by farmers more visually. If farmers are to be trained how to use their mobile devices appropriately, the training content must be in the local languages, more easily understandable by farmers, and using imagery to guide action. This will require innovating, translation of content, and its adaptation. Short and easy to consume content and users being supported to adopt long-life learning practices to continuously stay ahead of the technology will be the priority.

Twenty months after Covid-19 was declared a public pandemic, most African Universities seem to still be in a predicament about how to move towards a sustainable environment of technology-supported teaching, learning, research, collaboration, and use of technology in administrative operations. Strategic partnerships need to be created to facilitate the delivery of digital skills training. Universities in the SADC region must be encouraged to consider partnering with the private training providers to keep the training curricula up to date and relevant. Training ought to be affordable so that those who need them are not excluded. **The SADC universities should be key stakeholders in designing and delivering the digital skills, but they should be open to work with diverse partners because not everyone requiring the skills would have access to a university. Specialist modules could be developed to ensure policy makers, who usually lag innovation, keep ahead of it and to plan accordingly. The importance of working with incubators to enhance entrepreneurial aspirations through digitization is also incredibly important. CCARDESA has an important and essential role to play in this space in enabling the impact of the digital skills revolution to benefit agriculture.**

Why SADC governments must participate

The governments in the SADC region stand to benefit by participating because a huge industry for developing digital skills is emerging. This is an opportunity to strengthen the educational and training providers in preparing future workforces over the next 20-30 years. It is also an opportunity to create jobs in foundational digital skills training provision. For a country to transition to a mature digital ecosystem it will be important to invest in annual budgets to make that possible. Leveraging the role of the private sector in supporting digital skills training is therefore very important. **It was suggested by Universities that CCARDESA support the appeal to SADC governments to promote last mile solutions in SADC member states so that rural areas could have greater access to the internet.**

Fostering digital agriculture in incubators by means of collaboration with ecosystem stakeholders

A recurring theme identified in this study included, fostering the improvement of digital agriculture training with a sense of urgency and through closer cooperation and exchange of competences between the incubators and other stakeholders of the ecosystem.

Clearly the level of development of digital agriculture training is not uniform in the SADC Region. In some incubators (not including South Africa and Zimbabwe) advanced digital training for agriculture such as precision agriculture, digital financing, procurement platform development or IoT solution prototyping for agriculture are offered. In contrast, Universities appear to be more advanced in terms of digital training curricula (excluding Madagascar) such as AI for agriculture, programming/coding for agricultural systems and design of digital tools to help farmers with crop calendars and weather forecasting. Incubators rarely have any agri-digital trainings on offer.

With CCARDESA's links to Universities and Colleges they could enhance engagements between incubators and entrepreneurial agricultural graduates to enable incubators to specialize with the correct complement of subject matter specialists with an intrinsic knowledge of the pain points in specific commodity value chains and a solution mindset.

Partnerships between universities/university incubators and leading business support organizations

In the field of digital agriculture, mutual learning will be significantly enhanced by providing complementary expertise where it is lacking and sharing IoT/precision agriculture equipment for students and entrepreneurs. It will also promote a greater "entrepreneurship culture" within the Universities. The development of strong campus networks and the strengthening of NRENs are key to fostering higher education institutions and innovation hubs to effectively provide all types of digital services for teaching, digital agricultural training, digital agricultural entrepreneurship, and advanced research activities.

Closer cooperation between incubators/university incubators and the private sector

It is also important to boost the digital agriculture entrepreneurship sector through the acquisition of advanced skills in the space and an alternative model of sustainability for the incubators (especially those who are not supported by the government). Involving the private sector through regional or local agriculture/digital agriculture companies might offer internships for students and help aspiring entrepreneurs to acquire new skills. In addition, it will help a more entrepreneurship-oriented approach adapted to the current labor market where youth can innovate in a context where agriculture is still regarded as old fashioned (which may discourage youth to get into digital agriculture initiatives). Collaborations with private sector entities may also facilitate new forms of fundraising/investments such as open innovation experiences and the funding of specific training/incubation programs for youth[15].

Finally, digital agriculture must be guided by local priorities, policies, and capacity development in an on-going manner and must be promoted among incubators and innovation hubs to prepare the local youth to invest in the sector and develop new services for the local farmers and agricultural stakeholders. Government has a role in improving access to the digital communication channels for the population and farmers (Unstructured Supplementary Service Data (USSD) is still one of the most popular tools for farmers). This will go some distance in preparing the market demand for new solutions and enable farmers to exploit the opportunities. Collaboration across government departments, the private sector, and the incubation ecosystem towards the telecom operators (public and/or private)

[15] An interesting example has been provided by one training program that we have interviewed in South Africa, AGCO, an international manufacturer and distributor of agricultural machinery company that funded a skill development program in agribusiness (the Africa Agribusiness Qualification) in partnership with GIBS university in South Africa and Harper Adams University in the UK.

to improve the internet connection and make it available for the innovators (the entrepreneurs) and the users (the farmers and local population) is also required to facilitate the access to these services and promote entrepreneurship (internet is still very expensive in countries like Madagascar). **CCARDESA's role of raising awareness of SADC governments to prioritize the expansion of internet connectivity to rural and remote communities is critical in ensuring digital agriculture becomes a reality.**

Fostering and encouraging vibrant regional collaborative networks

There is a clear opportunity to strengthen the collaborations among universities, innovation hubs, governments, private and public sector players by establishing a **regional collaboration framework** that promotes interactions between SADC member states so that digital agricultural capacities and entrepreneurship are built in a uniform and sustainable manner.

Continuous lifelong learning will dominate the necessity to stay abreast of technology development and continued innovation. **CCARDESA can encourage Faculties of Agriculture to own the agendas of digital agricultural skills training in collaboration with other actors in the digital ecosystem.** Whilst the pandemic has accelerated the opportunity to enhance digital skills training, it has also accelerated the need for on-line continuous delivery of flexible digital skills training that is specialized.

DIGITAL ENTREPRENEURSHIP IN THE AGRICULTURAL SECTOR: PATHWAYS TO FACILITATE THE ACCESS OF YOUTH WITHIN THE SADC REGION

Digital agricultural entrepreneurship is focused on transforming traditional agriculture through digital entrepreneurship. Digital technology provides opportunities for farmers to find buyers for their produce, new farming methods and tools, innovative chances for connecting and collaborating with other farmers and other stakeholders, new sources of markets, new opportunities for continuous learning and new opportunities to out-compete other farmers.

However, youth aspiring to become successful farmers face diverse challenges that include access to land, access to finance, limited opportunities for education and skills, limited access to markets, inability to access quality inputs, under-developed infrastructure in rural areas and competing priorities (e.g., household duties). Female youth face specific challenges related to economic exclusion, exclusion from inheriting or owning land, social marginalization, time limitations associated with home duties, safety risks (gender-based violence) and limited access to technology.

Based on learning from others, the Mercy Corps' AgriFin Accelerate Program (AFA) has defined pathways that facilitate digital entrepreneurship in the agriculture sector. The profiles of promising youth farmers vary, and this means that the support necessary to be successful also varies. Female youth in particular needs special support. Youth that focus their entrepreneurial activities on value addition in the agriculture sector face specific challenges. However, digital technology offers good opportunities for mentoring, capacity building, access to digital financial services, access to quality inputs and equipment and access to markets. Support solutions that focus on individual youth farmers have been proven to be more expensive than platform-based solutions that congregate the youth, input and equipment providers, digital finance solution providers, capacity building platforms and technology-enabled market access platforms.

With goals for steady incomes, support to their families, and commitments to hard work, smart investments and accessing new methods, youth farmers need support in developing their capacities to access finance, access markets, access inputs and equipment. They also need access to empowerment platforms that can assemble various

contributors to form a connection with the youth farmers, "creating efficiencies and reducing costs through aggregation and cross-subsidization". Digital agricultural platforms limit the risks for partners and lowers the costs of access and involvement for youth farmers.

Pathways to facilitate youths to become digital entrepreneurs must recognize the opportunities and outcomes sought by the youth and outline the support to be provided to youth.

To effectively support youth to be successful in digital entrepreneurship in agriculture the recommended pathways must recognize the different youth persona. The pathways to success need to address the common and specific challenges to the diverse youth farmers. The AFA study suggested tapping into the youths' social networking tendencies, promoting longer-term perspectives, encouraging land prospecting and planning, delivering support at the point of committing to farming, use of technology to strengthen group dynamics and services, promoting value chain entrepreneurship, encouraging women-centric support platforms, promoting the right value chains, building financial identities through digital savings and planning services, building peer-to-peer mentoring networks, encouraging employment along the value chain, and tapping into influencers to promote benefits of digital finance systems.

The AFA Program study recommended that the private sector and development partners could support youth by designing programs and interventions that respond to the diverse and full range of youth identities, by adapting value chain methodologies to respond to challenges faced by the youth, using and promoting digital solutions to reach youth at large scales and promoting and strengthening value-adding opportunities in agriculture.

The CTA Handbook, An ICT Agripreneurship Guide: A Path to Success for Young ACP Entrepreneurs, outlined several success factors necessary for digital agricultural entrepreneurship. These include idea generation, building key skills, overcoming early challenges, understanding agricultural value chains, reviewing and improving the team's capacity, developing business plans and formalizing, sustaining and scaling the business. Some common mistakes and solutions are provided, and these relate to the single founder syndrome, solution-in-search-of-a-problem, not listening to the customer, choosing the wrong platform, inappropriate location, bad choices of team members, too much focus on raising money, poor understanding of finance and accounting, and poor understanding of the legal and regulatory environment.

The pathway to success for digital agricultural entrepreneurship must address the negative view of agriculture, limited and inaccessible capital, and poor business climate as these are among the chief obstacles to young agricultural entrepreneurs. Strong partnerships are recommended with local media stations and organizations to create recognition and gain support. The pathway to success depends on governments prioritizing agriculture by scaling up youth-oriented funding schemes for entrepreneurs. Governments must also provide incentives for agriculture and efforts to optimize the sector through digital technologies. These incentives could be grants, concessional loans with sector-sensitive repayment terms, and capacity building opportunities. The private sector is called upon to not only view agriculture as a high-risk enterprise but to design innovative products to service the agricultural sector to meet food security goals. The proposed success pathway recognizes the importance of Intellectual Property skills building and support to protect the innovations coming out of the African, Caribbean, and Pacific regions. Financial and business skills are also indicated as a priority for the success of digital agricultural entrepreneurs.

Pathways that will facilitate digital entrepreneurship in agriculture:

1. **A digitally enabled partners' platform to support the youth and facilitate their integration and participation.** This must be informed by the suitability of the platform's access by the target youth. The partners to be included on the platform include quality inputs suppliers, suppliers of leased/shared hi-tech equipment,

providers of platforms that give access to market information and direct access to markets, digital finance systems suppliers, digital training providers and mentors, and youth empowerment networks. With a role in fostering and coordinating the digital agriculture ecosystem, CCARDESA can ensure some relationship with a platform enabling youth engagement or indeed could combine on its website the two functionalities, thus increasing the draw of the ecosystem.

2. **Programs for the youth should integrate digital literacy** so that youth benefit from the emerging digital economy. Abundant platforms such as WhatsApp and Facebook could be used to deliver information, education, farming tips and practical skills.
3. **Capacity development is fundamental to the success of youth in digital agricultural entrepreneurship**. However, capacity development provided by educational institutions located in towns take the youth far away from their farms and this is retrogressive for the youth farmers. A recent AFA (2019) case study, Digital Pathways for Youth in Agriculture, revealed that there were education-agriculture skills mismatches, with higher education said to be creating "off-farm aspirations that were not satisfied by farm-based employment opportunities". Gaps were identified in the training curriculum which did not include practical agricultural, business, nor finance skills. Youth need specific training related to being successful digital agricultural entrepreneurs. The study recommended that partner engagements should focus on supporting youth with "bundles of services and targeted approaches delivered digitally". Three types of digital platforms were found to be effective in getting bundled services to youth farmers and these were television and radio, USSD enabled phones and internet-enabled devices.

Based on this study's results from selected Universities and incubators, youth digital entrepreneurship can be facilitated through different approaches:

1. **Provide access to information and knowledge specifically for youth.** Enhancing and enabling opportunities for youth to **access knowledge and information** on the institutions and channels to enable their engagement in digital agriculture is key. These may include:

    - Creating platforms that also provide information on where to solicit online training courses, associated entrepreneurship-building programs, and opportunities of scholarships, hackathons, and competitions.
    - Fostering websites or video channels showcasing case studies of youth success stories in the digital agriculture entrepreneurship space to encourage their participation.
    - Improving access to digital agriculture skills development for students, and teachers by sharing the details to encourage participation by youth.
    - Supporting training manuals for skills development in local languages or tailored to the local agricultural context.
    - Engaging farmers associations and their associated farming youth to learn new methods and best practices in farming techniques.
    - Fostering peer to peer learning of successful digital agricultural solutions in the local areas.
    - Leveraging social media channels to advertise these opportunities and any competitions available for youth engagement.
    - Disseminating through radio, social media, TV, and newsletters highlighting technologies and innovations produced by laboratories and research centers to promote R&D activities in the digital agricultural sector.

2. **Improve the digital agriculture curricula and training and its relevance to youth interests.** Appropriate models may include:

    - Building capacity and skills of higher education teams to recognize emerging digital trends.
    - Digital agriculture entrepreneurship modules in higher education institutions and incubators for youth.

- Ensure resources and budgets are available to implement training programs for youth.

3. **Enhance agri-entrepreneurship with appropriate technology and equipment to include tools and spaces to integrate modern digital techniques in the wider traditional agricultural system including:**

    - Provision of computers and data collection equipment (soil analysis equipment, toxicological equipment, weather analysis equipment, drones, IoT solutions, etc.).
    - E-advisory platforms to support agricultural extension services.
    - E-commerce digital channels to improve the access to markets for agri-entrepreneurs.

4. **Leverage and provide funds and scholarships specifically for youth.** A fund dedicated to supporting youth in testing out their ideas and opportunities would be very helpful to get them started. This could specifically help to:

    - Establish partnerships for trainings on how to improve the access to finance for digital agriculture entrepreneurs and guarantee the sustainability of the business.
    - Make modest seed funding available through competitions or hackathons.
    - Develop crowdfunding solutions.
    - Develop fundraising approaches and relationships with funding institutions aimed at youth employment.
    - Test youth solutions with the intention of scaling them to other areas once proven.

5. **Facilitate the access to knowledge for the agri-entrepreneurs.** Creating adequate digital infrastructure in rural areas, where many young people live, to efficiently support the implementation of digital education in schools and learning institutes is not enough. Access to knowledge and information remains an obstacle even where there is adequate access to internet or digital infrastructure. Often youth cannot properly use the information channels, and in other cases the ecosystem does not provide them with the possibilities to access important knowledge.

    Some idea and suggestions to help young people become more aware of the opportunities that the digital agricultural space might offer to them are presented:

    - Foster the development of a robust capacity building platform to provide youth the knowledge to get into the sector (online trainings available, incubators/accelerators programs and facilities, opportunities of scholarships/funds, hackathon, and competitions, etc.).
    - Develop a website/video channel with case studies of youth success stories in the digital agriculture entrepreneurship space.
    - Facilitate access of learning materials to support the skills of both students and teachers in the digitalization of agriculture by making available online the universities and incubators curricula.
    - Support in identifying the opportunities in the digital agriculture sector by developing training manuals for these skills and improving the technical skills of trainers within the local context.
    - Empower farmers associations to better target youth in rural areas, but also to help integrate the digital tools to promote best practices in terms of farming techniques and new crops.
    - Support knowledge sharing activities by encouraging peer-to-peer learning and benchmarking visits of successful AgriTech solutions in the region.
    - Make available the digital agriculture-related research findings in a language that is widely used by the local populations (e.g., Kiswahili in Tanzania instead of English) and using social media and/or video as dissemination channels.

- Disseminate knowledge on latest technologies and innovation through the creation of modern laboratories and research centers to promote R&D activities in the digital agricultural sector.

E-EXTENSION AND YOUTH ENTREPRENEURSHIP: AN EMERGENT OPPORTUNITY

E-extension is significantly early in its development across the African continent and somewhat underdeveloped. Extension services themselves are very weak and integrating ICT technologies are hard with defined curricula to support extensionists. Nevertheless, the African Forum for Agricultural Advisory Services (AFAAS) promotes advisory and extension services contributing to sustained productivity and represented a key stakeholder in this analysis. AFAAS is currently integrating ICT capacity building into its agenda as a priority, despite the lack of resources available for a consistent digital transition, and a means to empower its members. SARFAAS, the regional network of the Southern Africa Region disseminates to the field level but is still not fully operational.

AFAAS currently uses part of their website to encourage networking and information provision through https://www.afaas-africa.org/knowledge/ and uses email, social media, WhatsApp groups and sub-groups to disseminate information. Their D4AEAS Strategy is seeking to integrate AFAAS (extension and advisory services workers) and farmers into a digitally empowered state. Farmers are beginning to become digitally empowered, well trained, informed, and more productive and efficient in their farming activities.

The D4AEAS strategy has 4 pillars:

- Pillar 1: Building capacities of individuals and organizations
- Pillar 2: Developing and valuing relevant content
- Pillar 3: Developing and valuing relevant platforms and tools
- Pilar 4: Favoring rational and efficient decision-making

Malawi and Madagascar are active in the implementation of the strategy though capacity building and trainings, in particular the adoption of climate smart agriculture tools. AFAAS is trying to digitize the climate smart agricultural contents, which will be curated on a digital platform. AFAAS also hosts a hackathon to advance three solutions: a tool to manage extension workers, a CSA database to host the knowledge, and a weather and crop calendar information platform. AFAAS plans and manages the e-extension and the capacities existing in different regions and topics. The tools under development are open source for the countries that want to use them (even if developed by startups or private sector entities), with the scope of having a huge impact in promoting the access to extension services and develop the involvement of youth in the sector within the African context.

Another important stakeholder that promotes e-extension services is the parent-based Global Forum for Rural Advisory Services (GFRAS), a member-based organization which enhances the performance of agricultural advisory services for farm families and rural producers and contributes to the sustainable reduction of hunger and poverty.

GFRAS promotes the New Extensionist Learning Kit (NELK) for individual extension field staff, managers, and lecturers. It is based on The 'New Extensionist' - Roles, Strategies, and Capacities to Strengthen Extension and Advisory Services, a GFRAS position paper that discusses new capacities for rural advisory services and extension to address the current challenges in agriculture and to contribute better to agricultural innovation. The NELK opens a global view of extension advisory services that reinvents and clearly articulates the role of extension advisory services in the rapidly changing rural context. The Learning Kit contains 13 modules designed for self-directed, face-to-face, or blended learning and can be a useful tool for individual extension field staff, managers, lecturers and non-governmental organizations, and

other training institutions. The development process was designed and managed as an iterative journey of broad consultations, discussions, and feedback from a wide range of stakeholders.

Another project supported by GFRAS is the USAID funded Feed the Future Developing Local Extension Capacity (DLEC) project, which is led by Digital Green in partnership with the International Food Policy Institute (IFPRI). This project focuses on the improvement of extension programs, policies and services created through locally tailored, partnership-based solutions by mobilizing active communities to advocate for scaling proven approaches. DLEC accomplishes this objective through three interrelated sets of activities:

1. Country Diagnostics to make recommendations and inform strategies.
2. Action Research Engagements to test interventions and build an evidence base.
3. Communities of Practice to share and advocate for proven best-fit practices in extension.

A pilot project of the Sasakawa Africa Association (SAA) to build the e-Extension platform for small farmers in the context of the Covid-19 crisis and future prospects has been also launched. The project focuses on e-Extension and e-Learning services to mitigate the effects of Covid-19 and strengthen the resilience of African food systems. Three priority areas of support are "technology transfer" and "labor-saving agriculture" using ICT to reduce contact between people and secure social distance, and "access to input materials" as a response to the lack of effective logistics in lockdowns. Furthermore, the ideal e-Extension platform envisions not only improving agricultural productivity, but also resolving the "information asymmetry" that can occur in the entire value chain by actively utilizing ICT technology[xvii]. **CCARDESA could encourage the D4AEAS Strategy activities in the other SADC countries. Learning from experiences in Malawi and Madagascar could help scale the initiative further offering an additional digital agricultural entrepreneurship pathway**.

8 CONCLUSION

In SADC, approximately 70% of the region's population (363M people in 2020[xviii]) depend on agriculture for food, income, and employment. Globally, the agriculture sector employs 26% of the world's population. However, in 2020, 91 million more people faced hunger than in previous years, and 2.37 billion people did not have access to adequate food due to the disruption of food supply chains. The impact of Covid-19 on the world economy, agricultural food supply chains and its relationship to social stability was recognized. The already high food prices and rising fuel prices will worsen the current situation globally.

There is more urgency in ensuring that agriculture feeds the world's growing population, through conscious land use, lowering greenhouse gas emissions, judicious use of water and other natural resources, improving climate resilience, and providing living wages to the millions of smallholder farmers who make a significant contribution to global food production. Furthermore, innovations in the food sector are required to increase the efficiency and resilience of food production, to drive greater environmental sustainability but also to deliver greater traceability, food safety and more effective nutrition. Small scale producer's whose livelihoods depend on crop yields are disproportionately affected by climate risks. The exposure is both short-term as extreme weather events increase in frequency and severity, and long-term due to shifts in climatic patterns including temperature and levels of precipitation.

All these factors have accelerated the aspiration by countries to kickstart a digital economy approach to increase efficiency in public sector operations but also to facilitate the introduction of digital solutions in the agricultural sector. These solutions address low productivity, address supply chain inefficiencies by integrating traceability and logistics technologies, increase access to financial products and services through digital devices, and enhance resilience to climate change by using digital and data solutions to improve decision making on resource management allocations.

This study focused on key actors within the digital economy for agriculture, including governments, civil society, private sector, universities, individual entrepreneurs, and innovators to provide the first multi-element baseline to understand how these actors may continue to engage to drive digital integration and progress.

For digital innovations to be successful, they must be efficiently generated with end users, developed, tested, reiterated, refined, and ultimately scaled for development impact. The ecosystem in which innovation exists requires coordination, collaborative action, and resources to ensure that it can operate at multiple levels - local, national, and regional - and inclusive of relevant sectors. Adopting an ecosystem approach recognizes the different actors, relationships and resources that have important roles in taking good ideas to scale. It also demands effectiveness in each part of the innovation system which is moderated by other parts of the system (E.g., innovators being able to access capital) and an understanding that a change in one part of the ecosystem leads to changes in other parts of the system (E.g., increases in internet connectivity will accelerate testing new technologies).

THE BROADER POLICY ENVIRONMENT

The situational analysis helped identify an effective assessment tool (Section 4.2) tracking progress towards a digital economy to provide context for the results of this regional study.

The analysis illustrates a region in transition towards an enhanced digital enabling environment in the 16 countries. There were varying levels of maturity and content in examined policies, strategies, and legislation. Most countries are including some digitalization in their planning. In a smaller proportion of more advanced countries, digitalization is being embedded in national plans. The benchmark assessment highlighted a correlation between a more advanced

policy enabling environment and the maturity of the digital solutions available on the ground. The clusters of countries within different benchmark rankings help to identify the progress countries have made and where greater efforts may need to be directed. There are several good examples within the region to learn from. The top ten countries that ranked highest have agriculture sectors contributing less than 10% GDP, except for Tanzania. It is observed that countries with a higher proportion of GDP from agriculture have made slower progress in unlocking their digital economies.

Countries presenting as the most successful to date may have greater numbers of people engaged in the food system itself including retail, processing, trade, storage, logistics, marketing, and food preparation. These front-runners provide good areas of potential learning in certain foundational pillars necessary for a vibrant digital economy. Despite this, **there is no single country in SADC that has developed and published a digital agriculture strategy or roadmap at the present time**.

Despite the progress in an enabling environment, all 16 countries share common challenges and barriers faced by stakeholders in implementing digital solutions for agriculture. These include the limitation of policies and strategies formulated within single Ministries to effectively address aspects such as digital rural infrastructure and connectivity, rural financial services for farmers, the cost of data and its affordability (particularly for the illiterate and elderly). Advocating for a whole-of-government approach to develop a robust Digital Agriculture Strategy and roadmap for the Ministry of Agriculture, with consultation with other Ministries such as ICT, Finance, Water and Education would recognize the interdependence of these elements for society and create strategies more likely to be successful.

CCARDESA is well placed to support advancing digital policy environments for member states by facilitating learning sessions from each other, developing dedicated digital agriculture strategies that benefit from a more integrated whole-of-government approach and ensuring inclusive hubs or ecosystem hubs where actors from multiple disciplines and institutional backgrounds can formulate partnerships and collaborations.

One such way in which governments may be able to support the development of the ecosystem is to follow the approach taken to develop farmer registries such as the 1M farmer platform in Kenya or decentralized Smart AgriHubs developed by the European Union across member states and leveraging existing institutions in the agriculture sector. This will encourage successful digital solutions to be deployed to deliver more benefits to farmers by bringing end users into the design process for many AgriTech providers. It will also encourage governments to create the enabling environment required to scale and sustain the benefits.

INNOVATIONS

In the landscape analysis across the SADC region a total of 216 innovations were identified (Section 5) and illustrates the rapid proliferation of digital solutions. However, many of these are at an early stage with only 30% ready to scale, replicate, or achieve some level of sustainability. Whilst digital advisory is the most common use case, there were high incidences of agri e-commerce platforms and digital procurement solutions. The results showed a higher proportion of smart farming and agri e-commerce solutions for the region when compared to Africa as a continent but a lower proportion of both digital advisory and agriculture related digital financial solutions.

Countries with the greatest maturity towards a functioning digital ecosystem were found to have the highest number of innovations. In countries with a more advanced digital economic environment, there were more B2B models than B2C models. Businesses appeared to have greater digital literacy and business awareness. In countries less advanced, digital advisory services addressing knowledge gaps were more prevalent. Most innovations were created at a specific country level (84%), highlighting the potential positive impact that improving the enabling environments could make.

Half the number of innovations were addressing single use cases suggesting the need for further iteration and testing to develop viable and revenue generating business models to sustain their activities.

There was variation in the quality and quantity of the information about these solutions. The numbers of active, registered, and recurrent users and customer satisfaction levels therefore should be interpreted cautiously. This is also the case for social and financial impact on farming communities and households where data appeared to be patchy. The importance for solutions to generate quality data and information is apparent, but also to use it to build better relationships within a digital ecosystem. **CCARDESA is well placed to leverage its relationships with actors such as the World Bank to resource the enabling environment to ensure that digital solutions for agriculture can persist, grow, and evolve to create impact for farmers.** Furthermore, there are many technical assistance providers who can be included in the ecosystem to help the growth and investor-readiness of some of these solutions through incubators, accelerators, and University and innovation facilities.

Digital advisory solutions were the most common identified and designing with the user in mind is critically important. Content that is accessible and affordable to farmers cannot be underestimated. Hyper-localizing content, ensuring it is not too academic and fostering strategic relationships with input providers, financiers, traders, distributors, aggregators, commodity exchanges, processors and investors at a local ecosystem level are important objectives. Crowding in actors who can finance solution providers, as well as combine offers with rural financial services, are important. If greater digital advancement is desirable, digital skills to advance capacity all levels (from policy makers to farmers to agribusinesses to youth entrepreneurs) is a critical investment. It is important for a partner like CCARDESA to build trust within the ecosystem including generating more transparency, privacy, ownership of data and (cyber)security for its use. Ensuring that all parts of each value chain are well represented will facilitate robust food supply chains for the region and encourage value addition in the food system sector.

Many solution providers still have dependency on donor funds, but all need appropriate finance to develop their capacities and expand their user bases. The importance of the ecosystem was also highlighted by the innovators who use investors to support their business models which are predominantly business subscription fees (B2B), followed by individual subscription models (B2C), transaction fees and SaaS models. The cost of measuring their impacts is high but without this evidence, their ability to attract funding is limited.

CCARDESA plays a valuable role in ensuring that SADC members states, and institutional members, can work closely to stimulate the local ecosystem, connect actors so that constraints can be addressed, work to crowd in investors to help digital agriculture solutions grow, and improve the data and information on their impact so that they can scale.

DIGITAL SKILLS

It is likely that digital skills adoption in the SADC member states will be driven by activities in the broader economy rather than agriculture *per se*. However, in the SADC region digital skills will be a huge growth area to drive employment across multiple sectors.

The unmet training demand for digital skills in the region (Section 6) provides a significant business opportunity for private local, regional, and global training providers and will require partnerships across the education ecosystem to deliver. **CCARDESA has an important role to play in mobilizing Universities, Incubators and Accelerators to work much more closely together to deliver appropriate digital skills**. Whilst many Universities in the region teach basic and intermediate digital skills (ICDL), a proportion teach standard level digital skills and a smaller proportion teach advanced digital skills. These are taught in central departments of the institution as this appears an efficient way of deploying the teaching. However, Faculties of Agriculture have not yet embedded this.

The training programs that are most needed are the foundational programs that enable people to use digital tools in their day-to-day activities. **Appropriate training programs that take into consideration the local languages and local contexts will be a priority particularly for agriculture which demands relevant and local content**. Furthermore, it is likely that these programs dealing with low levels of literacy will require image or gamification-based approaches to enhance understanding of information by farmers more visually. If farmers are to be trained how to use their mobile devices appropriately, the training content must be in the local languages, more easily understandable by farmers, and using imagery to guide action.

The level of development of digital agriculture training is not uniform in the SADC region. In some incubators advanced digital training for agriculture such as precision agriculture, digital financing, procurement platform development or IoT solution prototyping for agriculture are being offered. In contrast, Universities appear to be more advanced in terms of digital training curricula such as AI for agriculture, programming/coding for agricultural systems and design of digital tools to help farmers with crop calendars and weather forecasting. **With CCARDESA's links to Universities and Colleges they could enhance engagements between incubators and entrepreneurial agricultural graduates to enable incubators to specialize with the correct complement of subject matter specialists with an intrinsic knowledge of the pain points in specific commodity value chains**. Collaborations with private sector entities may also facilitate new forms of fundraising or investments, such as open innovation competitions and courses and the funding of specific trainings or incubation programs for youth.

Digital agriculture must be guided by local priorities, policies, and capacity development in an on-going manner and must be promoted among incubators and innovation hubs to prepare the local youth to invest in the sector and develop new services for the local farmers and agricultural stakeholders. Government has a role in improving access to digital communication channels for the population and farmers (USSD is still one of the most popular tools for farmers). This will go some distance in preparing the market demand for new solutions and enable farmers to exploit opportunities. Continuous lifelong learning will dominate the necessity to stay abreast of technology development and continued innovation.

ENTREPRENEURSHIP AND EXTENSION

Digital technology provides valuable opportunities for young farmers to identify buyers for their produce, try new farming tools and methods, connect, and collaborate with other farmers and ecosystem stakeholders, find new sources of markets, and continuously learn. Evidence suggests that support solutions for individual youth farmers are more expensive than platform-based solutions that bring together the youth, input and equipment providers, digital finance solution providers, capacity building platforms and technology-enabled market access platforms. CCARDESA has a valuable role to encourage youth to build their capacities to access finance, market inputs and equipment to improve production.

As with the AFA Program, the private sector and development partners can support youth with programs and interventions that respond to youth identities, and challenges faced by youth. Using digital solutions to reach youth at a large scale, they can strengthen value-adding opportunities in agriculture. Three types of digital platforms were found to be effective in getting bundled services to youth farmers and these were television and radio, USSD enabled phones and internet-enabled devices. Governments can also promote and scale youth-oriented funding schemes for entrepreneurs and provide incentives (loans or capacity building). CCARDESA can call upon the private sector to design innovative products to service the agricultural sector to meet food security goals.

There are several examples of e-extension being employed by AFAAS by integrating ICT capacity building into its work trying to curate climate smart agricultural on a digital platform and support a Hackathon to advance solutions.

Furthermore, the Sasakawa Africa Association e-Extension platform envisions not only improving agricultural productivity, but also resolving the "information asymmetry" that can occur in the entire value chain by actively utilizing ICT technology. CCARDESA can leverage information workshops on these approaches and encourage member states to discuss and strategize the best solutions.

From 2030 onwards, the FAO expects there to be a fall in agriculture-contributed GDP for the poorest countries by the end of the century[xix]. A complex network of global actors' dependent on agricultural products for food security or as inputs for economic activity will also be affected as the recent crisis in food prices has demonstrated. With the high dependence on agriculture of the SADC region and the continuing impact of climate change, the digitization of agriculture is a priority.

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