Food and Agriculture Organization of the United Nations

STATUS OF DIGITAL AGRICULTURE IN 47 SUB-SAHARAN AFRICAN COUNTRIES











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FOREWORD

Sub-Saharan Africa has enormous potential to drive economic growth and transform the agriculture sector thanks to rapid population growth and advancement in digital technologies. Unfortunately, and despite gradual progress made toward the 2030 Agenda for Sustainable Development, the COVID-19 pandemic has exacerbated the challenges faced by sub-Saharan African countries, making the agricultural sector even more critical in ensuring food security. The pandemic has also demonstrated the urgent need for digitalization and accelerated the shift toward innovation and digital transformation to harness more digital economies. With almost 60 percent of the region's population under the age of 25, active engagement of youth in agriculture is essential.

Countries in sub-Saharan Africa are at varying levels of digital transformation, reflected in their differences in coping with complexity, untapped potential and availability of information. For the most part, vast populations in the region still experience acute food insecurity and lack access to basic digital technologies. As the main backbone of most of sub-Saharan Africa economies, agriculture remains a priority sector. Its digitalization is therefore fundamental to leveraging the benefits of digital technologies in transforming societies, improving livelihoods and accelerating the ability of the Sustainable Development Goals to eradicate poverty.

The *Status of digital agriculture in 47 sub-Saharan African countries* report is co-published by the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU). It aims at providing a holistic view of digital transformation in the agriculture sector of 47 countries in sub-Saharan Africa. The region's digital agriculture landscape is assessed through six key themes, namely: infrastructure, digital penetration, policy and regulation, business environment, human capital and agro-innovation.

Beyond the analysis of the region against the six focal themes, the report presents both the status-quo and challenges faced by countries in their digital transformation journeys, which can assist policymakers to identify possible areas of intervention to drive the process of agricultural digitalization in the region. It highlights the need to strengthen digital infrastructure for universal connectivity, to connect the unconnected in sub-Saharan Africa and to support the integration of digital technologies to advance digital agricultural transformation.

We would like to take this opportunity to thank our respective members and all relevant stakeholders for their invaluable engagement and contribution to this report and their active involvement during the consultation and validation process. We would also like to express our sincere gratitude to all colleagues and experts from FAO's regional and country offices and ITU's regional offices for their guidance, contribution and support. We hope this publication will reach broad audiences and provide a basis for further engagement to unlock the potential of digital agriculture in sub-Saharan Africa. We invite countries to continue updating us on their digital agriculture progress and to share experiences that can advance digital agriculture transformation and improve livelihoods in sub-Saharan Africa.

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FAO and ITU joined forces to facilitate the scaling up of digital technologies in agriculture globally, under the framework of the FAO-ITU cooperation and the mandate of the World Summit on the Information Society (WSIS) for facilitating Action Line 7 pertaining to e-agriculture. To that effect, the two agencies undertook this study to enhance the understanding of the status of digital agriculture in 47 countries in sub-Saharan Africa. This report highlights the potential of digital technologies to transform the agricultural sector and by extension to improve livelihoods in sub-Saharan Africa.

FAO and ITU would like to acknowledge and thank all their partners and the various contributors to this report for their support and commitment to the goal of this study, namely, to offer a holistic understanding of the status of digital agriculture in sub-Saharan Africa and how to advance it.

This study is an agency-wide comprehensive technical work, developed and finalized by numerous technical experts at FAO and ITU: Arnaud C. Gogan (ITU), Bonaventure Nyamekye (FAO), Caroline Gaju (ITU), Joshua Oiro (ITU), Nikola Trendov (FAO), Thembani Malapela (FAO), and Wei Liang (FAO).

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The team apologizes to any individuals inadvertently omitted from this list and expresses its gratitude to all who contributed to the status of the report.

ACRONYMS AND ABBREVIATIONS

A4AI	Alliance for Affordable Internet
ACE	Africa Coast to Europe
ADEA	Association pour le développement de l'éducation en Afrique
AfCFTA	African Continental Free Trade Area
AFD	Agence Français de Développement
AfDB	African Development Bank
AGRA	Alliance for a Green Revolution in Africa
AIPO	African Intellectual Property Organization
AVU	African Virtual University
CAADP	Comprehensive Africa Agriculture Development Programme
CAB	Central African Backbone
CARE	Cooperative for Assistance and Relief Everywhere
CEMAC	Economic and Monetary Community of Central Africa CEEAC
CGIAR	Consortium of International Agricultural Research Centers
CIDA	Canadian International Development Agency
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
CNPC	China National Petroleum Corporation
CORAF	Conseil ouest et centre africain pour la recherche et le développement agricoles
CTA	Centre technique de coopération agricole et rurale
DB2020	Doing Business 2020
EAAPP	East African Agricultural Productivity Programme
EASSy	Eastern Africa Submarine Cable System
EC	European Commission
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EPDC	Education Policy Data Center
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign direct investment
GDP	Gross domestic product
GFRAS	Global Forum for Rural Advisory Services
GHG	Greenhouse gas
GNI	Gross national income
GSMA	Global System for Mobile Communications
HCI	Human Capital Index
ICCO	Interkerkelijk Coördinatie Commissie Ontwikkelingshulp (Interchurch Coordination Committee Development Aid)
ICRA	International Center for Development Oriented Research in Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and communication technologies
IDA	International Development Association
IDRC	International Development Research Centre

IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILO	International Labour Organization
IMF	International Monetary Fund
ITC	International Trade Centre
ITU	International Telecommunication Union
JIRCAS	Japan International Research Center for Agricultural Sciences
MCC	Millennium Challenge Corporation
MNOs	Mobile network operators
MFIs	Mobile finance institutions
NCDF	National Center for Disaster Fraud
NEPAD	New Partnership for Africa's Development
OECD	The Organisation for Economic Co-operation and Development
OHADA	Organisation pour l'harmonisation en Afrique du droit des affaires
R&D	Research and development
RCoE	Regional Centres of Excellence
SADC	Southern African Development Community
SAIDA	Services Agricoles et Inclusion Digitale en Afrique
SDGs	Sustainable Development Goals
SEACOM	Southern and Eastern Africa Communication Network
SFSA	Syngenta Foundation for Sustainable Agriculture
TAAT	Technologies for African Agricultural Transformation
UEMOA	West African Economic and Monetary Union
UN	United Nations
UNCDF	United Nations Capital Fund
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Fund for Population
UNICEF	United Nations International Children's Emergency Fund
UNPF	United Nations Population Fund
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
WACS	West Africa Cable System
WARCIP	West African Regional Communications Infrastructure Program
WBG	World Bank Group
WCT	WIPO Copyright Treaty
WEF	World Economic Forum
WFP	World Food Programme
WIPO	World Intellectual Property Organization
WPPT	WIPO Performances and Phonograms Treaty
WSIS	World Summit on the Information Society

KEY MESSAGES

The potential for digital agriculture transformation in sub-Saharan Africa is enabled by the continent's youthful population and increased mobile penetration. Countries across the region are in varying stages of digital agriculture transformation, which creates an opportunity for the exchange of knowledge, expertise and lessons. However, an inclusive and collaborative process is essential so that no one is left behind.

Although the region has high potential for digital transformation, barriers still exist, such as limited infrastructure in rural areas, insufficient funding for agriculture, inadequate investment in research and development, agro-innovation and agricultural entrepreneurship, which are essential drivers for digital agriculture transformation.

An enabling business environment is fundamental to attract investment in digital agriculture. The majority of countries in the region still face challenges in creating a favourable business environment, especially for start-ups.

Sub-Saharan Africa is served by multiple undersea cables. Prioritising the connection to these cables to improve broadband access for both coastal and landlocked countries is needed. Undersea cables can also be complemented with national terrestrial broadband backbones that link both urban and rural areas.

It is essential that digital transformation for agriculture is anchored to addressing low digital skills in the population, especially among women, youth and rural populations, through customized digital skills development programmes.

Although there are existing policies on information and communication technologies (ICTs) and/or the digital economy, these are not aligned to existing agriculture policies, which hinders the process of digitalization in the agriculture sector. National strategies, therefore, need to be developed to support the digital transformation of agriculture.

As most interventions were at the production level, the digitalization process should encompass the entire agriculture value chain. As such, governments need to foster the transformation of inclusive agri-food systems by leveraging the potential of digital solutions across value chains.

Increased collaboration among countries, international organizations and private entities is necessary to create an inclusive set of digital public goods in agriculture that are sustainable and scalable.

EXECUTIVE SUMMARY

With the largest area of arable uncultivated land in the world, a youthful population of approximately 60 percent and vast natural resources, sub-Saharan Africa is uniquely positioned to double or even triple its current agricultural productivity. Such an increase in agricultural productivity would help lift more than 400 million people in sub-Saharan Africa who live on USD 1.9 or less a day out of extreme poverty and improve the livelihood of approximately 250 million smallholder farmers and pastoralists in the region. This however would require digital transformation of the agriculture sector through improved infrastructure, and increased access to and use of digital technologies for agriculture. To improve our understanding of the current landscape of digital agriculture in sub-Saharan Africa, the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU) undertook this study in 47 countries.

The report is categorized into two main sections. The first presents the output of desk-based research, whose country-focused results is presented through six thematic focal areas essential to understanding digital agriculture, namely: infrastructure, digital penetration, policy and regulation, business environment, human capital and agro-innovation. Each country profile aims at capturing the digital agriculture status of the respective 47 countries in sub-Saharan Africa. The second section highlights the main findings of the analysis of the country profiles and suggests possible steps for future action. The findings of the study are presented to FAO and ITU Member States, as well as all relevant stakeholders with the purpose of advancing and supporting investment in digital transformation of the agricultural sector in sub-Saharan Africa.

While the implementation of digital agriculture is beneficial, it is not without significant challenges. The study identifies the need to enhance key digital infrastructure such as access to electricity, reliable network coverage and access to digital devices, which is out of reach of most rural populations in sub-Saharan Africa. Whereas most countries recognize the importance of having national policies for digital agriculture, the majority of them have not as of yet implemented national digital agriculture strategies. Low levels of digital literacy, inadequate research and limited capacity development have further constrained the advancement of digital transformation in the agriculture sector in the region.

Irrespective of the existing challenges, digital maturity varies across countries. The study further highlights examples and initiatives existing in sub-Saharan Africa that can be promoted, replicated and scaled up to advance digital agriculture transformation. Sharing experiences and good practices in digital agriculture across countries in the region offers an opportunity for the inter-country transfer of knowledge, expertise and skills.

Leveraging digital technologies in sub-Saharan Africa will not only contribute to the development of national digital economies but also accelerate the competitiveness of the agriculture sector of the region. To that end, the study proposes opportunities for digital agriculture and impactful investments in the region that cut across the study's six thematic focal points. This includes proposals to create roadmaps in the form of national digital agriculture strategies, capacity building (especially among agriculture institutions), strengthening of digital skills, increased youth engagement, enhancing the business environment to attract investors to deploy digital products, and services across the agri-food systems.

Finally, although the present study provides a useful snapshot of the status of digital agriculture in sub-Saharan Africa against the six focal themes, further research is required to facilitate qualitative and quantitative impact assessment of the (positive and negative) environmental, social and economic effects (e.g. reduction of inputs/emissions) of the use of digital technologies in food and agriculture adequately support countries and the region as a whole to identify specific gaps and priorities for future investment to advance digital agriculture transformation. A digital 'readiness index' is also necessary to assist countries to understand and transform their digital agriculture landscape toward policy formulation, targeting interventions, resource allocation, partnership establishment and informed decision-making.

INTRODUCTION

Sub-Saharan Africa has the largest area of arable uncultivated land in the world and a youthful population of almost 60 percent under the age of 25, which is expected to double by 2050. And while agriculture currently accounts for 30 to 40 percent of the region's gross domestic product, employing an average of 54 percent of the working population (ILO, 2017), sub-Saharan Africa's agricultural productivity has the potential to double or even triple. However, agricultural transformation remains one of the region's most pressing priorities that has been difficult to achieve. Limited public funding prevents the provision of adequate institutional support and suitable business environment, which in turn hinders private sector participation and investment in agriculture. Of the 1.3 billion people in Africa, almost 400 million are extremely poor, living on USD 1.9 or less daily (African Union Commission and OECD, 2018). Despite having vast energy resources, only 43 percent of sub-Saharan Africa's total population and 25 percent of its rural population have access to electricity (Blimpo and Cosgrove-Davies, 2019). Although some progress has been made, much of sub-Saharan Africa is still unconnected and large populations cannot fully realize the benefits of connectivity as about one-third of the population is out of reach of mobile broadband signals. Only 22 percent of people in the region have Internet access, suggesting there are more illiterate people than there are Internet users in the region (ITU, 2021).

On the other hand, sub-Saharan Africa's digital transformation is already underway, which can leverage the potential benefits of digitalization and new technologies for agriculture. Digital agriculture offers opportunities for farmers and rural communities in a digitally driven agri-food system that has the potential to transform the perception of women and youth of the broad agricultural sector as a positive and fruitful source of job opportunities along the agricultural value chains. An inclusive, digitally transformed agriculture could help achieve meaningful livelihood improvements for Africa's 250 million smallholder farmers and pastoralists (CTA, 2021), while ensuring that sub-Saharan Africa's rural areas are not left behind.

The Malabo Declaration and the Agenda 2063 both emphasise and aim at increasing investment in agriculture to transform the sector and its associated food systems. The African Union (AU) has also prioritized the need for digitalization, with renewed investments, and the creation of the Digital Transformation Strategy for Africa, which aims at building a digital single market by 2030. This complements the AU's flagship projects such as a pan-African e-network. The AU is also aiming at harmonizing policies, legislations and regulations, building inclusive digital skills and human capacity across the digital sciences, judiciary, and education, including the creation of an environment conducive to fostering the development of digital agriculture.

How sub-Saharan African countries position themselves to harness and deploy digital technologies will determine the future competitiveness of the region's agriculture and its contribution to countries' economies. Yet, African countries are at varying stages of the digital agriculture transformation process and a long way away from the desired levels of development. Therefore, an effective roadmap for digital agriculture transformation will require a holistic and bottom-up approach that leaves no one behind, with cross-cutting support across stakeholders, including (but not limited to) those dealing with the digital economy, food production and processing, rural development, irrigation and water management, disaster management, telecommunication, governance, transportation, finance and commerce, education and social affairs.

Conceptual framework of this study

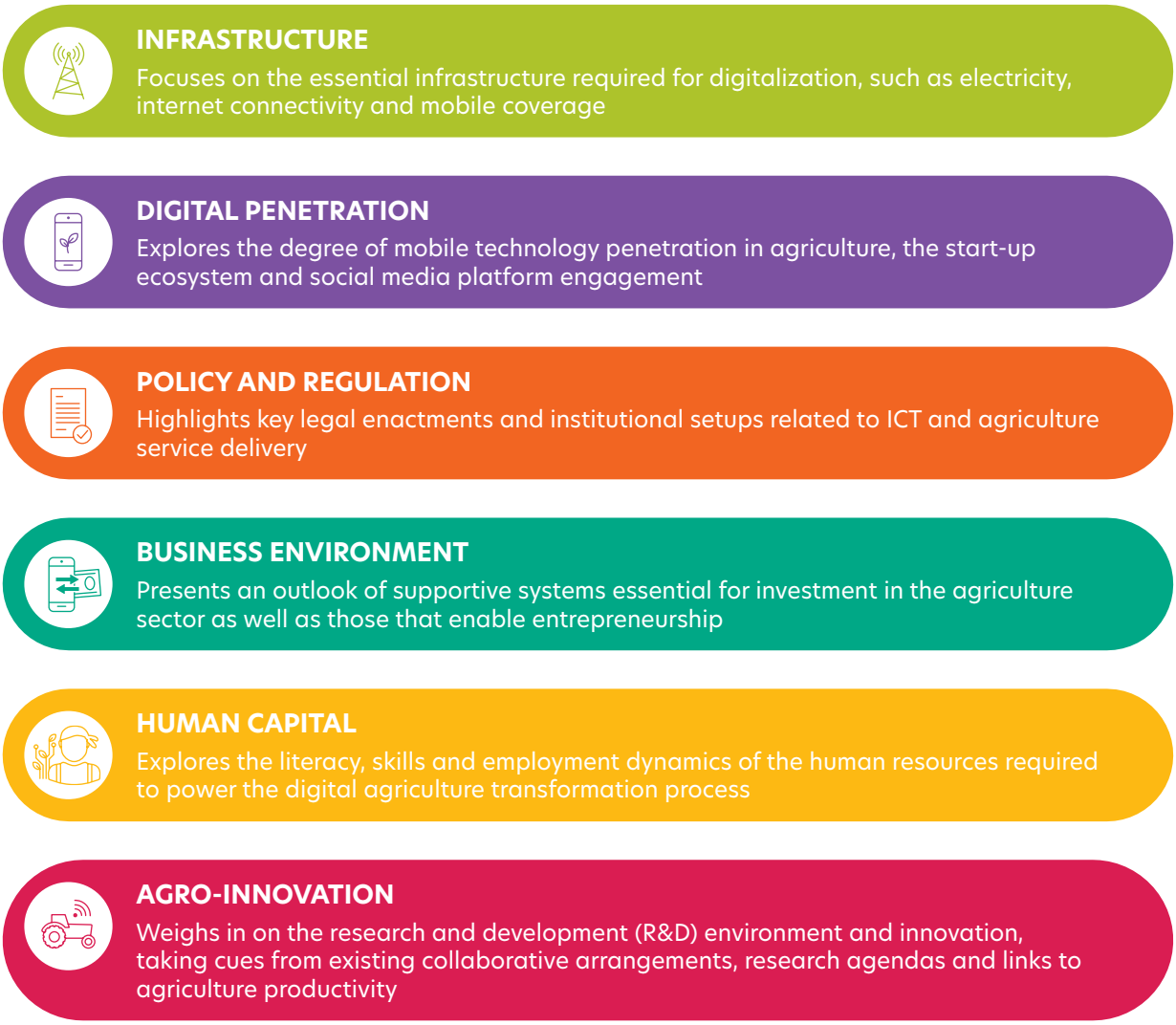
To better understand the status of digital agriculture transformation in sub-Saharan Africa, the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU) commissioned this study to assess and document the status of digital agriculture in the region, summarize key findings, and infer potential opportunities for digital agriculture transformation in sub-Saharan Africa in the respective 47 countries. The results would enable both FAO and ITU to

prioritize investments in digital agriculture as well as offer other interested parties these results for their own interventions.

This study was conducted as desk-based research that consulted various national, regional and international reports. Additionally, the research team conducted an e-consultation process to gather views, as well as consulting FAO and ITU country teams to validate the respective country profiles. The study examined the digital agriculture transformation process through six thematic areas (see Figure 1) supported by relevant indicators that enable a better understanding of digital agriculture maturity at the national and regional levels.

The process of digital agriculture transformation spans multiple issues including policymaking and regulation, limited access to finance, status of digital skills, and the need to understand and overcome existing digital divides, as well as access to infrastructure and information. Furthermore, the lack of broadband infrastructure in rural areas and connectivity to mobile devices, coupled with the limitations on inter-system data exchange present additional barriers and challenges that are considered and addressed within the 47 country profiles. The six themes cover the process broadly and present key enablers that need to be addressed when considering digital agriculture transformation.

Figure 1: Key themes in digital agriculture status assessment



More specifically:

INFRASTRUCTURE

This thematic area explores the issues related to the essential infrastructure required to sustain digitalization investments. The indicators and desk research findings focus on (but are not limited to) access to connectivity and electricity in rural areas, ICT affordability and features of smartphones, computers, etc., the ability to connect to and the coverage of broadband networks, Internet access costs, as well as affordability and availability of nascent technologies that focus on rural communities.

DIGITAL PENETRATION

This area focuses on the availability of digital services in the agricultural sector. It seeks to explore key elements that impact the digital agriculture transformation process in each country, such as Internet users, active subscriptions, the availability and cost of mobile phones and computers, the availability, type and role of mobile network operators (MNOs), and existing digital agriculture services within the sector that also serve farming communities. Specifically, this focal area of the methodology explores the usage levels of the Internet and other digital tools (e-commerce, digital finance, for example), as well as the extent to which farmers and rural communities leverage these tools to interact with service providers and the private sector.

POLICY AND REGULATION

This theme assesses the level of e-government services in rural areas and for farmers where possible. It explores existing mechanisms and institutional support for digital agriculture, and the relevant policies and regulatory framework needed to nurture and support digital agriculture transformation. Furthermore, it examines available laws and policies, including those addressing agriculture and food that could assist policymakers to identify gaps and limitations, while expounding the level of digital agriculture investments that can be made in a country. Selected policy and regulatory indicators can enable analysis of and serve as a reference for creating a digital agriculture ecosystem framework in the relevant countries under study.

BUSINESS ENVIRONMENT

This theme explores whether support systems or structures exist to promote local and foreign direct investment and entrepreneurship in a country. It encompasses an overview of the legal and regulatory components required to spur the growth and resilience of new, mostly private sector enterprises that focus on the agriculture sector, which are critical in attracting the youth who are currently at the forefront of the digital drive.

HUMAN CAPITAL

This theme relates to the education levels, literacy, digital skills and literacy, numeracy, and employment in agriculture of people in rural areas/ agricultural communities, especially youth and women, who can position themselves to propel the digitalization drive in the agriculture sector. Digitalization in agriculture sector doesn't just require highly skilled and knowledgeable people, but those who have the capacity to engage with and leverage digital solutions.

AGRO-INNOVATION

Understanding the environment of R&D and innovation in a country can expound the key elements that are essential for digital agriculture transformation. Most of the innovations are digitally driven, based on science and research, enable digital agriculture transformation, and create a digital competitive ecosystem. As such, this study aims at assessing to what extent a country is ready to perform in this area. Specific indicators include existing digital tools and services applied across agriculture value chains, adoption of technologies, available innovation programmes in the ecosystem, and actions taken by the public and private sector.

ANGOLA

Angola is a lower-middle-income country with a gross domestic product (GDP) of USD 62.3 billion. The country has extensive oil and gas resources, diamonds and rich agricultural land. However, the oil sector accounts for one-third of GDP and oil earnings drive the economy. Despite the country's economy being the third largest in sub-Saharan Africa, Angola continues to face significant challenges in reducing poverty and diversifying its economic growth (see Table 1).

The agricultural sector accounts for 9.4 percent of the country's GDP and employs 50.7 percent of the workforce (World Bank, 2020; ILO, 2019). In 2016, 94 percent of rural households were categorized as poor, and an estimated 80 percent of farmers were categorized as small holders. Immediately prior to the publication of this report, the government was prioritizing agriculture, specifically the promising fisheries sector (which represented 3 percent of the GDP in 2018). Out of 45.7 percent of Angola's arable agricultural land, only 7 percent is used, which signifies tremendous potential for agricultural growth.

The country's ICT is liberalizing – Angola has opened its telecoms market to attract foreign investments. Still, mobile penetration remains low with half of Angola's mobile addressable market remaining underserved. A number of countries are investing in Angola's ICT sector including Germany, China and the United Arab Emirates. Additionally, multilateral partners such as the World Bank and the European Union have invested in projects to improve the availability of agricultural digital technologies.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	32 866 268	WBG
Urban population (%)	2020	66.83	UNPD
Rural population (%)	2020	33.17	UNPD
GDP (current millions of USD)	2020	62 307	WBG
Agricultural land (km^2)	2018	569 525	FAO
Agricultural land (% of land area)	2018	45.68	FAO

INFRASTRUCTURE

Most of Angola's infrastructure was destroyed in the country's civil war and demining the millions of remaining land mines has been a slow process. Transport modes that include roads, railways and bridges were significantly impacted. For energy needs, the country depends on hydro-electricity, but it falls short of meeting national demand. About 7.3 percent of the rural population has access to electricity, while the power grid supports only 73.7 percent of the population.

Angola has four mobile network operators: UNITEL, MOVICEL, Angola Telecom and AFRICELL, three of which offer 4G connectivity with 50 percent coverage, while one is preparing to start operating. As a coastal country, Angola has advantageous access to the SAT-3, WACS and SACS fiber optic submarine cable, which provides gateway connectivity via Europe, Asia and America. Additionally, the country has an impressive 29 satellite earth stations. Angola Cables is an operator of fiber optic telecommunications and operates the Angola Domestic Network System (ADNS) that connects eight Angolan coastal cities - 70 percent of Angolans live close to the sea (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2018	7.33	WBG
		4G coverage (% of total coverage)	2019	50.00	GSMA
		Mobile (device) ownership (% of population)	2019	46.42	GSMA
		Secure access to Internet servers (per 1 million people)	2020	20.08	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2014	3.19	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	44.56	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	21.18	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.70	ITU

DIGITAL PENETRATION

While Internet connectivity in Angola remains low with over 10.4 million users representing 31 percent of the population, it is growing steadily (We are Social and Hootsuite, 2021). In urban areas, broadband Internet subscription and access to mobile devices has continued to increase. The number of mobile broadband subscribers rose from 2.7 per 100 people in 2010 to 21.20 per 100 people in 2019.

Angola has more than 15 million mobile phone users, 70 percent of whom are youth. The government created a strategy for digital inclusion of youth through ICTs. The strategy identified 12 main initiatives, which did not include agriculture. Rodrigues (2010) noted that the post-war potential of Angolan youth provides a huge opportunity for the country (see Table 3).

According to the GSMA, the penetration rate of mobile social networks in the country has been increasing over the past five years, rising from 5.3 percent to 6.8 percent. The number of applications in the national languages ranged from 55 to 57 over the past five.

Angola is seeking to strengthen its agriculture information systems and digital technologies to mitigate the impact of drought in the country.

Upcoming digital agricultural initiatives include 100 Angolan farmers participating in the Mavo Diami project by registering for a new satellite-based service that provides them with crop advice and weather updates on their smartphones. Another example is the Roque Online e-commerce platform that facilitates the sale of online products and connects small producers with seller's markets such as hotels and restaurants.

To improve digital inclusion across society, the government is building the Multimedia Library Network of Angola (REMA). It will feature 25 centres with covered areas of 2 100 m², one in each Angolan province and by 2020, nine fixed Mediatheques and six Proximity Mediatheques were installed.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	5.29	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	3.24	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	8.6	ITU
	Willingness	Mobile social media penetration (%)	2019	6.82	GSMA
		Number of apps in national language (quantity)	2019	57.98	GSMA
		Gender gap in social media use (%)	2019	49.55	GSMA
		Gender gap in mobile ownership (%)	2019	57.71	GSMA

POLICY AND REGULATION

The government has shown political will to support investment in digitization and digital agriculture. The Ministry of Telecommunications, Information Technology and Social Communication is the authority for electronic communications in Angola and is responsible for defining the sector's development policies. INACOM serves as the country's regulatory body and is responsible for the sector's policies and licensing. The 2017 Law on Electronic Communications and other laws regulate the telecommunications sector. In August 2019, the government introduced a plan to privatize a number of state service providers such as MSTelcom, Net One, Unitel, TV Cabo Angola and Multitel.

Angola's policy framework to encourage investment in digital agriculture is weak; agriculture is one of the areas under reconstruction concerning policy and innovation investment (UNCTAD, 2008) (see Table 4).

However, there are some initiatives for e-government and digital government strategies. Driven by the National Plan for the Information Society, 2005 (Plano Nacional para a Sociedade de Informação) and Strategic Plan for Electronic Governance 2013-2017 (Plano Estratégico para a Governação Eletrónica), the government is pushing toward e-government. Although these initiatives aim at attaining ambitious outcomes, such as the use of digital public services by a minimum of 10 percent of the population, there is no data on the results achieved (OECD, 2018). In the digital agriculture scene, FAO and Agrinatura, in collaboration with Angola's Ministry of Agriculture and Rural Development, launched the Capacity Development for Agricultural Innovation Systems initiative to support innovative capacities of smallholder farmers, agribusinesses and consumers.

The Innovation Lab for Payment Systems (LISPA) is another relevant initiative from private and public stakeholders. It is led by the National Bank of Angola and Standard Bank to promote engagement of the main players in the Angola start-ups landscape and to incentivize partnerships.

In partnership with MINAGRIP and with support from FAO Angola, the Ministry of Economy and Planning launched the National Investment Plan in Agriculture, Food Security and Nutrition (PNIASAN), 2021/2022.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2015	2.84	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2015	2.77	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	1.90	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.56	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	64.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Competitiveness and ease of doing business in Angola is hampered by unfavourable investment and institutional environment for the private sector. Angola lags behind on business environment metrics as shown in Table 5. For example, Angola ranked 137 out of 140 countries on the Global Competitiveness Index of 2018 due to weak infrastructure and inadequate human capital. It is difficult to obtain permits and approvals due to a heavy bureaucracy and lack of transparency.

The private companies that invested in Angola have had huge input costs, lack of reliable electricity and huge expatriate labour costs. Outside the gas and oil sectors, there is weak foreign investment in other sectors. For example, while FDI in oil and gas averaged USD15 billion per year from 2012 to 2016 (being 82 percent of total investment), agribusiness received only 6 percent.

Manyuchi (2016) examined the possibility of FDI in the Angola oil and energy sectors that lead to transfer of technologies. The study found no evidence of FDI translating to knowledge transfer and technologies to other sectors. Policy implementation to support the diversification of Angolan investment and technologies is needed (see Table 5).

Like most emerging economies, Angola has growing start-ups such as: Roque-Online, which seeks to connect the informal markets of the world with empowering technologies. The venture has grown from 250 to 36 000 members; DroneSIG uses drones to collect and analyse aerial data; HUMBITEC leverages geospatial and aerospace technology to improve precision agriculture; KEPYA is an agri-commerce digital solution with 500 users via web, SMS and telephony, which also facilitates transport, quality control and product traceability; and PAY 3 is a platform that allows payment for services and products in installments.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	-4 098	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.14	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2014	2.35	WEF
	Entrepreneurship	Time required to start a business (days)	2019	36	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2014	2.16	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.32	WEF

HUMAN CAPITAL

Of the 32.9 million population in Angola, the adult literacy rate remains below 80 percent. School enrolment for secondary (percentage gross) in Angola was reported at 50.7 percent in 2016 (World Bank, 2016) with secondary school enrolment, female (percentage gross) at 39.7 percent and male enrolment at 61.7 percent in 2016. The Gender Parity Index (GPI) is 0.7 at university level - (GPI indicates the level of access by females to education compared to males).

Angola has several public and private universities and higher educational institutions, yet most schools do not have access to ICTs. Angola lacks a dedicated ICT education policy. The government established the National Information Technology Agency to develop a national ICT policy. Despite the efforts of the government, the digital skills within the population are still low and evaluated at 2.4 out of 7 according to the World Bank in 2019 (see Table 6).

Overall employment in agriculture is 50.7 percent, of which 56.8 percent is female, signifying women bear most of the labour burden in farms. While the legal framework affords women the same rights as men. Household assets are generally the property of male heads of households and women do not have access to resources (see Table 6).

Human capital remains low despite progress in employment. For a better penetration rate, Angola must strengthen the digital skills of actors at various levels.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2014	66.03	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2014	77.43	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.45	WEF
	Employment	Employment in agriculture (% of total employment)	2019	50.73	ILO
		Employment in agriculture, female (% of female employment)	2019	56.78	ILO
		Unemployment, total (% of total labour force)	2020	7.77	ILO

AGRO-INNOVATION

The previous sections demonstrate that Angola lacks the structured approach required for digital agriculture investment. However, there are pockets of existing innovation and investments that are worth mentioning. The ATLANTICO established the first digital laboratory in Angola in 2018. The lab's main objective is to promote an ecosystem of entrepreneurship and digital innovation in Angola, through the aggregation of skills originated in technology start-ups, universities and national and international financial institutions. ATLANTICO's strategic focus is on transformation, innovation and digitalization through the development of digital and analytical skills.

Within agro-innovation, there are also a number of initiatives. For instance, the European Union is supporting research and innovation applied to family farming for climate change adaptation and resilience. The initiative seeks to build the capacities of stakeholders to generate knowledge and innovation in agriculture through the involvement of European research entities. Meanwhile UNDP's Accelerator Lab-Angola has been working at the ground level to trace local solutions collectively with young people to help articulate a response to the COVID-19 pandemic (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	10 723.36	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	11.08	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.05	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2017	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2014	2.01	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2015	2.68	WEF
		ICT goods imports (% of total imports)	2018	2.52	UNCTAD

BENIN

Benin is a lower-middle-income country. In 2019, more than half of its population (51.6 percent) lived in rural areas. Due to the excessive influence of its neighbouring countries, Benin's economic performance fluctuates greatly. Meanwhile, Benin's GDP has increased slowly but steadily rising by 2.3 percent from 2012 to 2018, while in 2015 the poverty rate was estimated at 40.1 percent, based on the international poverty line (World Bank, 2020). That said, Benin's moderate growth cannot significantly reduce poverty. The World Food Programme (WFP) estimates that around 23 percent of households in Benin are food insecure, making the population even more vulnerable to shocks or risks (see Table 1).

Benin is dependent on subsistence agriculture and almost 38 percent of the population earns a living from agriculture. With abundant irrigable land resources, Benin has great potential for agricultural development. Cotton plays an important role as a key cash crop and a leading export product, making up 80 percent of export revenues. Maize, rice, cassava and yams are the main food crops. However, Benin has experienced a steady increase in rice import, making the country the sixth largest rice importer in the world as of 2018. Also, frozen products such as poultry and fishery, as well as eggs and milk are also imported to meet domestic demand.

The agriculture sector in 2019 generated 27 percent of GDP and 38.3 percent of total employment (World Bank, 2019). Women make up 30 percent of employment in agriculture and 14 percent of agricultural households are led by women (World Bank, 2019). However, the overall proportion of agriculture's contribution to employment has declined steadily due to an increase of employment in the service industry.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	12 123 198	WBG
Urban population (%)	2020	48.41	UNPD
Rural population (%)	2020	51.59	UNPD
GDP (current millions of USD)	2020	15 652	WBG
Agricultural land (km^2)	2018	39 500	FAO
Agricultural land (% of land area)	2018	35.03	FAO

INFRASTRUCTURE

In Benin, around 40 percent of the population has access to electricity, with rural access increasing from less than 3 percent in 1996 to 17.4 percent in 2019.

With insufficient electricity supply and difficulties in connecting to the electricity grid, mobile operators are facing great challenges in expanding network coverage, particularly in rural communities. According to GSMA, the network coverage of the territory was 63.4 percent in 2019, with 2G at 98 percent, 3G at 89 percent and 4G at 45 percent respectively. Also, the usage of fixed line Internet services is quite low due to poor infrastructure, making mobile networks the mainstay of Internet connections. Furthermore, high cost is another constraint for operators to maintain the infrastructure, while the low number of users in rural areas due to a relatively low-level incomes further decreases the operator's motivations to expand infrastructure.

To improve the ICT infrastructure, the Government of Benin launched The Telecommunications and ICT Infrastructure Development (PDI2T), a flagship project aimed at providing basic infrastructure to accelerate broadband coverage. This includes the extension of fiber and 4G/LTE networks, as well as offering quality services. The World Bank also approved a loan for the Rural Digital Transformation Project, focusing on services and digital solutions in the agriculture and ICT sector. Meanwhile, the leading mobile operators, such as MTN and Moov, are also contributing to the improvement of infrastructure and services, by initially launching 3G and 4G network services in the country (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	17.37	WBG
		4G coverage (% of total coverage)	2019	45.00	GSMA
		Mobile (device) ownership (% of population)	2019	53.00	GSMA
		Secure access to Internet servers (per 1 million people)	2020	18.64	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.51	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	91.90	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	21.46	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.25	ITU

DIGITAL PENETRATION

As of January 2021, Benin's Internet penetration rate was 28.4 percent (3.5 million users). Although fixed Internet services have been available in Benin since 1995, access is limited to a small proportion of the population. More connections are being made through mobile networks. The number of mobile connections (10.27 million) increased by 3.8 percent between January 2020 and January 2021. Household computer users have also increased, with an average growth of 35 percent from 2012 to 2016.

Currently, the rapid growth of mobile phone users is raising awareness of the use of mobile money, particularly in urban areas, where 9 percent of people own mobile money accounts. However, men hold double the number of unique accounts at 12 percent compared to women who hold only 6 percent. The rapid growth of mobile and Internet

users has also impacted the use of social media. There was an estimated 1.6 million social media users in January 2021, reflecting an increase of 45 percent compared to 2020. However, according to GSMA there was likewise a gender gap of about 18.6 percent in social media use in 2019.

As of 2020, the mobile telephony sector was still dominated by the largest operator, MTN Benin, which has a market share of 68.2 percent, followed by Moov with 31.8 percent, according to the ARCEP Dashboard. However, the market is increasingly being flooded with a number of national and international operators, which is transforming the sector's competitiveness (see Table 3). La Société Beninois d'Infrastructures Numériques (SBIN) was created in 2016 as a public operator to manage digital infrastructure and provide telecommunication services to individuals and businesses. In March 2021, Sonatel Group was assigned to manage SBIN's provision of fixed and mobile telecommunication networks. Benin's Council of Ministers authorized the Minister of Digital and Digitalization to initiate procedures to grant a third mobile electronic communications network license to SBIN.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	27.22	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	4.24	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	25.45	ITU
	Willingness	Mobile social media penetration (%)	2019	9.21	GSMA
		Number of apps in national language (quantity)	2019	29.48	GSMA
		Gender gap in social media use (%)	2019	18.56	GSMA
		Gender gap in mobile ownership (%)	2019	33.33	GSMA

POLICY AND REGULATION

In Benin, the overall sector strategy and development are the responsibility of the Ministry of Digital and Digitalization (Ministère du Numérique et de la Digitalisation, MND). Apart from MENC, several regulatory institutions also play a key role, such as the Electronic Communications and Postal Regulatory authority (ARCEP), the Beninese Agency for the Universal Service of Electronic Communications and the Post (ABSU-CEP), the Digitization and Digital Agency and Services and Information Systems Agency.

The country's agricultural policy is mainly implemented through the Strategic Plan for the Development of the Agricultural Sector (Plan Stratégique de Développement du Secteur Agricole - PSDSA) with a vision and three key specific objectives to achieve by 2025. The Government of Benin has also set up an objective for ICT sector to "transform Benin into a digital service platform for West Africa to accelerate growth and social inclusion by 2021" through its Action Programme 2016-2021 (see Table 4).

Since 2019, and to further combine agriculture and the ICT sector, the Government of Benin has initiated the process of mainstreaming its own national digital agriculture into the country's overall agriculture development. With the support of FAO and ITU, the national digital agriculture strategy is awaiting final validation. In addition, in collaboration with the Alliance for Affordable Internet (A4AI) in 2019, the Government of Benin seeks to develop a Universal Access vision to boost digital connectivity in the country. Furthermore, the new Drone-Assisted Land Mapping for Climate Smart Cashew Production initiative will help farmers adopt climate-smart agriculture through drone technology.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.23	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.43	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.96	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.55	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	65	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

By fostering investment, including increasing FDI inflows reaching USD 230 million in 2019, Benin has improved its business environment. This is helping the country's economic development, while reforming the national regulatory framework, creating tax incentives to facilitate public-private partnerships and attracting private investments.

The average time to start a business in Benin is about 8.5 days. However, women face more difficulties and longer procedures because of additional required documentation when registering a business, such as an identification card, a marriage certificate, etc.

The Government of Benin has taken a series of measures to improve the business climate within the country. A five-year Government Action Plan worth USD 15 billion was launched in 2016 to achieve reforms in the infrastructure, agriculture and agribusiness sectors (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2020	230	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.53	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	1.72	WEF
	Entrepreneurship	Time required to start a business (days)	2017	8.5	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2018	2.32	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.19	WEF

HUMAN CAPITAL

The literacy rate in Benin remains low at 42.36 percent in 2018 with an evident gender gap. Of women aged 15 or older, only 31 percent were able to read and write. The rate was a bit higher for younger women aged 15-24 at 51.9 percent. Women account for 55 percent of the rural population and 30 percent of employment in agriculture. Therefore, such low literacy levels prevent them from adopting and handling advanced ICT tools and technologies. The low digital literacy level in Benin is also a result of low secondary school enrolment at 59 percent in 2016, ranking 106 of 130 countries (UNESCO, 2016). Higher levels of education are required to master advanced digital knowledge and techniques. Particular attention has been paid to the issue of gender imbalance. In 2019 the World Bank approved a grant of USD 90 million to empower adolescent girls in Benin by improving their access to secondary education and skills, thereby giving them more opportunities in the labour market once they graduate.

The Government of Benin has made great efforts in reforming education and enhancing the digital and innovation capacities of youth. For example, the Sèmè City project trains students and researchers and supports entrepreneurs in spurring innovation. Schools and NGOs have also begun to focus on the improvement of digital capabilities by providing computer-related courses. Also, an e-learning platform has been established and will soon be operational with the support of the European Union through the Projet d'Appui au Développement Durable du Secteur Agricole (PADDSA), which will facilitate access to knowledge. In addition, some start-ups like Cabinet S-Lab offer training on the use of digital tools. All of those practices generate opportunities in digital capacity development and improve digital skills of the new generation (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	42.36	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	60.95	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.68	WEF
	Employment	Employment in agriculture (% of total employment)	2019	38.27	ILO
		Employment in agriculture, female (% of female employment)	2019	29.76	ILO
		Unemployment, total (% of total labour force)	2020	2.54	ILO

AGRO-INNOVATION

Considering Benin's current levels of poverty and low agricultural productivity, modernising the agriculture sector is critical for the country. In the past few years, Benin has initiated several practices through projects or pilots to digitalize agricultural services, such as PCGIPP, a platform providing agriculture sector financial information; call centres for agriculture techniques and inputs and extension services; TechnoServe for the applications of drones; electronic entry management and e-voucher project for accessing inputs and fertilizers; as well as AgriYara for online trading of agriculture products.

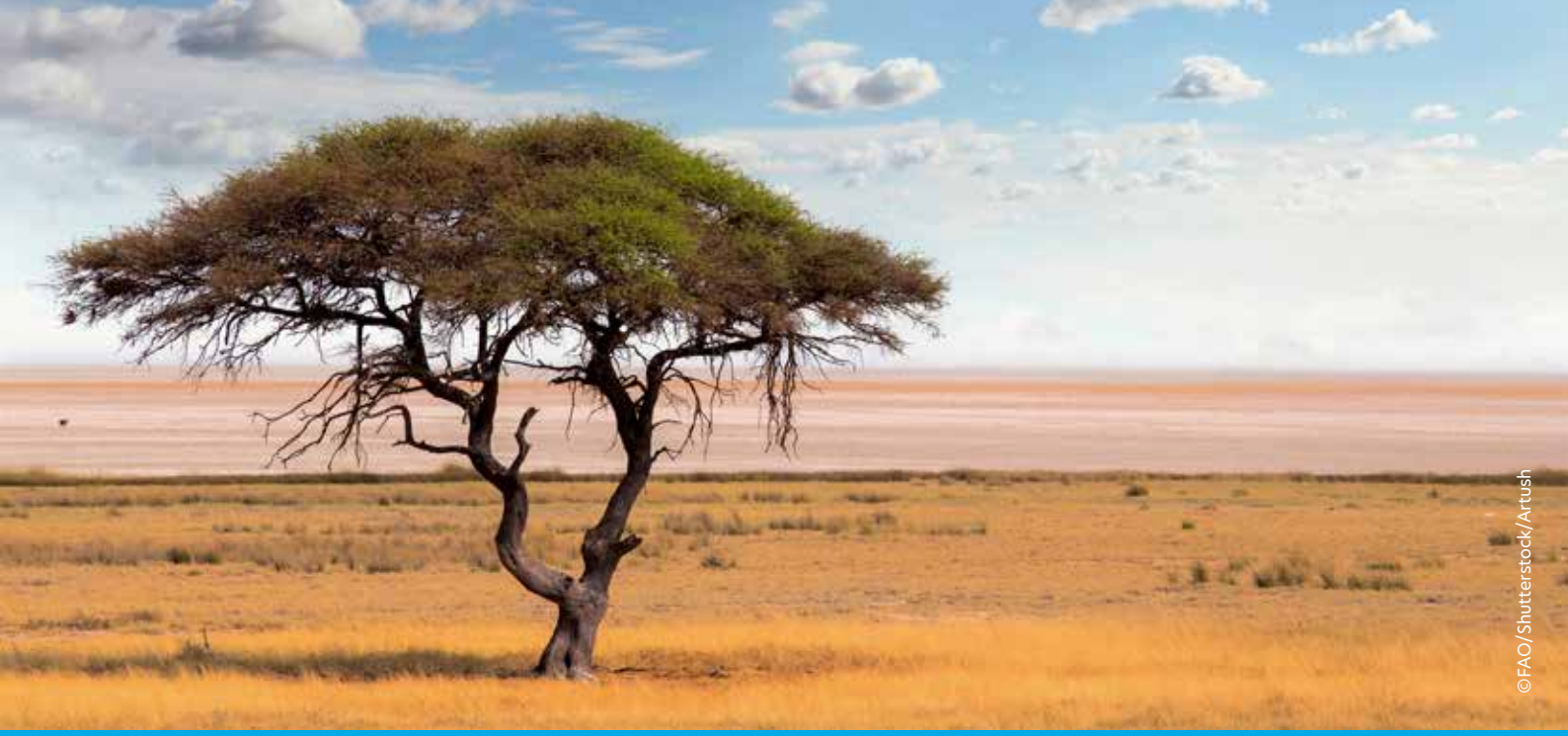
However, R&D levels remain quite low. The expenditure of R&D in agriculture only accounted for 0.6 percent of the total agriculture

GDP. The leading role in agriculture R&D is played by public agencies, universities and NGOs, represented by the National Institute of Agricultural Research of Benin (INRAB), the University of Abomey-Calavi (UAC), the faculty of Agronomy of the University of Parakou, etc. They contribute to the research on topics relevant to agriculture, technology and socioeconomic issues. Still, attracting and keeping qualified researchers is quite challenging in Benin with the R&D infrastructure still in need of improvement.

Some initiatives provide favourable environment and access to resources for researchers and technology start-ups. For example, Sèmè City serves as an open laboratory for students, researchers and entrepreneurs to obtain essential research material. It also supports around 250 start-ups to foster innovation. TEKXL, an incubator and EtriLabs, an innovation hub, also trained developers and tech entrepreneurs to accelerate start-ups (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	3 973.05	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	119.37	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.75	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.60	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	2.84	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	4.39	WEF
		ICT goods imports (% of total imports)	2019	1.51	UNCTAD



BOTSWANA

Botswana is an upper-middle-income country with a GDP of USD 15.78 billion. The service sector is the primary contributor to growth, constituting 60.6 percent of GDP in 2019. The country is also rich in natural resources and a leading exporter of diamonds. Botswana's population is about 2.35 million with the majority (70.8 percent) of its people living in urban areas as of 2020 (see Table 1).

Because the agricultural sector is predominantly composed of rain-fed crops and rangeland-based livestock production systems, Botswana is extremely vulnerable to the impact of climate change. The sector contributed 2.1 percent to Botswana's GDP in 2020 and employed 19.9 percent of the population in 2019. About 29.2 percent of the population still lives in rural areas, of which 60.7 percent are unemployed (21.4 percent women). In 2010, rural poverty was 8.3 percent compared to 3.3 percent in cities and towns, of which 33 percent are female-headed households.

Botswana may have one of the highest levels of access to mobile telephony in Africa, the majority of people still do not have affordable access to Internet. The enhanced ICT services required for effective participation in the knowledge economy and society continue to elude the vast majority of the country.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	2 351 625	WBG
Urban population (%)	2020	70.88	UNPD
Rural population (%)	2020	29.12	UNPD
GDP (current millions of USD)	2020	15 782	WBG
Agricultural land (km^2)	2018	258 616	FAO
Agricultural land (% of land area)	2018	45.63	FAO

INFRASTRUCTURE

Overall electricity coverage averaged 40.3 percent with 27.1 percent in rural areas. The government continues to electrify villages under the Rural Village Electrification Programme bringing the total of rural electrification progress to 88 percent with 435 out a total of 492 gazetted villages in the country now with access to electricity.

GSMA (2019) affirms good mobile connectivity in the country with 80 percent 4G coverage. About 74 percent of the population also owns mobile devices. The number of mobile connections in Botswana in January 2020 was equivalent to 150 percent of the total population. The market remains structured around three vertically integrated operators: Mascom Wireless, Orange Botswana and Botswana Telecommunications Corporation (BTC). For example, BTC plays the dual role of an ISP and a bandwidth supplier to ISPs. Furthermore, BTC has also enhanced rural broadband access to support e-learning services. The introduction of BoFiNet was intended to provide open access to backhaul infrastructure at lower prices.

The recent introduction of VSAT technology by BTC enables countrywide coverage even in the most remote parts of the country, giving farmers Internet connectivity through its vast telecoms network.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	27.58	WBG
		4G coverage (% of total coverage)	2019	80.17	GSMA
		Mobile (device) ownership (% of population)	2019	74.07	GSMA
		Secure access to Internet servers (per 1 million people)	2020	263.65	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.30	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	162.40	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	88.44	ITU
		Fixed broadband subscriptions (per 100 people)	2020	3.06	ITU

DIGITAL PENETRATION

As a landlocked country, the cost of accessing international undersea cables is high as a result of transit cost charged by operators in neighbouring countries. High broadband prices limit access to and use of the Internet. The 2012 RIA Botswana ICT Survey found that only 9 percent of respondents use the Internet mostly in urban areas, of which 71 percent accessed it for the first time via computer and 51 percent accessed it at work, while 52 percent stated that the high cost is the main reason for limited use of the Internet. Among the few households with an Internet connection, the most-used type of connection mobile 3G (44.4 percent), followed by ISDN dial-up (23.5 percent) and wireless broadband (17.3 percent). The Botswana Technology Centre study revealed that 91.5 percent of the sample rural population had never used a computer (BOTEC, 2000). In addition, about 18 percent of people in Botswana access social networks via mobile phones. Launched in 2020 the GABZ FREE Wi-Fi initiative provides free daily Wi-Fi for one hour per user in some public areas in Gaborone.

The information needs of rural Botswana are distinct from those of the urban centres. In most cases, the issue of most interest to rural areas is information on government schemes (BOTEC, 2000: p.1). Through the national public radio service, the government is the major source of information in rural areas, dating back to 1961 when Radio Botswana started broadcasting. One of its core functions was to encourage efficient farming. Botswana Television (BTV) also introduced farming programs to augment the voice broadcast through radio.

Nowadays, a range of digital agricultural services are penetrating the market, such as mAgri and Brastorme in partnership with Orange offering advisory services and marketplace respectively. Lunch Box, Plaasio, Greenhouse Technologies provide e-commerce services, hydroponics and value chain using the latest technologies such as blockchain, AI, etc. In addition, public digital agricultural services are already introduced to the sector through the Botswana Animal Information And Traceability System (BAITS), a platform for farmers to provide information on their livestock; Modisar, a farm management productivity software application; and Botswana Meat Commission that shares information about cattle pricing with farmers through mobile phone and Internet (Mahabile, 2013). PosoMoney is a mobile money platform that allows 66 000 registered customers to access a wide range of financial products and services.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	13.87	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	1.05	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	4.40	ITU
	Willingness	Mobile social media penetration (%)	2019	41.97	GSMA
		Number of apps in national language (quantity)	2019	31	GSMA
		Gender gap in social media use (%)	2019	93.16	GSMA
		Gender gap in mobile ownership (%)	2019	100	GSMA

POLICY AND REGULATION

Botswana has experienced radical changes in its ICT institutional and regulatory framework since 2006 when the market was liberalized to allow Internet service providers (ISPs) to provide voice over Internet protocol (VoIP), the mobile operators to build their own infrastructure and the international voice gateway to be opened to competition. This was further complemented in 2007 by Maitlamo, the National Information and Communications Technology Policy.

The National Development Plan 11 (NDP11), and significant investment has recently been made in upgrading Botswana's communications networks to facilitate new technologies. Botswana has clear policies providing direction in the agriculture and ICT sectors (National ICT policy, and National Policy for Agriculture Development). In addition, the Implementation of the Digital Transformation/4IR Strategy or SmartBots that was kickstarted in October 2020, aims at driving the digitization of the public sector and spurring Botswana toward a knowledge-based economy including digital agriculture.

The government is reviewing the Integrated Support Programme for Arable Agriculture Development (ISPAAD) that will be launched during the course of 2021 to enable critical infrastructure development such as digitalization.

In 2020 Botswana engaged with the United Nations Conference on Trade and Development (UNCTAD) and developed the National E-Commerce Strategy, with an overall objective to promote the diffusion and use of e-commerce throughout Botswana's commercial and public spheres, and alignment with digital agriculture transformation through the Government's Nteletsa II programme that is focussed on increasing rural access to ICT to connect Batswana's farmers worldwide.

In addition, the National Payments System Vision and Strategy (NPSS) 2020–2024 is designed to promote the use of digital payments platforms. The NPSS is expected to accelerate financial inclusion and support the growth of the digital economy.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.99	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.90	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.27	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.32	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	85	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In the last decade, the government prioritized investment in ICT and agriculture. In 2012, the Government invested BWP 70 million in the East Africa Submarine Cable System (EASS), which is providing local data users with one of the world's fastest speeds at lower costs. Another BWP 250 million has been invested in the development of the West African Cable System (WACS), a submarine fiber optic cable. In 2020, the government allocated BWP 1.39 billion for agriculture development. Also, to further diversify the economy, the government introduced the residency by investment programme to attract foreign investment in non-mineral sectors including agriculture.

Through the Companies and Intellectual Property Authority (CIPA), the government has firmly pursued reforms to improve the business climate for investors and entrepreneurs. This includes the introduction of electronic tax processes between 2016 and 2017. Launched in 2019, the Online Business Registration System (OBRS) has a key objective to achieve faster, cheaper and more accurate business registration. As part of this reform, the CIPA has integrated with the Department of National and Civil Registration and efforts are ongoing to finalise the integration with the Botswana Unified Revenue Service (BURS), as well as the PPADB systems.

Delivering a new growth model for Botswana will require the private sector to take the lead in investment and developing competitive outward-oriented firms. At the moment, while entrepreneurs are emerging, the private sector remains shallow. Botswana is promoting entrepreneurship development through the

Local Enterprise Authority (LEA) focusing on Agriculture and Manufacturing Sectors. However, the majority of smallholder farmers who happen to be women have no credit worthiness and thus have little access to sources of financial credit. Most commercial financial institutions are reluctant to extend credit to smallholder farmers with little or no collateral. Perhaps the "high-risk" business nature of agricultural production also plays a part.

Through the Industry Facility Support Fund, the government will assist smallholder dairy farmers to increase their production capacities by providing them with an accelerated business subsidy and an interest free loan, which will be administered by the National Development Bank (NDB).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	261	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.55	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.86	WEF
	Entrepreneurship	Time required to start a business (days)	2019	48	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.83	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.71	WEF

HUMAN CAPITAL

Adult literacy in Botswana was about 86.8 percent in 2013 (World Bank, 2020). However, this statistic is segmented, with the literacy rate among rural dwellers being as low as 37.4 percent. More than 70 percent of the rural population has been to a primary school (Moepeng, 2010), suggesting low rural capacities to adopt and use digital technologies (MoESD, 2020).

The government has undertaken a number of initiatives to streamline efforts to improve digital literacy. For example, the Botswana Innovation Hub in 2019 launched the country's first digital skills training programme. The programme sought to enlist the top 1 000 digital innovators in the country to benefit from modules that cut across agriculture, education and health, among others.

In Botswana, local farmers are well acquainted with conventional farming techniques acquired over generations of farming, but they lack the knowledge of contemporary farming techniques and technologies. The level of farmer training is relatively low and opportunities for further training are limited and expensive. Academic institutions like the Botswana University of Agriculture and Natural Resources (BUAN) through its Centre for In-service and Continuing Education (CICE), offer short courses and train farmers. However most farmers cannot afford to pay for such courses, let alone afford to come from remote areas to the city. Tertiary education remains a key route to quality employment, but tertiary and vocational systems align poorly with labour market needs.

2KO Botswana offers onsite training for local farmers and farming organizations on ICT and agriculture. Furthermore, extension and training services do not easily reach rural and remote areas (FAO, 2011). According to Statistics Botswana 2014, Botswana has the highest

literacy rate of 97.8 percent for youth aged 15–19, followed by 96.8 percent for youth aged 25–29. However, there is still a lack of skilled personnel in the agriculture sector.

Government schools from primary through tertiary are also equipped with computer laboratories where both learners and their instructors can work to improve their ICT skills.

The integration of technology in the education process has immensely improved the acquisition and retention of knowledge. A partnership between the Ministry of Youth Empowerment, Sport and Culture Development (MYSC), the Bill & Melinda Gates Foundation aims at building public libraries through a collaboration that seeks to provide free Internet access to public libraries and e-government services in Botswana.

Although e-learning initiatives bring many advantages to the education system, these rewards have not been fully realised. Four major challenges that should be addressed before an e-learning initiative can be introduced successfully are identified as: poor infrastructure, inadequate IT support, lack of e-learning policy, and lack of university management support. NELSCOM, a national e-learning steering committee has been established to provide a comprehensive report on the strengths and weaknesses of Botswana's e-learning strategy.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2013	86.82	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2013	97.46	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.69	WEF
	Employment	Employment in agriculture (% of total employment)	2019	19.90	ILO
		Employment in agriculture, female (% of female employment)	2019	15.28	ILO
		Unemployment, total (% of total labour force)	2020	17.70	ILO

AGRO-INNOVATION

The number of private and public sector initiatives that have been rolled-out to support local innovation among the youth is indicative of Botswana's agro-innovation. For example, the Go-To-Market programme, a three-year USD 3 million partnership between the De Beers Group and Standford University involved a week-long training for young innovators and industry players in agriculture, services, IT and the performing arts.

Botswana University of Agriculture and Natural Resources BUAN was the first in the nation to offer agricultural programmes geared toward precision agriculture. Through the Botswana Institute for Technology Research and Innovation (BITRI), the government has established a software development centre. The Botswana Open University (BOU), in collaboration with Huawei Technologies Botswana, formed the Huawei ICT Academy to encourage students to cultivate professionals and practical skills. SmartBots, a government initiative under the Digital Implementation Strategy, announced the 2021 Virtual Smart Hackathon Challenge targeting citizens aged between 18–35 years of age to participate in the development of the mobile Gov App.

Finally, the initiative of First Steps Venture Centre (FSVC), a technology entrepreneurship development program within the Botswana

Innovation Hub (BIH), is mandated to coordinate the establishment of a functional and integrated national innovation ecosystem. Key to this is the creation of an Innovation Fund that promotes innovation through provision of seed/early-stage funding to companies or organizations registered with the Botswana Innovation Hub, which may subcontract part of the development work to universities and research organizations. In addition, the Innovation Fund serves to encourage companies and organizations awarded funding to transfer skills to citizen employees by providing cash grants to be utilized for institutional training and on the job training programmes.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	333.47	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	97.94	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2016	3.05	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2017	2.27	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.28	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.68	WEF
		ICT goods imports (% of total imports)	2019	2.93	UNCTAD

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BURKINA FASO

Burkina Faso is a landlocked and low-income country. Due to continuous impacts of security and a humanitarian crisis, its GDP grew by 6 percent in 2019, slightly lower compared to its 6.8 percent growth in 2018. In 2020, 69.3 percent of the country's population lived in rural areas and 30.6 percent were still living below the national poverty line.

The country's economy relies on subsistence agriculture, contributing 20.4 percent of the total GDP in 2020. As of 2019, subsistence agriculture employed nearly 80 percent of the active population (World Bank, 2019, 2020). Characterized by low productivity and largely affected by climate, agriculture production cannot meet domestic demand. About 3.3 million people suffered food insecurity, accounting for 16 percent of the country's total population (WFP, 2019). As the main cash crop, cotton is a vital source of foreign currency and cotton exports reached an average of USD 239 million per year, making cotton production a key driver for the agriculture sector's development.

The country's ICT has experienced growth with the sector prioritized as part of five key areas of the president's development programme. The goal is to make the public data infrastructure central in social and economic development.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	20 903 278	WBG
Urban population (%)	2020	30.61	UNPD
Rural population (%)	2020	69.39	UNPD
GDP (current millions of USD)	2020	17 369	WBG
Agricultural land (km^2)	2018	121 000	FAO
Agricultural land (% of land area)	2018	44.23	FAO

INFRASTRUCTURE

The World Bank reports that electricity coverage in urban areas was 64.6 percent in 2019 and only 4.8 percent (as of 2014) in rural areas. To increase the access rate, the government set a goal of reaching 80 percent by 2020 in its National Plan for Economic and Social Development. In Burkina Faso, over 50 percent of the population owns mobile phones. In terms of mobile Internet penetration, overall connectivity was 39.3 percent in 2019, with better coverage of 2G and 3G, at 97.9 percent and 65 percent respectively, and minimal 4G coverage, at only 8.6 percent.

Burkina Faso has made efforts developing its ICT infrastructure in recent years with support from development organizations, such as the eBurkina Project funded by World Bank, aiming at building a digital platform to provide e-services to citizens, companies and entrepreneurs (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2014	4.75	WBG
		4G coverage (% of total coverage)	2019	8.64	GSMA
		Mobile (device) ownership (% of population)	2019	50.86	GSMA
		Secure access to Internet servers (per 1 million people)	2020	5.98	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2014	3.54	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	105.81	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	31.70	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.07	ITU

DIGITAL PENETRATION

The overall low electricity access and unstable supply leads to low fixed broadband subscriptions, with only 12 per 100 inhabitants. However, compared to the downturn in fixed broadband, mobile cellular subscriptions increased sharply. Fixed-network broadband download and upload speed is at an average 10.7 and 8.5 Mbit/second respectively. Also, the number of mobile connections in January 2020 was approximately 97 percent of the total population.

With the increasing use of mobile phones, mobile money has become available and popular in the country. Orange Money and Mobicash, run by the two large operators Orange and Telmob, have facilitated mobile money transfers and payments among the population, and now even compete with traditional banks.

However, the country has relatively low social media penetration, with only 9.4 percent in 2019, and a low gender gap score of 9.7 due to low awareness and lack of information (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.47	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	7.76	GSMA
		Number of apps in national language (quantity)	2019	18.53	GSMA
		Gender gap in social media use (%)	2019	9.47	GSMA
		Gender gap in mobile ownership (%)	2019	38.27	GSMA

POLICY AND REGULATION

Considering the important role of agriculture in the national economy, it has always been a powerful instrument for poverty reduction and hence given particular emphasis when designing policies and strategies. The Strategy for Accelerated Growth and Sustainable Development (SCADD 2011-2015) defined five key agricultural commodities as priorities and a national vision was incorporated into its National Programme for the Rural Sector (PNSR), to further making agriculture "modern, competitive, sustainable and an engine of growth".

On the other hand, viewing the increasing importance of digital technologies, Burkina Faso adopted in 2018 a national strategy for the development of the digital economy (2018-2027), to improve infrastructure and promote digital technologies applied in the country. However, the absence of digital agriculture policy shows that the country has to find its way in connecting agriculture and ICT industries (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2015	3.75	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2015	3.80	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	3.51	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2015	3.15	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	84	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4)*

BUSINESS ENVIRONMENT

According to the World Bank Doing Business ranking, to start a business in Burkina Faso takes 13 days. Burkina Faso scored 88.2 of 100, ranking higher than the regional average with no evident disparity between men and women. However, women entrepreneurs find it more difficult to access digital financial services due to lack of knowledge and awareness compared to men.

The Government of Burkina Faso has made efforts in creating a sound business environment for agriculture and rural development through policies and initiatives, such as the Strategic Framework for Poverty Reduction, adopted in 2003, aimed at creating a more favourable business climate for private investment and SMEs in rural areas.

Furthermore, a lot of effort has been made to support agricultural entrepreneurs. For example, business accelerator programmes called Impulsa Tu empresa (or boost your business in English) were implemented to help SMEs access market and capital to further support their business development. Also, iDEAL Burkina Project aims at helping provide youth entrepreneurs and farmers access to markets through the use of ICT (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2015	208	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.42	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2014	1.47	WEF
	Entrepreneurship	Time required to start a business (days)	2019	13	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2014	1.64	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.25	WEF

HUMAN CAPITAL

In 2018, the adult literacy rate of people 15 years of age or older in Burkina Faso was 41.2 percent. In the past two decades, the literacy rate increased by 28 percent and about 58.3 percent of youth between 15 and 24 are literate, with slight disparity between youth male and female, at 61.8 percent and 54.7 percent respectively. Meanwhile, the percentage of secondary school enrolment, at 41 percent, is far less compared to 95 percent of primary school, highlighting the issue of accessing higher education and specialized capacities. This also leads to a low score of 2.89 out of 7 among the population regarding the country's digital aptitude.

To unlock the potential of ICT, a series of programs and initiatives have been taken in Burkina Faso. In collaboration with African Youth Network in 2016, UNESCO sought to promote ICT tools and social media channels for youth girls to enhance their digital capacities and entrepreneurial skills. Digital Factory Simplon-AUF was set up in January 2020 to train youth in web development. The Ministry of Education, together with the Orange Foundation carried out the Digital Schools Program to equip schools with computers and tablets (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	39.35	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	58.87	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.89	WEF
	Employment	Employment in agriculture (% of total employment)	2019	26.21	ILO
		Employment in agriculture, female (% of female employment)	2019	21.41	ILO
		Unemployment, total (% of total labour force)	2020	4.96	ILO

AGRO-INNOVATION

In Burkina Faso, digital tools have been applied in various forms in the agriculture sector, such as the use of drones for rice production, the use of radio and phones to obtain agriculture information, as well as the establishment of the agriculture market information system (AMIS) and meteorological information system for agriculture development. The digitalization of the agriculture sector seems to be advancing, slowly bridging the digital divide in Burkina Faso.

Apart from digital services for agriculture, agricultural R&D in Burkina Faso is mainly supported by public institutions. One of the largest of such entities is the Environmental Institute for Agricultural Research (INERA), which employs two-thirds of the country's agricultural and environmental researchers. Universities (such as the University of Ouagadougou) and NGOs (such as the Association for the Promotion of Livestock in the Sahel and in the Savannah (APESS) and the Center Ecologique Albert Schweitzer) also play an important role in conducting agricultural research. Furthermore, in 2011 Burkina Faso created a national fund for research and innovation for development (FONRID) to support R&D (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	3 208.17	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	107.19	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.62	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	1.01	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2014	3.17	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2014	3.45	WEF
		ICT goods imports (% of total imports)	2019	2.74	UNCTAD

BURUNDI

Burundi is a low-income country with a population of 11.8 million people as of 2020. About 86 percent of the population was registered as employed in the agriculture sector in 2019. Burundi has 400 inhabitants per square kilometre, making the country one of the mostly densely populated in Africa. Its economy is agro-based and 86.23 percent of the people live in rural areas; with 90 percent of the population reported to be living on less than USD 2 per day. Historically, the country experienced a decade of civil war (1993-2003) which had severe effects on the economy. Burundi also experienced political instability in 2015.

While more than 50 percent of the population is chronically food insecure, Burundi has a potential to increase its food production, as the country has abundant rainfall, a large farming population, and a vast network of water bodies such as rivers, dams and lakes. The main crops grown are banana, cassava, coffee, sweet potato and beans. Coffee is the main export, accounting for more than 60-80 percent of export revenues.

Agriculture supports more than 86 percent of the labour force and accounts for 38 percent of Gross Domestic Product (GDP). Also, its GDP per capita remained low at USD 274 in 2020, making the country face great challenges in fighting against poverty. Although the government is committed to investment in ICTs, this has generally been limited, partly due to political instability. Still, in cooperation with the World Bank, the government undertook a 13 000 km fiber optic project to cover Bujumbura, 17 provinces and the borders. In 2018, the government launched the Burundi Broadband Project. A new ICT strategy running through 2028 was designed in 2020.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	11 890 781	WBG
Urban population (%)	2020	13.71	UNPD
Rural population (%)	2020	86.29	UNPD
GDP (current millions of USD)	2020	3 258	WBG
Agricultural land (km^2)	2018	20 330	FAO
Agricultural land (% of land area)	2018	79.17	FAO

INFRASTRUCTURE

Burundi's infrastructure, such as its fixed line network particularly outside the main urban areas, is limited. For transportation, Burundi relies on roads with no rail infrastructure. Most roads face erosion and are in a poor condition. Burundi's electricity needs are partially supplied by the parastatal providers; the shortfall is imported from the neighbouring Democratic Republic of Congo. Consumption in 2018 was estimated at 315.6 GWh of which 273 GWh was consumed in Bujumbura, 18.7 GWh in Gitega and 23.9 GWh by the rest of the country.

Mobile network operators include Econet Leo, Onatel Burundi, Lacell SU and Viet Nam's Vietell Telecom. Internet service providers include Cbinet, Spidernet, USAN, Lami wireless and NT Global. Two of the mobile operators launched 3G and LTE services to capitalize on the growing demand for Internet access. In February 2018, Lumitel, the Burundian subsidiary of the Viettel telecoms group, extended its 4G service to the whole country. According to GSMA, 3G and 4G network covers only 40 percent and 25 percent of the population respectively (GSMA, 2019) (see Table 2).

The first sections of the fiber optic network project launched by World Bank and the government were switched on in early 2014, and additional provinces were added later. Based on these and other positive developments, the government and the International Telecommunications Union (ITU) developed the ICT Strategy 2028 to make use of the telecommunications to promote the country's socio-economic development.

Additionally, the Burundi Backbone System Company SM (BBS), a joint venture between local telecommunications operators, signed an agreement with national regulators to install and operate over 1 000 km of fiber optic cable to cover the entire country. The resulting Burundi Broadband System (BBS) involved the creation of a 1 250 km fiber optic backbone connecting all 17 provinces. In the cooperative model, the Government of Burundi did not have an ownership stake in the BBS directly but through Onatel, a state-owned mobile network operator that controls 80 percent of the mobile telephone market. Unfortunately, some of the private operators were unable to contribute funds and Onatel faced bankruptcy after a failed privatization. As a result, the government revoked the status of BBS's status and took ownership of it.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	3.09	WBG
		4G coverage (% of total coverage)	2019	25.00	GSMA
		Mobile (device) ownership (% of population)	2019	40.69	GSMA
		Secure access to Internet servers (per 1 million people)	2020	8.66	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.29	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	55.77	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	11.14	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.04	ITU

DIGITAL PENETRATION

As of 2021, there were more than 1.5 million Internet users, an increase of 21 percent from 2019. Internet penetration was reported at 9.9 percent. According to Cable (2020), the average price of 1 GB of mobile data is USD 0.12 (see Table 3).

In 2019, there were 6.64 million mobile phone subscribers and mobile phone connections are equivalent to 59 percent of the total population. Mobile penetration, approaching 60 percent, remains low by regional standards, suggesting considerable room for growth. Access to Internet connectivity and mobile devices are important contributions to digital agriculture investment in Burundi. Mobile broadband coverage is still low, and operators are reluctant to expand their networks due to unpredictable regulatory environment, an adverse business environment, meagre profit margins driven by both high infrastructure deployment, maintenance costs, and weak consumer demand, especially in rural areas (World Bank, 2020).

Table 3 provides additional information related to digital penetration, for example, the price of local mobile cellular calls per minute was USD 0.12 in 2017.

Although there is limited application of technology in agriculture, agriculture represents the backbone of the country's economy and presents a huge opportunity for digital agriculture. The Agri ProFocus platform allows networking and promotion of businesses in the agricultural sector and is an example of the very limited digital services for farmers in Burundi. The platform offers network members an online space where they can be visible and showcase their activities, as well as for the promotion of their products.

Data about digital gender divide is unavailable, however, based on Digital Gender Gaps with a gender gap of approximately 30 percent in Internet use suggests that women's use of the Internet is much lower than that of men in Burundi.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.12	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	4.47	GSMA
		Number of apps in national language (quantity)	2019	6.74	GSMA
		Gender gap in social media use (%)	2019	20.20	GSMA
		Gender gap in mobile ownership (%)	2019	10.57	GSMA

POLICY AND REGULATION

The Regulatory Agency for Telecommunications (ARCT) is responsible for regulating communications in Burundi. ARCT regulates by processing applications for licenses, establishing standards for equipment and operation, arbitrating disputes, ensuring fair competition, and managing the frequency spectrum. However, in Burundi there are two models for governance regarding the digital or ICT sector: a supra-ministerial entity (President's Office) and a line ministry level policy oversight. The strategic framework is guided by the Politique Nationale de Développement des Technologies de l'Information et de la Communication (PNDTIC 2010-2025), i.e. The National ICT Development Policy 2010-2025; the National Development Plan 2018-2027 and the Burundi ICT Strategy 2028.

While these policies assign implementing functions to existing institutions, the respective institutions have limited capacity to conduct the said functions and these policies were found to lack a clear roadmap (World Bank, 2020:23). For example, the PNDTIC 2010–2025 set ambitious objectives and indicators that have not been achieved, such as one computer per census hill, at least one multi-service tele-centre per municipality and to spread applications in local languages. It remains to be seen if the new strategy launched in 2020 will yield positive results.

However, the government has enacted new laws to support digital payment systems to facilitate mobile money services, which is another opportunity for digital agriculture solutions in the area of financial services and mobile payments. International Communications Consultancy Organisation (ICCO) is an international emergency relief and development organization made up of the partnership of 13 mobile finance institutions (MFIs) to develop their capacity to scale up mobile money services to rural communities and smallholder farmers.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.03	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.04	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.35	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.35	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	64	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The COVID-19 pandemic led to a recession. Burundi's annual GDP growth contracted, reaching 0.3 percent after four-year increase, pushing the country deeper into poverty. Investment figures in Burundi have shown a similar declining trend, According to UNCTAD's 2020 World Investment Report, FDI inflows to Burundi are quite limited, with agriculture and mining attracting more investments.

The government has made progress in terms of improving the business climate notably through the adoption of a new investment law. However, the investment culture is still characterized by political instability, high cost of public services, ambiguous trade policies, poor infrastructure, low skilled labour and limited privatization. See Table 5 for specific parameters on doing business in Burundi.

Digital entrepreneurs in Burundi are limited but emerging. This is impacted by the high cost of data, electronic gadgets and a small market for digital solutions. Additionally, finance for start-ups is not available due to institutional and policy support for new digital entrepreneurs. Examples of budding start-ups include PayWay a payments platform aggregator, E-Soko (an online e-commerce market platform), and Nova taxi (a ride-hailing application).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.56	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.57	WEF
	Entrepreneurship	Time required to start a business (days)	2019	5	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.83	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.59	WEF

HUMAN CAPITAL

The government has prioritized primary education and as a result primary school children are performing better than regional averages. However, significant challenges exist. For example, the influx of children in schools due to a free education for all policy and poor resourced schools. Even though basic digital skills are mandatory and embedded into secondary school, few schools are able to deliver relevant training and ensure the quality (World Bank, 2020:14). Since over 86 percent of the country's population is employed in the agriculture sector, with the education system not addressing digital skills, Burundi's digital agriculture landscape has a digital skills gap.

The following statistical figures from 2018 are indicative: Basic education had a Gross Enrolment Ratio (GRE) of 111 percent (total), 111.2 percent (female), 111.7 percent (male), secondary education had a GRE of 48.5 percent (total), and tertiary education had a GRE 6.1 percent (total), 3.8 percent (female), 8.4 percent (male). In universities, ICT is taught as a subject, however, there are no notable outcomes due to the absence of adequate connectivity, electricity and ICT equipment. However, the government is committed to creating new higher education disciplines available for students, which will include areas such as technology and AI (Government of Burundi, 2020 and World Bank 2020:48). Higher educational institutions are now offering ICT-related courses either as crosscutting or dedicated departmental courses. For example, during the 2017/2018 academic year, approximately 3 431 students were reportedly enrolled in related courses (World Bank, 2020:49).

The private sector is reported to be offering some digital skills training although specific data reference is unavailable. Burundi's only tech hub, Buja Hub, is also offering a series of digital skills initiatives. For example, it is an implementing partner of the Digital Skills 4 Africa initiative run by Google. There are also pockets of digital skills training by NGOs or international organizations, although concrete data is not readily available.

There is still a need for unified human capital development in digital skills, within higher education and specific to agriculture digital skills, while training needs to be part of the national agenda. Access to electricity, connectivity, lack of ICT equipment and enabling policies do inhibit Burundi's human capital investment in digital agriculture.

If properly invested in, digital skills are poised to create new jobs, spur innovation and transformation of the informal sector, while ushering new entrepreneurial skills (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2017	68.38	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2017	88.22	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.22	WEF
	Employment	Employment in agriculture (% of total employment)	2019	86.21	ILO
		Employment in agriculture, female (% of female employment)	2019	93.66	ILO
		Unemployment, total (% of total labour force)	2020	0.80	ILO

AGRO-INNOVATION

Agricultural innovation is at its infancy in Burundi with low in-country R&D. Family farming provides 95 percent of the food supply with low investment in mechanization and technology. The Ministry of Agriculture manages the Institut des Sciences Agronomiques du Burundi (ISABU), which conducts agricultural research, and the Centre National de Technologie Alimentaire (CNTA), which promotes technological innovations for food processing (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	1 070.91	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	149.62	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.06	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.39	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.03	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.36	WEF
		ICT goods imports (% of total imports)	2019	2.43	UNCTAD

CABO VERDE

Cabo Verde is a lower-middle-income country with a GDP of USD 1.7 billion. The country has a population of 555 988 of which 66.6 percent live in urban areas. Poverty fell to 35 percent in 2015 and is mainly concentrated in rural areas. Much of urban poverty is a consequence of deprivation and economic decline in rural areas (see Table 1).

The agriculture sector (9 percent of GDP) is developing but lags far behind meeting domestic needs. Only 19.6 percent of the country's land is used for agriculture, while Cabo Verde imports 85 percent of its food needs. Crops produced by smallholder farmers include maize, beans, sweet potatoes and cassava. Services account for roughly 74 percent of economic activity and 65 percent of labour force participation, mostly in tourism. In 2005, 81 percent of rural households in the country were involved in primary sector activities directly linked to agriculture and livestock.

Agriculture employs 10.6 percent of the population and continues to be adversely affected by the impact of the year-long drought of 2017 which caused enormous and unpredictable risks for rural populations. Cabo Verde has made progress in its ICT sector, having liberalized it in 2005, with measures taken to encourage competition, to bring economic growth, expand opportunities and improve service delivery and quality. The vision of Cabo Verde as an ICT hub aims at contributing to this economic diversification, leveraging digital technologies. It has been articulated in the Strategic Plan for Sustainable Development (PEDS in its Portuguese acronym - Plano de Desenvolvimento Sustentáve) for the 2018-2030 timeframe.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	555 988	WBG
Urban population (%)	2020	66.65	UNPD
Rural population (%)	2020	33.35	UNPD
GDP (current millions of USD)	2020	1 704	WBG
Agricultural land (km^2)	2018	790	FAO
Agricultural land (% of land area)	2018	19.60	FAO

INFRASTRUCTURE

The country has shown a strong political will to develop its telecommunication infrastructure, to transform Cabo Verde into a digital platform of quality services. Access to electricity in urban areas is high at 95.3 percent coverage and 95.9 percent in rural areas respectively making it a unique case with better access in rural than in urban areas. Cabo Verde is undergoing technological change thanks to a USD 60 million investment from Cabo Verde Telecom to deploy 4G via fiber to the home. The incumbent operator has obtained USD 25 million funding from the European Investment Bank (EIB) to connect the country to the EllaLink cable that came into service at the end of 2020. At the same time, Huawei is developing a pilot experiment of 5G implementation according to the Multisectoral Economic Regulation Agency (ARME) of Cabo Verde. The Government of Cabo Verde has awarded telecom companies CV Mobile and Unitel T+ the frequencies and license to offer 4G services to consumers.

The number of mobile connections was equivalent to 102.3 percent of the total population in January 2021, with Internet penetration reaching about 61.9 percent across the country. However, there is a gap between mobile Internet coverage and adoption, 30 percent of the population have access to mobile broadband but do not use it.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	95.94	WBG
		4G coverage (% of total coverage)	2019	0.00	GSMA
		Mobile (device) ownership (% of population)	2019	75.76	GSMA
		Secure access to Internet servers (per 1 million people)	2020	178.06	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.48	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	97.98	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	76.54	ITU
		Fixed broadband subscriptions (per 100 people)	2020	4.47	ITU

DIGITAL PENETRATION

Digital technologies represent a great opportunity for Cabo Verde but at the cost of USD 4.8 per 1 GB of data that has remained relatively unchanged over the last five years, affordability remains a main obstacle. The per minute cost of prepaid cell phone local calls and text message decreased slightly over the period 2013-2017.

As of January 2021, Cabo Verde had 346 000 Internet users and an Internet penetration access rate of 70 percent. In addition, 82 percent of mobile applications are in the national language and 63 percent of the population have access to the top ranked applications. In terms of social media, Cabo Verde had 300 000 users and a penetration rate of 53.7 percent as of January 2021 (see Table 3).

Through the implementation of the eGovernment project, the government of Cabo Verde is attempting to build a nationwide eGovernment office network and a national data centre. The first phase of the eGovernment project was initiated in 2010 and delivered in 2014, which mainly included the construction of a national

data centre and an upgrade of the government communications network. The second phase of the project further upgraded the ICT infrastructure. The integrated ICT training system WebLab was jointly developed with the Cabo Verde Ministry of Education to support the country's ICT talent cultivation. Cabo Verde's Núcleo Operacional para a Sociedade de Informação (NOSi, in English the Operational Nucleus for Information Society) developed more than 150 websites and 77 types of eGovernment software, covering social security, agriculture, distance learning and tele-health, and Enterprise Resource Planning (ERP) for all government departments, schools, hospitals, and state-owned enterprises in Cabo Verde.

In 2019, a group of 60 farmers gathered for the launch of the first mobile phone app that enables them to access micro-credit in a climatically patterned region by Caixa Economica.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.81	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	2.76	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	2.59	ITU
	Willingness	Mobile social media penetration (%)	2019	48.48	GSMA
		Number of apps in national language (quantity)	2019	82.83	GSMA
		Gender gap in social media use (%)	2019	85.93	GSMA
		Gender gap in mobile ownership (%)	2019	80.41	GSMA

POLICY AND REGULATION

Significant reform of the ICT sector has taken place since the mid-2000s. A new telecommunications law was introduced in 2005 that ended the fixed and international communications monopoly of Cabo Verde Telecom (CVT). The Multispectral Economic Regulation Agency (Agência Reguladora Multisectorial da Economia [ARME]), the industry regulator, was created in 2018. A second mobile operator, T+ Telecomunicações, was launched in December 2007 as a competitor to CVT.

In 2004, the government created NOSi, a cross-cutting and comprehensive unit for critical state reform and administrative modernization, with ICT as its foundation. NOSi seeks to establish an information society by implementing specific measures to mobilize society, the private sector and the public sector to take initiatives that spur e-governance. NOSi is split across three entities: NOSiCloud, NOSiApps and NOSiAkademia, operating respectively in cloud computing, e-government and online support sectors.

Cabo Verde's Digital Strategy (EDCV) is being implemented in alignment to the vision adopted by the Government Program for the IX Legislature (2016–2021). The EDCV reassesses the seven "action pillars" of the Strategic Plan for the Information Society (PESI) approved in 2005 by the government of VIII Legislature. Among Cabo Verde's legislations and strategic plans, the country is signatory to the Budapest Convention, and has articulated a national strategy on cybersecurity in 2016 as well as legislation on cybercrime in 2017.

The government has also launched a series of ICT initiatives, including the construction of secure data centre capacities, programs to attract members of the diaspora who possess advanced digital skills, and plans to improve international access through submarine cables, in line with the government's plans to taking a leadership position vis-à-vis its digital economy. The EIB loan will provides USD 60 million of new investment to Cabo Verde Telecom that will also

expand 4G coverage across 10 islands, expand fiber optic Internet access to homes while enabling renewable solar energy to power the telecom network.

The ideal of creating an ICT cluster in Cabo Verde is based on the transformation of the country into an international centre for business. To that end, the government has created the Institute of Support and Business Promotion (Pro Empresa) offering several programmes such as Young StartUp, Micro Entrepreneurship, Procredit and Express+. REMPE and PROMEB are supported by FAO and the African Development Bank (AfDB) to promote blue economy innovation and entrepreneurship.

Cabo Verde prioritizes the fight against poverty and the development of agriculture in its programs and policies, such as the National Development Plans from 1980 to 2002 and the Strategic Plan for the Development of Agriculture (PEDA) 2004–2015.

The government has launched the Strategic Plan for Sustainable Development (Plano Estrategico de Desenvolviment Sustentavel, PEDS), an ambitious development strategy for 2017–2021. It aims at positioning Cabo Verde as a mid-Atlantic economic hub based on the circulation of people, goods and information and the provision of IT and logistics services. The PEDS envisions an ambitious five-year USD 4.3 billion programme that aims at accelerating growth, building on ongoing support from the international community and fostering greater involvement of the large and affluent Cabo Verdean diaspora, notably in transfers of technology, know-how, and entrepreneurship. In 2018, the government began the second phase of PEDS, the objective of which was to reduce poverty and inequalities, aiming at producing agricultural products by investing in training and machinery.

Furthermore, The Institute of Quality Management and Intellectual Property has a remit for policy implementation and monitoring of all IP-related rules and regulations. The main laws and regulations for the protection of intellectual property (IP) rights are the Law on Copyright, the Industrial Property Code and the Resolution 25/2010 that include inventions, utility models, factory, trade and services marks, industrial designs, names and emblems of establishment, logotypes, and awards, among others.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.47	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.38	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.25	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.72	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	81.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In its investment promotion policy, the Government of Cabo Verde is committed to providing benefits and facilities to foreign investors and local entrepreneurs. Cabo Verde has adopted an open but fragmented FDI entry regime through its 2012 Investment Law (UNCTAD, 2018). The law defines the general conditions of entry in economic activities, and it also guarantees freedom of enterprise and equal treatment of foreigners. The government created a guarantee fund to improve access to credit and stimulate private financing, and has also sought to reduce tax burdens, simplify the system of tax declaration and payment of taxes. All these measures serve to extend free access to the Cabo Verdean market to various economic actors (see Table 5).

The government is also developing a data-matching platform to detect tax fraud, reinforce arrears recovery, and strengthen the technical skills and capacity.

That said, although SMEs generate 70 percent of jobs and contribute 25 percent of GDP, their growth is constrained by the lack of access to finance and banking services. The law on Business-in-One-Day from 2018 foresees full online company registration and is implemented by NOSi, which is in charge of rolling out digital technologies in the public administration. Cabo Verde is preparing to promote direct private sector investment and public-private partnership mechanisms in establishing, exploring and maintaining fiber optic cables (Ellalink Amilcar Cabral, PEACE and DILCE) and building the data centre in Mindelo.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	104	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.64	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.62	WEF
	Entrepreneurship	Time required to start a business (days)	2019	9	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.04	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.62	WEF

HUMAN CAPITAL

Employment in agriculture has declined over the past five years, from 14.6 percent in 2015 to 10.6 percent in 2019. This regression was observed in the level of employment in agriculture for women (percent of female employment). Youth unemployment is high: in 2019, 50.38 percent of people aged 15–24 were unemployed. Most unemployed youth live in urban areas (see Table 6).

Until recently, Cabo Verde relied on foreign schools for tertiary education. The University of Cabo Verde was created in 2016, but its curricula focus largely on theoretical studies, rather than fostering the development of technical skills and offering specialized training, which are essential for economic diversification in the target sectors, including digital. The teaching of agricultural entrepreneurial culture has not been prominent either. Furthermore, there are very few technical and vocational institutions in Cabo Verde that could offer digital agriculture programmes.

On the other hand, The Mundu Novu (New World) programme that started in 2009 seeks to integrate ICT in the Cabo Verdean education system. This includes equipping classrooms and promoting access to computers as a way to bridge the digital divide. Weblab, a technological initiation program was launched in 2018 in 44 secondary schools across the country, with approximately 6 000 students enrolled in three technology modules.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2015	86.79	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2015	98.11	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.035	WEF
	Employment	Employment in agriculture (% of total employment)	2019	10.6	ILO
		Employment in agriculture, female (% of female employment)	2019	5.47	ILO
		Unemployment, total (% of total labour force)	2020	13.41	ILO

AGRO-INNOVATION

Agricultural productivity remains variable due to Cabo Verde's geographic location, physical and climatic conditions (semi-arid region of the Sahel), vulnerability to erosion and desertification and its mountainous relief. Furthermore, inequalities in land ownership, fragmentation of small farms, limited water resources and the high cost of mobilization exert additional pressure on the already scarce cultivable land (10 percent of the area) (see Table 7).

Challenges in research and technological development through the strengthening of university-industry cooperation in R&D persist. Although the University of Cabo Verde plays an important role in training agricultural scientists, the country's higher education sector is not involved in digital agriculture R&D. The Instituto Nacional de Investigação e Desenvolvimento Agrário (INIDA) is the only agency involved in agriculture R&D in Cabo Verde. Despite an increase in the number of post graduate qualified scientific researchers at the master's level in recent years, the institute lacks a critical mass of PhD-qualified researchers, especially in the digital agriculture transformation processes.

The Cabo Verde Technology Park is under construction and will serve as a physical space where all ICT initiatives congregate, creating an ecosystem that is based on close collaboration of businesses and technology. In addition, the Cabo Verde Digital initiative is a public agency promoting values of entrepreneurship and innovation. It is the government's arm to follow up on a series of public initiatives, including a coding school for children, scholarships to create businesses, and public support to attract digital nomads to the country. It aims at creating a leading digital hub across three areas of intervention: community, training, and acceleration.

Another initiative is the NOSi Akademia, a training and qualification programme, which offers professional internships and certification. It is inherent in the NOSi mission to lead the digital transformation in the public sector, to improve citizens' lives and promote innovative collaborations among companies.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	88.34	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	80.27	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	N/A	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	1.17	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.22	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.68	WEF
		ICT goods imports (% of total imports)	2019	3.04	UNCTAD

CAMEROON

Cameroon is a lower-middle-income country with an estimated population of 26.5 million as of 2020. Agriculture forms the backbone of Cameroon's economy, employing 43 percent of its workforce (49 percent of whom are women). It provides 15.1 percent of the country's GDP and 30 percent of its export revenue. Cameroon's agrarian population is essentially made up of small-scale farmers and their families, who constitute approximately 70 percent of the population. The number of poor individuals in the country increased to 8.3 million people with 90 percent of them living in rural areas (see Table 1).

The contribution of the digital sector to the country's GDP is still very low at 2.9 percent, providing 10 000 direct and 500 000 indirect jobs. Other areas that have seen considerable progress include increase in household equipment (such as radio, television, and computer) and the regulation of quality of service. However, other targets still appear to be far from reach, such as the number of jobs in the digital space or the percentage of the population with access to mobile broadband (MINSPOTEL, 2018).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	26 545 864	WBG
Urban population (%)	2020	57.56	UNPD
Rural population (%)	2020	42.44	UNPD
GDP (current millions of USD)	2020	39 802	WBG
Agricultural land (km^2)	2018	97 500	FAO
Agricultural land (% of land area)	2018	20.63	FAO

INFRASTRUCTURE

Cameroon has seen a slow increase over the years of access to electricity with about 24 percent electricity distribution in rural areas. By 2020, the government had aimed at achieving a 48 percent countrywide electrification rate, a 75 percent electricity access rate in urban areas and a 20 percent rural electrification rate.

In terms of mobile connectivity, Cameroon has 4G services available in some parts of the country with 53.4 percent coverage. Moreover, more than half of the population (56.7 percent) owned mobile devices as of 2019. Cameroon has four major telecommunication service providers (MTN, Orange, Viettel, and the state-owned CAMTEL) and one virtual operator (YooMee). MTN is the leading service provider with 48 percent of the mobile market share or 8.7 million subscribers. MTN's and Viettel's 3G and 3.5G networks reached almost 90 percent of households nationwide in 2019 each (98 percent in urban areas and 84 percent in rural areas).

Even though Cameroon has high mobile broadband (3G, 3.5G and 4G) coverage, only 23 percent of households nationwide had an Internet connection (mobile or fixed) in 2019, and this percentage is much lower in rural areas, especially in the Centre, Northwest, and Adamawa regions. This is despite the fact that over 50 companies provide Internet in Cameroon with over a million clients subscribed through AIRBITS, Matrix, CFAO Technologies, etc. In addition, 89 percent of households possess a phone (at least 7 households out of 10 regardless of the region. About 14 percent of households own a computer (29 percent in urban areas, 5 percent in rural areas).

Cameroon is making steady progress in establishing a supportive infrastructure toward a digital economy. The Cameroon Digital 2020 programme aims at refining connectivity nationwide, including the National Broadband Network for the establishment of modern high-speed telecommunication infrastructure and service platforms in Cameroon (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	24.02	WBG
		4G coverage (% of total coverage)	2019	53.40	GSMA
		Mobile (device) ownership (% of population)	2019	56.73	GSMA
		Secure access to Internet servers (per 1 million people)	2020	16.73	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.82	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	95.1	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	14.63	ITU
		Fixed broadband subscriptions (per 100 people)	2020	2.69	ITU

DIGITAL PENETRATION

Currently, the average cost of 1 GB of data is USD 2.74 per month, and with the proposed levy of CFA 200 (USD 0.34) on software and application downloads, costs are expected to further increase. With an estimated per capita income of USD 1 500 in 2018, the prevailing rates are over and above the recommendation of 1 GB of data costing 2 percent or less of average monthly income. The percentage of individuals

using the Internet increased from 10 percent in 2013 to 23 percent in 2017, while computer penetration was at 13.7 percent in 2017 (see Table 3).

The low penetration rate of Internet is common for both genders with only 36 percent of women compared to 45 percent of men as Internet users are mostly in urban areas, leaving rural regions underserved.

In 2019, GSMA reported that about 13.9 percent of the country's population actively engaged with social media platforms while 48 mobile apps existed in the national language. However, less than 1 percent of Cameroonian companies in the sectors of manufacturing, wholesale trade and retail services sell products and services online. About 90 percent of companies used a computer in 2016 (93 percent for SMEs) and 76 percent of companies had an Internet connection in 2017 (73 percent for SMEs). This is steadily improving due to rapid growth of e-commerce platforms. There are also gaps in financial inclusion, with 31 percent of men having access to financial accounts versus 23 percent of women. While close to 30 percent of the adult population made or received a digital payment, only 5.2 percent paid their utility bills digitally through online platforms.

From a public perspective, Cameroon is using GIS systems to first register land before implementing redistribution mechanisms (WEF et al., 2015). The country launched the NEXUS+ app for tracking cargo by geolocation. The partnership between public-private sector has also strengthened over the years. For example, the country's telecom providers collaborated with AgroSpace and Agro-Hub to provide market linkages to eliminate price asymmetry between rural farmers and buyers (see Table 3).

Cameroon has a number of innovative start-ups such as Digifarms, Help Farmers Cameroon, Africaware and Agrocom that provide a range of solutions from data management, e-commerce, advisory services, financial and marketing linkages to early warning solutions. Jangolo is a farm management mobile application that supports farm productivity, serving 8 000 farmers in Cameroon, and providing a platform for bookkeeping, logistics, sales, training, and access to the market prices. Agrix Tech provides recommendations in local languages using interactive voice response (IVR), and Freshbag is a platform that connects farmers and vendors.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.75	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	13.93	GSMA
		Number of apps in national language (quantity)	2019	48.01	GSMA
		Gender gap in social media use (%)	2019	59.06	GSMA
		Gender gap in mobile ownership (%)	2019	75.31	GSMA

POLICY AND REGULATION

The country's digital landscape was boosted by the launch of the National Strategy of Digital Cameroon by 2020 in 2016, which recognised the digital economy as a driver of development. This is supported and complemented by the eGovernment Master Plan and other initiatives such as information and knowledge-based society by the Ministry of Scientific Research and Innovation; implementation of ICT development programmes by the Ministry of Higher Education; and the introduction of compulsory ICT related programs in primary and secondary schools.

The new wave of digital agriculture requires more robust policy formulation, implementation and regulatory frameworks. Laws enacted to promote digitalization and ICT services include the Framework or Law on Consumer Protection, Cybersecurity and Cybercrime Law and the Law on Electronic Commerce in Cameroon.

The government's digital strategic plan includes prioritising digital entrepreneurship. This includes developing a local digital industry, and encouraging research and innovation, with the specific objectives for producing more computers and ICT products domestically, reducing ICT imports, and creating research and development hubs for digital technologies. Potential actions include enacting taxation measures to support start-ups, creating a venture capital fund, using government procurement to support company innovation, and setting up a forum between the government and ICT companies (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.57	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.11	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.41	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.12	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	64	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Cameroon is moving steadily towards digital transformation with the share of its national budget allocated to ICT increasing from 0.5 percent in 2010 to 1.2 percent in 2017. Between 2000 and 2016, the digital economy's contribution to Cameroon's GDP increased from 1.4 percent to 5 percent and generated 10 000 direct jobs and USD 232 million in tax revenues. The government initiated several projects including undersea cables, the Central African Backbone, urban optical loops, a National Broadband Network (NBN) project, an e-Post project, a Pan-African network of online services and Multipurpose Community Telecentres, investing CFA 700 billion. In 2015 a contract was signed with Huawei to provide electrification for 350 villages in Cameroon.

Cameroon's diverse financial landscape has 454 active formal institutions, including 11 banks,

six financial institutions, 412 MFIs, 19 insurance companies, four electronic money institutions, and the postal service. Digital finance services are provided by banks in partnership with telecom operators. Access to financial services grew from 12.2 percent in 2014 to 34.6 percent in 2017. On average, there are only 3.64 ATMs per 100 000 adults.

The business development service sector shrunk, both in absolute terms from 5 303 firms in 2009 to 1 337 firms in 2016 and as a share of economic activity. Most enterprises are online marketplaces and IT services or Internet cafes, rather than high-value software programming or hardware development.

The percentage of firms with female participation in ownership is 39.7 percent, the percentage of firms with majority female ownerships is 31 percent and firms with a female top manager is 22.9 percent (World Bank, 2016). There are avenues dedicated to women entrepreneurs, such as Fintech Challenges or B2B platforms initiatives with the German Federal Ministry for Economic Cooperation and Development (BMZ) (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	782	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.32	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.38	WEF
	Entrepreneurship	Time required to start a business (days)	2019	13.5	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.21	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.86	WEF

HUMAN CAPITAL

The country has a comparatively literate youthful (85.1 percent) and adult population (77.1 percent). And while digital literacy does not seem to correspond with mean performance (WEF, 2019), the government has successfully integrated ICT into Cameroon's education curriculum aimed at empowering youth and equipping them with the needed digital skills for development.

As of 2021, there were nine technical schools of agriculture, six training schools, three regional agriculture colleges, 35 farmer training centres, 24 rural training centres and 11 young farmers training centres. The private sector has also taken the lead in building youth capacities to support the digital agriculture sector. For instance, the Knowledge for Development without Borders (KFDWB) NGO partnered with other development agencies, universities and local communities to provide ICT training for girls in a rural area of Cameroon.

At the private level, family farm schools, the family and rural schools created in the 1990s, and rural family houses provide training to rural people for their social and professional integration. The NextGen Centre is a technological school with a special focus on girls, which currently has over 800 pupils trained in STEM-related courses. In addition, since the launch of the Huawei ICT Academy in Cameroon, 236 teachers have been certified while 659 students have been trained in ICT through the e-learning platform Learn On.

Several initiatives to support the socio-professional integration of young people have been launched by the Ministry of Youth and Civic Education: the Multifunctional Centers for the Promotion of Youth; the Rural and Urban Youth Support Project and the National Civic Service of Participation in Development. New training niches have also emerged in universities with the creation of specialized majors to provide Cameroon with highly qualified human resources in the field of ICT. Students are trained in management of information systems, industrial IT, computer systems maintenance, electronics, computer engineering, telecommunications and networks, and communication (MINEDUB, 2018). The Divisional Reward of Excellence in Digital Economy (MDN) provides support and awards to best students for digital inclusion in rural areas (2035 MIJEF programme) as well as the donation of computers and printers to administrative services and schools of said localities.

Also, 20.2 percent of companies have an IT specialist (computer technician, telecoms personnel, etc.). This proportion is very high in large companies where 73.6 percent have ICT specialists (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	77.07	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	85.08	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2018	3.90	WEF
	Employment	Employment in agriculture (% of total employment)	2019	43.49	ILO
		Employment in agriculture, female (% of female employment)	2019	47.70	ILO
		Unemployment, total (% of total labour force)	2020	3.62	ILO

AGRO-INNOVATION

Compared to the 2018 budget of CFA 1.6 billion, the country's agriculture sector has since suffered budget cuts. The allocation also represented only 1.75 percent of the annual budget allocation. In the area of research and innovation, there is limited collaboration between educational institutions and industry (UNESCO, 2018). The rare cases of digital innovation are typically process innovation or business model innovation. However, the support ecosystem around entrepreneurship has been growing, and as of 2021, the country has 18 technology hubs.

Cameroon has an important wealth of digital start-ups with a significant transformation potential in very large companies. Over 3 000 digital start-ups are recorded in the sector of application development, virtual and augmented reality, artificial intelligence, robotics and e-commerce. These start-ups actively cooperate and communicate through premises such as ActivSpaces, a physical co-working space, and two WhatsApp groups with more than 250 members. These fora enable digital entrepreneurs to meet and exchange information.

Digital innovation in Cameroon is supported through various initiatives such as Globe-trotter, which aim at supporting young digital start-ups to transition their projects into digital companies. In addition, 200 Cameroonian start-ups were trained in digital entrepreneurship by the Cameroon-Israel Cooperation Programme, and each year, a dozen of young Cameroonians take part in the Huawei Seeds for the Future international programme under the cooperation framework between Cameroon and China.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	5 351.50	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	107.16	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.60	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2015	0.39	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.26	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	4.29	WEF
		ICT goods imports (% of total imports)	2017	3.39	UNCTAD

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CENTRAL AFRICAN REPUBLIC

The Central African Republic is a low-income country with GDP growth down to zero (World Bank, 2021) and 57.8 percent of its population living in rural areas as of 2020. Conflicts, violence, poor health conditions, and insecurity has led to high rates of poverty with 71 percent living below the poverty line (World Bank 2018). It has also generated a large number of refugees and internally displaced persons. As a result, 85 percent of the population is severely food insecure, 40 percent of children are stunted and nearly 3 million people require humanitarian assistance.

Among all sectors, agriculture is the largest and contributed 33.9 percent to GDP in 2020. Also, 69.9 percent of the population is engaged in agricultural activities, making agriculture a main income for the majority of households. The dominant crop is manioc, while coffee and cotton are the main cash crops. The country also has abundant forest resources with timber accounting for around 16 percent of export earnings. However, forced displacements and persisting conflicts and insecurity in the country prevented agri-food value chain actors from accessing farms, services and markets, causing low productivity and profits (see Table 1).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	4 829 764	WBG
Urban population (%)	2020	42.20	UNPD
Rural population (%)	2020	57.80	UNPD
GDP (current millions of USD)	2020	2 303	WBG
Agricultural land (km^2)	2018	50 800	FAO
Agricultural land (% of land area)	2018	8.15	FAO

INFRASTRUCTURE

The Central African Republic's rate of access to electricity, has icnreased from 9.8 percent to 14.3 percent between 2010 and 2019. According to the World Bank, a slow increase has been transpiring in rural areas, starting from almost 0 in 2010, to 1.5 percent in 2019. Despite having abundant water and solar resources, little has been done to unlock this potential due to weaknesses in the country's political and institutional framework. 4G coverage jumped from 0 to 8.6 percent in 2019 (GSMA, 2019) with a high concentration in the capital, while 3G coverage is a bit higher, at 30 percent according to ITU.

Since the liberalization of the private sector, mobile operators have been playing an important role in improving ICT infrastructure in the country. For example, the Orange Group, in collaboration with Parallel Wireless and I Engineering Group, aims at deploying 3G, 4G and 5G software-based networks in the country. In this way, rural populations can also benefit from the services with faster and wireless connectivity (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	1.53	WBG
		4G coverage (% of total coverage)	2019	8.64	GSMA
		Mobile (device) ownership (% of population)	2019	24.64	GSMA
		Secure access to Internet servers (per 1 million people)	2020	1.24	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	33.62	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	5.03	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.01	ITU

DIGITAL PENETRATION

Telecommunications in the Central African Republic mainly includes radio, television, telephone (fixed and mobile). Radio is the principal channel of obtaining information. The overall Internet penetration rate was below 5 percent in 2016 and rose to 14 percent in January 2020, while fixed line connection remains lower than 1 percent per 100 inhabitants. The number of mobile connections increased by 9 percent between 2020 and 2021, and was equivalent to 30.7 percent of the total population, growing at a much faster rate compared to fixed lines. The fixed line market is mainly controlled by the Central African Telecommunications Society (SOCATEL), whereas the mobile market is more competitive with four leading companies involved. Telecel is currently the market leader, followed by Orange, Moov and Azur. Most of the telecommunication services provided are concentrated in the capital, leaving the rest of the country with low accessibility.

According to the country's telecommunications regulatory authority, around one-third of the population uses mobile phones. Despite an increase in the number of mobile phone users, digital financial services such as mobile payments (e.g. Orange Money) haven't yet been widely accepted due to the predominance of traditional cash transactions. Data provided by the World Bank (2011) indicate that only 3.3 percent of the population owns a bank or mobile-money account. The growth of mobile

phones also slightly increased social media users, with a penetration rate at 2.9 percent in January 2021 and a gender gap score of 18.35 (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	8.25	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	2.43	GSMA
		Number of apps in national language (quantity)	2019	24.43	GSMA
		Gender gap in social media use (%)	2019	18.35	GSMA
		Gender gap in mobile ownership (%)	2019	45.74	GSMA

POLICY AND REGULATION

Overall, there is room for improvement on its regulatory and legal frameworks. Efforts have been made through the launch of a few national plans and strategies. For example, the National Plan for Information and Communication Infrastructure (NICI) was launched in 2002 and the Law on Telecommunications Regulation was legislated in 2007.

In general, the country is highly dependent on support from development organizations. The World Bank Group approved a USD 50 million grant integrated into the new Country Partnership Framework to help the Central African Republic's development efforts. Meanwhile, women's empowerment and digital development are identified as cross-cutting priorities within this framework (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	58	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

According to the World Bank, the time required to start a business in the Central African Republic is 22 days, which remains unchanged since 2015 with no disparity between male and female. Due to the tedious and long procedures required for business creation, the country scored 35.6 out of 100 for its performance of doing business in 2019, below the average for sub-Saharan Africa.

The country's FDI inflows have resumed after the 2013 civil war, reaching USD 26 million in 2019. The overall business climate in the Central African Republic is not favourable for investors, due to persisting conflicts and violence and weak infrastructure within the country, leading to high risks with possible low return. The government has thus taken measures and reforms to maintain stabilization and to provide a better business environment. This includes tax reduction for agricultural products like wheat flour, milk and frozen fish, and zero rate for exports and international transport services. Internally, there are several initiatives to help SMEs start their businesses. For example, through a UNDP micro-finance programme, entrepreneurs can invest and accumulate capital while women are given specialized funds for financial assistance (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	26	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	22	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

The security situation and frequent displacements and conflicts have had negative impacts on the country's education. Schools lack human and material resources and are sometimes forced to close. The Central African Republic has a relatively low literacy rate at 37.4 percent for people above the age of 15 and 38.3 percent for youth between the ages of 15–24 as if 2018, with an evident disparity between youth male and female, at 47.8 percent and 28.7 percent respectively.

Primary education school enrolment was 87.8 percent in 2012 while the rate for secondary education was markedly lower at 17.8 percent. High school dropout rates, as well as lack of basic and more advanced education, limit the potential role formal education can play in addressing digital gaps and driving digital transformation. This is particularly relevant to the agriculture sector that employs around 70 percent of the country's population.

Even though there is no available data indicating the country's digital skills level, it is evident that problems afflicting the political environment, infrastructure, health, as well as education limit the overall progress of digitalization and lead to high dependence on external supply.

That said, the Central African Republic recognizes the importance of developing its education and digital skills. To further improve access and quality of education, the government adopted the Education Sector Plan (2020-2029). To deal with interruption of education due to security issues, other channels such as radio broadcasting have been explored to provide instruction. The Orange Foundation has also contributed to equipping schools with digital facilities and devices (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	37.40	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	38.27	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	69.85	ILO
		Employment in agriculture, female (% of female employment)	2019	72.61	ILO
		Unemployment, total (% of total labour force)	2020	4.33	ILO

AGRO-INNOVATION

As a key sector for economic development, agriculture in the Central African Republic is always playing a crucial role and receives continuous financial assistance from donors. In terms of R&D capacity within the country, there are several institutions that deploy their efforts in agricultural research. Chief among them is the Central African Agricultural Research Institute (ICRA), which is the principal agriculture research agency that focuses on crops and forestry, while the National Livestock Development Agency (ANDE) conducts livestock and veterinary research.

The latest available figures shows that the Central African Republic spent USD 2.7 million on public agricultural research in 2011, an increase of 41 percent compared to 2009. However, as another main funding source, donor funding of agriculture R&D fluctuates due to political instability.

In terms of areas of research, crops and livestock remain the two main thematic areas for research, accounting for 53 percent and 41 percent respectively. The gender gap of researchers is huge with 81 percent being male and only 19 percent being female. Furthermore, R&D in the Central African Republic still faces many critical challenges, including weak infrastructure, lack of training, lack of qualified researchers, and low income to retain talent.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	622.23	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2016	105.99	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.15	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.40	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2018	3.87	UNCTAD

CHAD

Chad is a low-income country with a GDP of USD 10.09 billion. The country began exploring its oil resources in 2003, which has since been the backbone of the economy constituting 60 percent of export revenues. The population is estimated to have grown by 3.1 percent in 2021 with only 23.5 percent living in urban areas. Poverty levels however remain high with an estimated 66.2 percent of Chad's population living in severe poverty (see Table 1).

The country's agriculture sector is a major contributor to the economy constituting 47.7 percent of GDP in 2020 (World Bank, 2020). The sector is also a key employer in Chad's labour force with about 75.1 percent of Chadians and 73.4 percent of women obtaining their livelihoods from agriculture. Key non-oil exports emerging from the agriculture sector are cotton, gum arabic and livestock. Although agriculture land constitutes 39.9 percent of the total land area, only 6 percent is under cultivation. This is due to the adverse impact of climate change, resulting in long periods of droughts that adversely impact smallholder farming activities (World Bank, 2019). Smallholder farmers have adopted sustainable solutions including rainwater harvesting techniques, although this remains a challenge with just about 1 percent of agriculture land under irrigation.

Productivity in agriculture is hampered by knowledge and technology gaps, which points to the potential of digitalization to transform the agriculture sector in Chad. The ICT sector in Chad is already benefitting from streamlining of policy direction with discussions in 2020 on how digital technologies can be integrated in all key socio-economic activities, including agriculture.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	16 425 859	WBG
Urban population (%)	2020	23.52	UNPD
Rural population (%)	2020	76.48	UNPD
GDP (current millions of USD)	2020	10 093	WBG
Agricultural land (km^2)	2018	502 380	FAO
Agricultural land (% of land area)	2018	39.90	FAO

INFRASTRUCTURE

As a country on the road to recovery, Chad's infrastructure is being steadily redeveloped. Access to electricity is currently low with a rate of 8.4 percent in 2019 due to inadequacy of transmission and distribution networks (World Bank, 2018). Limited citizen engagement on the Internet since 2018 also slowed down progress in expanding Internet access with an estimated 37 percent and 26 percent mobile and broadband connections respectively as of 2020 (We are Social and Hootsuite, 2020). Mobile connectivity is not yet easily accessible to the over 78 percent of rural dwellers. About 85 percent of the entire population has 2G coverage , while 15 percent of the population is not covered at all by mobile signals from the two largest operators (GSMA, 2016). The cost of operation by MNOs has gone up with tax on mobile operations increasing from 7 percent in 2016 to 9 percent in 2019. Airtel Chad and Tigo Chad are the two MNOs offering 3G and 4G services within reach of 25 percent of the population. LTE services by Tigo Chad, expansion in broadband capacity from O3b networks by 66 percent and the expansion of national fiber backbone infrastructure provide a positive outlook of the sector. The telecommunication industry has potential to drive economic growth. This is further complemented by other promising steps such as the European Investment Bank Initiative towards digitalization, especially in rural areas. Chad has been allotted a USD 12 million investment to double the ICT sector's contribution to the country's economy. Millicom has set up a data management centre with an IT power load of 400 kW (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2018	2.28	WBG
		4G coverage (% of total coverage)	2019	12.00	GSMA
		Mobile (device) ownership (% of population)	2019	39.77	GSMA
		Secure access to Internet servers (per 1 million people)	2020	1.28	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	52.89	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	2.98	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0	ITU

DIGITAL PENETRATION

Following the lifting of an earlier ban on Internet services by the government, the number of mobile connections increased by 10 percent between 2019 and 2020, with a massive increase of 252 percent in users engaged on social media (We are Social and Hootsuite, 2020). The use of mobile phones also increased with a recorded 34 percent shift between 2019 and 2020, bringing ownership to 75.5 percent of the entire population.

Focusing on rural areas, the ITU (2018) reports that although mobile coverage is limited in rural areas, about 52 percent of households owned mobile phones. In terms of the cost of services, the ITU indicates that voice and SMS usage constituted 21 percent of average monthly gross national income (GNI) and 87 percent of the income of the lowest 20 percent of earners in 2014 (see Table 3).

There has also been a surge in the number of mobile app developers, transforming service delivery in the country. The use of mobile based applications continues to rise with 15 percent of Chadians registered on mobile money platforms as of 2014 (We are Social and Hootsuite, 2020). The steps to recovery in the country has triggered the entrepreneurial ecosystem with MNOs and financial institutions collaborating to provide electronic and mobile money solutions. In the donor community, mobile phones have equally been leveraged for surveillance of pastoralists and their activities in rural areas.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	23.33	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A,	ITU
	Willingness	Mobile social media penetration (%)	2019	2.04	GSMA
		Number of apps in national language (quantity)	2019	10.95	GSMA
		Gender gap in social media use (%)	2019	8.16	GSMA
		Gender gap in mobile ownership (%)	2019	0.00	GSMA

POLICY AND REGULATION

The Ministry of Posts and New Information Technologies currently oversees ICT development, serving as a lead implementer of the country's ICT strategy. Among actions prioritised by the ministry is the mainstreaming of ICT solutions into policy reduction initiatives and bringing them to the doorsteps of vulnerable populations mostly found in rural areas (ITU, 2018). As of this publication, announcements by the government point to a proposed new digital strategy for the next 10 years (2020-2030). The government's current National Development Plan was already expected to drive industrialization of agriculture and boost exports by the end of 2021. The current vision 2030 plan also seeks to develop infrastructure that boosts industrialization as well as prioritize ICT infrastructure that enhances low-cost access and supports innovation in the agriculture sector. The plan also seeks to align efforts in improving resilience in farming systems, especially in dry areas, by preserving biodiversity and enhancing climate adaptation strategies.

To augment government efforts, the World Bank for example approved a USD 41 million grant in 2018 to promote the adoption of technological innovations in the agriculture sector for sustainable food production (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	2.97	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.45	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.47	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.02	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	58.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The oil and gas industry in Chad has contributed to expansion in related businesses and investment in the country, but the business environment still suffers from political instability and infrastructure deficiencies affecting investor interest. That said, the government has doubled efforts to reform the business environment and diversify the economy.

Earlier efforts such as that by the African Development Bank to support the operations of small and medium enterprises in 2013 highlighted weak institutions, difficulty in accessing finance, and poor enforcement of regulations as challenges affecting growth of businesses. Key proposed strategies aimed at eliminating these barriers were the promotion of public-private dialogue, reduction in taxes and levies, creating more opportunities for private sector growth and strengthening the financial sector to provide credit for start-ups.

Institutions such as AFSIC- Investing in Africa have prioritized the agriculture sector in recent efforts at attracting investors into the country. AFSIC creates networking platforms for businesses and shares information on opportunities within the agriculture sector in the country. Also, FDI inflows have increased with USD 567 million investment capital pumped into the economy in 2019 and USD 461 million in 2018, mostly into the oil sector (UNCTAD, 2020) (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	567	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	2.78	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.01	WEF
	Entrepreneurship	Time required to start a business (days)	2019	58	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/extremely easy)	2017	2.46	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.03	WEF

HUMAN CAPITAL

The influx of refugees into Chad as a result of three major humanitarian crises presented challenges in the educational sector. This impacted related indices such as literacy and learning. Adult literacy stood at 22.3 percent in 2016 (World Bank, 2016) and youth illiteracy around 69 percent, translating into 2 million youth unable to read and write (UNICEF, 2014). Generally, access to higher education is low with secondary school enrolment recorded as 20.5 percent as of 2019 showing no significant change compared to 2018 (20.2 percent).

Initiatives have been implemented to create the right support system in education to develop the country's human capital. In 2019, the Ministry of National Education and Civic Promotion organised a teacher' training programme to bring teachers up to speed with the right teaching techniques, among others. The most recent attempt at promoting ICT education led to the development of a 10-year strategy called Education and Training in Liaison with Employment (EFE) prioritizing how ICT solutions can be adopted in improving higher level education through e-learning (Fall, 2007). In 2018, China together with the International Centre for Higher Education Innovation-UNESCO and the Centre of Higher Education Research of Southern University of Science and Technology organized a seminar exploring how higher education can be improved through e-learning in Chad. Currently, only the University of N'Djamena and the Mongo Polytechnic University organise training in ICT related courses; a situation the seminar hoped to change through electrification of all universities, assessment of ICT capacity training potentials of institutions, the building of a digital library and MOOC centre (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2016	22.31	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2016	30.79	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.89	WEF
	Employment	Employment in agriculture (% of total employment)	2019	75.06	ILO
		Employment in agriculture, female (% of female employment)	2019	73.39	ILO
		Unemployment, total (% of total labour force)	2020	2.26	ILO

AGRO-INNOVATION

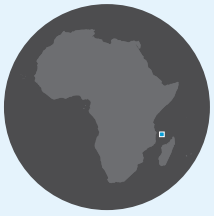
The country's agriculture sector is characterised by low-yielding technologies and practices affecting productivity (World Bank, 2018). Furthermore, agriculture research led by the Chadian Institute of Agriculture Research for Development remains low, which limits the introduction of modern tools, experimentation and testing in the sector. However, efforts are underway mostly driven by donor organizations to change the narrative. For example, the World Bank through the West Africa Agriculture Productivity Program aims at contributing to the promotion of improved technologies to support smallholder farmer activities, especially in rural areas. An estimated 360 000 people expected to benefit from the project. The Strengthening Productivity and Resilience of Agropastoral Family Farms Project aims at strengthening rural road infrastructure, supporting family farms and adding value to agropastoral products with about USD 96.65 million earmarked for the project.

In enhancing innovation, the Association for the Promotion of Invention and Innovation (APIIT) in Chad has attempted to consolidate efforts to enhance innovation through partnerships with industry and financial institutions in the country. For example, the Founder Institute also launched a chapter in N'Djamena in 2020 to support start-ups in accessing funding and gaining traction for scaling up their solutions (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	4 601.26	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	118.48	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.42	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.05	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.55	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.03	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

COMOROS



The Comoros is a lower-middle-income country with a GDP of USD 1.2 billion, of which half comes from agriculture. The services and industry sectors account for 40 percent and 10 percent of GDP respectively (see Table 1).

The Comoros has a poverty rate of 64.6 percent. Agriculture employs 34.4 percent of the labour force (World Bank, 2019). Similarly, over 80 percent of farmers in the country are smallholders. Together with development partners, the government of the Comoros is taking steps to improve agriculture. This has reflected in a number of ambitious policies and projects. With 70.4 percent of the land area of the country conducive for agriculture, there is great potential for growth in the sector. Present efforts are focused largely on increasing productivity and protecting natural resources.

Despite being the last country to introduce a mobile telephone network in the world, Comoros has seen massive development in its ICT sector, especially in the last five years. Nevertheless, fixed and broadband penetration is still low, and costs of mobile services are high. Multilateral agencies such as the World Bank are supporting the country to improve its ICT sector.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	869 595	WBG
Urban population (%)	2020	29.38	UNPD
Rural population (%)	2020	70.62	UNPD
GDP (current millions of USD)	2020	1 220	WBG
Agricultural land (km^2)	2018	1 310	FAO
Agricultural land (% of land area)	2018	70.39	FAO

INFRASTRUCTURE

Electricity access in the Comoros presently stands at 84 percent, with 98.2 percent in urban areas and 78.2 percent in rural areas. Energy is generated from predominantly biomass sources, hydro power, oil and natural gas, geothermal plants and renewables such as wind and solar. The main network operators in the Comoros are the partly state-owned Comores Telecom (ComTel) and Telma Comores, both of which offer 4G services. However, only 40 percent of the population have access to mobile services while less than 1 percent can access broadband services.

Several efforts have been made to improve infrastructure in the Comoros. For instance, the World Bank financed the Comoros Regional Communications Infrastructure Program in 2018 to improve connectivity (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	78.24	WBG
		4G coverage (% of total coverage)	2019	82.00	GSMA
		Mobile (device) ownership (% of population)	2019	34.89	GSMA
		Secure access to Internet servers (per 1 million people)	2020	9.2	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	54.37	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	9.46	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.11	ITU

DIGITAL PENETRATION

Almost 8.5 percent of the country's population have access to Internet while only 0.11 percent of the population uses fixed broadband and 9.46 percent for mobile broadband. Besides the major network operators, the other Internet service providers in the country are Centralcom Plans DSL, Centralcom Cable, Halo Fixed Wireless, Hughesnest, Viasat and Centralcom Fiber. In addition to the low rates of Internet access, cost also remains high (see Table 3).

The Comoros has over half a million mobile phone users, representing 67.6 percent of the population. About 46 percent of mobile phone users access the Internet through their phones, which partly compensates for the low penetration of broadband services. Meanwhile, the penetration rate of mobile social media is 15 percent.

In terms of the use of ICT tools in agriculture, ICT-powered regulatory systems have been instituted to facilitate seed and fertilizer application. Through the Strengthen the Adaptive Capacity and Resilience to Climate Change in the Agriculture Sector (CRCCA) programme, farmer-trainers are selected and equipped to train other farmers on techniques and technologies that improve agricultural activities. Thousands of farmers have benefited from the project since it was launched in 2014. Through the Enhancing Adaptive Capacity and Resilience to Climate Change in the Agriculture Sector in the Comoros project, climate resilient technologies were introduced into ago-sylvo-pastoral systems.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.38	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	19.54	GSMA
		Number of apps in national language (quantity)	2019	21.06	GSMA
		Gender gap in social media use (%)	2019	44.74	GSMA
		Gender gap in mobile ownership (%)	2019	54.73	GSMA

POLICY AND REGULATION

In 2004, the government announced plans to transform the telecommunications sector, pursuant to which the telecommunications functions of the national postal and communications operator, SNPT, were separated to establish ComTel. The National Regulation Authority of Information and Communications Technology (ANRTIC) was later established in 2009 to oversee the implementation of ICT policies and regulate the sector. Following recommendations by the World Bank, ComTel was privatized in 2013. With further support from the World Bank, the Regional Communications Infrastructure programme was launched to increase connectivity and coverage of broadband networks (see Table 4).

The government receives support from IFAD, FAO and the World Bank to support the National Investment Plan (NIAP) that promotes and coordinates investments in the country. Other policies are the Enhancing Adaptive Capacity and Resilience to Climate Change. In the agriculture sector in Comoros, the Comprehensive Africa Agriculture Development Program (CAADP) aimed at promoting market access, food security and agricultural research and the promotion of new technologies. The sector is regulated by the Ministry of Agriculture, Fisheries, and Environment. The Rural Centres of Economic Development (RCED) also coordinate a number of projects and programmes.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	82.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Because the Comoros is a member of the Common Market for Eastern and Southern Africa (COMESA) free trade area, tariffs and policies that govern agribusinesses involved in trade are determined by the COMESA Common External Tariff (CET). Generally, tariffs are low and non-tariff barriers have also been eliminated with the exception of rice. Since the country is classified as one of the least developed countries (LDCs), businesses enjoy a total duty and quota-free access to the European Union (EU) with the exception of arms and armament exports (see Table 5).

There is not much clarity of what FDI means in the Comoros and investors may be faced with some hurdles such as a limited local market, poor infrastructure and unskilled labour. Political instability has also been a major source of disturbance to the business landscape. However, the government has demonstrated commitment to reforming the investment code and establishing an office that will serve as the single point of contact for all business-related needs, including foreign investment. This has reflected in the continued rise inward flow of FDI over the last few years. The investment profile of the country was also boosted when it joined the World Bank's Multilateral Investment Guarantee Agency (MIGA). At present, China is the biggest investor in the Comoros. Huawei has channelled substantial investment into the ICT industry of the Comoros.

Agribusinesses, restaurants and other businesses in the food value chain in the Comoros are also beginning to leverage technology to offer reservations and delivery services to customers. Such services are common in the big cities such as Moroni and Moutsamoudou.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	8	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	16	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

UNESCO figures peg literacy rate in Comoros at 58.8 percent. Among the youth, literacy stood at 78.3 percent, with youth males at 78.2 percent and youth females at 78.3 percent as of 2018. Enrolment at the secondary school level at present stands at 50.4 percent. Specifically, enrolment among females is 51.7 percent while that of males is 49.1 percent. In terms of accessibility to ICT for education, the Comoros adopted a national policy in 2004 that aims at promoting infrastructure for improved access, integrating ICTs and computers into teaching and learning as much as possible, in addition to sever other goals (see Table 6).

There are a number of opportunities for digital training in the Comoros including the Knowledge

Academy's Digital Transformation Training and the USGs courses. The University of Comoros also offers a few ICT-related courses.

Through the World Bank-funded Integrated Development and Competitiveness Project launched in 2019, financial commitment has been pledged to create an enabling environment for agriculture to thrive, including providing support to agricultural entrepreneurs. The goal is to create a market-driven and competitive agribusiness sector. A number of youth-led start-ups are also being incubated and given the support to scale up.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	58.82	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	78.27	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	34.38	ILO
		Employment in agriculture, female (% of female employment)	2019	31.57	ILO
		Unemployment, total (% of total labour force)	2020	8.43	ILO

AGRO-INNOVATION

According to the World Bank, the lack of digital technologies such as mobile money or other forms of digital credit limits access to finance, especially in rural areas. The majority of payments continue to be made through cash as a result of the delayed operationalization of electronic payment instruments. A USD 15 million investment from the International Finance Corporation (IFC) has the capacity to create the enabling environment for digital solutions such as mobile money services, e-agriculture, e-health and e-governance, and is reflective of the improvements being made in the sector. Farmers in the Comoros have been introduced to the use of modern feeder systems and solar-powered incubators by FAO (see Table 7).

Ongoing research and development projects include the Family Farming Productivity and Resilience Support Project by IFAD earmarked for 2017 to 2022. With over 70 percent funded by IFAD and partly by other domestic partners, the project seeks to help 35 000 smallholder farmers to build resilience against climate change, address food insecurity and promote alternative livelihoods. The Building Climate Resilience through Rehabilitated Watersheds, Forests and Adaptive Livelihoods project funded by the Least Developed Countries Fund also ended in 2020. The project aimed at researching and promoting technologies for watershed restoration and reforestation. Over 38 000 people benefited from the project.

The Comoros National Investment Promotion Agency launched the Greenhouse and Vegetable Market project in 2011 to establish at least three vegetable farms in each of the Comoros Union Islands; and 25 green houses for producing lettuce, tomatoes, cucumbers and other vegetables.

On the research front, higher education institutions like University of Comoros and Kampala University along with other institutions such as the Agricultural Research Council (ARC) continue to advance research to improve agriculture in the Comoros.

The country remains open to digital innovation and solutions for improving agriculture. This

is why during the last Comoros Development Conference, a government delegation including the president raised EUR 4.2 billion to help revamp the country and see it bloom into an emerging economy. One of the goals pertaining to this pursuit is to eventually become a supplier of digital infrastructure.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	372.62	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	99.83	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.56	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	1.18	UNCTAD

CONGO

Congo is a lower-middle-income country with a GDP of approximately USD 10.8 billion (see Table 1). The country experienced an economic crisis in 2014 due to a drop in oil prices, but slowly recovered in 2018. The country's population is 5.5 million, 67.8 percent of whom live in urban areas, mostly concentrated in Brazzaville and Pointe-Noire (see Table 1). In 2011, Congo's poverty rate stood at 41 percent, which was a decrease by 10 percent from 2005 (World Bank, 2015). However, the rate is substantially higher (70 percent) among the 32.2 percent who live in rural areas (FAO, 2021).

Congo is rich in natural resources, particularly tropical forests (which constitute 65 percent of the territory), mineral resources and oil reserves. The agriculture sector contributed 4 percent of the country's total GDP (International Trade Administration, 2020) and employs 33.5 percent of the population, of which females accounted for 32 percent (see Table 6). Subsistence agriculture is dominant, however. Over 90 percent of Congo's arable land (or one-third of its territory), remains uncultivated. The main cash crops are beans, sugarcane, cocoa and coffee. Food crops are mainly cassava, maize, groundnut, banana, etc. However, most of the staple foods are produced by family farming. Due to a limited capacity in providing enough food to meet domestic demand, Congo depends to a great extent on food imports (WFP, 2019), accounting for 80 percent of total food consumption (International Trade Administration, 2020). Moreover, 21.2 percent of children aged below five suffered stunting. These facts present a great challenge for Congo, which needs to ensure food security and decrease the vulnerability of its population.

Congo's ICT sector is growing with significant progress made in the mobile sector. There is a strong demand by the population to access Internet services. However, challenges are also quite evident, including weak infrastructure, high cost, low income, and unstable connections, which leave a significant room for improvement.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	5 518 092	WBG
Urban population (%)	2020	67.83	UNPD
Rural population (%)	2020	32.17	UNPD
GDP (current millions of USD)	2020	10 885	WBG
Agricultural land (km^2)	2018	106 280	FAO
Agricultural land (% of land area)	2018	31.12	FAO

INFRASTRUCTURE

According to World Bank estimates, Congo has significantly improved its electricity access from 38.08 percent in 2008 to 48.3 percent in 2019. However, electricity supply is mainly concentrated in cities (92.4 percent). Only 12.7 percent of rural areas have access to electricity. Congo has abundant energy resources including natural gas, tar sands and hydropower, but is yet to meet its potential. As a result, domestic power supply does not yet meet demand, while the national grid and distribution system need to be upgraded. The Rural Electrification Project was launched in 2013 aiming at providing sustainable access to electricity in 53 rural centres in 10 departments, covering a total of 5 100 households (African Development Bank Data Portal).

3G services in Congo were primarily launched in 2011 by Airtel Congo in Brazzaville. 4G services were later introduced in 2018. MTN Congo is a key competitor providing 2G, 3G and 4G services within the country. GSMA reported that 4G coverage reached 67.2 percent as of 2019, significantly improving from 0 percent in 2015 (GSMA, 2019) (see Table 2). However, the fixed line infrastructure is relatively inadequate in Congo, resulting in low fixed broadband subscriptions, at 0.01 per 100 people.

Congo's digital infrastructure development has been facilitated by the Central African Backbone (CAB) regional interconnection programme, with its first phase completed in 2017 to connect a fiber optic backbone to Gabon's network. The second phase is underway to connect Congo to the networks of Cameroon and the Central African Republic (World Bank, 2018). Meanwhile, its National Coverage Project also aims at improving access to the Internet by constructing fiber optic network connecting Pointe-Noire to Brazzaville (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	12.67	WBG
		4G coverage (% of total coverage)	2019	67.20	GSMA
		Mobile (device) ownership (% of population)	2019	51.72	GSMA
		Secure access to Internet servers (per 1 million people)	2020	8.34	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2018	95.34	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	6.05	ITU
		Fixed broadband subscriptions (per 100 people)	2014	0.01	ITU

DIGITAL PENETRATION

In Congo, digital transition is transpiring at a slow pace and challenges persist. Data shows that only 8.7 percent of individuals use the Internet. Despite high mobile cellular subscriptions at 95.34 per 100 people, active mobile broadband subscriptions remain low at 6.05 per 100 people (see Table 2). This is partially due to high prices for mobile data, at USD 23.33 for 1 GB (see Table 3), which is not affordable for most mobile users. This situation has been slowly improving as operator prices fell 23.8 percent between 2019 and 2020, bringing an increase of 53.3 percent of Internet traffic (ARPCE,2020). Social media penetration

is growing in Congo, reaching 13.1 percent in 2019 (see Table 2), especially among young people for communications.

According to the 2020 mobile Internet market report published by Agence de Régulation des Postes et des Communications Electroniques (ARPCE), the mobile Internet market is mainly dominated by MTN and Airtel with a total of 2.8 million subscriptions, reflecting an increase by 35.4 percent. MTN is still dominant with 62.5 percent of market share, followed by Airtel, at 37.5 percent. Mobile Internet penetration stood at 54.5 percent in 2020 (ARPCE, 2020).

Mobile money services have also been provided by these two major players since 2012 (Massanga and Miere, 2020) and have been widely accepted among the urban population. Mobile money has panned out to be a dynamic market with 2.1 million subscribers as of 2020, with MTN having 80 percent of market share and 20 percent to Airtel (see Table 3).

In terms of online businesses, AgriZoom is an Android app-powered e-commerce and crowdfunding platform that helps farmers, fishing communities, and agro-processors raise funds and access market to avoid food waste. It includes a web media that promotes agricultural entrepreneurship.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.94	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	13.07	GSMA
		Number of apps in national language (quantity)	2019	48.85	GSMA
		Gender gap in social media use (%)	2019	43.76	GSMA
		Gender gap in mobile ownership (%)	2019	81.98	GSMA

POLICY AND REGULATION

In 2019, the national strategy Vision Congo Digital 2025 was approved to facilitate the country's transformation into a digital economy through e-citizenship, e-government and e-business. To support the implementation of this strategy, a series of laws have been promulgated covering data protection, cybersecurity and electronic transactions. The ICT sector is mainly regulated by the ARPCE which was set up in 2009. It has been appointed as the service provider for the implementation of the Digital Hub with the goal of monitoring e-transactions.

Congo also tries to provide a sound political ecosystem for agriculture development. A series of laws and regulations have been adopted to regulate land, agriculture, livestock and forests. Congo has established four special economic zones to support the development of agriculture, mineral processing as well as wood industry. For agriculture in particular, more investments will flow for the development of crop production and processing as well as forestry (Ministry of Special Economic Zones). Meanwhile, the International Partnership for Human Development (IPHD) is working with the Ministry of Agriculture to launch an agriculture programme aiming at developing seven farms and eight operation centres of agricultural machinery (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	75.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In general, Congo offers a stable and secure environment for businesses to operate. It has adopted incentive measures such as tax privileges regions for domestic SMEs and companies investing more than FCFA 100 million. It also has a special tax regime applicable to enterprises engaging in agropastoral, agriculture and fishing (ENSafrica, 2019). However, constraints like a weak ICT infrastructure, inconsistent water and electricity supply, inadequate qualified labour forces, high transport costs still pose major challenges for investment.

Meanwhile, time-consuming procedures are considered a main obstacle in terms of doing business in Congo. According to Doing Business 2020, it takes 49.5 days to start a business, while one additional day is needed for married women as a marriage certificate is required when applying for an identification card. The Centre des Formalités des Entreprises (CFE) has been established as a one-stop shop that centralizes several registration procedures and organizes commercial registration for companies (World Bank, 2020), but efficiency remains a problem.

Congo is largely affected by global oil prices. The UNCTAD World Investment Report 2020 notes that FDI inflow decreased to around USD 1 billion between 2018 and 2019. To reduce dependency on the oil sector, Congo has taken a series of actions to attract more investment. It has signed bilateral investment agreements with a range of countries, created special economic zones, as well as diversified new investment channels, including in the agriculture, forestry and information sectors. Furthermore, Congo has a large amount of uncultivated land, making it possible to unlock the investment and development opportunities in agriculture, especially for agro-processing and mechanized agriculture. According to the Ministry of Special Economic Zones, agriculture-relevant companies can settle in the special economic zone of Oyo-Ollombo and acquire approval to operate their businesses (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	3 366	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	49.5	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

In Congo, 80.3 percent of people aged above 15 are literate (see Table 6). Of the country's youth illiterate population (aged 15-24), females accounted for 59 percent. Meanwhile, 65 percent of indigenous children are not in school, and the total number of out-of-school children reached 130 688. Education is considered as a critical way to fulfil the labour market with qualified workforce. In this context, the government continues to expand its education expenditure. The Education Sector Strategy 2015-2025 was developed to focus on three main pillars including providing 10-year basic education to all children; matching human resources to the economy's need; and making the education sector management efficient. Considering the insufficient numbers of people with ICT skills, the strategy highlighted the importance of introducing ICT to schools to enhance capacities of both teachers and students, as well as the necessity of training with particular focus on the needs of the labour market.

To further lift the digital literacy level, several projects and start-ups have been carried out to improve ICT infrastructure for education and enhance capacity building. IPHD in partnership with the United States Department of Agriculture (USDA) and the Ministry of Education of the Republic of Congo launched a school feeding project to improve children's access to school feeding and learning conditions; School connectivity & Y'ello Bibliothèque pour tous is a programme launched in 2009 by La Fondation MTN Congo, aiming at using IT tools and new technologies for courses and training in schools and universities; the CAB project equipped the public university with software tools and interconnected the 11 higher education establishments in Brazzaville; Schoolap, a platform that offers digital lessons for students and teaching materials for teachers; Grande école du numérique du Congo launched in 2016 to train youth in web and digital professions; and PUITS (University Program for Innovation in Technologies and Services), established in 2018, supports young people with innovative projects in their business creation (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	80.30	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	82.06	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	33.53	ILO
		Employment in agriculture, female (% of female employment)	2019	32.04	ILO
		Unemployment, total (% of total labour force)	2020	10.27	ILO

AGRO-INNOVATION

The expenditure of agriculture R&D has declined since 2008, accounting for 0.26 percent as a share of agricultural GDP in 2016. About 88 percent of researchers have master's and doctoral degrees but 60 percent are above the age of 50. Female researchers only represent 14 percent. The National Agricultural Research Institute (IRA), Forestry Research Institute (IRF) and the Natural Sciences Institute (IRSEN) are the leading agricultural R&D agencies that employ the majority of researchers in the country, however, the number decreased in recent years due to retirement. Moreover, the digitalization level of agriculture remains low. The adoption of technologies is limited mainly due to a shortage of qualified labour, despite low costs.

Agriculture start-ups exist in the Congo. Most of their earnings accrue from exporting agricultural products such as aquarium fish, timber, eggs, coffee, etc. There are also a few private incubators targeting young entrepreneurs. For example, BantHub creates favourable working spaces for tech-entrepreneurs; Yékolab assisted young innovators develop the mobile payment application Wapicash Transfert, and Total Start-up Center supports business skill enhancement. Agri Zoom is an e-commerce and crowdfunding platform and mobile app created in 2018 to help farmers secure funding opportunities and access markets. In 2019 the Congo and France signed a memorandum of understanding (MoU) to establish a "digital club" for bilateral cooperation in digitalization, including incubators, training centres, as well as companies supporting local start-ups (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	801.37	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	107.32	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.49	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.26	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	A/N	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	A/N	WEF
		ICT goods imports (% of total imports)	2019	2.25	UNCTAD

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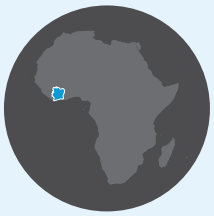
CÔTE D'IVOIRE



Côte D'Ivoire is a lower-middle-income with a population of 26.3 million people, 48.3 percent of whom are living in rural areas. That said, the country has one of the fastest-growing economies in Africa with 1.8 percent GDP growth, although about 57 percent of the rural population is below the national poverty line and the rural/urban gap has widened (see Table 1).

The agriculture sector remains the country's backbone accounting for 28 percent of the national GDP, 40 percent of the country's export and employing 40 percent of the workforce with a large percentage of those living in poverty. Yet, 13.3 percent of the population is undernourished, and 29.6 percent is malnourished (World Bank, 2019).

The digital economy represented 7.2 percent of GDP in 2017 and 9.8 percent in 2018, with a forecast increase to around 11 percent in 2020, thus providing around 5 400 direct and 100 000 indirect jobs. The performance of the digital economy has led Côte d'Ivoire to be ranked among the most technologically competitive countries in Africa (ITU, 2019).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	26 378 275	WBG
Urban population (%)	2020	51.71	UNPD
Rural population (%)	2020	48.29	UNPD
GDP (current millions of USD)	2020	61 349	WBG
Agricultural land (km^2)	2018	212 000	FAO
Agricultural land (% of land area)	2018	66.67	FAO

INFRASTRUCTURE

Even though two-thirds of Ivorians have access to electricity, only 41.9 percent of the rural population can reap these benefits, causing an obstacle to rural markets and limiting access to storage facilities.

In Côte D'Ivoire, 74.9 percent of the population is covered by 3G, and 55 percent of the territory has 4G coverage. While 57 percent of Ivorians have mobile devices, one-third of which are smart phones, there are nevertheless significant mobile coverage gaps for rural areas. The Autorité de Régulation des Télécommunications/TIC de Côte d'Ivoire (ARTCI) has identified that 48 percent of the country's 8 518 localities (representing 23 percent of the total population) were not covered by any mobile service (see Table 2).

In the telecommunication market, the mobile sector is the strongest overall, accounting for the vast majority of voice and data connections. Most Ivorians access the Internet using mobile devices. The country's three MNOs (Orange CI, MTN and Moov) provide effective competition with 34.1 million connections, of which 65 percent are broadband (We are social and Hootsuite, 2020), and 23 percent mobile Internet users (of which "smartphoners" represent more than 90 percent). This mostly benefits urban areas where about 15 percent use the Internet on a weekly basis. The rate drops to only 3 percent for rural areas, and only 1 percent of youth (15–24 years) have Internet access at home.

The fixed Internet and broadband sectors are underdeveloped, however, with access to more submarine cables, the situation has gradually improved with decreasing prices (Henry Lancaster, 2020).*

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	41.89	WBG
		4G coverage (% of total coverage)	2019	55.18	GSMA
		Mobile (device) ownership (% of population)	2019	56.94	GSMA
		Secure access to Internet servers (per 1 million people)	2020	56.60	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2016	4.92	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	152.00	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	66.19	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.99	ITU

**https://www.budde.com.au/Research/C%C3%B4te-d-Ivoire-Ivory-Coast-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses*

DIGITAL PENETRATION

Smartphone adoption is quickly spreading in urban areas among young people (who represent almost half of subscribers). Youth are attracted to accessing the latest features or technologies on the market, attractive offers by the MNOs (Club's cool, Funzone or Moov'In) and very low prices to make mobile calls and send SMS (ICT Prices, 2017). The Internet segment also recorded a total number of 17 million subscribers against 10 million at the start of 2017, for a penetration rate of 72 percent against 30 percent for the entire continent (Bruno Nabagné Koné, 2017), largely attributed to the continuous dropping of

the average smartphone price to USD 94 (CFAF 57 000) and an average price of USD 3.20 per 1 GB data.

In 2017 almost 77 percent of the population had a phone, nearly a third of which was a smartphone, yet only 2 percent of rural populations buy online, 18 percent of Ivorian companies have their own website, and 60 percent of them use email with their suppliers or clients.

MNOs have worked to increase the number of transactions in the digital ecosystem and have launched initiatives to digitize payments in agriculture, which in turn has increased the use of digital finance services in rural areas (26 percent) higher than in the cities (22.6 percent), with an evident gender gap (female, 28 percent and male 38 percent) and only 6 percent used for receiving agricultural payments.

Boosted by the rise of the middle class and urban youth, e-commerce is viewed by a growing number of Ivorians as a way to do their shopping through platforms like Jumia, Afrimarket, HelloFood, BabiKen, or Yaatoo, the leading curb side pick-up e-commerce platform for retail food supply.

That said, the country has a low penetration of mobile social networks rated at 18.7 percent. Some of the main reasons include the unaffordability of smartphones and low digital literacy rates. The gender gap in the use of social media is also high (34:80), due to lower literacy rates among women (see Table 3).

The range of digital agriculture solutions is broad, ranging from those providing data and information services, access to insurance and finance, precision agriculture, and connecting market links (GSMA, 2020; RIA, 2020).

MNOs like Orange through mAgri and MTN partnering with Effects Advans are already offering information services on weather forecasting, market prices, saving accounts and crop and livestock extension via Unstructured Supplementary Service Data (USSD), IVR, SMS, call centres, and web chatbots to smallholders (mostly cooperatives). Weight Control provides information on weight for purchased goods and "inclusive guarantee" is a form of digital agricultural insurance. WeFlyAgri, Investiv and BeatDrone provide precision farming services using drones, with remote sensing helping smallholders improve yields and optimize farming practices.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.20	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	4.62	ITU
		Fixed broadband prices as a % of adjusted per capita income	2019	10.08	ITU
	Willingness	Mobile social media penetration (%)	2019	18.72	GSMA
		Number of apps in national language (quantity)	2019	48.01	GSMA
		Gender gap in social media use (%)	2019	34.80	GSMA
		Gender gap in mobile ownership (%)	2019	70.47	GSMA

POLICY AND REGULATION

Keeping pace with digitalization, the National Agency for the Universal Service of Telecommunications (Agence Nationale du Service Universel des Télé communications, ANSUT) was set up in 2012 to implement the country's digital strategy (Plan d'Action Du Gouvernement Developpement et Numerique) and to spread the use and adoption of ICT, thereby narrowing the digital gap between urban and rural areas.

In 2012 the government created the Platform for Fighting Cybercrime to conduct investigations and cybersecurity awareness projects. Between 2015 and 2018 the regulators removed duties levied on IT equipment, tablets and mobile devices, to expand access to electronic devices. In October 2017 the Parliament passed the Loi d'Orientation de la Société de Communication, aimed at supporting inclusive, open and transparent information.

In order to promote access to ICT equipment, the Ivorian government launched the One Ivorian, One computer project and promoted a telecom liberalization policy to reduce the costs of fixed and mobile telephony and Internet.

One of the many actions and reforms undertaken within the framework of development to promote the ICT sector by the government was the emphasis on new and digital technologies since 2012 (updated in 2014). These included the Digital Solutions Project for the Opening up of Rural Areas and Agriculture (PSNDEA), initiated in 2018 with technical support from the World Bank Group. It aims, among other things, at (i) reducing the digital divide by providing connectivity in rural areas; and (ii) providing digital services to rural communities for an improvement of thier agricultural value chain. In the same vein is the Agro-Industrial Pole Project in the Bélier region (2PAI-BELIER), initiated in 2016 with the technical and financial support of the AfDB. It set up the base of an agro-industrial pole to transform and modernize agriculture in the Bélier region (centre of the Ivory Coast) through ICT. The second iteration of the National Agricultural Investment Plan (PNIA II) is well aligned with PSNDEA in terms of digital agricultural innovation, and specifically addresses digital identity and geospatial projects (see Table 4).

As of 2021, the government worked with La Recherche Agronomique pour le Développement and Agence Français de Développement on smart agriculture and technological innovation. Also, the National Office of Technical Studies and Development (BNETD) advises the government on policy for digital transformation in multiple domains, including agriculture.

The government worked with MNOs to subsidize computers purchased with mobile money, bringing their cost down from as much as USD 300–400 when purchased from retailers to around USD 100. This was also in addition to the construction of 5 000 cyber centres in rural areas to promote digital inclusion. In 2019, the government announced a living income differential to be paid for every tonne of cocoa procured, reforming production and pricing in the farmers' interest, making a strong case for digital procurement.

Finally, in 2018 the country was ranked 172 globally in the UN's E-Government Development Index, placing it highest among the ECOWAS countries.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.61	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.35	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	4.04	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	61.8	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

As an emerging economy, Côte D'Ivoire has initiated reforms to boost its business environment and has seen an improvement in the 2019 Doing Business ranking, going to 122nd place in mid-2018. Continuous improvement in the business climate has attracted national and international investors, which translated into the creation of 7 423 companies from January to June 2018. The country also set up a large free trade zone in Grand-Bassam. In 2006 the Village des Technologies de l'Information et des Biotechnologies (VITIB) was established to coordinate and develop the activities of the free trade zone. The Ivorian government holds an 8 percent stake in the company, with the rest of its equity belonging to various public and private actors. In order to strengthen the business environment for e-commerce, the government is partnering with UNCTAD and the Government of Germany to improve the e-commerce ecosystem in the country.

The volume of private investments in Côte D'Ivoire at mid- 2018 amounted to around USD 600 million; an increase of 76 percent compared to this same period in 2017. Currently available funding for digital agriculture in Côte D'Ivoire is built around two primary sources: the PSNDEA World Bank funding (USD 70 million over 5 years) and the PNIA II engagement (USD 784 million). However, a significant challenge for young start-ups remains the availability of funds: they typically lack assets for collateral and bear high risks, as well as often facing high-interest loans from traditional banks and some degree of bias (see Table 5).

In the rural areas, only 19 percent of the population save to start, operate, or expand a farm or business of which 18 percent are females. Only 2 percent of youth in rural areas borrowed money from financial institutions. On the other hand, in 2020 the e-commerce company Afrikrea raised USD 1 million in funding. With just around USD 2 million of funding received by local tech start-ups, Côte d'Ivoire remains a nascent tech ecosystem only now entering the top 20 African markets in terms of funding. Although the current funding situation is meagre, there is a large and growing pool of investors active in Côte D'Ivoire that are definitely within reach. The culture of entrepreneurship is not yet prolific enough, as socially it is not yet considered a valued career choice.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1 009	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2016	2.72	WEF
	Entrepreneurship	Time required to start a business (days)	2019	6	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2016	2.69	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

With just 47 percent of the population 15 and older able to read and write (UNESCO, 2018) and with only a 26 percent enrolment rate in secondary schools, education can play a major developmental role in enhancing digital skills for the future of agriculture, a sector that employs 40 percent of the population. Of 23 068 education institutions (preschool to high school) 55 percent are in rural areas (see Table 6).

Education and literacy have undergone some changes with the promotion of new channels and alternatives, in particular the dynamic use of ICT. NGOs and the private sector are active in education, which is considered a core government policy.

Through its programme Grande Ecole du Numérique Africaine, Orange aims at mobilising its infrastructure, access and expertise to help meet the challenge of training young people in digital technology. Through the Des Chiffres et Des Jeunes (DCDJ) fellowship programme, Ivorians between 18 and 34 years of age can train in intensive data science and analytics. The Kalaan Foundation also prioritizes digital literacy in its projects.

Generally speaking, talent is available in the market to build a successful career so long as it can be paid for.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2019	89.89	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2019	83.63	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.8	WEF
	Employment	Employment in agriculture (% of total employment)	2019	40.15	ILO
		Employment in agriculture, female (% of female employment)	2019	31.04	ILO
		Unemployment, total (% of total labour force)	2020	3.50	ILO

AGRO-INNOVATION

The reforms initiated by Côte D'Ivoire in research are yielding positive results through government investments. Gross R&D expenditure in agriculture and veterinary sciences (percent of GDP) increased slightly from 2.81 percent to 3.29 percent of GDP. Although the government is increasingly focusing on university-industry cooperation in R&D, the collaboration between ecosystem actors has so far been limited. Tech events happen only on a monthly basis. In 2018, there were about 10 tech events gathering more than 100 people. Mainstream media does not often cover start-ups, but there are about ten blogs that do that, for example: Alassaut, l'Actu Web d'Edith, and Aboukam.net.

There are about 15 different incubation and acceleration programs for start-ups in Côte D'Ivoire, including JokkoLab, Orange Fab, She is the Code, Janngo, etc. (Briter Bridges, 2018). Two of these, Vitib and Dream Factory, are public initiatives, (see Table 7).

The involvement of the corporate sector in the tech space is led by MNOs. They are taking advantage of the opportunities presented by the evolving tech environment to innovate and tap into local skills. In 2014, Orange launched an accelerator programme, Orange Fab, aimed at supporting start-ups in developing solutions for its platforms and enhancing service delivery

to its customers. A year later, Moov launched Cyberlab to train 4 500 Ivorian entrepreneurs in mastering digital tools and to develop activities on the Internet. In 2017, MTN Business Côte d'Ivoire launched the programme Y'ello Startup aimed at supporting young local tech entrepreneurs and identifying future business partners for MTN Y'ello Startup and Seedspace Abidjan, with local impact investors like TRECC or Comoe Capital. In 2018, the ecosystem experienced a promising growth with the launch or announcement of new initiatives like MEST (2019), Orange Corners and Seedstars Academy. Given the nascence of the overall ecosystem, the incubation and acceleration offerings are substantial.

About half of the programs started abroad (e.g. Founder Institute) and have been replicated in Côte D'Ivoire. The targets of these programs are early-stage start-ups, aspiring entrepreneurs and university students. In digital agriculture, the Saemaul Undong Foundation organizes hackathons and bootcamps to tap the potential of rural areas. The PSNDEA has also organized a series of hackathons nationwide between 2018 and 2019 and is undertaking the technical and managerial incubation of the winners during 2021.

Although not all local start-ups have the "codes" or speak the same "language" as international venture capital investors, the talents, innovative solutions and opportunities to invest in local start-ups are there for those ready to capitalize on that. Côte D'Ivoire's ecosystem has promising agricultural technology ventures that are using mobile and digital technologies to offer hyperlocal solutions tackling local agri-food challenges.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	9 158.88	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	114.28	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	3.08	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.50	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2016	3.29	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2016	4.26	WEF
		ICT goods imports (% of total imports)	2019	3.48	UNCTAD

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DEMOCRATIC REPUBLIC OF CONGO

The Democratic Republic of Congo (DRC) is a low-income country with 72 percent of the total population living in extreme poverty, despite a slight decline in its poverty rate (World Bank, 2018). Youth under 15 years of age will account for nearly half of its population in the next few decades. About 7.7 million experience acute food insecurity, while almost 2 million children suffer from severe malnutrition (see Table 1).

Currently, nearly 54.4 percent of the country's population lives in rural areas (see Table 1) and 64.3 percent is employed by the agriculture sector. The agriculture sector performance in DRC is highly affected by political instability in spite of its vast and fertile farmland resources. About 13.9 percent of the total land area is suitable for agriculture. The majority of food crops such as cassava and maize, and cash crops like coffee, cocoa, sugar and palm oil are mainly cultivated by smallholder farmers. Half of all forest resources in Africa are in the DRC, covering most of the underdeveloped northern and central regions. The country's livestock and fisheries sectors have been damaged significantly since the civil war.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	89 561 404	WBG
Urban population (%)	2020	45.64	UNPD
Rural population (%)	2020	54.36	UNPD
GDP (current millions of USD)	2020	49 869	WBG
Agricultural land (km^2)	2018	315 000	FAO
Agricultural land (% of land area)	2018	13.90	FAO

INFRASTRUCTURE

Even though the DRC is endowed with rich mineral and hydraulic resources, they are largely underdeveloped. The DRC has a low electricity access rate, at 19 percent in 2019, with 41 percent in urban areas according to the World Bank. But the government aims at unlocking the country's potential and to that end continued enhancing electricity access from 2018 to 2022, seeking to ensure general access to electricity for all segments of society by 2025.

Meanwhile, GSMA data also shows that there has been a remarkable increase of 4G coverage, from 0 percent in 2017 to 34 percent in 2019. A similar increase was seen in the number of active mobile broadband subscriptions, rising from 3 to 19.5 per 100 inhabitants between 2013 and 2019 (ITU, 2019). The rapid spread of mobile phones means the country relies on cellular networks more than wired infrastructure.

Government agencies are now adopting ICT tools, mostly computers, to increase their efficiency. However, unstable power supply and slow Internet connections are great challenges, particularly for agencies in rural areas.

The government's focus on improving the country's ICT infrastructure starts with the improvement of electricity supply. In 2020, the government signed an MoU with General Electric to accelerate the supply of electric energy to benefit more households. Meanwhile, the DRC is involved in Central African Backbone (CAB) to establish fiber optic networks within the country as well as connecting to other Central African countries (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	1.00	WBG
		4G coverage (% of total coverage)	2019	34.00	GSMA
		Mobile (device) ownership (% of population)	2019	42.74	GSMA
		Secure access to Internet servers (per 1 million people)	2020	3.85	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.09	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	45.55	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	19.53	ITU
		Fixed broadband subscriptions (per 100 people)	2019	0.01	ITU

DIGITAL PENETRATION

The number of Internet users in the DRC is on the rise. It increased by 122 percent between 2019 and 2020 (9 million users) reaching 19 percent Internet penetration in 2020. However desktop computers are scarce in rural households due to lack of power supply. Feature phones are also commonly used by rural households instead of smartphones, while radio remains the principal channel through which news and information is obtained.

The mobile sector is dominated by four key players. As of the first quarter of 2020, their share of the mobile Internet market was 32.3 percent for Airtel, 36.7 percent for Vodacom, 28.1 percent for Orange and 2.8 percent for Africell. However, operators and consumers both face barriers created by the taxes and fees incurred by the sector. Access prices remain very high with an average cost of USD 50 for 6 GB per month as of 2015. These factors cause a slight

decrease of mobile cellular subscriptions from 2014 to 2020, with the rate slipping from 50.3 to 45.6 per 100 inhabitants (see Table 2).

Even though the DRC is still a cash-oriented society, with only 4 percent of the population having an official bank account, there is an increasing demand by households and small businesses for money transfers. After the Banque Centrale du Congo (BCC) launched a regulatory framework on e-money in 2011, four mobile operators obtained licenses to start trialling mobile money services. As a result, mobile payments have become more competitive and the sector as a whole more financially inclusive. Mobile money reached a penetration rate of 9.2 percent in the first quarter of 2020. The key services provided are mainly money deposits and transfers, television and utility bill payments, purchases from merchant as well as international transactions. The main mobile money services are Orange Money by Orange, Airtel Money by Airtel, and Vodacash by Vodacom and M-Pesa (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	N/A	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	3.52	GSMA
		Number of apps in national language (quantity)	2019	39.59	GSMA
		Gender gap in social media use (%)	2019	31.83	GSMA
		Gender gap in mobile ownership (%)	2019	0.00	GSMA

POLICY AND REGULATION

Realizing the potential impact of digital transformation, the DRC adopted Horizon 2025, a national digital plan that prioritizes key areas where action is needed. Namely infrastructure, content, application use, and governance and regulation. Given that most services provided by telecom operators are concentrated in urban areas, the national plan aims at improving infrastructure to allow operators and services to enter the rural market.

The Agriculture Sector and Rural Development Strategy (SSADR) envisions an inclusive and prosperous food system in which smallholders can easily access inputs, services and markets. Currently, the most pressing task for the DRC is recovery and ensuring national food security. To that end, a National Agricultural Recovery Plan was adopted to address the most urgent issues faced by the sector. The plan also aims at developing a modern, high-yield agriculture system for all farming households, while encouraging value chain actors to adopt improved technologies to increase productivity. This is considered a critical step for the digitalization of the country's agriculture sector (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	79.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The biggest constraint the DRC faces in attracting and retaining foreign investment and donor assistance is the deteriorating security situation within the country. Since 2009, the government has enacted policy reforms to improve its business and investment climate while fostering a market-oriented environment to attract foreign capital. The National Agency for Investment Promotion (ANAPI) was created precisely to facilitate the investment process. The adoption of a series of laws, regulations, and incentives boosted the country's score in Doing Business 2020 to 91.6 of 100. The Doing Business report reports that it takes 7 days to start a new business in the DRC (see Table 5) with no disparity between male and female applicants, while the sub-Saharan regional average is 21.5 days. The DRC has joined several trade-oriented regional and international organizations, offering a promising trade outlook that would link the country to the rest of the world. With its vast natural and human resources and potential to explore, the mining sector attracts more investments. Nevertheless, the agriculture sector is increasingly getting more investor attention.

Since the DRC launched its Investment Code, 96 projects were approved of which fifteen were earmarked for agro-industry and two for telecommunications, which generated more than 2 000 job opportunities. The Loi Agricole grants tax reductions and exemptions to investors to ensure cost-saving and risk resilience for agribusinesses. Moreover, the National Agriculture Investment Plan (NAIP) 2014–2020 emphasized the important role of the private sector and aims at improving the livelihood of farmers by facilitating agricultural enterprises and agri-food industries.

Some of the groundwork to unlock this potential has been done. To support youth entrepreneurs, the African Development Bank initiated the Youth Entrepreneurship in Agriculture and Agri-business Project (PEJAB) in collaboration with the Ministry of Finance and Budget and the Ministry of Agriculture. The project aims at tackling youth unemployment by enabling fresh graduates to start agribusiness with easy access to finance. The Government of the Democratic Republic of Congo also launched the Young Farmers Initiative to encourage youth entrepreneurs to start businesses in the agriculture sector (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1 478	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.51	WEF
	Entrepreneurship	Time required to start a business (days)	2019	7	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/extremely easy)	2017	2.82	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

Reflecting the challenges facing the education sector, the DRC's literacy rate for adults above 15 years of age was estimated at 77 percent in 2016, with 66.5 percent for adult women compared to 88.5 percent for adult men (UNESCO, 2020). Low public expenditure in education to the tune of only 2.3 percent of GDP, stunts the overall levels of educational in the country. Political instability, violence and conflicts also affect schools and the security of school children in no small measure.

In terms of ICT prevalence in schools, 73.8 percent use a computer and 84.8 percent use the Internet for higher education, compared to 1.4 percent and 1.1 percent for primary school, and 12.9 percent and 15 percent for secondary school. Lack of necessary digital equipment prevents youth from learning basic digital knowledge, resulting in only 13.2 percent adults aged 15 years of age and older using the Internet and 9.2 percent using computers. The gap is even larger between urban and rural populations, at 20.8 percent and 2.1 percent for Internet usage respectively. To address these gaps, some initiatives have been undertaken. For example, the application E-class RDC allows students from primary schools to universities to receive online courses at home. An e-learning platform called KaziAfrika offers courses in various areas including information technology skills. Also, through the Digital Schools programme, 37 schools were equipped with computers.

Citing the importance of digital skills, the DRC has clearly accounted for the enhancement of educational and public digital capacities in its Horizon 2025 national plan (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2016	77.04	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2016	84.99	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.8	WEF
	Employment	Employment in agriculture (% of total employment)	2019	64.30	ILO
		Employment in agriculture, female (% of female employment)	2019	71.51	ILO
		Unemployment, total (% of total labour force)	2020	4.55	ILO

AGRO-INNOVATION

With agriculture considered a main driver of economic development, agricultural R&D in the DRC is booming with the support of the government and donor-funded projects. It is also bolstered by active participation of public agencies, universities, the private sector and NGOs. R&D in agriculture covers a variety of areas that include crops, livestock, forestry, fisheries, food technologies and commodity research.

The Institut National d'Etudes et de Recherches Agronomiques (INERA) plays the leading public agency role, and accounts for nearly half of the researchers in the country. In 2016, agricultural research overall contributed to only 0.24 percent of agriculture GDP. Regarding the qualification level of researchers, Less than 50 percent of researchers hold master's or doctoral degrees. While this is still quite low due to existing infrastructural and capacity constraints, the number has nevertheless increased sharply compared to 2009.

Numerous initiatives and events launched across the country assist agri-food value chain actors to access the latest practices and innovations. The Kinshasa International Agricultural Fair is one such example. This event brings together agricultural operators, investors and banks to present a showcase of the agricultural potential of Kinshasa and other provinces of the DRC, innovations and research results in the field of agriculture. The government also launched the Analytical Capacity Building Programme to improve agriculture R&D capacities in four academic institutions.

Horizon 2025 also underlines the importance of supporting and promoting start-ups with funds and skills training. As a result, entrepreneurs and young start-ups have been encouraged to engage in business through a number of support mechanisms such as support platforms in Kinshasa, incubators like Le Hub and Konnect SAS, among others (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	7 657.00	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	109.86	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.43	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.24	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.81	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.28	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

DJIBOUTI

Djibouti is a lower-middle-income country with a GDP of USD 3.3 billion, and a population of approximately 1 million people. With average rainfall at just 130 millimetres per year, Djibouti is categorized as an extremely arid country. Only 1 300 ha are actually cultivated, and the most practiced agricultural technique is the oasis type given the absence of permanent surface water sources. In this context, Djibouti is almost totally dependent on its imports to feed its population.

Agriculture plays a minor role in the economy, contributing only 1.3 percent of the GDP. About 21.9 percent of the total population lives in rural areas, and about 24.6 percent base their livelihoods on agriculture. The budget deficit was estimated at 14.2 percent of GDP in 2019, financed mainly by loans and external aid. Poverty remains widespread, with one out of six people (17 percent) living on less than USD 1.9 or less a day in 2019, based on the 2019 Djibouti Poverty Assessment. Unemployment was 21.57 percent among youth labor force, 11.26 percent among women and 10.77 among men as of 2019.

Starting in 1988, the Government of Djibouti began implementing reforms in its ITC sector to improve access to high-speed Internet for the population.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	988 002	WBG
Urban population (%)	2020	78.06	UNPD
Rural population (%)	2020	21.94	UNPD
GDP (current millions of USD)	2020	3 384	WBG
Agricultural land (km^2)	2018	17 020	FAO
Agricultural land (% of land area)	2018	73.43	FAO

INFRASTRUCTURE

According to the World Bank, almost 25 percent of the rural population had access to electricity in 2019, compared to 71.6 percent in urban areas.

Given its strategic port and trade locations and from an ICT perspective, Djibouti already has 11 local and international undersea cables, including Gulf Bridge International (GBI), Transcontinental Europe India Gateway (EIG), EASSy, SEACOM, SEA-ME-WE 3, the regional Aden-Djibouti cable, AAE-1 and SEA-ME-WE 5.

The Djibouti Data Center (DDC) is the first and only carrier-neutral data centre. It offers a robust product portfolio, which includes flexible options for simplified, competitively-priced cable head access, backhaul, for both global and regional network operators. It also offers colocation, Virtual Point of Presence (vPOP) and an Internet Exchange Point (DjIX), all at a purpose-built, Tier 3 data centre facility. It is already hosting data from the US Army, MTN, China Mobile and Facebook among others.

Djibouti Telecom, a state-owned enterprise (SOE), enjoys a monopoly on first, middle and last-mile connectivity, providing all ICT services in the country (including fixed telephony, mobile services, and broadband). Growth in the mobile and Internet sectors accelerated with the launch of 3G in 2011, and the ensuing roll out of a full-blown LTE network in 2016. The number of mobile connections in Djibouti in January 2021 was equivalent to 43.5 percent of the total population. However, a geographic digital divide exists where 70 percent of urban households own at least one mobile phone compared to 25 percent of rural households. Only one-third of the rural population is less than 10 minutes away from a location where a phone call can be made.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	24.99	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	N/A	GSMA
		Secure access to Internet servers (per 1 million people)	2020	49.60	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	43.93	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	23.62	ITU
		Fixed broadband subscriptions (per 100 people)	2020	2.54	ITU

DIGITAL PENETRATION

To promote the development of a strong digital economy that benefits everyone, the government organized an international conference in 2018. It highlighted the potential benefits of a digital economy and proposed a concrete roadmap to support the sector. Djibouti has not yet liberalized its telecommunication market, which has affected prices, access, and quality of mobile and fixed services. That said, there has been a considerable improvement in the average mobile price of 1 GB according to Cable, plummeting from USD 37.92 in 2019 to USD 1.12 in 2020.

The ITU and the Ministry of Communication, Post and Telecommunication (MCPT) started deployment of WiMAX that has brought affordable Internet and mobile broadband connectivity to many rural areas in Djibouti. Internet penetration in Djibouti stood at 55.7 percent in January 2021.

A household report from 2018 indicated that around 55 percent of individuals above 35 years of age reported having had access to the Internet in the three months prior, virtually all of whom did so using mobile devices. Nevertheless, a large urban-rural digital divide was evident. About 71.3 percent of urban households reported access to the Internet versus only 0.7 percent of rural households. Twenty percent of Djibouti's urban homes have access to a computer, compared to zero percent of rural homes. Social media penetration in Djibouti stood at 26.1 percent in January 2021.

Mobile money service only appeared in 2018 when the private company mDJF started advertising its products. Possibly, the steep prices retained on both sides of the transaction hindered the rapid adoption of this new technology. Djibouti Telecom (the state-owned and only available TCL Company in the country) then launched in June 2020 D-Money, a digital mobile money service that allows users to carry out digital money transfers and payments directly from their mobile phones. A wide range of financial transactions can now be carried out over the Internet or by SMS.

Local and national digital platforms and online government services are making an increasing amount of information and public services available to Internet users. In 2018, the Public Administration Modernization Project for Djibouti enabled access to e-government and promoted efficiency of selected revenue administration services. The project comprised the development of a digital platform and e-services, the establishment of a citizen service centre (CSC) pilot, and institution-building.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.12	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	5.71	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	5.24	ITU
	Willingness	Mobile social media penetration (%)	2019	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

The strategies followed by Vision Djibouti 2035 revolve around five pillars: peace and national unity; good governance; economic diversification; consolidation of human capital; and regional integration. Pillar three in particular aims at developing a diversified and competitive private sector-driven economy. Digital economy solutions developed under enhanced competition can boost innovation and pave the way for new opportunities for the region's educated youth by way of enhanced economic growth and a better functioning domestic labour market.

Djibouti Telecom has developed a new transformation strategic plan PSD-DT-2021 in 2019, comprising several components. These include an international, regional and national strategy with two major programmes, Djibouti

Connector & Connected (Djibouti Connecteur & Connecté) and Digital Djibouti (Djibouti Digital). The focus remains however very much outward looking, or to become a regional digital hub.

In 2015, the government created the Agence Nationale des Systèmes d'Information de l'Etat (ANSIE) to connect the country's administrations by a high-speed network with collaborative communication tools, and to develop transversal IT applications to host them in a single data centre in order to improve the efficiency of administration. Through this agency, the government intends to establish a political and regulatory framework as well as the much-needed sound management of the electronic administration.

From an agriculture perspective, Djibouti's National Investment Plan for the Agriculture Sector and Food and Nutrition Security (PNIASAN 2016-2020) aimed at achieving the following: (i) leasing land for agriculture in other countries in the region, particularly Ethiopia and Sudan, to create a buffer stock of food, as arable land is limited in Djibouti; and (ii) developing more arable land in the country through irrigation systems and mobilization of surface water.

The government also adopted the Strategy for Accelerated Growth and Promotion of Employment (SCAPE), and the National Employment Policy (NEP), both conceived to promote the culture of entrepreneurship (particularly with young people and qualified women). These initiatives provide support mechanisms to strengthen commerce, tourism, agrobusiness, and the provision of construction materials and services to companies and individuals.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	4.5	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2001 Djibouti created a National Investment Promotion Agency (NIPA) mandated to enhance regulatory frameworks to accelerate private sector involvement. Launched in March 2017, NIPA is a one-stop shop initiative that houses several agencies involved in the process of starting a business.

The Djibouti International Free Trade Zone (DIFTZ) was officially inaugurated in July 2018 to expand manufacturing and processing capacities as well as creating jobs in Djibouti.

In 2018, Djibouti implemented six reforms in the areas of business creation, transfer of ownership, protection of minority investors, obtaining loans, enforcing contracts and

settling debt insolvency. The cost of registering a business was 41.9 percent of gross national income per capita in 2018, down from over 200 percent. In addition, the government launched the Djibouti Partial Credit Guarantee Fund (DPCGF) to facilitate access to finance for SMEs.

The Djibouti Economic Development Fund (DEDF) is a public institution of a commercial nature seeking to support the creation or development of SMEs through the loans and technical assistance. The DEDF offers long and medium-term loans of between FDJ 3.5 million and FDJ 50 million.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	182	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	14	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

Djibouti has announced its intention to connect all schools in the country to high-speed Internet, and to equip every student with a tablet. Ultimately, the country could also adjust its school programs and training courses to ensure that the lessons provided are in line with the needs of the digital economy.

School enrolment increased from 80.5 percent in 2016/2017 to 90.2 percent in 2017/2018, while attendance at primary schools rose from 89 percent to 93 percent. Nationally, 38.2 percent of girls attend school, compared to 64.5 percent of boys; the disparity is larger in regions outside Djibouti City. Only 22 percent of youth have no schooling as compared to 65 percent of those aged 25-64 years.

The low number of schools outside the cities is also responsible for the big difference between the 67 percent enrolment rate in urban areas and 49 percent in rural areas. In rural areas, schools also tend to be far from homes. About 20 percent of rural primary schools do not have water supply and 55 percent do not have electricity.

The University of Djibouti was established in 2006 with faculties in law, economics and management, science, humanities, languages and social sciences, medicine and engineering, as well as a Technical Institute of Industry and a Technical Institute of Tertiary Services. The university deployed the country's first-ever "smart classroom" in 2020, conducting multiple rounds of technical training for the university's IT staff as well as operational training for teachers. The university also participates in the Erasmus Mundus Program and collaborates with the private sector, especially in the fields of logistics, transportation and civil engineering.

A number of private and public vocational training entities shut down or are operating on a partial basis. This includes training centres, the Ali Sabieh vocational training college, and the Service National Adapté (SNA). The SNA, which was highly regarded by private sector

employers, used to train skilled workers in various fields before it shut down.

Most young people do not participate in the formal economy. Low labour market-relevant skills are an additional mitigating factor. Almost 50 percent of the working age population have never attended school.

ICT firms have a high demand for specialized engineers and technicians trained in coding, cybersecurity, etc., as well as new managerial skills that emphasize flexibility and innovation. Expanding the use of ICT, digital learning and skills development is a key pillar of the reform efforts of the Ministry of Education and Professional Development (MENFOP). This is at in its infancy and requires additional investment to reach scale, especially in terms of schools in remote areas. Other initiatives also aim at developing digital skills, such as the Center for Technology and Innovation for Development, through its Code for Youth project, as well as Women ICT Djibouti.

The Djibouti Support for Women and Youth Entrepreneurship (SWYE) project aims at improving economic opportunities for entrepreneurs, with a special focus on women and youth. A key component of the project is to provide skills training to entrepreneurs and small enterprises.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	N/A	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	N/A	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	24.55	ILO
		Employment in agriculture, female (% of female employment)	2019	22.14	ILO
		Unemployment, total (% of total labour force)	2020	11.57	ILO

AGRO-INNOVATION

In 2011, the government signed a cooperation agreement with Agence universitaire de la Francophonie for regular co-financing of missions by teachers and experts, scientific events and research projects (in partnership with CERD), the launch at the university of the partner Francophone digital centre, and the annual allocation of funding for master's and doctoral degrees. The Creative Spaces lab housed at the University of Djibouti aims at increasing job and learning opportunities in technology as well as building stronger start-up and entrepreneurial communities.

The Leadership and Entrepreneurship Center (CLE) is dedicated to the development of entrepreneurship and innovation in various economic and industrial sectors. Supported by the Ministry of Economy and Finance, which oversees industry, CLE aims at supporting and accelerating the growth of businesses (including agribusinesses) in Djibouti. In cooperation with UNDP, CLE planned to launch in 2021 a series of funding for small projects and start-ups, including agribusiness-oriented projects.

The Djibouti Young Entrepreneurs Club (DYEC) was set up in 2015 had twenty young entrepreneurs selected and trained in various areas including agriculture. Participants were provided with a platform to network, learn and collaborate on leveraging technology. Le Centre de Technologie et d' Innovation pour le Développement (CTID) is privately managed and

predates CLE. CTID provides diverse ICT activities and projects, social and solidarity innovation, renewable energies, agribusiness, environment and services. Furthermore, the UNDP Youth Leadership Programme (YLP), in partnership with the youth-serving organizations CTID and Good Planet Africa, provides training and capacity-building for youth through workshops, innovation camps, hackathons and other activities.

In 2018, a hydroponics pilot project with low-cost and low technology approach took a complete cycle through financial contributions from the World Bank, and the technical support of the Ministry of Agriculture and FAO. About 25 youth were also engaged in a hands-on training on hydroponics techniques. In 2020 and 2021 FAO, in a joint project with UNICEF and WFP, introduced a demonstrative hydroponics unit in a school in the surrounding rural area of Djibouti. Trained youth were exposed to digital agriculture open-source tools, including online platforms, such us Arduino IOT Cloud, MyDigital. Farm, and The Things Network for the LoRA type of communication in areas not covered by 4G network.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	44.62	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	126.33	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.63	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

EQUATORIAL GUINEA

Equatorial Guinea is an upper-middle-income economy with a population of 1.4 million people, 72.2 percent of whom live in the Continental Region while 27.8 percent live in the Insular Region. About 73.1 percent of the population is urban, due to the greater concentration of people in the cities of Malabo and Bata.

Industry (45.2 percent) and trade (89.8 percent) contributed most to GDP in 2020. Agricultural land represents more than 850 000 hectares, of which only 26 percent is exploited, of which subsistence agriculture occupies more than 85 percent of the cultivated area and is geared toward production and household consumption. However, despite this potential, the Equatorial Guinea's food supply is 80 percent dependent on imports, which would explain the country's persistent food insecurity. As a result, 77 percent of the country's population lives in poverty; 57 percent of people do not have access to drinking water and 16 percent of children under five suffer from chronic malnutrition.

Equatorial Guinea's ICT is generally modest in the areas of technological innovation at sub-regional, continental and even global levels, but the country seems determined to enhance its ICT and telecoms sector (see Table 1).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	1 402 985	WBG
Urban population (%)	2020	73.10	UNPD
Rural population (%)	2020	26.90	UNPD
GDP (current millions of USD)	2020	10 022	WBG
Agricultural land (km^2)	2018	2 840	FAO
Agricultural land (% of land area)	2018	10.13	FAO

INFRASTRUCTURE

About 66.6 percent of Equatorial Guinea's population has access to electricity, of which 90.9 percent are in urban areas and only 2.2 percent in rural areas. When disaggregated by location, only 25 percent of the rural population uses non-solid fuels compared to 91 percent in urban areas (World Bank, 2015).

In terms of connectivity, the number of mobile connections in Equatorial Guinea was equivalent to 54 percent of the total population in January 2021.

For many years, the government has made significant economic efforts to develop the public telecom infrastructure with the sole objective of bridging the digital divide. The state-owned incumbent, Guinea Equatorial Telecommunications Society (GETESA), which launched its GSM network in 2000, dominates the market. In 2009, Green Com, a subsidiary of a Kuwaiti-based company, launched as the second mobile operator under the Muni brand. GETESA launched 3G in 2011, and 4G LTE in 2020, followed by Green Com's launch of 3G in 2016 and 4G in 2019. In addition to lower prices, competition between the two operators has resulted in a diversity of consumer offers, especially of 3G services. Internet access has also improved thanks to the connection of Equatorial Guinea to the ACE (Africa Coast to Europe) in 2012.

Established in 2020 as form of FDI, AfriOne is a new company that offers mobile devices and telecommunications. It is the first information and communication technology devices assembly plant in Equatorial Guinea aiming at rendering the local ICT market more affordable.

In 2011 the government created the Management of Equatorial Guinea Telecommunications Infrastructures (GITGE) to trade, operate and maintains the country's telecommunication infrastructures (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	2.16	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	N/A	GSMA
		Secure access to Internet servers (per 1 million people)	2020	33.5	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2018	45.17	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2018	0.14	ITU
		Fixed broadband subscriptions (per 100 people)	2019	0.01	ITU

DIGITAL PENETRATION

About 26.2 percent of Equatorial Guinea's populations are Internet users. Although the government claims that 95 percent of municipalities have access to a fiber optic network, Internet penetration in Equatorial Guinea stands at 26.2 percent as of 2021. The number of social media users as of January 2021 was equivalent to 9.1 percent of the total population, of which 97 percent accessed social media using mobile devices. The most visited social media platforms were Facebook (64.9 percent), Pinterest (11.5 percent), YouTube

(10.2 percent), Twitter (9.2 percent), Instagram (3.5 percent) and LinkedIn (0.6 percent). The cost of mobile data per 1 GB is USD 12.73. By way of example, accessing the Internet in a cybercafé for an hour costs USD 1.80. In addition, Equatorial Guineans consume more than 2.03 GB per month (global average), the percentage of households with computers stood at 15.8 percent and the percentage of households with Internet was 9.3 percent in 2017.

According to the United Nations, in 2016 approximately 20 percent of the population had deposits in commercial banks. If a bank does not have a branch in the location where an individual wants to do business, they would not have access to their funds there. ATMs are only available at limited locations (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	12.78	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

The government's development agenda is guided by a medium-term strategy paper, the National Economic Development Plan: Horizon 2020, which targets economic diversification and poverty reduction. The first phase of Horizon 2020 focused on infrastructure development and was concluded in 2012. The second phase focused on economic diversification, targeting strategic new sectors such as fisheries, agriculture, tourism and finance. In the area of agriculture, authorities aimed at increasing production by 2020 to sustain the development of agri-food, which is pegged as a priority sector in the diversification policy; reverse the trend of increasing food imports; and diversify exports.

The Industrialization Plan, which covers the period up to 2020 aimed at encouraging economic diversification by granting certain privileges to the national and international private sector for the development of specific industrial sectors, including agri-food.

The Ministry of Telecommunications and New Technologies is responsible for country's digitalization plans. Its imperatives are linked to the Government's Horizon 2020 national development strategy and include enhancing international capacity, improving quality of services, making prices more affordable, ensuring competition between operators, extending coverage across the country, strengthening regulations, improving ICT training, and promoting the development and take-up of new applications and services within different sectors of the economy. The General Law of Telecommunications of 2005 is the relevant legislation for the sector and, since its enactment, fixed line, mobile and Internet services have been open to competition. The Telecommunications Regulator Organ came into being after adoption of the law to regulate the sector.

Through a general legal framework for data protection matters, Equatorial Guinea enacted Law No. 1/2016, of 22 July 2016 (the

"Data Protection Law"). In terms of electronic communications and networks, Equatorial Guinea has also enacted Law no. 2/2016 of 22 July 2016 (the "Electronic Communications Law") that regulates its electronic communications and networks.

ORTEL, the country's telecommunications regulatory body, was created in 2005 to monitor the conditions of competition in the market, protect Internet users, as well as to respect the conditions of operation and provision of public services, and other telecommunications activities. Through ORTEL, the government intends to boost and increase the speed of Internet connectivity by installing Ethernet concentrators (Hub) throughout the country (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	50.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Through Presidential Decree number 71/2014, HOLDING Equatorial Guinea was created as a public entity of exclusive state participation. Among its various functions as an executing arm of the government's economic policy, it co-invests in profitable projects focused on agriculture, livestock, fisheries, mining and services in general, with a view to eliminate dependence on revenues from the hydrocarbon sector.

The government has made significant efforts to reduce the time required to start a business, decreasing from 150 days in 2015 to 33 days in 2019, according to the World Bank.

The government is generally supportive of FDI, which is regulated by the Foreign Investment Law (Decree 72/2018 of April 2018).

In 2017, the government passed Decree No. 67/2017, published in September 2017, to establish a one-stop shop or "single window" to simplify the process of registering a business with the aim of bringing down to seven the number of days required to establish a business. The "single window" was launched in January 2019, pursuant to the government equipping the facilities for processing applications, and training staff. The government has also adopted, among other things, the Automated System for Customs Data (ASYCUDA) to make the country's customs administration more efficient and more transparent.

The country does not have a business facilitation mechanism for equitable treatment of women and underrepresented minorities in the economy, but there are laws that make it illegal to discriminate against women (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2020	452	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	33	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

Equatorial Guinea's literacy rate was higher than 90 percent and the gross enrolment rate in primary education reached 80 percent and the repetition rate 24 percent. However, there are still disparities relating to place of residence, with only 40 percent of girls in rural areas completing primary school compared to 56 percent in urban areas. Unemployment affected 9.2 percent of the working population in 2020 and the hydrocarbon sector employed only 4 percent of the workforce. The lack of sufficiently skilled agriculture labour is a major obstacle to producers in sub-Saharan Africa entering global value chains (ECA, 2013). However, Equatorial Guinea recently marked a slight increase in employment in the agriculture sector (percent of total employment) from 42 percent (2015) to 39.5 percent (2019).

The National University of Equatorial Guinea (UNGE) is the Alma Mater Studiorum of institutions of higher education in Equatorial Guinea. In the 2017-2018 school year, 7 707 students were enrolled in the university. The faculties with the highest percentage of enrolment during the school year in question were law, political science, communication, and philosophy, with only 30 enrolled in agricultural technologies, and 12 percent enrolled in the faculty of fisheries.

In terms of vocational and technical education, there are limited specialties, which generally do not meet the needs of the country's professional sector. As a result, training active workers is often the responsibility of the employer or the individual themselves, seeking training outside the country. In the area of non-formal skills training, the Ministry of Education and Universities (MEEU) works with the Ministry of Employment and Vocational Training for the building construction and service sectors and with the relevant sectoral ministries for specific courses (agriculture, fisheries, mining, and the oil and gas sector). The government and some national and/or international companies have set up several training schemes, particularly in the agriculture, fisheries, mining, and oil and gas sectors, to develop the skills of their staff (or of the young people they wish to recruit later) quickly and effectively. These schemes include in-house training through an internal supervision system.

The General Department for the Promotion of Employment and Vocational Training (DGPEFP) is the main public structure tasked with identifying and anticipating skills requirements. Most new training centres are located in Bata and Malabo whereas other continental regions only have one centre or no centres at all. As a result, people from rural areas have no access to technical and vocational education and training (TVET) locally. Moreover, the courses on offer (service

occupations) do not suit the local economic landscape, which comprises mainly agricultural, livestock or fishing activities. TVET has been largely delegated to the private sector, which runs over 75 percent of TVET centres. Between 2016 and 2018, the number of TVET centres increased from 25 to 45, with strong growth in private centres, which make up 85 percent of new institutions. The agriculture sector, which employs 39.5 percent of the working population, does not have an investment policy commensurate with its development and job creation potential.

Equatorial Guinea's first ICT training institute was established by the technology company ZTE in 2015. Its excellent teaching facilities and the network-wide communications laboratory provide a comprehensive environment for students to train on cutting-edge technologies (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2010	94.37	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2010	97.97	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	39.51	ILO
		Employment in agriculture, female (% of female employment)	2019	42.50	ILO
		Unemployment, total (% of total labour force)	2020	9.15	ILO

AGRO-INNOVATION

Although Equatorial Guinea's share of public agriculture expenditure is 1.7 percent, the sector has significant potential to provide sufficient food production for the country.

The National Institute for the Promotion of Agricultural Technology in Equatorial Guinea (INPAGE) was established as an autonomous, decentralized body, linked to the Ministry of Agriculture, Livestock and Rural Development (MAGADER), which supports, through subsidies, the production of cocoa earmarked for export (see Table 7).

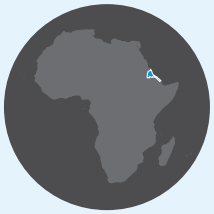
Supported by GIGTE, the TEG CAMPUS is the largest tech event in Central Africa. With the aim of promoting awareness, the TEG CAMPUS platform connects entrepreneurs, innovators, and developers to create a professional network around all opportunities in the African ICT sector.

The National Institute for Business Promotion (INPYDE) supported by the UNDP provides entrepreneurship training, offers funding mechanisms for start-ups and encourages innovation. In addition, the African Observatory of Science, Technology and Innovation (AOSTI) is hosted by Equatorial Guinea.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	239.42	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	109.47	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.32	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

ERITREA



Eritrea is a low-income country. Agriculture, animal husbandry and fishing remain the mainstays of the economy, with approximately 80 percent of the population relying on agriculture for their livelihoods. About 65 percent live in rural areas and 37 percent of the population faces high food insecurity. Although the majority of the population still relies on agriculture, animal herding and fishing for their survival, the sector only accounts for about 16.9 percent of GDP and about 20 to 30 percent of commodity exports (Agriculture Sector Strategy, 2014). Additionally, about 70 percent of the population is under 35 years of age.

The digitalization of agriculture in Eritrea is expected to be driven by supportive systems. The country's telecom sector operates under a state-owned monopoly with the Eritrean Telecommunication Services Corporation (EriTel) as the key service provider. EriTel has rolled out 3G services to improve service delivery.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	3 213 969	WBG
Urban population (%)	2020	35.77	UNPD
Rural population (%)	2020	64.23	UNPD
GDP (current millions of USD)	2011	2 065	WBG
Agricultural land (km^2)	2018	75 920	FAO
Agricultural land (% of land area)	2018	75.17	FAO

INFRASTRUCTURE

Eritrea has seen a rather slow increase over the years with regards to electricity access. As of 2019, Eritrea had 36.7 percent electricity distribution in rural areas. Fixed and mobile communications are owned by the government and operated by the Eritrea Telecommunication Services Corporation (EriTel). Eritreans fulfilling compulsory national service cannot own a mobile phone. There were 767.5 thousand mobile connections in Eritrea in 2020 or equivalent to 21.5 percent of the total population. Despite its coastal location, Eritrea does not have a submarine cable landing station.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	36.69	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	N/A	GSMA
		Secure access to Internet servers (per 1 million people)	2020	0.85	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2017	20.36	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	0	ITU
		Fixed broadband subscriptions (per 100 people)	2017	0.03	ITU

DIGITAL PENETRATION

Customers must pay at least USD 46 to get an active mobile subscription. Voice credits cost USD 3.65 and local mobile cellular calls per minute cost USD 0.13 as of 2015. Officially, there are 146 fixed broadband subscriptions in the entire country. Dial-up home access costs USD 200 per month. There were about 248 000 Internet users in Eritrea in 2020, a decrease of 15 percent compared to 2017. Internet penetration in Eritrea stood at 6.9 percent in 2020. Individuals using the Internet (percent of population) was 1.31 as of 2017.

There are 100 Internet cafes in the country, most of which charge USD 1.34 per hour and have less than 10 computers. There were 6 300 social media users in Eritrea in 2020, a decrease of 71 percent compared to 2017. The number of social media users in Eritrea was equivalent to 0.2 percent of the total population in January 2021.

From an agriculture perspective, the Agricultural Strategic Information System Division (ASISD) department within the Ministry of Agriculture manages weather data collected from around 120 agro-meteorological stations. It reports on monthly and seasonal rainfall in the summer and autumn rainy seasons, which facilitates timely decision making. Supported by FAO, the implementation of eLocust3 is assisting the government to assess the movement and breeding of locusts as part of early warning mechanisms in regions throughout the country.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	N/A	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

Policy development is under the purview of the Communications Department of the Ministry of Transport and Communications. The Ministry of National Development, the Ministry of Information and EriTel are equally closely involved in the development of ICT policy.

In 2019, the Ministry of Agriculture (MoA) established the ASISD by merging under one umbrella different units within the MoA (GIS and remote sensing, ITC, etc.) to better support the government's sectoral plans, programmes and projects. This includes the Education Development Strategy; the Agriculture Development Strategy; and the Technical and Vocational Education Training Project 2010-2016. Furthermore, it is aligned with the Eritrea National Agriculture Development Policy and Strategy, the Five-year Strategic Agricultural Development Plan (2019-2023) and the draft Strategic Development Plan (2016-2020), and the Small and Medium Commercial Farmers Strategy (SMCFS). The MoA has also introduced the Minimum Integrated Household Agricultural Package, a project that will aid the modernisation and expansion of various sectors of agriculture in the country (Ministry of Information: Eritrea, 2021). That said, Eritrea does not yet have an officially recognized national or sector-specific cybersecurity strategy, or laws on data governance related to the agri-food sector.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	25	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The government strongly encourages companies and individuals to invest in infrastructure projects, particularly in building residential housing, roads, airports, ports and hospitals. Eritrea is aiming at creating a modern, private sector-led economy (Macro Policy 1994; National Indicative Development Plan 2014-2018).

Despite the liberalization of the economy, accessing capital remains difficult. The central bank controls all of Eritrea's retail and commercial activities and holds 90 percent of the country's deposits and 80 percent of private sector claims. Also, start-ups that target the digital agriculture market find it difficult to obtaining initial capital support such as loans.

More than 75 percent of the population lives in rural villages and there are few support programs or policies that enable citizens to successfully launch a business. Businesses in Eritrea also face several infrastructure challenges, such as high fuel prices and inconsistent provision of electricity and water. An entrepreneur in Eritrea needs an average of 84 days to open a business, 59 days to get electricity and 59 days to import goods. The government has created a Free Zone Authority in Massawa to attract new investors, primarily in energy, tourism and fishing.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	67	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	84	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

The country has a comparatively literate youthful population of 93.3 percent and an adult population of 76.6 percent. In the post-independence time, illiteracy rate was estimated at about 80 percent. The Eritrean government has successfully undertaken capacity-building programmes. For instance, the government has partnered with AfDB to support ICT skills development for youth employability and entrepreneurship. Much more has also been done in the agribusiness sector. The AfDB initiative, ENABLE Youth Eritrea, is a skills and capacity development project that builds entrepreneurship in agribusiness to create a conducive environment for young men and woman to become owners of profitable agribusinesses.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	76.57	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	93.27	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	63.12	ILO
		Employment in agriculture, female (% of female employment)	2019	68.35	ILO
		Unemployment, total (% of total labour force)	2020	7.44	ILO

AGRO-INNOVATION

The promotion and/or scaling up of innovation is done through partnerships with relevant national institutions, such as the National Agriculture Research Institute (NARI). However, digitalizing the agriculture sector is hampered by inadequate and low skill capacities of staff to undertake ground-breaking research.

To date, Eritrea's agriculture sector has benefitted from a EUR 4 million project known as Development Smart Innovation for new innovations on smallholder farms, the strengthening of research, education and innovation support, and capacity-building aimed at increasing youth employment.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	403.51	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	102.02	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.09	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2011	0.30	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

ESWATINI

Eswatini is a lower-middle-income country with a population of about 1.2 million people, most of whom live in rural areas. About 70 percent of the rural population lives below the national poverty line and 25 percent are considered extremely poor. Smallholder farmers remain the backbone of rural livelihoods in Eswatini with over 75 percent of the country's total population – 60 percent of whom are women – relying on subsistence farming. Eswatini's economy is fairly diversified, with agriculture and manufacturing contributing significantly to the country's GDP, accounting for about 8.2 and 40 percent respectively.

However, the agriculture sector has been impacted by weather-induced crop failures, pests and diseases and limited access especially by smallholder farmers to financing instruments and technology. Agricultural activity has been declining in Eswatini over the last two decades. Its exports to South Africa accounts for about 60 percent of total output while importing approximately 90 percent of goods from the same trading partner.

On the other hand, the country's drive toward a knowledge-based and digital economy is underpinned by a vibrant telecommunications market. The enabling legislative and regulatory environment has allowed for easy participation in the market by individuals, as well as private and public institutions. This has encouraged investments in new networks and ICT infrastructure, and upgrades for legacy systems to meet the demands of the growing local ICT market.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	1 160 164	WBG
Urban population (%)	2020	24.17	UNPD
Rural population (%)	2020	75.83	UNPD
GDP (current millions of USD)	2020	3 962	WBG
Agricultural land (km^2)	2018	12 220	FAO
Agricultural land (% of land area)	2018	71.05	FAO

INFRASTRUCTURE

Eswatini has a 77.2 percent national coverage of electricity (2019). The electricity supply is linked regionally to the electricity supply network known as the Southern African Power Pool. This ensures the supply of power at reliable and low-cost rates. Electricity access has improved in rural areas through the government's Rural Electrification Program with about 72.9 percent of rural dwellers connected.

Mobile communications services are currently provided by two service providers (MTN Eswatini and Eswatini Mobile) using 2G, 3G and 4G/LTE technologies, with a combined network coverage of over 98 percent for 2G, 91 percent for 3G and just over 47.40 percent coverage for 4G/LTE. The service providers are currently engaged in an aggressive expansion exercise for 4G/LTE networks with plans to attain 85 percent coverage. With a population of approximately 1.2 million, mobile subscriptions account for 93.5 percent, whereas broadband subscription is about 13 per 100 inhabitants. Also, 3G coverage is within reach of about 47.4 percent of the population.

Fixed telecommunications services are provided by the Eswatini Posts and Telecommunications Corporation (EPTC), offering broadband services through fixed line and optic fiber connections. To date, the EPTC offers ADSL for both residential and business customers.

Over the past few years, the country has seen a significant growth in the number of service providers, more especially for Internet and broadband services, from just four companies in 2014 to 17 in 2019. This change has resulted in a highly competitive telecommunications market, characterized by high quality and affordable services. Between 2014 and 2019, prices of communication services (mobile voice and mobile Internet) have come down by over 200 percent in some cases. Over the same period, high speed broadband powered by 4G/LTE and fixed technologies have been introduced in the market.

The Eswatini Communications Commission ensures fair play in the industry through regulation, licensing and subsequent monitoring compliance to regulations and laws governing the industry.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	72.94	WBG
		4G coverage (% of total coverage)	2019	47.40	GSMA
		Mobile (device) ownership (% of population)	2019	65.68	GSMA
		Secure access to Internet servers (per 1 million people)	2020	110.33	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.38	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2017	93.53	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	15.91	ITU
		Fixed broadband subscriptions (per 100 people)	2017	0.71	ITU

DIGITAL PENETRATION

In 2018, 36 percent of households in Eswatini owned a mobile device or computer, but with no access to the Internet. Only 4 percent of the population neither have a mobile device nor a computer. In addition, 51 percent use mobile or Internet regularly. For 96 percent of the population, cell phone services and electricity are available. In Eswatini, 3.4 percent of households have fixed broadband and 46 percent have mobile broadband. However, the GSMA (2019) reports that only 21.9 percent of Swazis are actively engaged in social media platforms, through mobile technology. There is a relatively low number of mobile apps in the local languages. Equally, Cable (2020) reports of high data prices with users having to pay as much as USD 13 for 1 GB of data.

Digital penetration is progressing in Eswatini through various platforms established by public or private entities, such as the OVC Management Information System. Through Eswatini MTN Mobile Money technology, it ensures OVC beneficiaries in rural areas receive their payments in a fast and reliable manner. Rural areas accounted for 82 percent of the total mobile money payment. However, banks find it costly and risky to serve rural SMEs, smallholders and particularly the poorest strata of the population.

The government launched the Computerisation of Tinkhundla Centres to serve as hubs for e-government services that aim at providing infrastructure for communities to access government services from their constituencies. Furthermore, the Eswatini Agricultural Science Information System (SASIS) collects data on agricultural production while also providing functions on database administration, queries and reports. Additionally, other service providers like EPTC, Real Image, DataNet also offer data centres, IT-related services and disaster recovery services to the market.

Concerned about the relative lack of farmers' organizations' membership data, the Electronic Membership Data Management System for the Swaziland National Agricultural Union (SNAU) was launched in 2016. It has over 23 000 registered farmers. In addition, an e-voucher system was developed that uses smartcards for farmers to access farming inputs from agri-dealers located in close proximity to 10 000 farmers in Eswatini.

The Ministry of Agriculture (MoA) has digitalized the national plant health inspectorate web-based service to provide online plant health services. It also established four innovation platforms for honey, goat, horticulture and indigenous chickens. In 2020, The National Agriculture Marketing Board (NAMBoard) launched Farm Store, an online market platform.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	13.31	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	5.33	ITU
		Fixed broadband prices as a % of adjusted per capita income	2016	15.20	ITU
	Willingness	Mobile social media penetration (%)	2019	21.95	GSMA
		Number of apps in national language (quantity)	2019	5.00	GSMA
		Gender gap in social media use (%)	2019	64.78	GSMA
		Gender gap in mobile ownership (%)	2019	96.21	GSMA

POLICY AND REGULATION

Over the years, the government has developed a range of policies and strategic instruments to provide a road map to economic recovery, all of which are yet to deliver. Key among these is the National Development Strategy (NDS) that was originally conceived in 1997 to span a 25-year horizon. It was adopted in 1999 and revised in 2014, before evolving into the Strategy for Sustainable Development and Inclusive Growth (SSDIG), with a vision to be achieved by 2022, and the Poverty Reduction Strategy and Action Plan (PRSAP), approved by the cabinet in 2007.

Vision 2022 includes an industrial development policy, which seeks to be humane, sustainable, social, and above all, technological. The NDS strategy focused on seven macroeconomic pillars, including: agricultural development; economic acceleration; industrialization and diversification; environmental management and sustainable development; infrastructure development; balanced regional growth and urbanization; research and development; and governance and sound economic management.

The agriculture sector has seen momentous developments over the last ten to fifteen years, during which the government has formulated several policies to create an enabling environment within the sector. This included the Comprehensive Agriculture Sector Policy (CASP-2005), the National Food Security Policy, the National Irrigation Policy, the Livestock Development Policy, the National Forestry Policy. All of the above-mentioned policies are nearing their period review point and are accompanied by the draft National Agricultural Research Policy (NARP), and the draft National Agricultural Extension Policy (NAEP). The sector is further guided by the Eswatini National Agriculture Investment Plan (SNAIP) 2015-2025 and the Comprehensive Africa Agriculture Development Programme (CAADP).

From an ICT perspective, Eswatini adopted the National Information and Communications Infrastructure (NICI) Policy. It also established an independent regulatory office in 2013 (the Eswatini Communications Commission) that is responsible for oversight and supervision of the electronic communications sector and the Electronic Communications Act of 2013.

In addition, a National Broadband policy has been drafted and is currently being refined for validation by stakeholders. The National Broadband policy as well as the National Cybersecurity Strategy 2022 seek to specifically improve the Internet governance framework and services provision in the country. Other institutions that will be established as called for by the policies include a National Internet Governance Forum (IGF), a National Computer Emergency and Response Team (CERT) and a Data Protection Authority.

Toward digitalization and to address the digital divide, the government adopted a Strategic Road Map: 2019-2023 aiming at implementing e-government to centralise data and systems into a single solution. The road map also aims at digitally transforming key strategic sectors, including agriculture, energy, ICT and education, manufacturing and agro-processing, and tourism. In addition, the government's commitment to battle climate change and climate change preparedness have been demonstrated by the development of the national climate change policy (NCCP).

In terms of education, the first National Education and Training Improvement Programme (NETIP) was adopted in 2013. It articulated various educational sector activities within the short-term period of three years (2013/14-2015/16). The NETIP II seeks to operationalize two policy documents, namely the Education Sector Strategic Plan (ESSP) covering the period 2010-2020 and the Education and Training Sector (EDSEC) aiming at introducing ICT in all sectors of the education system, including agriculture.

From an entrepreneurial perspective, the revised SMME National Policy is intended to update the existing one that was first issued in 2004. The aim is to create a modern, comprehensive, targeted and coherent framework that will create a highly competitive, profitable and entrepreneurial sector.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.20	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	2.95	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.60	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	59.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The persistent decline in FDI and business dynamism in Eswatini has created, among other things, capital stock obsolescence and a persistent decline in capital productivity in the domestic private sector. Investments are generally provided for in the Eswatini Investment Promotion Act of 1998. Antitrust laws exist to avoid monopoly tendencies and are guided by the Eswatini Competition Commission. In 2011, Eswatini developed the Fiscal Adjustment Roadmap (FAR) and the Economic Recovery Strategy (ERS) with a view to accelerate and sustain economic growth.

To date the country has hosted a number of multinational corporations like the Coca-Cola Concentrate factory, YKK Africa and Mondelez International, to name just a few. Two sites have already been declared special economic zones through legislation under the Special Economic Zones Act of 2018. The first is the Royal Science and Technology Park, which will leverage biotech industries and high-value agribusiness. The other site is the King Mswati III International Airport Zone. Both of these special economic zones offer lucrative incentives to qualifying investments in bio-science, technology and innovation.

However, the country's start-up ecosystem is yet to be prioritized through legislation to support new businesses with incentives, especially in agriculture, whereas agricultural capital development expenditure (CDE) is allowed as an incentive for agriculture. Lack of capital, the high cost of business registration and unfavourable attitudes towards young entrepreneurs present serious obstacles to a youth-led MSME sector.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	130	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.63	WEF
	Entrepreneurship	Time required to start a business (days)	2019	21.5	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.50	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

With an adult literacy rate of 88.4 percent, skills and a trainable workforce are abundant in Eswatini. There is no huge gap between literacy rate for adult women and men, with 88.5 percent and 88.3 percent separately. Youth literacy rate is 95.5 percent.

Primary education is free and there are grants for orphaned and vulnerable children at the secondary and high-school levels. Access to secondary education continues to be very limited and inequitable. According to the Annual Education Census (AEC, 2015) report, at lower secondary school level, the net enrolment rate is 27.7 percent while the gross enrolment rate is 88.4 percent. At the senior secondary school level, the net enrolment rate is 11.8 percent while the gross enrolment rate is 62.7 percent.

Eswatini has thousands of graduates annually from tertiary institutions in various disciplines including technology, commercial disciplines, education, and agriculture among others. The University of Eswatini (UNESWA) is the only governmental university and the only one offering agricultural sciences at the post graduate level. However, weak wireless services are the greatest obstacles to the use of ICT facilities by the students.

The government also supports international undergraduate and postgraduate studies for Eswatini students in advanced fields that are not available in the country through scholarship funding at international academic institutions.

However, there were adverse effects associated with skilled-labour cross-border migration and the high labour adjustment costs induced by the Employment Act amendments and the new Industrial Act of 2000. Youth constitute just 12 percent of the country's workforce and only 29 percent of youth were engaged in agriculture as of 2016. Given that the youth unemployment rate stood at 46.22 percent as of 2019, according to ILO, the Eswatini Youth Enterprise Revolving Fund (YERF) was set up by the government under the Ministry of Sports Culture and Youth Affairs to equip youth with relevant skills to address the various challenges they face.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	88.42	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	95.47	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.5	WEF
	Employment	Employment in agriculture (% of total employment)	2019	12.15	ILO
		Employment in agriculture, female (% of female employment)	2019	10.10	ILO
		Unemployment, total (% of total labour force)	2020	23.40	ILO

AGRO-INNOVATION

Agricultural R&D spending in Eswatini fell significantly between 2009-2012 but increased somewhat thereafter, in inflation-adjusted terms. Eswatini invested 0.70 percent of its GDP accrued from agriculture in agricultural research. Three agencies were involved in agricultural research in Eswatini in 2016: the government agency DARSS, and two units at UNESWA, the country's main university. UNESWA employs a comparatively high number of PhD-qualified researchers, whereas DARSS only employed one during 2009-2014. In 2016, UNESWA employed 60 percent of the country's agricultural researchers of whom 10 were PhD-qualified researchers.

The Government of Eswatini developed the Royal Science and Technology Park (RSTP), which features a special economic zone to facilitate FDI as well as R&D facilities to enable the transfer of research results into the marketplace. The combined annual turnover of the 36 start-ups incubated by the RSTP is E 15 million across five different sectors including digital agriculture themes. However, not all of the 36 companies were already generating revenue as only 70 percent of the products had gone through market validation while the remaining 30 percent were still at prototype development stage.

The Innovation Park at RSTP comprises the National Data Center, the Advanced School of Information Technology, the National Contact Centre and the Information Technology Business Incubator. The Advanced School of IT provides world-class ICT training, nurturing entrepreneurship through innovation and research, with superior ICT facilities and specialized ICT courses. The Information Technology Business Incubator (ITBI) enables creators to commercialize their innovations in the fields of computer, mobile phone, Internet and electronic products or processes through entrepreneurship.

In collaboration with UNDP, RSTP launched the Agri-Tech open innovation in 2020, giving local innovators an opportunity to commercialise their innovations in the agriculture sector through the provision of co-working spaces and amenities, capacity building and access to networks, business facilitation, intellectual property protection services, legal services and fundraising support, including seed capital from UNDP.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	348.49	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	100.71	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	N/A	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.70	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.06	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.06	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

ETHIOPIA

Ethiopia is a low-income country with a population of almost 115 million people, 78.3 percent of whom live in rural areas. Most people depend on agriculture for livelihood. There are 12 million smallholder farming households accounting for 95 percent of agricultural production and 85 percent of total employment. In 2020, agriculture contributed 35.5 percent to the country's GDP – the total GDP of the country is almost USD 108 billion (World Bank, 2020).

Agriculture is the backbone of the economy and the largest export earner, with coffee being the main export. Other main export products include oil seeds, dried pulses, hide and skin. Major crops cultivated include teff, maize, barley, wheat and sorghum (FAO, 2018). Besides crop production, livestock production is widespread, with cattle, poultry, sheep and goats being the most common.

Despite the country's favourable climate and abundant water resources, agricultural productivity remains a challenge due to a dependency on rain fed agriculture, low rate of fertilizer use, land degradation and lack of agricultural machinery. In recent years, the country has experienced internal political disruptions, and locust scourge invasion. However, the country is now considered as one of the fastest growing economies with its youthful and dynamic population.

Ethiopia's ICT sector is state-run, but the government is supporting its development and liberalization. The state owned Ethio Telecom provides telecommunications services and maintains a monopoly on the market. However, the government is in the process of liberalizing the sector by offering two nationwide telecommunications service licenses to interested private players. The International Finance Corporation (IFC) is supporting the Ethiopian Communications Authority (ECA) with these license awards. The country's digital economy has untapped potential that can increase exports and create employment for youth and women, among other benefits.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	114 963 583	WBG
Urban population (%)	2020	21.70	UNPD
Rural population (%)	2020	78.30	UNPD
GDP (current millions of USD)	2020	107 645	WBG
Agricultural land (km^2)	2018	379 030	FAO
Agricultural land (% of land area)	2018	33.56	FAO

INFRASTRUCTURE

In Ethiopia, 48.3 percent of the total population has access to electricity, with 92.8 percent of the urban population being connected to the grid compared to only 36.3 percent in rural areas. In 2019, the government renewed the National Electrification Programme 2.0, which seeks to connect 65 percent of the population to the grid by 2025 – with most rural areas earmarked for off-grid solutions.

According to Rodriguez-Caastelan et al. (2021), an estimated 15 million Ethiopians are out of reach of cellular network and 60 million without access to Internet. About 18.6 percent of Ethiopia's population has access to the Internet. This is partly due to fact that 78.8 percent of the population live in rural areas (with no Internet access), the lack of infrastructure and the monopoly of Ethio Telecom in the telecommunications sector. State monopoly of the sector has traditionally generated revenue from cities to develop rural infrastructure (Bekele, 2020). In 2017, the fixed broadband subscriptions (per 100 people) were at 0.06 while mobile cellular subscriptions (per 100) were 37.

The Ethiopian Telecommunications Corporation (ETC) has installed a number of fiber optic cables. For example, Ethiopia has access to international broadband fiber connectivity through SEACOM and a backhaul link through Djibouti. The current nationwide fiber optic backbone network essentially reaches all main towns and key border crossings in the north, east and south of the country (ITU, 2018). With funding from the World Bank, ETC seeks through the Ethiopia Digital Foundation Project to improve digital connectivity in the country. The project aims at "extending affordable broadband Internet access to all firms, citizens and government entities by 2030 and doubling broadband penetration by 2021" (World Bank 2020).

A GSMA consumer survey undertaken in 2015 and focusing on Internet inclusivity revealed that the gender gap in Internet usage in Ethiopia was high (60 percent) with women having less access to Internet than men. Low income, scattered settlements and low population densities have made it expensive to extend fibre and satellite services to rural areas due to the cost involved limiting Internet access by households in rural areas (Gamesa, 2015). Through the Digital Foundations Project, the government is expected to stimulate investment in rural Internet and broadband policies in support of prospective private sector investments (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	36.28	WBG
		4G coverage (% of total coverage)	2019	69.94	GSMA
		Mobile (device) ownership (% of population)	2019	35.56	GSMA
		Secure access to Internet servers (per 1 million people)	2020	5.69	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.56	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2017	37.22	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	13.90	ITU
		Fixed broadband subscriptions (per 100 people)	2017	0.06	ITU

DIGITAL PENETRATION

In 2020, 21.4 million Ethiopians constituting 19 percent of the population were using the Internet. The year-on-year growth in the number of Internet users is about 2.6 percent (We are Social and Hootsuite, 2020). Mobile cellular subscription per 100 people was 37.2 in 2017. Also, 35.5 percent of the population owned mobile devices in 2019. Liberalization of the telecommunication sector is expected to improve digital penetration. Ethio Telecom has succeeded in reducing tariffs by about 50 percent culminating in an increase in voice and data traffic. The average price of 1 GB of mobile data is USD 2.44 (see Table 3).

A number of initiatives have been undertaken by the government to expand digital services to rural farming communities. For example, the Ministry of Agriculture in partnership with Digital Green has built the capacities of subject-matter specialists to produce local videos, which are used by extension officers in farming communities. A study by Olaniyi (2018) shows that the Ethiopian Commodity Exchange Commission provides commodity price information to farmers in real time using electronic boards in 31 centres across the country. The Ethiopian Soil Information System project (EthioSIS) focuses on digital mapping soil resources and the creation of a database for smallholder farmers. Similarly, the Shallow Ground Water Mapping project collates data and maps out underground water to support irrigation decision-making. The Agriculture Commercialisation Clusters programme creates an e-marketing platform for consumers to buy directly from farmers in communities. The Agriculture Transformation Agency's National Market Information System gathers crop data for dissemination to farmers and other value chain actors.

A significant number of private start-ups are rendering information services in rural areas. Digital Green also launched FarmStack, an agricultural advisory service platform that captures data on weather, soil types, market information and agriculture practice content. This data is then made available to farmers through multiple channels. Yerras Gebeya runs an e-marketing platform for livestock trading with e-payment systems. Debo Engineering focuses on plant disease management using image detection algorithms via mobile phones. Awesome Africa provides the platform for training of farmers on permaculture using local languages. M-Birr has made mobile money services available to over 1.2 million Ethiopians enabling subscribers to shop for groceries and pay for other basic utility services.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.44	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	9.52	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	25.01	ITU
	Willingness	Mobile social media penetration (%)	2019	5.36	GSMA
		Number of apps in national language (quantity)	2019	47.77	GSMA
		Gender gap in social media use (%)	2019	19.41	GSMA
		Gender gap in mobile ownership (%)	2019	0.00	GSMA

POLICY AND REGULATION

The Ethiopian Communication Authority is the regulator for the telecommunications sector. The government is prioritising the improvement of Internet and broadband services. In 2016, a Broadband Plan was drafted to streamline state investment in broadband for the period 2016-2021. The strategy aims at extending mobile broadband coverage to all rural areas and to support agriculture service delivery. It also aims at setting up 16 000 rural communication centres across all districts.

The Growth and Transformation Plan II (2016-2020) is expected to transform Ethiopia into a low middle-income country by 2025. For agriculture growth, the plan will push through five key directions, namely: (i) development of smallholder crop and enhancement of pastoral agriculture; (ii) provision of all rounded support to educated youth to enable them to engage in agriculture; (iii) provision of support to domestic and foreign investment in sub-sectors such as crop, flower, vegetables, fruits and livestock; (iv) implementation of holistic measures to address challenges in the supply of agricultural inputs; and (v) implementation of a scaling up strategy where suitable in various agroecological zones (see Table 4).

The National ICT policy was developed in 2017 to promote and facilitate extensive use of ICT in key sectors including agriculture. One of its key strategies is to design and implement computerized information systems and applications for the agriculture sector; an essential driver of anticipated growth in digital agriculture.

Furthermore, the government launched "Digital Ethiopia 2025", a digital strategy that aims at ensuring the country's readiness for the development of a digital technology-based economy. The strategy identifies four pathways in transforming its economy through digitalization, namely: (i) unleashing value from agriculture (ii) achieving global value chains in manufacturing (iii) building IT enabled services (iv) leveraging 'digital' as the driver of competitiveness in the tourism sector.

With reference to the first pathway to unleash value from agriculture, the government aims at mapping out existing digital technologies in agriculture and opportunities to accelerate a digitally enabled agriculture transformation. The government will also leverage blockchain and other IT solutions in agriculture, where feasible.

Focusing on agriculture, Ethiopia's ten-year Agriculture Sector Policy and Investment Framework (2010-2020) among other things, aimed at achieving sustainable agriculture production as well as accelerating agricultural commercialisation and agro-industrial development. The agriculture extension strategy enacted in 2017 highlights digital agriculture as one of the pathways to ICT-based technology adoption in the sector. ICT-kiosks will be set up to offer technology-related advice and market information. As part of the strategy, the government will establish data and performance management systems as well knowledge resource centres at the Woreda administrative division levels. ICT enabled devices such as mobile phones, radio and television will be used to promote education and information exchange.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.65	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.91	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.04	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.06	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	29	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2020 the World Bank approved USD 500 million in grant and credit to support Ethiopia's Homegrown Reform Agenda, which also seeks to spur economic growth by expanding the role of the private sector. To that end, the government is allowing private participation in the management of its port and logistic sectors. The World Bank's 2020 doing business report states that it takes 32 days to start a business in the country.

In terms of Ethiopia's the legal environment, Investment regulation No. 474/2020 creates three categories of investment areas: (i) areas for joint investment with the government; (ii) areas for domestic investors; and (iii) areas for joint investment with domestic investors. Investment in agriculture is also open to foreign investors (see Table 5).

Mobile money services are emerging with new regulations allowing new players to enter the market. In 2020, the National Bank of Ethiopia supported Ethio Telecom to allow nationals and Ethiopians abroad to engage in transactions. This is expected to increase access to banking services.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	2 516	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.43	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.16	WEF
	Entrepreneurship	Time required to start a business (days)	2019	32	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.47	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.46	WEF

HUMAN CAPITAL

Adult literacy rate in Ethiopia is 51.8 percent. Literacy among the youth is higher at 72.8 percent (UNESCO, 2017). According to UNESCO, primary school enrolment was 101 percent in 2015. Secondary school enrolment was 35 percent in 2015. Enrolment at the secondary level was slightly higher among males (35.6 percent) than females (34.3 percent). Teaching faculties across the country are gaining traction as centres for the advancement of digital literacy skills. For example, the Amhara e-classes project supplied 551 computers in rural communities with a projected reach to 6 000 students. The project has also provided training in e-learning through Rasperry Pi connected devices and assistive technologies to improve the teaching environment in schools.

The Ministry of Science and Higher Education with support from the World Bank has drafted a National Digital Skills Country Action Plan, which for the next 10 years seeks to equip students in higher educational institutions with the relevant digital skills to improve their employability. Digital skills courses will be introduced at the intermediate and advanced levels in all technical and vocational education and training (TVET) programmes. Computer engineering, computer science, information systems and related programmes will be supported in about 33 public universities across the country. The action plan will also provide supportive ICT infrastructure, smart classrooms and virtual laboratories. Microsoft through the Education Transformation Agreement has also collaborated with the Ministry of Education to improve ICT related competencies in Schools.

According to Anberbir (2015) and UNESCO (2021), despite the increase in the number of universities in Ethiopia (the country has 68 public universities), the use of ICT for education remains low. However, efforts have been made by some educational institutions to provide on-campus digital training. For example, in 2019, Nokia signed a partnership agreement with the Addis Ababa Science Technology University and the Addis Ababa Institute of Technology to provide high-level technical skills to students.

Youth unemployment in Ethiopia is low at 3.2 percent as of 2020. However, over 2 million youth aged 15–24 enter the labour market annually. A study by the Netherland Enterprise Agency in 2020 notes that companies struggle to find employees with the right skill sets for jobs available.

Support programmes have been initiated to improve digital skills and employment of labour in the country. For example, Microsoft4Afrika has collaborated with Gebeya Inc., a Pan-African EdTech company, to launch a virtual skills lab to build digital skills capacities and to increase the employability of youth. This is expected to provide apprenticeship-based training to 200 African software engineers over a period of six months. The government also partnered with the Netherlands through the on-going CASCAPE project to build youth capacity to scale up evidence-based best practices for agricultural production in Ethiopia (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2017	51.77	UNESCO
		Literacy rate, youth total (% of people ages 15–24)	2017	72.76	UNESCO
		Digital skills among population (index ranking 1–7: not at all/ to a great extent)	2019	3.75	WEF
	Employment	Employment in agriculture (% of total employment)	2019	66.63	ILO
		Employment in agriculture, female (% of female employment)	2019	58.71	ILO
		Unemployment, total (% of total labour force)	2020	2.79	ILO

AGRO-INNOVATION

Ethiopia's agriculture sector has key research institutions contributing to research and innovation to improve the sector's productivity. The Ethiopian Institute of Agricultural Research (EIAR) remains a lead public sector institution mandated to spearhead innovation and research in agriculture. In 2015, EIAR collaborated with the International Maize and Wheat Improvement Center and the Central Statistical Authority to test the effective use of DNA fingerprints for tracking crop varieties.

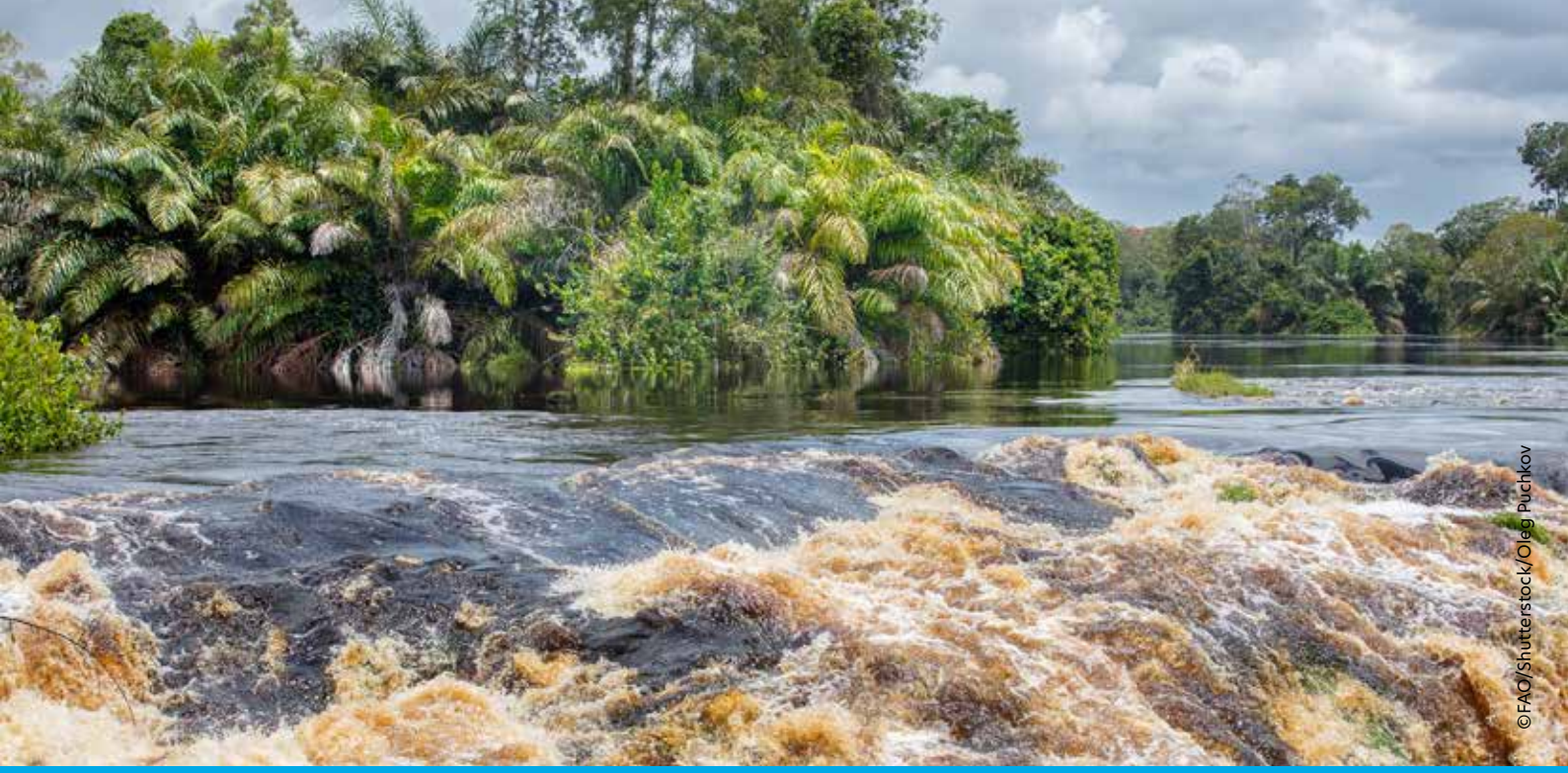
There is a burgeoning public-private collaboration on a number of initiatives that offer valuable contributions to agriculture in terms of financial capital as well as integrating technological innovations to enhance the output and productivity of the agricultural sector and access to markets. An example of such an organization is the Agricultural Transformation Agency (ATA) in Ethiopia, which fosters public-private cooperation for key value chains. OCP Africa and the Morocco-based Mohammed VI Polytechnic University (UM6P) also joined in a strategic partnership to support agri-techs in Ethiopia to scale up. Programs such as the FinTech Addis Exhibition & Forum together with Agri-tech Expo and the Agri-tech Movers Forum are helping bring exposure to agri-techs in Ethiopia, giving agribusiness entrepreneurs the opportunity to exchange knowledge and resources as well as promoting the use of digital solutions for mitigating challenges.

As part of the Digital Ethiopia 2025 plan, the government will also support and incentivise agritech entrepreneurship. Specifically, the government will engage private stakeholders, start-up founders and technical experts to offer mentorship and tailored support to fill high-end technology needs within industry and agribusiness (see Table 7).

The budding tech space has also seen private players organising accelerator programmes for young start-ups such as xHub Addis, iCog Labs, iceaddis or the blueMoon lab, which organises competitions twice a year to identify new start-ups that ultimately benefit from training and coaching programmes over the span of four months. Growth Africa lab organises training workshops in finance and business development for start-ups with turnovers over USD 50 000 over a span of six months. Through such spaces new start-ups such as Yerras Gebeya, Yene-pay, Awesome Africa, and Mesafint Alebel currently provide relevant services ranging from disease management, mobile payments, training via mobile technology and livestock trading.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	26 683.31	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	108.42	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2016	2.38	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.29	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.64	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.50	WEF
		ICT goods imports (% of total imports)	2018	2.84	UNCTAD



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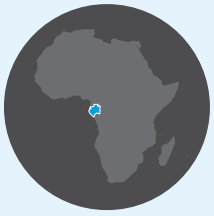
GABON



Gabon is an upper-middle-income country with an estimated GDP of USD 15.5 billion in 2020, mainly accrued from its industrial sector, which contributed 48 percent to GDP. The resource-rich country is highly urbanized with an estimated population of 2.2 million, of which only 9.9 percent live in rural areas (World Bank, 2020).

The country's economy has a predominantly youthful population of 1.7 million people. Unlike other countries in the sub-region that are heavily dependent on the agriculture sector, the World Bank indicates that the employment in the country's agricultural sector declined by 5 percent from 2010. Persons employed in the sector stood at around 30 percent of the population in 2019.

The country's economy was projected to bear the brunt of the COVID-19 pandemic, and it has destabilized and hampered development in all sectors including ICT development. But the government's commitment to scale up and improve its digital infrastructure could revitalize the various sectors of the economy, and particularly stimulate renewed interest in the agriculture sector by attracting men and youth, who are typically less inclined to work in this sector.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	2 225 728	WBG
Urban population (%)	2020	90.09	UNPD
Rural population (%)	2020	9.91	UNPD
GDP (current millions of USD)	2020	15 593	WBG
Agricultural land (km^2)	2018	22 126	FAO
Agricultural land (% of land area)	2018	8.59	FAO

INFRASTRUCTURE

Gabon boasts an impressive electrification rate of 90.7 percent (98.3 percent in urban areas and 24.2 percent in rural areas) as of 2017. It has an installed capacity of 443 MW, of which 40 percent was obtained from renewable energy in January 2016. This increased to 720 MW in 2020. The country is set to consolidate its gains in the energy sector with the planning and construction of the Ngoulmendjim dam (115 MW), Empress Eugenie Falls dam (84 MW), and FE2 Falls dam (36 MW) hydro projects.

The number of mobile network operators reduced from four to three after Maroc Telecom, which held a 51 percent share in Gabon Telecom merged with Moov Gabon. Mobile data usage has spread rapidly with 62 percent of the population subscribed to mobile services in 2020 (We are Social and Hootsuite, 2020). Both Airtel Gabon and Gabon Telecom Mobile (Libertis) have launched LTE services, but the coverage remains limited. Although the country has sufficient international bandwidth on the SAT-3/WASC/SAFE submarine cable, this facility has been underutilized. However, the emergence of the ACE submarine cable, together with progressing work on the CAB cable, has increased backhaul capacity supporting mobile data traffic.

The e-Gabon project (2016–2022) financed by the World Bank aims at modernizing the equipment and infrastructure of health establishments and the establishment of incubators specializing in ICT. The Digital Villages project, launched in 2015 by Samsung is aimed at providing educational, health and social platforms in remote rural areas (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	24.15	WBG
		4G coverage (% of total coverage)	2019	35	GSMA
		Mobile (device) ownership (% of population)	2019	69.30	GSMA
		Secure access to Internet servers (per 1 million people)	2020	44.03	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2016	3.98	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	138.78	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	94.30	ITU
		Fixed broadband subscriptions (per 100 people)	2020	2.00	ITU

DIGITAL PENETRATION

The rollout of 3G/4G services has caused a rise in Internet usage with a penetration rate of 200 percent. About 62 percent of the population have access to the Internet, with active mobile broadband subscriptions increasing from 1.65 million in 2016 to 2 million in 2019. There were 750 000 social media users in January 2020, an increase of 7.2 percent between April 2019 and January 2020. The government is poised to turn the country into an ICT hub. To that end, it has signed an agreement with AfDB in 2018 for a feasibility study for the country's component of the Central African Backbone (CAB) project, which will provide the 901.8 km fiber optic connectivity required to cover 14 missing links on the Gabonese national backbone. To minimize the country's dependency on Western digital

infrastructure, the government has submitted a bid to the African Union to become a regional Internet exchange point (IXP) for Central Africa (see Table 3).

Nevertheless, there is no agriculture-specific digital services apart from mobile money services that are accessible to all. The services offered are basically in the field of technical advice, management advice or marketing.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.89	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	1.72	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	7.17	ITU
	Willingness	Mobile social media penetration (%)	2019	33.73	GSMA
		Number of apps in national language (quantity)	2019	51.38	GSMA
		Gender gap in social media use (%)	2019	69.54	GSMA
		Gender gap in mobile ownership (%)	2019	92.34	GSMA

POLICY AND REGULATION

The development of the country's ICT sector is woven into the Emerging Gabon Strategic Plan. This plan has served as a guide to much of the country's economic policy priorities in recent years. As part of that plan, the government has rolled out the Digital Gabon strategy, which seeks to speed up ICT activity in the country through increased investment, the construction of a high-speed national network, the breeding of local content and entrepreneurs, and the digitization of television broadcasts, and e-government services. Projects outlined under the Digital Gabon plan include the development of the Central African Backbone (CAB) network and national fibre optic network, the launch of an incubator for domestic start-ups and the establishment of Digital Villages in rural areas.

Gabon has put in place an institutional framework for the development of ICT with the creation of the National Agency for Digital Infrastructures and Frequencies (ANINF) in 2011, the implementation of the Gabon Digital Plan, then the creation in 2012 of the communications and post-regulation authority (ACERP) responsible for establishing a legal and regulatory framework for digital development. The year 2012 also saw the creation in Gabon of the Company of Heritage and Digital Infrastructures (SPIN) with the mission of operating, maintaining and marketing the digital infrastructures made available to it by the state, in order to reduce the digital divide in Gabon. Several regulatory texts have been adopted or are in the process of being adopted, including laws on cybercrime, cybersecurity, electronic transactions, data protection, electronic communication, and the establishment of cryptology and digital economy in Gabon.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.55	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.67	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.70	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	63	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The government has devised a strategy to promote other non-oil sectors by granting incentives to investors. Other measures to enhance the business environment include a one-stop-shop for investors; a public-private partnership (PPP) framework; a domestic arbitration court; and codes for hydrocarbons and mining. Other legal frameworks such as the investment charter, framework of capital equity operations, have been adopted in order to attract new investment into the country.

The tax and customs incentives backed by the Agricultural Code extended through the adoption and publication of Law No. 002/2013 are expected to diversify the economy and promote agribusiness to reverse the dwindling economic growth resulting from the decline in oil reserves. The government also launched the public-private agricultural partnership programme (GRAINE) to promote the cultivation of oil palm and other food crops. It is worth noting that the government has made special provisions for certain agriculture companies eligible to benefit from credit facilities, state grants and free import of certain agricultural products.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Source	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	UNCTAD	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	WEF	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2016	WEF	WEF
	Entrepreneurship	Time required to start a business (days)	2019	WBG	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2016	WEF	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	WEF	WEF

HUMAN CAPITAL

Gabon has a high youth literacy rate of 89.8 percent and adult literacy of 84.7 percent as of 2018. Even though there is no policy to integrate ICT into the education curriculum, the National Ministry of Education brought forth an outline project in 2006 for school computer equipment aimed at improving the digital skills of students. Over the years, the country has made remarkable investments in the ICT sector, and as a result, Gabon rose 10 places in the 2017 world ICT classification. It is now the sixth most-connected country in Africa.

The government has been working toward developing an e-education platform since 2010 as part of the Digital Gabon project, which is geared toward equipping schools with the needed infrastructure to connect them with each other. This has yielded results with an estimated 20 middle and high schools across Libreville and its suburb benefiting from the initiative.

A partnership between Airtel Gabon and UNESCO launched the ICT youth project Train My Generation to give young people scientific and entrepreneurial training using ICT, as well as equipping secondary school teachers with new digital skills. About 5 000 young people were slated to receive ICT training in the first phase while supporting a smaller group to develop mobile applications, set up cooperative maintenance centres, etc.

Olam, a global agribusiness, offered to send aspiring Gabonese farmers on training courses. About 2 500 people were to observe cocoa farming in Côte d'Ivoire, train as bulldozer operators in Morocco or learn modern farming techniques at a palm oil plantation in Asia. This was to help develop 100 000 ha of oil palm plantations, a partnership between Olam and Gabon.

In partnership with the Samsung Group, the government has launched the Digital Village project to build 2 000 connected villages by 2025. The objective of the project is to reduce the digital divide between urban and rural areas, but above all to promote education, health and the environment. The villages will have digital schools to promote primary education in their communities.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	84.67	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	89.78	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.19	WEF
	Employment	Employment in agriculture (% of total employment)	2019	29.96	ILO
		Employment in agriculture, female (% of female employment)	2019	45.76	ILO
		Unemployment, total (% of total labour force)	2020	20.47	ILO

AGRO-INNOVATION

The National Scientific and Technological Research Centre (CENAREST) is the principal research agency in Gabon mandated to research crops, livestock, forestry, fisheries, economics and to undertake social development studies. Apart from government setups, the private sector is also actively supporting innovation and research in agriculture. For example, through the Agricultural and Rural Development Project – Phase II (2018–2023), IFAD seeks to create multi-actor innovation platforms in 16 production areas in Gabon. This is intended to enhance consultation among actors and create local collective dynamics that will facilitate market access and co-finance action plans by innovating platforms to test and disseminate innovative techniques to improve rural agriculture productivity.

In partnership with the AfDB, the government embarked on a project to support agricultural transformation and youth entrepreneurship promotion. This fits into the Green Gabon Initiative aimed at contributing to reducing Gabon's food dependency by 2025 and improving the population's living conditions through support to growth-bearing sub-sectors and youth entrepreneurship. Some of the project's complementary components include developing value chains of promising sub-sectors, promoting youth entrepreneurship in the agricultural sector and agribusiness, etc. The National Agency for the Promotion of Investments in Gabon (ANPI-Gabon), in line with its support for start-up growth through funding, mentorship, etc. has signed an agreement of CFAF 500 million with the African Financial Company (Cofinal), intended for small and medium-sized enterprises in Gabon. This is aimed at providing support to local businesses during their first three years of operation.

In 2018, Société d'Incubation Numérique du Gabon (SING) was launched in partnership with the government and the World Bank. The company offers companies support services for digital transformation (advice and diagnostics, IT solutions, etc.) and operates as a business incubator, through its Cohort Innovation 4.0 acceleration programme, offering support funding and execution, access to mentorship and investor training, etc.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	944.10	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	107.06	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.16	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2011	0.09	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2016	2.59	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2016	2.58	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

THE GAMBIA

The Gambia is a low-income country with a GDP of USD 1.9 billion. About 62.6 percent of its population of 2 million people live in urban areas and 37.4 percent in rural areas. Approximately 62 percent of the population are poor and 48 percent live below the poverty line of USD 1.9 per day (see Table 1).

Agriculture is the principal source of livelihood in the Gambia for the rural population. It provides employment for approximately 27 percent of the population but contributes only 21.30 percent of the GDP. Poverty is more a rural phenomenon as 74 percent of Gambians below the national poverty line live in rural areas.

The ICT sector has been a genuine contributor to national revenue as well as serving other socio-economic purposes like the creation of employment in both the formal and informal sectors of the Gambia.

The government has integrated ICT as part of its priority sector within the new Development Plan to ensure positive spill over effects across the digital economy, including digital agriculture. It has entered into a partnership with other industrialized countries to introduce modern machinery and automated devices into farming (Ministry of Agriculture, The Gambia, 2020).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	2 416 664	WBG
Urban population (%)	2020	62.58	UNPD
Rural population (%)	2020	37.42	UNPD
GDP (current millions of USD)	2020	1 902	WBG
Agricultural land (km^2)	2018	6 050	FAO
Agricultural land (% of land area)	2018	59.78	FAO

INFRASTRUCTURE

As of 2019, 27.6 percent of rural areas had access to electricity. The country has Internet connectivity like 4G services available in parts of the country at 31 percent coverage as of 2019, although coverage of 2G is 98 percent across the country. About 57.4 percent of the population owns mobile devices.

The presence of the four mobile operators (Africell, Comium and Gamcel, and Qcell), and their investment in infrastructure that support 3G and 4G services, is felt in rural areas that have witnessed drastically increased mobile density to 24.5 percent. The Gambia has only one fixed line operator, Gamtel with 59 000 subscribers, 12 000 of which are wireless end-users.

Two medium wave channels are utilised under the state-owned Gambia Radio and Television Services (GRTS) to broadcast various local radio programs. The National Television channel is operated by GRTS to provide country-wide coverage through three television transmitter stations across the country, with 80 percent of programs produced locally, covering health, education, agriculture, sport, religion, etc.

There are eight Internet service provider (ISP) licenses issued by the MoICI, but only six are operational. Internet cafes and telecentres are booming. They promote limited but affordable connectivity to rural areas, hence the need for multi-purpose ICT centres (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	27.59	WBG
		4G coverage (% of total coverage)	2019	30.96	GSMA
		Mobile (device) ownership (% of population)	2019	57.44	GSMA
		Secure access to Internet servers (per 1 million people)	2020	28.97	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.45	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	110.81	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2018	36.76	ITU
		Fixed broadband subscriptions (per 100 people)	2018	0.19	ITU

DIGITAL PENETRATION

The high cost of Internet subscription remains one of the primary hindrances to broader access, with the median price being USD 5.10 as of 2020. The introduction of 3G wireless Internet connections via mobile devices has rendered the Internet more accessible, but only a small subset of the population can afford the data packages, mainly concentrated in the Greater Banjul Area. Internet use in the country has slowly grown over the past two decades with 19.8 percent adoption in 2019, compared to 6.2 percent in 2007 (World Bank, 2020). In addition, data coverage of rural areas is well-developed, but not affordable to the rural population. The access to mobile data is limited to messaging. Additionally, the older generation's ICT literacy level is extremely low and not sufficient to use mobile apps or online services (see Table 3).

Even though Gambians actively use social media platforms (Facebook 89.09 percent, Twitter 4.59 percent, etc.) (Statcounter, 2020), and 15.5 percent of the country's population was

actively engaged with social media platforms, only three mobile apps were available in the country's national language (GSMA, 2019).

Gambian youth are adept at mobile phone use. Most youth use social media platforms like Facebook (220 000 users or equivalent to 50 percent of the total number of Internet users in the country). Most of them are also adept at Internet access and computer use (e.g. e-mail), with a general interest in other ICT areas such as networking or software development.

The ICT landscape in rural areas is slightly different from the Greater Banjul Area. This is also largely due to very limited infrastructure such as Internet cafes, ICT centres and ICT training activities available in the regions. The main issue is related to the absence and instability of electricity, which makes the operating of ICT centres almost impossible. One of the biggest regions, the Central River Region, does not have a single ICT centre.

Gambia's digital ecosystem is transforming its agriculture sector. Existing agritech start-ups include Tesitoo, Money farm, Farmfresh, Jollof-Trade and Technofarms, which provide opportunities for farmers to market their produce directly to consumers. GamFruits collect and digitize important agricultural data on climate-smart agriculture.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	5.10	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	8.37	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	15.49	GSMA
		Number of apps in national language (quantity)	2019	3.00	GSMA
		Gender gap in social media use (%)	2019	53.49	GSMA
		Gender gap in mobile ownership (%)	2019	53.49	GSMA

POLICY AND REGULATION

The Gambia is mainstreaming ICT in all public and private activities to enhance its socio-economic development goals. In view of this, the Ministry of Information and Communication and Infrastructure (MoICI) has taken significant strides in creating an environment conducive for sector players to operate in. Infrastructure policy plans and strategies have been developed. It encompasses plans of action such as the Gambia's e-government Strategy from 2017 (e-education, e-health, e-agriculture, e-trade, e-tourism).

Furthermore, the Gambia has adopted an ICT for Development (ICT4D) Policy Statement (2018-2028) that will help donors and the EU to launch a comprehensive digitalization programme and the Gambia's Broadband Policy 2020-2024. This is based on a review of the ICT4D Policy, which is a continuation of the four-year action plan (2014-2017) ICT4D II, which in turn is an extension of part I that was implemented from 2009-2012. Other related policies have also been developed, such as the 2013 Universal Access Policy and its regulations enactment of the ICT Act of 2009, which has provisions in line with acts on electronic transaction and personal data protection.

A new National Development Plan (NDP) 2018-2021 was launched in 2018 with a clear focus on youth development and ICT, improving the regulatory services and policies, creating a national ICT agency and a national data centre to strengthen e-government, establish a national technology park to spur research and

development, and increase roll out of regional ICT centres to enhance connectivity to schools and rural communities. Additionally, the Gambia accounted for the Youth and Trade Roadmap for the ICT sector that is part of The Gambia Youth Empowerment Project (YEP), a four-year initiative to build skills, enable value addition and foster market connections (see Table 4).

The Gambia National Agricultural Investment Plan - Food and Nutrition Security (GNAIP-FS, 2017-2026) also calls for digital innovation in the agricultural sector. Furthermore, The NDP envisions a transition to a green economy, driven by SME private sector investment, the use of climate-smart agriculture technologies, and the inclusion of youth and women as key actors. Also aligned with NDP, the National Export Strategy considers the establishment of a national innovation park with digitalization of the agriculture sector. As of publishing, the government was preparing a new Gambia National Agricultural Investment Plan - Food and Nutrition Security (GNAIP-FS, 2017-2026).

Other relevant policies include: the Agriculture and Natural Resources policy (ANR 2017-2026), The Gambia Environment Action Plan, the National Climate Change Policy, the National Adaptation Plan, The Gambia Sustainable Land Management Investment Framework, the National Nutrition Policy, the National Youth Policy and the Gender Policy.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	4.48	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	4.39	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	3.26	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	3.59	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	73.7	EC/ITU

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BUSINESS ENVIRONMENT

In 2001, the government promulgated The Gambia Investment Promotion Act and The Gambia Free Zones Act to regulate local and foreign investment. Although the ICT infrastructure is not wholly open for investors, proposals from potential investors geared toward improving the infrastructure for extending access - particularly broadband technologies - are highly welcome. The bulk of FDI has been in the power generation, financial and IT sectors.

SMEs create income for over 50 percent of the population, employ 40 percent of youth, contribute 20 percent to GDP and represent 99 percent of the private sector. In agriculture, SMEs provide inputs, processing, marketing and other services and most are youth and women-led. It is important to highlight that youth (people younger than 35 years old) represent approximately 88 percent of the workforce in SMEs, while youth-led enterprises represent the majority of firms (56 percent). In rural areas, very few businesses have computers and even

fewer have an Internet connection. The demand for ICT services and ICT skills is very low, if not nonexistent. At first glance, and in the short term, the ground does not seem to be very fertile for the development of the ICT market in rural areas unless it is limited to specific services such as printing, photocopying, document editing and formatting.

The Gambia established a strong public-private partnership to enhance infrastructure and service delivery aimed at the digitalization drive. For instance, the government supported innovators and private investors to develop the YEP Tech Startup support programme, aimed at providing an enabling environment for digital businesses to thrive in line with the National Development Plan (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	32	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.50	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.36	WEF
	Entrepreneurship	Time required to start a business (days)	2019	8	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.38	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.91	WEF

HUMAN CAPITAL

Large-scale emigration over the past decade has drained the country of its most educated and productive workers, especially in rural areas. As a result, there is a shortage of agricultural labour due to the exodus of young people from rural areas. That said, the country's digital literacy seems to be above average (WEF, 2019).

The ICT related skills acquired among the young population (aged 15 years and above), including computing and phone repair, amount to less than 2 percent of all skills, with respectively 1 887 claiming to have received these trainings through a TVET institution in 2012.

Skills gap is a major factor affecting SMEs' capacity to change and provide improved services. ICT training is mostly concentrated on basic IT skills. Various training providers offer different levels, from basic training on how to use a computer and basic office software to some advanced training on specific topics. However, the quality of the training is very heterogeneous between TVET and even between courses. Five TVET institutions offer training specializing in the ICT sector. Among those institutions, the Young Men's Christian Association (YMCA) and the Quantum Net Institute of Technology (QIT) focus on ICT. Public ICT training centres are managed by the University of The Gambia (UTG). Some of the TVET are also providing ICT training for rural communities such as the Balal Rural Empowerment Sustainable Development Initiative and the Rural Community Information Centre (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2015	50.78	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2015	67.16	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.03	WEF
	Employment	Employment in agriculture (% of total employment)	2019	27.03	ILO
		Employment in agriculture, female (% of female employment)	2019	33.07	ILO
		Unemployment, total (% of total labour force)	2020	9.64	ILO

The Government of the Gambia and UNESCO Dakar started the implementation of the Youth Empowerment project through TVET programme (2018-2022) aiming at creating an enabling environment that empowers youth, particularly girls, with the needed skills for the job market as well as providing alternatives through TVET.

Moreover, to build the capacities of youth to fill the skills gap and ensure digital transformation, the Give1 Project Gambia has trained young girls aged between 13 and 20 in IT, particularly web design, computer graphics, coding and database design. Also, the project launched "the All-Girls Tech Camp" in 2015 to train young girls in urban and rural areas of the Gambia in ICT skills. The acquisition of these skills presents an opportunity for digital transition that could help curb youth unemployment in the country, which stood at 12.44 percent in 2019 (World Bank, 2019).

The University of The Gambia established the Gambia Technical Training Institute (GTTI) that offers two-year craft and technician training programs. The courses offered include information technology, mechanical, electrical and construction engineering.

AGRO-INNOVATION

The 2020 budget emphasised the government's commitment to transform the agriculture and natural resource sector into a modern market-oriented commercial sector with integrated value chains.

Most firms in the sector do not engage in R&D activities given their limited human and financial resources. There is very limited collaboration between Gambian companies to innovate or to develop collaboration with foreign tech hubs, suppliers or networks that promote innovation. Taxation is very high on ICT companies, sometimes up to 23 percent, which is one of the stated reasons that companies can rarely afford to invest in R&D or personnel training.

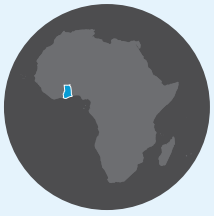
There is no highly visible technology hub that helps structure the community or is a natural counterpart for the government when discussing ICT policies, for example, and one that can provide a series of integrated services for both the community at large and individual innovators. Equally, incubator platforms set up by both the private and public platforms exist to support the growth of start-ups. Examples are Start-up Incubator Gambia, UNDP Gambia and Accelerator Lab.

Startup Incubator Gambia supports the development of young Gambian entrepreneurs through an array of business support services and resources. Empretec Gambia trains and prepares entrepreneurs to establish successful enterprises or to grow and expand their businesses. Special emphasis is given to computer literacy and IT. There is only one embryonic tech hub, Jokkolabs, hosted by the YMCA. Jokkolabs works at a very low scale with very limited capacities (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	278.55	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	92.07	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.40	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.88	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.27	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	4.21	WEF
		ICT goods imports (% of total imports)	2019	0.76	UNCTAD

GHANA



Ghana is a lower-middle-income country with an estimated population of 31 million people of whom 57.3 percent live in urban areas. The country's GDP is estimated at USD 72.3 billion. Ghana has about 147 827 km^2 of agricultural land, making up 65 percent of the total land area. The service sector contributes most to the economy comprising 44.1 percent of GDP in 2019. About 13.3 percent of people live on USD 1.9 or less a day although the economy has grown over the years (see Table 1).

The agriculture sector has been highly prioritized by the government with numerous flagship programmes. The sector contributes 17.3 percent of the GDP and 30 percent of export earnings, and it employs 29.8 percent of the population with 70 percent as smallholder farmers. Ghana's agriculture sector produces key crops such as cocoa, coffee, citrus and rubber for exports. Major staples include cassava, plantain, rice, maize, sorghum and millet.

Ghana has been tipped as one of the trailblazers of digitalization and innovation. It serves as a hub for global tech giants such as Google, which established an Artificial Intelligence centre in the country. Twitter has also recently located its African headquarters in Ghana. The ICT sector, through telecommunication services, contributed 3.6 percent to GDP. The country's liberalized competitive telecommunication industry has also experienced growth following major sector reforms that opened the door to international companies since 2008.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	31 072 945	WBG
Urban population (%)	2020	57.35	UNPD
Rural population (%)	2020	42.65	UNPD
GDP (current millions of USD)	2020	72 354	WBG
Agricultural land (km^2)	2018	147 827	FAO
Agricultural land (% of land area)	2018	64.97	FAO

INFRASTRUCTURE

The country boasts advanced infrastructure with its power sector serving neighbouring countries such as Togo, Burkina Faso and Benin. There is also high access to electricity with the country serving about 93.8 percent and 70 percent of its urban and rural populations respectively.

GSMA (2019) affirms that 2G, 3G and 4G coverage was 96.8 percent, 89 percent and 68 percent respectively. Through partnerships with companies such as Parallel Wireless, Ghana aims at strategically improving rural network connectivity using low-cost virtualized radio access systems. Four MNOs – MTN, Vodafone, Airterl-Tigo and Glo – currently provide mobile network services. As of publishing this report, the government was planning to acquire full stake of Airtel-Tigo. MTN holds the biggest market share (55 percent) followed by Vodafone (22 percent), Airtel-Tigo (21 percent) as of 2020 (see Table 2).

The country's broadband service has expanded with the launch of LTE services by MTN in 2016 and Vodafone in 2019. Vodafone also secured a block of 800 MHz spectrum for USD 30 million. All MNOs have deployed fiber optic cables as a backbone to microwave transmission or metro fiber network to support voice and data traffic to end-users. Broadband and Internet services are enhanced with Ghana's connection to Europe via the 14 500 km West African Cable System, courtesy of MTN with over 500 gigabits per second connectivity speed. In 2010, Glo Ghana also connected the country to a high capacity 9 800 km of undersea fiber optic cable as part of its data infrastructure. Google also extended its fiber optic network with long-distance fiber cables to connect to urban-fibre networks to bridge service delivery in the urban and hinterlands.

Internet penetration stood at 50 percent in 2021 with services mostly available in dense urban cities and less widespread in rural areas. However, Internet access has remained topical in recent policy and discourse given government focus on the farm sector in rural economies.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	70.01	WBG
		4G coverage (% of total coverage)	2019	68.0	GSMA
		Mobile (device) ownership (% of population)	2019	61.08	GSMA
		Secure access to Internet servers (per 1 million people)	2020	59.41	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.13	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	130.22	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	99.90	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.25	ITU

DIGITAL PENETRATION

Ghana's digital ecosystem has experienced healthy growth following government investments and plans to position it as a regional hub for digital services. For example, the government's E-transform project under the auspices of the World Bank seeks to harness information technologies such as Wide Area Networks to improve operations in public institutions, including the agriculture sector.

The agriculture sector leads in the last mile of digitization in the country with both private and government participation. There are over 25 agritech start-ups providing a range of services in different value chains. In 2017, the government piloted the E-Agriculture programme, which is an ICT initiative within the West African Agriculture Productivity Programme to use Internet and ICT solutions to provide prompt and efficient agriculture extension services across value chains. Components of the programme that focused on information provision using ICT include: the E-Agriculture portal, which serves as the knowledge and operational process management platform; E-Subsidy managing the affordability of fertilizers and their accessibility to farmers; an Interactive Voice Response (IVR) system and Call Centre that provide advisory services through toll free lines to farmers in English and local languages; and E-Extension through which officers were equipped with advanced technologies for data sharing, gathering and reporting to enhance precision in service delivery (see Table 3).

MNOs have also partnered with private entities to leverage digital solutions in agriculture in urban and rural areas. In 2016, Cargill partnered with MTN, Tigo and e-zwich to use digital channels to profile farmers for digital payment for cocoa purchases. In 2014, the Ghana Rubber Estates Limited (GREL) partnered with Tigo Money and MTN money to make e-payments to outgrowers.

Focusing on private initiatives, Farmerline's digital solutions shifted farmer profiling using digital data collection tools that improved the delivery of in-person training and compliance to global certifications. Esoko's Insyt tool also uses mobile and web-based digital solutions with integrated smart identity solutions for farmer profiling.

Agrocenta offers a platform for trade between smallholder farmers and consumers with over 48 000 farmers registered on their platform. In 2018, in partnership with GSMA mobile, MTN Mobile money piloted mAgri, a mobile-based tool for digitalization of the entire procurement process in agriculture. Trotro Tractor also brings mechanization services within reach of farmers by connecting them with tractor operators within the country. GSMA in 2019 reported that about 67 mobile apps were developed in the country's national language.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	0.94	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	2.03	ITU
		Fixed broadband prices as a % of adjusted per capita income	2016	12.81	ITU
	Willingness	Mobile social media penetration (%)	2019	19.42	GSMA
		Number of apps in national language (quantity)	2019	67.00	GSMA
		Gender gap in social media use (%)	2019	33.06	GSMA
		Gender gap in mobile ownership (%)	2019	100	GSMA

POLICY AND REGULATION

The Ministry of Communication and Digitalization, established under section II of the Civil Service Law, 1993 (PNDCL, 327) as amended by the Civil Service Act, 2001, has the core mandate of initiating policies to enhance information and communication infrastructure and service delivery in Ghana.

Regarding digitalization and ICT services, Ghana's ICT for Accelerated Development (ICT4AD) Policy, the National Broadband Policy and Implementation Strategy, Ghana's National Cybersecurity Policy & Strategy and Digital Financial Services Policy are some of the recent policies enacted to streamline developments in the ICT and telecommunication sector (see Table 4).

Launched in 2003, the ICT for Accelerated Development Policy specifically aims at developing Ghana's information society and economy. It pursues a multi-sectorial ICT led socio-economic development goal to develop Ghana's ICT sector using ICTs as broad-based enablers of the country's development goals. In the context of agriculture productivity, one of the 14 pillars of the ICT4AD policy focuses on modernization of agriculture and the development of an agro-business industry.

Ghana's 2012 broadband strategy also sought to: establish a relationship between broadband policy and universal access policy to make broadband policy universal by 2015; facilitate affordable access to broadband infrastructure for all by 2015; ensure last mile connectivity to communities and homes by 2020; and promote uptake of broadband via suitable content and applications and plan towards converged infrastructure and service delivery. To that end, a board was set up to establish synergies between the policy and key sectors such as agriculture.

The country has also successfully launched a national cybersecurity policy in 2014 with food and agriculture highlighted as one of the critical national information infrastructure areas vital to the nation, which, if incapacitated, could have devastating outcomes on the economy.

The Ministry of Food and Agriculture is developing the digital agriculture policy, strategic plan and action plan to guide the implementation of e-agriculture in the country. The ministry is making a conscious effort to coordinate and harmonize all the ICT-initiatives (both in private and public) within the agriculture sector to ensure synergy and to avoid duplication. The core function of the Ministry is to render agricultural extension services and other advisory services to actors along the agricultural value chain. To this end, a 10-year Digital Agricultural Advisory Service Strategic Plan is being developed to lead implementation.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.64	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.72	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.95	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.35	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	88	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2021, Ghana's relevance in Africa's business sector was boosted with the country hosting the secretariat of the Africa Continental Free Trade Area. To support businesses, the current government set up the Ministry of Business Development. During its first term, it sought to promote the development of medium and small enterprises, increase entrepreneurial capacities of the youth and enhance the country's image as an investment destination through effective branding.

Focusing on legal frameworks in the business sector, the Ghana Investment Promotion Center under Ghana Investment Promotion Centre (GIPC) Act, 2013 (Act 865) necessitate that all foreign companies be registered with GIPC. Foreign companies require equity capital of USD 500 000 in cash or capital goods to operate if they are wholly foreign owned or USD 200 000 in the case of a joint venture with a Ghanaian national (see Table 5).

Several initiatives have been undertaken by the government to improve its business environment. In 2017, the "National Identification Project" and the "National Digital Property Addressing Systems" were launched to enhance business operations through improved national address systems. The Interoperable Electronic Platform (IEP) aims at reducing the risk of doing business by facilitating electronic payment via mobile money and also enhancing the credit base of enterprises to improve their ability to obtain financial support from mainstream banks.

Another key project to improve its business environment is the Paperless Port Project implemented to create a paperless port operations system to facilitate the clearance of goods and reduce man hours by leveraging technology and advanced infrastructure.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	2319	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.18	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.57	WEF
	Entrepreneurship	Time required to start a business (days)	2019	13	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2016	3.13	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.94	WEF

HUMAN CAPITAL

Adult literacy rate is 79 percent (89.9 percent for males and 83 percent for females). Similarly, youth literacy is high with 92.5 percent of the youth able to read and write. The country's free education policy is expected to increase access to education and boost the rate of literacy among the youth. Ghana is home to nine public universities and about 25 private universities. Also, the country has six colleges solely focused on agricultural education.

The National ICT4AD policy prioritized ICT skills and education with proposed strategies that include modernizing the country's educational ICT infrastructure, promoting training in ICT skills in schools, and identifying and developing a

pool of ICT professionals to meet the manpower needs of the country (see Table 6).

The Ministry of Education has also begun a process to reform the education sector between 2018 and 2030. The reform seeks to integrate ICTs in education with the overall purpose of developing the desire and competencies in children to use ICTs, equip pre-tertiary learners with ICT skills, infuse ICT into education and promote technology-based teacher training and education at the tertiary level. Ultimately, the country aims at creating an open university framework as an avenue for workers to enrol in tertiary programmes.

Several private organizations have also prioritized ICT education and undertaken different interventions to support the less privileged. In 2019, Africa ICT Right in partnership with the America Tower Corporation - as part of the digital village ICT learning project - sought to establish ICT learning centres across the country, beginning with Savelugu in the Northern Region. The Ghana code club has since 2015 partnered with the government to promote ICT skills and has currently served over 8 000 youth aged between 6 and 18 years. It has also trained 30 teachers.

It is estimated that by 2030, over 9 million jobs will require digital skills in the country, translating into about 20 million training programmes estimated at USD 4 billion in revenue. To address unemployment challenges, in 2020 the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) introduced the "ICT skills training for students and job seekers" programme and the "Digital skills for entrepreneurial women" to empower girls and women across the country.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	79.04	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	92.49	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.21	WEF
	Employment	Employment in agriculture (% of total employment)	2019	29.75	ILO
		Employment in agriculture, female (% of female employment)	2019	22.10	ILO
		Unemployment, total (% of total labour force)	2020	4.53	ILO

AGRO-INNOVATION

Recent reviews of government budgetary allocation to the agriculture sector suggests that the government of Ghana is close to meeting the goal of 10 percent budgetary support for agriculture, as committed to in its joining of the Comprehensive Africa Agricultural Development Programme. Around 5.8-7.5 percent of the government's budget was allocated to agriculture between 2012-2015 (IFPRI, 2019). However, an observed continuous decline in allocations for agriculture research and knowledge transfer has emerged as a major concern (IFPRI, 2019).

In a bid to further innovation, the government set up the Accra Digital Centre under the leadership of the Ministry of Communications and Digitalisation to create working spaces for young enterprises that need a support infrastructure. The National Board for Small Scale Industries in partnership with the Kwame Nkrumah University of Science and Technology also set up the Kumasi Business Incubator. It assists final year students who have business ideas through guided expert support.

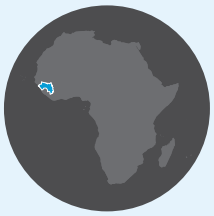
Several innovation hubs by international organizations and the private sector currently create an enabling environment for start-ups to scale their operations. For example, MEST provides critical skills in software development and communication skills to entrepreneurs from its hub in Accra. The initiative leverages hands-on-projects, guest lectures and its global support staff with start-ups benefitting from its 18-months package. The Ghana Climate Innovation Centre, founded in 2016, is leading the drive for a green economy with a focus on key areas including climate-smart agriculture. The centre funded by a grant from the government of Denmark, Netherlands and the World Bank has supported over 101 businesses and aided these to secure early stage and growth stage funds to the tune of USD 1.84 million. Other hubs include AgriHub Ghana Knowledge Space and Reach for Change Ghana (see Table 7).

Several start-ups have sprung up in the agriculture sector including Esoko, Cow Tribe, Syecomp Ghana Limited, Farmerline, Trotro Tractors, Sesi Technologies, Agrocenta, AgroInnova, Farm Cure and AniTrack. The services they provide range from data management, e-commerce, advisory, financial and marketing linkages.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	11 927.28	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	118.06	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.57	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2017	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	0.91	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	4.18	WEF
		ICT goods imports (% of total imports)	2019	2.47	UNCTAD

GUINEA



Guinea is a low-income country with a population of 13.1 million, of whom an estimated 63.1 percent live in rural zones. Guinea's population also skews young, as 61 percent of its citizens are under 35 years of age, and 40 percent are under 15 years of age (USAID, 2016).

In 2020, the GDP of the country was estimated at USD 15.6 billion by the World Bank. In the same year, the IMF estimated GDP per capita at USD 926.3. In 2020, the contribution of the agricultural sector to GDP was 18 percent while the sector employs nearly 60.7 percent of the working population. The rate of women working in agriculture is 6.8 percent (WBG, 2019) (see Table 1).

Regarding the state budget, rural development (agriculture, fishing, livestock), received funding of 12.4 percent in 2021. The agriculture sector plays a key role in poverty reduction and rural development, and provides income for 57 percent of rural households. Furthermore, 9.2 percent of the population lives below the income poverty line of USD 1.9 or less a day (WBG, 2019).

Since 2020, Guinea has made strategic investments in information and communication technologies. The country is currently working to lift the brakes off its digital transformation.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	13 132 792	WBG
Urban population (%)	2020	36.88	UNPD
Rural population (%)	2020	63.12	UNPD
GDP (current millions of USD)	2020	15 681	WBG
Agricultural land (km^2)	2018	145 000	FAO
Agricultural land (% of land area)	2018	59.01	FAO

INFRASTRUCTURE

Through the Small Hybrid Electricity project in Guinea (PEHGUI), the Rural Electrification Project (PER), the Electricity Sector Recovery Project (PRSE) and three interconnection projects approved by the World Bank between 2015 and 2019, Guinea has a growing rate of access to electricity in urban areas, reaching 87.7 percent in 2019. However, the rural access remains low, at 16,4 percent of the rural popoulation.

From 2011 to 2018, the rate of telephone network coverage increased from 40 percent to 79 percent in the country, with a large presence of different mobile operators. Guinea has 91 percent 2G coverage, 75 percent 3G coverage, and 8.6 4G coverage (GSMA, 2019). The mobile operator Orange Guinea switched to 4G in 2019 and launched mobile technology in Conakry, covering all the municipalities of the capital: Kaloum, Dixinn, Ratoma, Matoto and Matam.

Guinea has four mobile operators: MTN Guinea operating under the brand Areeba; Orange, a subsidiary of Senegal's Sonatel; Intercel, launched in 1993 as Télécel, which is now a subsidiary of the incumbent operator in Sudan Sudatel; and Cellcom, a United States telecommunication firm. Orange and MTN dominate the market and have both launched 3G mobile broadband along with Cellcom.

There is no fixed line operator in Guinea. Voice communications are through mobile networks. Fixed-broadband is available through fixed broadband wireless networks and optical fiber provided by mobile operators to businesses in urban areas.

In 2017, the market also included four Internet service providers, namely: ETI, MouNa Group Technology, Skyvision Guinée and VDC Télécom. The ACE fiber optic submarine cable entered into service in of 2013.

The number of mobile connections in Guinea in January 2020 was equivalent to 79 percent of the total population compared to 12.91 million subscriptions in 2019, which had increased by 7 percent from 2018 (12.01 million subscriptions). Mobile penetration is estimated at 105.1 percent compared to 101 percent in 2018.

Guinea took another step toward its digital sovereignty through the construction of its first ever national data centre in 2020. Guilab, a telecommunications infrastructure operator, has signed a partnership agreement with Facebook for installation of a content distribution network (CDN) on its premises (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	16.39	WBG
		4G coverage (% of total coverage)	2019	8.64	GSMA
		Mobile (device) ownership (% of population)	2019	53.31	GSMA
		Secure access to Internet servers (per 1 million people)	2020	6.78	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.62	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	100.80	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	23.17	ITU
		Fixed broadband subscriptions (per 100 people)	2019	0.01	ITU

DIGITAL PENETRATION

According to Cable (2020), the average price of 1 GB of mobile data in Guinea is USD 2.08. ITU also reports that the price of local mobile cellular calls per minute was USD 0.07 in 2017 (see Table 3).

In 2016, about four out of five Guineans (79.1 percent) owned a mobile phone, of which 8.3 percent were smartphones. Nearly 8 percent of girls aged 15-24 years have accessed a computer once, but only 4 percent have accessed a computer at least once a week.

The number of mobile Internet subscriptions was 2.55 million in Guinea as of January 2020, or roughly 20 percent of the population. In Guinea, Internet use in the past 12 months prior to publication shows that 32 percent of men aged 15-49 years have used the Internet compared to only 15 percent of women. In 2018, the proportion of the population that had accessed a mobile broadband network but did not use mobile Internet services was 18 percent, but the proportion of the population not covered by a mobile broadband network was 64 percent. Internet bandwidth usage increased from 468 bit /s in 2013 to 12 066 bit /s in 2017.

In March 2021, social networks penetration was mostly to Facebook (72 percent), Twitter (8.8 percent), Pinterest (9.6 percent), YouTube (5.3 percent), Instagram (2.9 percent) and Reddit (0.5 percent). Private companies are increasingly turning to Facebook to target Guineans with disposable incomes, and government ministries have begun using Facebook as a platform to communicate with the general population.

There are few services in Guinea serving digital agriculture. Kóbiri is a mobile service that allows Guineans to pay for services by mobile phone and also offers rental services for agricultural equipment. M-Makiti provides day-to-day information to farmers and consumers on the price of consumer agricultural products or seeds in Guinea using the USSD service of the operator Orange. DrumNet is an ICT-enabled platform that delivers services to agro-buyers, banks, farm input retailers and farmers. Allô224 is another service that lists restaurants in the city of Conakry and users can book, view and order their favourite meals online. The new supplier and partnership marketplace digital platform Bourse de Sous-Traitance et de Partenariats (BSTP) is helping SMEs across Guinea improve their competitiveness and sell their goods and services. Launched in December 2018, BSTP connects large companies across all sectors of the economy with local suppliers in areas including catering, hospitality, logistics, construction, and agribusiness.

Introduced by the government, the e-voucher system is a digital platform-based solution for the distribution of farm inputs that instantly sends out electronic coupons (or vouchers) by SMS to the mobile terminals of a database of farmers (beneficiaries) notifying them of subsidies granted to them and where these can be collected.

The proportion of the adult population with a bank account increased from 7 percent in 2014 to 23.5 percent in 2017. Digital financial services are used by 2 million subscribers, a number significantly below Guinea's market potential. Three e-money issuers (Orange, MTN, and PAYCARD) have been licensed to operate, but the supply of services stagnates at the level of transfers and payments, not reaching second generation services targeting credit and savings through a more integrated financial sector.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Source	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	Cable	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	ITU	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	ITU	ITU
	Willingness	Mobile social media penetration (%)	2019	GSMA	GSMA
		Number of apps in national language (quantity)	2019	GSMA	GSMA
		Gender gap in social media use (%)	2019	GSMA	GSMA
		Gender gap in mobile ownership (%)	2019	GSMA	GSMA

POLICY AND REGULATION

The 2016-2020 National Development Plan (Plan National de Développement Economique et Social, PNDES), grounded in the country's long-term vision (Vision Guinea 2040) with the stated goal of promoting strong, high-quality growth that will improve the well-being of Guineans, brings an economic structural transformation and places the country on a sustainable development path. The PNDES also focuses on "enhancing the digital economy as indispensable factors of development and a cross-cutting sector with direct multiplier effects on all other sectors of economic activity." The Ministry of Posts, Telecommunications and Digital Economy defines the sector policy. A National Strategy for the Development of ICTs and the Digital Economy was adopted for the period 2016-2020, promoting intelligent legislation and regulation through the drafting of a law on electronic transactions, protection of personal data, cybersecurity and cryptology, digital convergence and drafting of law enforcement texts. The Authority for Regulation of Posts and Telecommunications is the sector regulator, guided by the 2015 Law on Telecommunications and Information Technologies. In addition, government initiatives, such as the planned National Backbone Network in Guinea, have been supportive in encouraging increased investment in the sector. The Autorité de Régulation des Postes et des Télécommunications (ARPT) is in charge of regulating e-commerce activities under the authority of the Ministry of Posts, Telecommunications and Digital Economy.

The Guinean law on e-commerce was passed in June 2016. The Cybersecurity and Data Protection Law (N. L/2016/037/AN) approved by the parliament in July 2016 governs the sharing of consumer data and analytics. The law introduced rights on protection and privacy of information, and triggered transparency with the potential to democratize information sharing and consumers' rights. The law aimed at transforming consumers from "subjects" into "clients".

Guinea's vision for agricultural development sees the country as an "emerging agricultural power in 2025, with an economically and socially viable mode of production". Since 2007, the Government has adopted a National Agricultural Development Policy (PNDA) on the basis of the National Agricultural Investment and Food Security Plan (PNIASA), modern, sustainable, productive, and competitive agriculture in regional and international markets.

In terms of ICT, improving access to growth markets for agricultural products entails strengthening the operational capacities of SIPAG and the relaunch of the livestock SIM and its extension, which are digital tools at the service of agriculture but carried by the state (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	2.95	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.43	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.97	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.18	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	68.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In the 2016-2020 national strategy document at the level of strategic objective 1.4.4, the government intended to promote the creation and support of companies in the digital sector. From 2015, Guinea enabled its investment environment through the Investment Code Law. This code sets out the legal and institutional framework for private, domestic and foreign investment in the country, and is supervised by the Agency for the Promotion of Private Investment (APIP). The ease of starting a business has increased thanks to the one-stop-shop set up by APIP to facilitate registration of businesses. In addition, a regulatory and legislative framework for the promotion of industrial production was developed. Furthermore, the National Charter of MSMEs, the National Quality Policy, and the National Strategy for the Promotion of Intellectual Property were also adopted. The private sector development strategy of the Guinean government (Stratégie de développement du secteur privé - SDSP) has assigned a crucial role to women and youth in the country's development agenda.

Furthermore, the Investment and Development Bank of the Economic Community of West African States (BIDC) has granted Vista Bank Guinea a credit line of ERU 10 million (approximately USD 11.3 million) to support the financing and promotion of SMEs and PMIs in Guinea. Additionally, USD 11 million financing agreements are intended for the Support Project for the Transformation of Guinean Agriculture and Youth Agricultural Entrepreneurship (PATAG EAJ).

Over 90 percent of the Guinean private sector consists of informal micro, small, and medium enterprises (MSMEs) in agriculture, trade, or services, with low salaries (less than USD 50 per month) and low literacy rates (25 percent). It is estimated that 80 percent of the workforce is employed in this sector and that only 2.2 percent of enterprises have a bank account. Conakry is clearly the country's economic hub, with an estimated 70 percent of SMEs located in its greater metropolitan area.

Nearly 90 percent of Guinean SMEs are estimated to be informal or semi-formal. According to a recent study, 57 percent of small businesses are informal, and 29 percent are self-employed entrepreneurs, most of whom are not registered as businesses either.

However, in 2014, only 57 percent of people over 25 years of age borrowed money from a formal institution, and 43 percent of people aged between 15-24 years borrowed money from a

formal institution. The credit-to-private-to-GDP ratio in Guinea is 9.8 percent due to the absence of specialized banks, a fully operational guarantee fund and a stock exchange.

Quite surprisingly, the percentage of business managers above 65 is extremely high in Guinea, at 64 percent. Conversely, the percentage of young entrepreneurs was very low: only 11 percent were younger than 35 and only 14 percent were run by women (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	45	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.29	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.03	WEF
	Entrepreneurship	Time required to start a business (days)	2019	15	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	5.43	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	4.26	WEF

HUMAN CAPITAL

The literacy rate as of 2018 was 39.6 percent and 53.9 percent for youth based on UNESCO estimate. The agriculture sector employed 60.7 percent of the population in 2019, with a marked continuous reduction in percentage since 2015 according to ILO.

Guinea's only agricultural university is the Institute Superieur Agronomique Valery Giscard D'Estaing de Faranah (ISAV/F) and its veterinary university is the Institute Superieur de Medicine Veterinarie (ISSMV), located in Dalaba. In addition, there are five national Agricultural Education and Training (AET) centres. Four national schools for agriculture and livestock (ENAE in French) are located in Boffa, Kankan, Macenta and Tolo, and one national forestry school (ENATEF in French) is located in Mamou. These five national schools train roughly 500 students per year, who receive diplomas at the completion of their training. However, the institutions need further public and private investment in staffing, curriculum materials and students to produce more and higher-quality graduates.

In terms of initiatives to develop the digital skills of youth, several actions have been undertaken by universities and private education organizations to strengthen the capacities of training and research institutions in the field of ICT. ARPT has also undertaken initiatives to strengthen digital skill. The ministry in charge of telecommunications/ ICT, through the WARCIP project, has also carried out skills-building actions for executives of the telecommunications sector, in Guinea and abroad.

Most growth-oriented SMEs prefer to train their employees on-the job, while 16 percent of the enterprises indicated that they offered specific staff training (WB Enterprise Survey, 2016) (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	39.62	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	53.94	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.35	WEF
	Employment	Employment in agriculture (% of total employment)	2019	60.65	ILO
		Employment in agriculture, female (% of female employment)	2019	61.80	ILO
		Unemployment, total (% of total labour force)	2020	4.35	ILO

AGRO-INNOVATION

The Research Institute Agronomique De Guinee (IRAG) in Conakry is the main R&D agency for agriculture and has the most research staff and agricultural R&D funding nationally (ASTI, 2014). Broad topics that IRAG conducts R&D on include crops, livestock, natural resources, post-harvest handling and agricultural engineering. IRAG also develops new agricultural technologies, creates and tests new plant varieties for adaptability within Guinea's four regions, and provides technical assistance to farmer groups and individuals.

Specific EAS provision by IRAG includes advice on fertilizer dosage, information on phytosanitary techniques and adaptations, and provision of technical assistance through training of the extension staff at the National Agency Promoting Rural and Agricultural Consulting (ANPROCA, for its abbreviation in French). Further broad research with agricultural links and synergies is done at the Gamal Abdel Nasser University of Conakry (UGANC)/Center for Study and Environmental Research and the National Research Center on Fisheries and Marine Resources (CNSHB). In general, these agricultural research and training institutes do not communicate and coordinate well with farmer groups and farmers, nor sufficiently with the EAS system.

Saboutech is a non-profit organization focused on identifying and supporting SMEs and start-ups in IT, renewable energies or the environment in crucial stages of their development by creating a privileged space and a stimulating environment dedicated to spurring the growth of these SMEs. They are also a venue for various events around entrepreneurship and innovation in Guinea.

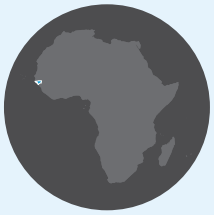
The OseTonEmploi Incubator is a support structure for entrepreneurs in the creation and development of innovative or high added value businesses (see Table 7).

In addition, the Guinean Institute for Standardization and Metrology (IGNM) - a public scientific and technical establishment with legal personality and financial and managerial autonomy - is made up of four divisions, including the Standardization Division that includes the agri-food, civil engineering and construction, electromechanics, environment and chemistry-textile sections.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	2 148.24	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	125.17	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.20	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.17	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	5.03	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	5.44	WEF
		ICT goods imports (% of total imports)	2016	1.63	UNCTAD

GUINEA-BISSAU



Guinea-Bissau is a low-income country with a GDP of USD 1.4 billion as of 2020. The economic growth is slow and volatile, affected by political instability, which perpetuates the country's poverty and vulnerability. Of the country's population of 1.9 million people, 55.8 percent live in rural areas and 44.2 percent of the urban population live in slum areas. Also, 35.3 percent of the total population lives below the international poverty line of USD 1.9 or less a day (PPP), a decrease from 59.7 percent in 2010 (see Table 1).

The agriculture sector is a key driver of the economy, having contributed 30.9 percent of the country's GDP in 2020. The International Labour Organization (ILO) estimates that agriculture employs around 60.5 percent of the total population with women accounting for 64.1 percent of that. Guinea-Bissau is rich in resources, but limited capacity and weak governance extends agriculture beyond its potential, precluding diversification and limiting it to a single commodity. Agriculture in Guinea-Bissau largely depends on family farming, with about 120 000 small-scale farmers. The main food crop is rice for domestic consumption, while the main cash crop is cashew nut, which accounts for 95 percent of exports (IFAD) and employs about 75 percent of rural households (World Bank). High dependence on cashew exports makes Guinea-Bissau vulnerable to external shocks, especially global price fluctuation. Agriculture in Guinea-Bissau faces numerous challenges such as low productivity, difficulties in accessing markets and financial resources, price fluctuations, etc. Even though the country produces rice domestically, demands are ultimately met by importing expensive rice.

Food security and nutrition situation are problematic for Guinea-Bissau because its limitation on a single-food, rice-based diet. As a result, 28.3 percent of the total population is undernourished (AFDB, 2020) and one-third of children aged under five suffer stunting (IFAD, 2020).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	1 967 998	WBG
Urban population (%)	2020	44.20	UNPD
Rural population (%)	2020	55.80	UNPD
GDP (current millions of USD)	2020	1 432	WBG
Agricultural land (km^2)	2018	8 151	FAO
Agricultural land (% of land area)	2018	28.99	FAO

INFRASTRUCTURE

Guinea-Bissau is slowly improving its basic infrastructure, but overall rate of access to electricity remains low at 31 percent as of 2019. The gap between urban and rural areas is evident, with 54.3 percent of the coverage mostly concentrated in the capital city Bissau, and 12.9 percent in rural areas. Electricity only accounts for 0.5 percent of the country's national energy consumption. There are huge opportunities to process Guinea-Bissau's ample renewable resources like solar, wind and hydroelectricity, but these have not yet been exploited to their full potential due to a lack of technical capacity and financial support.

In its National Action Plan in the Renewable Energy Sector (PANER) (2015-2030), the electricity sector was considered a priority with a goal of achieving 75 percent of electricity demand fulfilled by renewable energies and 72 percent of the total population with access to electricity through the national grid by 2030. Guinea-Bissau is also one of the target countries of the Regional Off-Grid Electrification Project (ROGEP) supported by Lighting Africa. This will help the country improve its energy access, particularly through stand-alone solar systems, and will further facilitate social development by providing education and public health facilities with better electricity supply.

Currently there are two mobile operators in Guinea-Bissau, Orange and MTN, with the former maintaining market dominance since 2013. In terms of network coverage, 3G was launched in 2015 by the two operators (ITU, 2017), rapidly reaching 90 percent coverage in 2019. 2G has a wide coverage as well at 98.8 percent. Meanwhile, 4G/LTE was first launched in Guinea-Bissau by Orange in 2015 and has reached 62 percent in 2019 (GSMA, 2019).

Before joining ACE, Guinea-Bissau was the only country in West Africa that was not connected to a submarine cable. In 2017, Guinea-Bissau signed a MoU with the World Bank for a USD 47 million ACE project, aiming at connecting the country to submarine cable, however, its unstable political situation has slowed down the project (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	12.91	WBG
		4G coverage (% of total coverage)	2019	62	GSMA
		Mobile (device) ownership (% of population)	2019	47.30	GSMA
		Secure access to Internet servers (per 1 million people)	2020	3.05	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	97.25	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	46.71	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.12	ITU

DIGITAL PENETRATION

Internet penetration in Guinea-Bissau is very low at only 3.9 percent. Fixed-broadband subscriptions at 0.064 percent are almost non-existent. Mobile cellular coverage is much better at 82.8 per 100 people. However, it is important to note that the country had a high mobile penetration even before the introduction of 3G and 4G services by Orange and MTN, and in 2019 this rate was estimated at 81 percent. Mobile payment services in the country were also launched by MTN and Orange in 2010 and 2016, with a total subscriber base of 220 000 in 2016 according to AfDB.

Meanwhile, mobile data price has decreased sharply, from USD 11.71 in 2019 to USD 4.12 in 2020 (see Table 3), however, data-only mobile broadband plans still represented more than 18 percent of the monthly average income between 2019 and 2020 (ITU, 2020). Social media penetration remained low at 12.94 percent in 2019, but slowly increased to 280 000 users in January 2021 (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4..12	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	12.94	GSMA
		Number of apps in national language (quantity)	2019	12.63	GSMA
		Gender gap in social media use (%)	2019	16.98	GSMA
		Gender gap in mobile ownership (%)	2019	47.20	GSMA

POLICY AND REGULATION

Guinea-Bissau 2025, The Strategic and Operational Plan 2015-2020 "Terra Ranka" outlines the strategic direction of the country's national development toward 2025. It identifies four growth engines for a diversified economy: agriculture and agro-industry, fishing, tourism and mining. Agriculture and agro-industry will continue relying on the development of rice and cashew sector, with the aim of producing more value-added and processed products, as well as the enhancement of fishery resources. Meanwhile, Terra Ranka also recognize the importance of the digital sector as one of the critical support sectors for competitiveness and a lever of growth for the entire economy. The Ministry of Transport, Communications and ICT is responsible for the implementation of the digital economy goals (ITU, 2018). Digital sector and agriculture value chain development have been included as two of the four national programs. A National Agriculture Investment Plan was adopted in 2017 to further focus special attention on agriculture. However, the country went through a political crisis since mid-2015 which hampered the implementation of Terra Ranka and the other national plans (AFDB, 2020). To recover from the instability, an emergency programme was launched in 2019 by the government to drive economic growth and fight poverty based on directions of Terra Ranka (AFDB, 2020).

Furthermore, there has been a decrease in public spending on agriculture and rural development. Total public expenditure is largely affected by external funding (95 percent), which raises concerns of the extent that donor priorities can be aligned to domestic strategic orientations (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	46	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

According to Doing Business, Guinea-Bissau scored 75.5/100. It takes 8.5 days to start a business, with one more day for women because married women have to obtain permission to conduct business from their husbands in accordance to the civil code. The whole procedure is relatively costly, as it accounts for 88.8 percent of income per capita.

The country has witnessed a fluctuation of FDI inflows affected by the internal political situation. In 2019, according to UNCTAD, FDI inflows reached USD 31 million, a slowly recovery from 2015. Offshore oil exploration and the tourism sector are increasingly attracting foreign investments. However, limitations in infrastructure and regulatory framework might discourage investors for the upfront investment required for agriculture.

Many development projects in the country rely on donor grants as well as support from international organizations. For example, IFAD allocated USD 16 million to launch an agriculture project in Guinea-Bissau to help increase income for family farming households, promote youth employment and boost entrepreneurship, and facilitate investment in mobility and logistics to improve access to markets (IFAD) (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	31	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	8.5	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

The literacy rate of the country stood at 45.6 percent in 2014, with a huge disparity between males and females, accounting for 62.2 percent and 30.8 percent respectively. Illiterate women have limited chances of accessing training and education with barriers like early marriages, lack of identity papers, etc. The country has exerted effort to reach gender parity for basic primary education with primary school enrolment rate at 73 percent for males and 69.5 percent for females. However, the out-of-school percentage shows that in 2014, 29 percent of primary school-age children were out of school, and 26 percent for secondary school-age children, indicating a clear disparity between urban vs rural, and male vs. female. Only 14 percent of children enrolled in in the first year of primary school complete the final year (UNESCO, 2015)

The youth unemployment rate is estimated at 4.59 percent in 2019 based on ILO estimates. The rate for the working population accessing vocational training also remains quite low, representing less than 5 percent (IFAD).

Given that women account for 64.1 percent employment in agriculture, improving women's education and training, as well as enhancing their access to digital and business skills are of paramount importance for women in Guinea-Bissau. In 2020, the Orange Foundation in partnership with the non-profit organizations ESSOR and ANADEC, set up a Digital House in Guinea-Bissau to support 1 500 extremely vulnerable women to acquire digital skills training for better access to the job market (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2014	45.58	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2014	60.40	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	60.48	ILO
		Employment in agriculture, female (% of female employment)	2019	64.14	ILO
		Unemployment, total (% of total labour force)	2020	3.16	ILO

AGRO-INNOVATION

The expenditure of agricultural R&D in Guinea-Bissau only accounted for 0.02 percent of agricultural GDP. The country has a critical shortage of qualified agricultural scientists and relatively aging researchers (aged above 40 years). There are significant under-investments in the agricultural R&D in Guinea-Bissau.

The National Agricultural Research Institute (INPA) is the only agricultural research agency in Guinea-Bissau, mainly focusing on crop and livestock research. It is also in charge of the dissemination of information and technology and the provision of training. Another critical constraint is the lack of higher education institutes, NGOs or private sector entities conducting agricultural R&D in the country.

The government has taken measures to improve this situation. For example, the government requested support from the Conference of Heads of African and French Agricultural Research (CORAF) to rebuild its national agricultural research system. Also, research is considered a central part of Guinea-Bissau's National Agriculture Investment Plan.

Meanwhile, it cannot be neglected that in 2017, youth aged below 24 years of age accounted for 60.9 percent of the population, and should be 4.59 percent in 2019. The youth of Guinea-Bissau move to urban cities at a large scale. Currently, there are a few innovative start-ups for youth capacity development. For instance, InnovaLab, a social enterprise aims at supporting young people in research and job creation by fostering entrepreneurial ecosystem development. This is achieved through various activities like forums, tech camps, open labs, bootcamps, and the hackathon Geração de talentos!" (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	516.40	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	106.74	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.39	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2011	0.02	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

KENYA

Kenya is a lower-middle-income country with a population of almost 54 million people, 72 percent of whom live in rural areas. The country has 58 million ha of land, 46.5 percent of which is dedicated to agriculture, while 3.5 million ha are forests. Kenya is characterised by a diversity of landscapes and about 47 000 km of its land is national parks, reserves and sanctuaries. In essence, Kenya's economy is dependent on agriculture and tourism (FAO, 2016) (see Table 1).

Agriculture, forestry and fisheries are central to the economy, contributing 35.2 percent of Kenya's GDP, which stood at USD 98.8 billion in 2020. The agriculture sector employs 54.3 percent of the total population and 70 percent of the rural population. Furthermore, agriculture contributes 65 percent of export earnings, and provides for the livelihood (employment, income and food security needs) of more than 80 percent of the Kenyan population.

There are approximately 4.5 million smallholder farmers of whom 3.5 million grow crops, 600 000 are pastoralists and 130 000 are fishers. Most smallholder farmers depend on rain-fed agriculture and practice mixed farming – maize and beans are mostly grown. Crop and livestock yields have stagnated in the last four decades. For example, Kenya's total productivity for agriculture dropped by 10 percent between 2006 and 2015 (IFAD, 2020).

Kenya is at the forefront of technological innovations in Africa and has a buzzing digital economy, with Nairobi often referred to as the "Silicon Savannah" of Africa. The government has created a conducive policy environment for ICTs, invested in broadband connectivity via undersea cables, and recently launched the Digital Economy Blueprint – a framework to improve Kenya's ability to leapfrog economic growth.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	53 771 300	WBG
Urban population (%)	2020	28.00	UNPD
Rural population (%)	2020	72	UNPD
GDP (current millions of USD)	2020	98 843	WBG
Agricultural land (km^2)	2018	276 300	FAO
Agricultural land (% of land area)	2018	48.55	FAO

INFRASTRUCTURE

The country has the infrastructure needed for launching a digital economy, and it is committed to expanding infrastructure networks, domestic and regional across East Africa. More than 75 percent of the population have access to electricity, with a 61.7 percent coverage of rural areas.

The country has 3G services that cover 95.8 percent of the population, while 4G coverage reaches 64.3 percent. There are four GSM network providers: Safaricom with 71.2 percent of market share, followed by Airtel at 17.6 percent, Telkom Kenya at 7.4 percent, and the recently launched Finserve Africa/Equitel at 3.8 percent. Safaricom activated its 5G network in Kenya in 2021.

The government has invested in Kenya's broadband connectivity. Four undersea fiber optic cables (SEACOM, TEAMS, EASSY, and LION2) connect via the coast of Kenya. Undersea cables have driven improved Internet speed in the country. There are also other fiber optic cables owned by companies such as the Kenya Electricity Transmission Company and Kenya Power. The National Optic Fibre Broadband Infrastructure (NOFBI) has reached all 47 counties in Kenya.

Internet penetration is at 90 percent, with widespread mobile Internet. The adoption of mobile technology and mobile Internet in Kenya has advanced more rapidly in recent years. The investment in mobile broadband, increased fiber optic cable connections to households, and the rapid spread of low-cost smartphones and tablets have contributed to the upwards rise of Internet uptake. For example, Internet subscription grew by 21 percent in 2019 (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	61.69	WBG
		4G coverage (% of total coverage)	2019	64.26	GSMA
		Mobile (device) ownership (% of population)	2019	57.51	GSMA
		Secure access to Internet servers (per 1 million people)	2020	239.46	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	5.10	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	114.20	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	41.08	ITU
		Fixed broadband subscriptions (per 100 people)	2020	1.25	ITU

DIGITAL PENETRATION

In 2019, close to a quarter of the population in Kenya was using the Internet. Mobile subscription per 100 people was at 96.3. Mobile cellular penetration was 103.77 per 100 inhabitants – higher that most countries in the region. Broadband subscription per 100 people was 41 during the same period. According to the Communications Authority of Kenya, broadband usage statistics are increasing due to the expansion of 4G networks. Additionally, mobile data subscriptions stood at 99 percent versus 1 percent for wired Internet subscriptions.

Kenya launched the digital-for-agriculture (D4Ag) project that aims at shifting online

all farming activities as a way of locking out brokers, curbing loss of subsidised inputs and enhancing productivity. During the last three years, Kenya's digital agriculture has seen a rise in digital solutions. The GSMA AgriTech Report noted three uses: (i) last-mile digital tools (solutions that digitize transactions, i.e. procurement payments, digital receipts, etc.); (ii) market linkage tools (solutions that formalise agricultural value chains by connecting crop producers and buyers); and (iii) direct-to-farmer hubs (one-stop shops through which third-party agricultural service providers offer their services directly to farmers).

Rural Kenya reflects accurately the country's rural-urban divide due to developmental challenges such access or lack thereof to electricity connectivity. For example, Safaricom 4G network covers 77 major towns. The major hindrance to the adoption by rural communities of technologies is the cost of Internet. In 2020, the average mobile data price of 1 GB was USD 1.

That said, initiatives exist in agriculture that are designed to reach rural areas. For example, the AfriScout app provides pastoralists with current information by directing pastoralists to nearby water sources and pasture. Twiga is an online B2B marketplace for the supply of fruits and vegetables. Apollo Agriculture provides a platform for farmers to access credit and farm inputs through crop health assessment. SunCulture develops and offers solar-powered irrigation systems. Tulaa provides an online marketplace for loans and commerce platform for rural farmers. M-Farm is a digital platform offering market price information for various agricultural commodities. Farm Drive connects unbanked smallholder farmers to financial institutions (see Table 8).

Another common challenge is providing agriculture content in local languages, with Kiswahili being the most common local language. For example, the MoA-INFO is a platform that provides free agricultural recommendations to farmers via SMS with both English and Kiswahili interfaces. Many digital solutions targeted at farmers are increasingly providing language interface and content in Kiswahili.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.05	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	3.31	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	16.23	ITU
	Willingness	Mobile social media penetration (%)	2019	16.33	GSMA
		Number of apps in national language (quantity)	2019	53.39	GSMA
		Gender gap in social media use (%)	2019	56.59	GSMA
		Gender gap in mobile ownership (%)	2019	81.75	GSMA

POLICY AND REGULATION

The country's regulatory and policy oversight for communications lie with the Communications Authority of Kenya (CA), established in 1999 by the Kenya Information and Communications Act, 1998. The country's key ICT policy is the Kenya National ICT Policy (2019). It defines the current and future strategy of the government in evolving and emerging technology landscapes in Kenya. The policy defines key focus areas: (i) mobile first; (ii) market; (iii) skills and innovation; and (iv) public service delivery (see Table 4).

The other policy framework is the Digital Economy Blue Print, through which the ability of Kenya and Africa to leapfrog economic

growth can be improved. It has a sub-goal to grow the contribution of ICT to the economy to 10 percent by 2030. The blueprint hinges on five pillars: digital government; digital business; infrastructure; innovation driven entrepreneurship; and digital skills and values. It also highlights the cross-cutting issues that need to be considered for the success of a digital economy. In this way, the blueprint addresses some of the items raised above, for example, infrastructure. While this policy is futuristic and poised in the right direction, it only mentions agriculture in passing as a sector example in five instances.

The Kenyan government is recognizing the potential of digital technologies in agriculture. In 2019, the government launched the Agricultural Sector Transformation and Growth Strategy 2019–2029 (ASTGS) with an overarching goal of maximising the potential of agriculture in achieving food security and improving farmers and local community incomes. ASTGS acknowledges the role of research and innovation and commits the National Agricultural Research Institutions (NARIs) to adopt data and technology to support agriculture. The ASTGS envisions extensive opportunities for digital applications and analytics in agriculture.

Makini et al. (2020) examined the impact of policies on the digitalization of agriculture and concluded that while the Government of Kenya and the private sector have heavily invested in ICTs – especially in the provision of support infrastructure – there was still a lack of specific policy, legal and institutional frameworks to support the agriculture sector's idiosyncrasies. The study recommended some policies that encourage private sector participation, supporting digital literacy for ICT4Ag players, among other recommendations.

Meanwhile, due to the growth of mobile finance transactions, the government introduced the Finance Bill 2020 that is essentially a new digital services tax (DST) that taxes income from services provided through a digital marketplace in Kenya at the rate of 1.5 percent of the gross transactional value.

Other supporting policies include the National Broadband Strategy (NBS) 2018–2023 aimed at providing broadband services to all citizens. For example, through this policy the government hopes to increase digital literacy in schools to 85 percent, increasing access to broadband coverage of 3G to 94 percent of the population by 2020, achieve 50 percent digital literacy among the workforce and expand broadband to the 47 counties. Meanwhile, all 47 counties now have ICT roadmaps to align with local county development plans (CDPs) and the National ICT Master Plan. The ICT roadmaps guide local authorities in aligning investment to both national and international standards.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.83	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.83	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	4.20	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	4.02	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	87.5	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Kenya has a favourable investment climate, and the country is one of the largest recipients of FDI in Africa. According to UNCTAD (2020), FDI stood at USD 1.3 billion in 2019 with the ICT sector attracting the lion's share of that. The 2020 Doing Business Report of the World Bank noted improvement in reforms related to registering property, getting credit, protecting minority investors, tax payment and resolving insolvency. Examples of some laws governing opening and running a business in Kenya include: Companies Act 2015, Insolvency Act 2015, Income Tax Act and the Movable Property Security Rights Act 2017. In addition to the examples above, each sector has specific laws and regulations. According to the World Bank, the time required to start a business in Kenya is 23 days (see Table 5).

As stated above, agriculture in Kenya comprises mostly smallholder farmers and requires financial support to maximise productivity. Meanwhile, the country has large agro-processing industries, with the presence of multinational companies like Del Monte, Unilever, BIDCO and Nestle. Agro-processing companies play an important role in the agro-food value chain – including offering markets to producers, channelling investment into infrastructure, providing technical support to farmers and facilitating the technology transfer (UNDP, 2012).

Kenya has a strong financial market to support agricultural investments; one study cited more than 30 institutions offering support to agriculture. However, most financial institutions consider agriculture costly and risky. For example, in 2013, the Association of Microfinance Institutions (AMI) reported that over 70 percent of the loan portfolio was for business related loans, while only 8.5 percent is dedicated to agriculture. Meanwhile, while agriculture offers opportunity for rural youth and women, they lack access to finance due to lack of savings and conventional collateral, having weak or no credit history, and low or no regular income flows.

The digital revolution in Kenya has offered hope for financial inclusion – mobile money platforms offer much potential for rural communities. M-Pesa is the most common mobile money platform and has transformed the way businesses transact across all sectors. Vodafone and Safaricom, launched M-Pesa in 2007 and the service has spread across the region. Safaricom also launched the M-Shwari (meaning "calm" in Kiswahili), in partnership with the Commercial Bank of Africa. As a mobile banking platform, M-Shwari provides access to both savings and short-term credit based on users' transactions and savings history. A number of similar mobile services are mushrooming, including Digifarm, and M-Pesa Global. According to a 2016 study, such financial technology solutions lifted 194 000 households (or 2 percent of Kenyan households) out of poverty and motivated more women to move into farming. The rapid rise of Kenya's start-up ecosystem is attracting young and new entrepreneurs, and the trend is likely to spill over into the agri-food tech industry.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1 332	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.71	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.03	WEF
	Entrepreneurship	Time required to start a business (days)	2019	23	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/extremely easy)	2017	4.01	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	4.76	WEF

HUMAN CAPITAL

Kenya's adult population of 15 years of age and older has an 81.5 percent literacy rate, with 85 percent for males and 78.2 percent for females separately. Youth aged between 15-24 years of age have a literacy rate of 87.8 percent (UNESCO, 2018). Kenya's Digital Economy Blue Print aims at integrating ICTs in education to increase the country's skill base. This aligns with Kenya's vision 2030. Currently, the state of ICTs in schools lags behind with infrastructure in Kenyan schools considered unsustainable (see Bariu, 2020 for an elaborate discussion) (see Table 6).

In September 2016, Kenya launched Digi School, the nation-wide digital literacy programme with a vision to prepare every pupil for the digital world. In 2018, the programme distributed over one million devices to more than 19 000 public primary schools across the country (Morara, et al., 2020). Morara et al. enumerated some of the challenges experienced in implementing this programme. For example, 75.2 percent of teachers had difficulty using computers, signalling prolific lack of digital skills.

Another similar example is the Education Broadband Connectivity project (EBC) which is part of the Universal Service Fund to improve education through digital learning. The EBC project adopted a national approach to Internet connectivity for tertiary college institutions. To date the project has connected 887 secondary schools across the country. The project gives priority to secondary schools that are already teaching a computer studies curriculum.

Kenya has a number of agricultural training institutions across the country, one source cited 31 institutions. The Agricultural Sector Development Strategy 2010-2020 highlighted education and training as an important enabler of agriculture. While science, technology and innovation are explicitly mentioned, the strategy did not refer to ICT training and development in agriculture. Nonetheless, the National Information, Communications and Technology (ICT) Policy provides for the development of requisite skills needed for the economy in general (MICT, 2019:8). A study evaluating digital skills needed in Kenya lamented the deficiencies of skills in formal education. For example, "stakeholders agreed that public universities in Kenya do not provide the right skills to match market needs" (Mercy Corps, 2019: 9).

New technology hubs, online platforms (such as Google Digital Skills and Safaricom's Blaze Platform), new training institutions, smaller universities (such as Strathmore) are addressing the digital skills gap. Examples of these programmes include a Huawei partnership with the Information and Communication Technology (ICT) Authority of Kenya to provide training to 377 students under the Presidential Digital Talent Program (PDTP). The training seeks to develop and expand Kenya's ICT talent. The government, Microsoft and Stanbic Bank are also providing digital skills training to entrepreneurs. But Kenya's challenge remains on how to focus digital skills training on agritech, rather than just on new tech start-ups. However, there are some efforts in digital agriculture. In 2018 for example, Google announced KES 100 million grant to train Kenyan farmers on digital skills.

Kenya has a youth unemployment problem. The Kenya National Bureau of Statistics estimates that unemployment among youth aged 20-24 years of age is at 19.2 percent (KNBS, 2018). The government developed the Kenya Youth Agribusiness Strategy (2018-2022) to address the issues of youth entrepreneurship in Kenya's agricultural sector. The strategy addresses the issues facing youth in agriculture, including training, but it does not mention digital skills.

Through the Ajira Digital Initiative, the government has improved digital skills among its youth in underserved communities. Meanwhile, private initiatives such as the Digital Literacy for Employability and Entrepreneurship Project (DLEEP) by TAP Africa targeted girls aged 15-19 years of age. The programme focused on practical digital and agri-business skills that can allow participants to start innovative farm ventures.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	81.54	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	87.83	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.55	WEF
	Employment	Employment in agriculture (% of total employment)	2019	54.34	ILO
		Employment in agriculture, female (% of female employment)	2019	59.34	ILO
		Unemployment, total (% of total labour force)	2020	2.98	ILO

AGRO-INNOVATION

Kenya's digital ecosystem has seen a proliferation of digital solutions designed to improve agriculture across value chains. In terms of agricultural research, the Kenya Agricultural and Livestock Research Organization (KALRO) was created under the Kenya Agricultural and Livestock Research Act of 2013 to coordinate agricultural research. In its strategic plan 2017-2021, KALRO sought to advance technologies and innovations for agricultural products value chains along four objectives (under KRA1). For example, during the East African Farmers Digital Conference held in 2018, KARLO launched 14 agribusiness apps to support farmers.

However, to date, a number of digital solutions and innovations in agriculture have sprouted across the ecosystem from the capital city. Nairobi is regarded as the cradle of technological innovations in Kenya with a growing number of tech-hubs, start-ups and innovation programmes. Kenya's ICT sector is increasing at a phenomenal rate. For instance, the value of the ICT sector expanded by 12.9 percent from USD 345.6 million in 2017 to USD 390.2 million in 2018. The growth of start-ups and similar ventures is led by the private sector with minimal government support. However, at the end of 2020, the Kenyan Senate introduced the Start-up Bill 2020 to protect the interest of Kenyan entrepreneurs and investors. The bill promises tax breaks, intellectual property protection and funding access. Kenya joins other African countries such as Tunisia, Senegal, and Mali that have similar laws (see Table 7).

According to CGIAR and partners (CGIAR, 2019), there are "about 113 institutions offering digital solutions for agriculture" in Kenya. A similar study found a lack of awareness of these digital services by small holder farmers. Furthermore, the farmers' specific needs were unknown by the developers (Akuku, Haaksma and Derksen, 2019:22-23; compare with Xie, Luo and Xhong, 2021).

There are numerous start-ups that seek to contribute innovatively to the agritech industry, to the extent that the country's then President referred to Kenya in his 2015 State of the Nation address as "a start-up nation". Fintech is the most represented industry in Kenya's digital landscape, followed by energy, environment and e-commerce. Examples from the agriculture sector include Twiga Foods. Founded in 2013, this mobile-based food delivery firm links farmers and vendors to fair and trusted markets. WeFarm is a farmer-to-farmer digital network that allows farmers to solve problems, share ideas, and spread innovation through a free SMS platform.

Kenya has many hubs and/or innovation labs operated by both local enterprises, multinational companies and international organizations. Examples include the UNDP

Accelerator Labs, which focuses on Kenya's unemployment through four approaches: sense making, solution mapping, collective intelligence and designing and testing. Panda Labs by World Wide Fund for Nature (WWF) focuses on innovation in environment. The Maarifa Kona Innovation Labs is managed by a consortium of NGOs under the Smart Network and is hosted by Save the Children UK. It seeks to transform humanitarian action through innovation, fast funding, early action and localisation. Another notable innovation lab is the Feed the Future Animal Health Innovation Lab run by USAID. The lab seeks to identify interventions to reduce livestock diseases, particularly deadly cattle diseases. A sister lab from Feed the Future is the Horticulture Innovation Lab in Kenya, which focuses on African indigenous vegetables, pest-exclusion nets, seed systems and related topics.

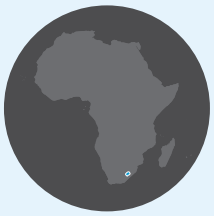
The government is in the process of building Konza Technopolis, a large technology hub outside Nairobi that seeks to attract numerous large multinationals to spur technology growth in the country. In its first phase, Konza aims at creating over 20 000 jobs.

Kenya's private sector also has innovation labs, including IBM Research-Africa, which seeks to drive innovation in key areas such as water, agriculture, transportation, healthcare, financial inclusion, education, energy, security and e-government. The US-based advisory service firm Cross Boundary, in partnership with the Rockefeller Foundation, runs the Mini-Grid Innovation Lab in Nairobi. MasterCard runs the MasterCard Lab for Financial Inclusion. It seeks financial agricultural solutions for smallholder farmers. While there are also national innovation programs and initiatives, they are mostly based in the capital city Nairobi, or have sprouted to other major cities. Counterintuitively, these urban-centric initiatives seek to solve developmental problems that in most cases are experienced more profoundly by people in rural areas.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	22 552.15	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	110.99	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.81	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.48	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	4.30	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	4.67	WEF
		ICT goods imports (% of total imports)	2019	3.81	UNCTAD

LESOTHO



Lesotho is a lower-middle-income country with a population of almost 2.2 million people. It is estimated that 71 percent of the country's population lives in rural areas and 44 percent of the population is engaged in agriculture. The country has a mountainous terrain and only 10 percent of the land can be cultivated. The agricultural sector accounts for about 6.4 percent of the GDP, and the country's agricultural produce cannot meet its population's demands. The national poverty rate was 56.6 percent in 2002 and 49.7 percent in 2017, and while poverty rates are falling in urban areas (reduced by 13 percent), they are rising in rural areas, leading to wider urban-rural inequality.

Maize, wheat, pulses, sorghum and barley are the primary agricultural crops in Lesotho, while the main livestock reared are sheep, goats and cattle. Lesotho imports 70 percent of its annual food consumption, increasing the import bill. Due to a number of factors – including severe land degradation, unfavourable weather conditions and reliance on rain fed crops – agricultural productivity has been declining.

The country suffered political instability recently and its reliance on the South African economy affects its own economy. However, the government has made significant efforts to invest in the digital economy, despite the complex political situation. Lesotho's proximity to South Africa has boosted its infrastructure.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	2 142 252	WBG
Urban population (%)	2020	29.03	UNPD
Rural population (%)	2020	70.97	UNPD
GDP (current millions of USD)	2020	1 845	WBG
Agricultural land (km^2)	2018	24 333	FAO
Agricultural land (% of land area)	2018	80.15	FAO

INFRASTRUCTURE

Through the Lesotho Electricity Company (LEC), the country produces about 40 percent of its total need and imports 60 percent from Mozambique and South Africa. In 2015, about 72 percent of households in urban regions were connected to the grid while the share of households in rural areas with access to electricity was just 5.5 percent. The Government of Lesotho established the Rural Electrification Unit (REU) in 2004 to extend the grid to rural areas not serviced by the national power utility, LEC (Mpholo, et al., 2018). But the roll out has been very slow. As of 2019, access in urban and rural areas stood at 75.8 percent and 32.2 percent respectively.

There are two mobile operators in Lesotho. Vodacom Lesotho (VCL) launched in 1996 and is a subsidiary of the South African mobile group with the same name. Econet Telecom Lesotho (ETL) launched in 2002 and is the country's incumbent telecommunications operator. In 2019, the two mobile operators launched 4G networks, while 2G and 3G networks cover almost all of the country. Lesotho has achieved 98.5 percent 2G coverage, nearly full for 3G and 75 percent 4G coverage, thanks in part to the Universal Service Fund (USF).

The USF is currently testing 5G technology with the Central Bank of Lesotho (CBL) as a pilot. USF is a vehicle under the Lesotho Communications Authority, through which all citizens have access to high quality, diverse and affordable communication services. USF invests in broader broadband, telephony, postal and broadcasting services. Since 2009, the Fund has collected 1 percent of the network operators' net operating income.

Meanwhile, connectivity infrastructure has developed considerably, with three international gateways offering access through South Africa to the Eastern Africa Submarine Cable System (EASSy), SEACOM, and West Africa Cable System (WACS) submarine cables.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	32.16	WBG
		4G coverage (% of total coverage)	2019	75	GSMA
		Mobile (device) ownership (% of population)	2019	71.90	GSMA
		Secure access to Internet servers (per 1 million people)	2020	70.02	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	2.98	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	72.94	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	64.05	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.24	ITU

DIGITAL PENETRATION

Lesotho has 72.9 active mobile cellular subscriptions per 100 people. UNCTAD notes that ownership of SIM cards exceeds the country's population (UNCTAD, 2019:13), which is likely due to multiple ownership. In contrast, mobile phone ownership per percentage of population was estimated at 76 percent in 2016 (ITU, 2017). In 2017, the Lesotho Communications Authority estimated mobile phone ownership to be 79 percent.

Digital penetration in Lesotho remains high, however, despite having 98 percent 3G coverage, 70 percent of Lesotho residents do not use the Internet. Maseru, the capital city, has the highest number of Internet users at a 45 percent penetration rate – implying more people, especially in rural areas, have not used the Internet. The rural districts of Thaba-Tseka, Mokhotlong, Qacha's Nek and Quthing, for example, had no users at all (LCA, 2019). Due to poverty levels at 49.7, broadband services remain unaffordable for the poor. Internet access cost is still high. A 500 MB data package costs approximately USD 6, which represents six percent of the country's monthly GNI per capita (ITU,2018).

The USF carried out a survey to understand the reasons of lack of Internet usage uptake (LCA, 2019:7). Some of its findings show that 67.5 percent of citizens had never used the Internet; 57.1 did not know what the Internet is; 59.4 percent did not know how to use the Internet; 49.3 percent did not own a device for accessing the Internet; and 40 percent found the Internet too expensive to use. The government concluded that the main reason for people not using the Internet was the lack of digital literacy.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.13	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	6.29	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	6.23	ITU
	Willingness	Mobile social media penetration (%)	2019	19.58	GSMA
		Number of apps in national language (quantity)	2019	23.00	GSMA
		Gender gap in social media use (%)	2019	94.71	GSMA
		Gender gap in mobile ownership (%)	2019	100	GSMA

POLICY AND REGULATION

The Ministry of Communications, Science and Technology is responsible for sector oversight, while the Lesotho Communications Authority is responsible for regulation of telecommunications, broadcasting, radio frequency and postal services (ITU, 2017). Lesotho's policy backbone is supported by four main policies: the ICT Policy for 2005, Lesotho's Communications Policy of 2008, the National Broadband Policy of 2014 and the National Strategic Development Plan (NSDP) (Phase I 2012/13 – 2016/17; and Phase II 2018/19 – 2022/23). The ICT Policy of 2005 aimed at integrating ICTs in all sectors of the economy, including agriculture.

Lesotho's 'cocktail policy regime' has produced some positive infrastructural and connectivity successes alluded to in the above sections. Furthermore, it has enabled implementation of an e-government strategy that has facilitated the smooth migration from analogue to digital. For example, the Lesotho eGovernment Infrastructure Phase I enhanced the capability of the government's data centres and portals, which in turn improved the effectiveness of public service delivery across ministries, key government agencies and local governments (UNCTAD, 2019). The second national strategic plan (NSDP Phase II) seeks to improve the enabling environment, strengthen public institutions and create a stable investment opportunity for private sector participation. The second goal is to build the capacity of human resources by improving knowledge and skills, particularly for women and girls. It also includes promoting ICT literacy and lifelong learning of citizens through e-learning and awareness programs, thus reducing the digital divide. The final goal is to promote the development

of digital solutions and content creation in all strategic areas of the policy.

These policies have supported the network growth and accessibility, achieved rural connectivity, facilitated e-government projects, and enabled national e-payment systems. However, there is lack of agro-based content services to exploit the opportunities realised and rural people lack the necessary digital skills. Meanwhile, social media platforms are being used for consumer-to-consumer (C2C) or business-to-consumer (B2C) transactions.

There was no evidence that the favourable policy has influenced digital agriculture activities in Lesotho. A 2009 report by UNCTAD had challenged the agriculture sector to (i) identify viable and useful technologies and best practices; (ii) acquire, adapt and disseminate technologies and techniques for commercial, community, family farming; and (iii) promote technologies that add value and shelf life to agricultural products. There are few initiatives reported where Lesotho participated in the World Bank's Agricultural Productivity Program for Southern Africa (APPSA), whose purpose was to increase the availability of improved agricultural technologies in participating countries in the Southern African Development Community (SADC) region.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.31	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.49	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.87	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.53	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2019	16.00	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

With an average of 15 days to complete legal requirements to start a business, Lesotho scored 59.4 in the ease of doing business ranking in 2020. Foreign direct investment in Lesotho amounted to USD 118 million in 2019, showing a slight decrease from the USD 129 million of 2018. The country's textile industry and hydro electric facilities are the top investment choices. To streamline import and export, the government established ASYCUDA, an automated customs data management system. Due to favourable climatic conditions, availability of water bodies, and good policy framework investment in Lesotho agriculture is deemed to be a good choice.

Lesotho agritech investment remains untapped. Efforts to boost that include the Lesotho Enterprise Assistance Programme (LEAP), a matching grant scheme designed to provide financial and technical assistance for small and medium enterprises. The Vodacom Innovation Park is also a technology-based business incubator for young entrepreneurs to leverage technology and mobile communication to grow their businesses.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	118	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.44	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	1.62	WEF
	Entrepreneurship	Time required to start a business (days)	2019	15	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	1.51	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.42	WEF

HUMAN CAPITAL

UNESCO reports that about 76.6 percent of the country's total adult population (15 years of age and above) is literate. Women in Lesotho have a higher literacy rate of 84.9 percent, compared to men who are 67.7 percent literate. Lesotho performs above the sub-Saharan average. The country introduced free and compulsory primary education (FCPE), which increased the enrolment levels in schools.

In terms of digital skills training, the National University of Lesotho (NUL), the Lesotho College of Education, Lerotholi Polytechnic, Limkokwing University, Computer Business Solutions and Botho University all offer degrees in computer science and ICT-related fields. Nevertheless, few students major in ICT-related careers.

Lesotho has poor access to basic digital skills training, which hinders the development of its digital agriculture. The few trained graduates are absorbed within government and main MNOs, and the remainder migrate to South Africa where there are broader opportunities.

The reasons for low digital skills include the high cost of mobile phones and computers, low smartphone and computer penetration, lack of formal ICT training at schools, and inadequate access to electricity in rural areas. While the USF has improved connectivity and ICT equipment in schools, Internet accessibility remains a challenge, especially in rural areas.

According to the World Bank (2019), Lesotho's agriculture sector has the potential to create opportunities for the roughly 34.4 percent of youth who are unemployed. The Kingdom of Lesotho in collaboration with the IFAD, Lesotho has initiated phase two of the Smallholder Agriculture Development project (SADP) (2020–2026) to support youth and women in rural areas with increased access to climate-smart technologies to improve productivity.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2014	76.64	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2014	86.63	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.49	WEF
	Employment	Employment in agriculture (% of total employment)	2019	44.3	ILO
		Employment in agriculture, female (% of female employment)	2019	39.83	ILO
		Unemployment, total (% of total labour force)	2020	24.65	ILO

AGRO-INNOVATION

Very little is published on the status of agricultural innovation in Lesotho. In 2016, Lesotho invested 0.94 percent of its agricultural GDP in agricultural research, which is far less than the regional average. The Department of Agricultural Research (DAR) is government-owned and one of two agencies that conduct agricultural research in Lesotho. A recent report noted that Lesotho has insufficient agricultural research capacity and that "as of 2016, only 14 percent of DAR's researchers held PhD degrees; its pool of researchers is young and inexperienced; and opportunities for training, mentoring, and career growth are limited." Lesotho and FAO are working together to improve the national agricultural research and extension system in the country.

Investment by the private sector and various organizations in the agro-innovation landscape in Lesotho has been forthcoming. The following international and regional innovation programmes (giving either funding or mentorship) are open to Lesotho: The Innovation Prize for Africa, The Anzisha Prize, GSMA Innovation Fund, The Injini Edtech Accelerator Program, The Royal Academy Prize for Engineering, and Google's Launchpad Africa programme. The local Vodacom Innovation Park is an incubator and accelerator program established in 2015 to support the development of sustainable, high impact, job-creating start-ups and social enterprises in Lesotho. Since its launch, the Vodacom Innovation Park has trained entrepreneurs in a wide range of industries including agriculture, fashion, e-commerce, and mobile app development.

In 2019, the Global Entrepreneurship Network announced the opening of the Start Up Hurdle in Lesotho to help local entrepreneurs hone their pitch skills and discover solutions to the challenges they face. This happened at a time when entrepreneurial support is lacking, and the ecosystem is still devoid of opportunities for entrepreneurs to scale their ventures. To that end, the Bacja Entrepreneurial Project intends to assist unemployed youth (21-35 years of age) who hold LGCSE/COSC certificates to become entrepreneurs who can employ others and drive economic growth. This will be done in partnership with the Basotho Enterprises Development Corporation (BEDCO), the Lesotho Revenue Authority (LRA) and Standard Lesotho Bank.

It is evident that Lesotho's agro-innovation is at its infancy. However, more opportunities are on the horizon as key digital investments fall in place. Since more than half of Lesotho's citizens live in rural areas, and the majority engage in subsistence agriculture, the key to agro-innovation is in unlocking the country's agriculture potential. This includes as an immediate policy priority for Lesotho the need to promote innovative agribusiness initiatives that prioritise increased competitiveness, improved market access and added value.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	98.53	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	95.97	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.28	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.94	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.12	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.21	WEF
		ICT goods imports (% of total imports)	2017	2.67	UNCTAD

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LIBERIA

Liberia is a coastal state in West Africa. It is a low-income country with a population of 5 million people. About 52.1 percent of the population lives in urban areas. The country is emerging from two major crises – the end of a civil war that lasted from 1989 to 2003, and an Ebola virus disease outbreak in 2014 and 2015. Liberia has a young population (estimated at 2.8 million people in 2020) and the economy is heavily dependent on the export of minerals. Liberia's GDP was USD 2.9 billion in 2020. Although the country is rich in natural resources like gold, diamonds and fertile soils, the economic potential of these resources remains untapped (see Table 1).

Prior to the civil war, agriculture contributed about 40 percent of Liberia's GDP. By 2018, agriculture, forestry and fisheries (value added) contributed 37 percent of the GDP. Liberia was a big producer of rubber and has plantation agriculture producing cocoa, coffee, palm oil and sugar cane. Agriculture is still the main provider of livelihood for most smallholder and small plantation farmers (estimated at 48.9 percent of the workforce). The World Food Programme noted that Liberia is a food deficit country with 0.45 million food insecure people in November 2020, and 0.55 million food insecure people during the lean season of 2021. The war displaced many rural families, which had a huge impact on agricultural productivity.

The government acknowledges that major investment in infrastructure (energy, roads, information communications technology (ICT) is necessary to unlock growth. Additionally, the post-civil war government seeks to strengthen weakened institutions and improve governance. The digital economy of Liberia has positive prospects with the arrival of undersea cables from the western coast of Africa, but infrastructural challenges do exist. New investments in the digital economy of the country are emanating from the government, the private sector, multilateral organizations, as well as the local digital ecosystem players. The government enacted the National ICT/Telecommunications Policy, a key catalyst of digital technologies.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	5 057 677	WBG
Urban population (%)	2020	52.09	UNPD
Rural population (%)	2020	47.91	UNPD
GDP (current millions of USD)	2020	2 950	WBG
Agricultural land (km^2)	2018	19 540	FAO
Agricultural land (% of land area)	2018	20.29	FAO

INFRASTRUCTURE

In general, Liberia's infrastructure was severely damaged during the civil war. For example, the war left the national roads network in a state of disrepair. According to World bank, 27.6 percent of Liberians have access to electricity, with 7.6 percent access in rural areas and 46.4 percent in urban areas. Liberia's electricity is costly as it is mainly diesel generated. The 'sustainable for all' (SEforALL Action) aimed at increasing access to electricity to 100 percent by 2030. Most rural areas are off the grid and rely on biomass.

The country's telecommunications infrastructure was equally damaged through the conflict with the remaining networks mostly in Monrovia (AfDB, 2013). The country has three mobile network operators, Lonestar, a subsidiary of the South African MTN Group that entered the market in 2001, Orange, which started operating in 2016, and Novafone, which started operating 2015. According to GSMA, in 2019 4G services were available in almost half of the country, with 48.9 percent coverage, while 51.5 percent of the population owns a mobile device (see Table 2).

Through the enactment of the National ICT/ Telecommunications Policy, the government, the Ministry of Post and Telecommunications (MoPT) and Liberia Telecommunications are aiming at expanding Liberia's broadband infrastructure. Liberia has access to the Africa Coast to Europe Optical Fiber Submarine Cable (ACE) funded by the World Bank at a cost of USD 25 million, although in 2016 only 20 percent of the capacity was being used. Increased broadband connectivity led to a drop in Internet access prices and the improvement of Internet speed. In 2017, active mobile broadband subscriptions were 11.7 per 100 inhabitants. To manage the broadband infrastructure, the Cable Consortium of Liberia (a public-private partnership) was established to operate Liberia's cable landing point and the ACE cable system.

Access to ACE was a positive development, but there are calls to have other connections to other sea cables due to constant downtimes in implementation (Net Hope, 2015). In response, the government partnered with USAID and Google to invest in building a fiber ring around Monrovia and its environs to increase broadband penetration. In 2017, a joint venture was launched between Google, Mitsui & Co (Japan), Convergence Partners (South Africa), and the World Bank's International Finance Corporation to create a company called CSquared to complete this work. CSquared provides the wholesale infrastructure around metropolitan Monrovia, making it possible for the government and other entities to connect to the Internet using reliable fiber connections.

Prior to that, Invenio, an American Silicon Valley non-profit organization was contracted by USAID to expand affordable, sustainable, and reliable rural Internet connections throughout Liberia, aiming at connecting or improving Internet access in 37 different sites across the country, many of which are in remote and rural areas.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	7.62	WBG
		4G coverage (% of total coverage)	2019	48.94	GSMA
		Mobile (device) ownership (% of population)	2019	51.46	GSMA
		Secure access to Internet servers (per 1 million people)	2020	6.13	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	2.83	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2017	56.57	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	11.70	ITU
		Fixed broadband subscriptions (per 100 people)	2017	0.19	ITU

DIGITAL PENETRATION

In 2017, 7.9 percent of Liberia's population was using the Internet, while mobile cellular subscription per 100 inhabitants was 56.6 percent. In contrast, less than 0.1 percent of the population had access to Internet in 2012. In 2018, there were 9 000 fixed broadband subscriptions, up from 63 in 2011. Likewise, mobile cellular subscriptions grew from 1 500 in 2000 to 2.7 million in 2017 (although the peak was 3.6 million in 2015).

According to Digital Liberia 2020, the number of mobile connections increased by 995 000 or 32 percent between January 2019 and January 2020. Of the three mobile operators, LoneStar MTN has 60 percent market share, Orange has 45 percent, and Novafone has 8 percent. Challenges in delivering Internet access to rural areas as well as giving women access to technology exist. Men are more likely than woman to use the Internet in Liberia, which is ranked 95 among 100 countries in the Economist Intelligence Unit's Inclusive Internet Index). In January 2020, there were 530 000 social media users in Liberia, a number that could be commensurate with Liberia's youth population. According to GSMA, mobile social media penetration in 2019 was 19.6 percent (see Table 3).

The average cost of mobile data per 1 GB was USD 3.25, which is expensive for the local population. According to the Alliance for Affordable Internet (A4AI), Internet cost of the lowest 20 percent of earners constitutes a staggering 47.6 percent of their income to access said 1 GB of data, against a 2 percent recommendation by the UN Broadband Commission (similar conclusion by ITU in 2016). According to the UN Broadband Commission on Sustainable Development's Target 2 for 2025, entry-level broadband service in developing countries should not cost more than 2 percent of monthly GNI per capita.

Data of government use of digital technologies for agricultural information to farmers is scarce. However, a few examples exist. The government collaborated with the African Development Bank to launch programmes like an e-database platform, e-wallets for farmers to get easy access to agricultural inputs and cash to enhance productivity. The government also partnered with the non-profit organization Cultivating New Frontiers in Agriculture (CNFA) to implement Feed the Future Liberia Agribusiness Development Activity (LADA) (2015-2020), which is funded by USAID and aims at expanding access and use of agricultural inputs, improving post-harvest loss and streamlining agricultural value chains.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.25	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	8.28	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	10.65	GSMA
		Number of apps in national language (quantity)	2019	58.00	GSMA
		Gender gap in social media use (%)	2019	55.60	GSMA
		Gender gap in mobile ownership (%)	2019	34.43	GSMA

POLICY AND REGULATION

The Ministry of Post and Telecommunications (MoPT) is responsible for developing ICT policies, while the Liberia Telecommunication Authority (LTA) is the regulator. The enabling legislation is The Telecommunications Act, 2007. The government approved the Policy for the Telecommunications and Information Communications Technology (ICT) 2019-2024 to guide the sector. It aligns with the Poverty Reduction Strategy (PRS) policy. The policy seeks to establish the Universal Access Fund, establish service penetration in rural areas, and liberalize the telecommunication sector.

The policy is also forward thinking as it mentions the government's commitment to e-agriculture by improving information sharing flows between farmers, consumers, and agriculturists. The policy neither states how this will be achieved, nor does it have outcomes or priorities. But it does refer to mainstreaming gender by avoiding having ICTs creating a gender divide. That said, the government's Agriculture Sector Investment Plan II: 2018-2022 has not yet been formally adopted. The policy recognises the numerous challenges facing agriculture in Liberia; however, it does address the digitalization of agriculture. A full review of this policy was conducted by Hendriks (2018) (see Table 4).

Liberia's national e-government strategy (2014-2018) outlined the government's vision of increased access to e-services, improved efficiency, and transparency and coordination between government entities. The functions of this policy were incorporated in the new ICT policy.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	3.29	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	3.81	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	2.78	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	3.19	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2019	17.00	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The post-war business environment is challenging but appears promising – the economic impact of the Ebola virus disease was compounded by falling iron ore and rubber prices. There are opportunities in investing in infrastructure, in agriculture and fisheries. The World Bank's Ease of Doing Business ranks Liberia at 175 among 190 economies as it takes 18 days to register a business. The Ministry of Commerce and Industry has created a one-stop shop for business registration. The Handbook of Opening Business in Liberia provides a summary of the steps and procedures to be followed.

In 2019, FDI in Liberia was USD 86.7 million, or 2.8 percent of the country's GDP. Laws governing FDI in Liberia include the 2010 Investment Act, the Revenue Code, the Public Procurement and Concessions Act, and the National Competitive Bidding Regulations. According to the Investment Act of 2010, some business sectors are reserved for Liberians. Through the Liberia Agriculture Sector Investment Program (LASIP), the government sought to outline the investment strategies for agriculture, and it identified key areas of importance. Although potential value chains were identified, agritech or investment in agri-food value chain digitalization was not identified. In addition, the Pro-Poor Agenda for Prosperity and Development 2018-2023 (PAPD) is the second in the series of five-year National Development Plans (NDP) subsumed under the Liberia Vision 2030 framework. It follows the Agenda for Transformation 2012-2017 (AfT). It factors in lessons learned from the implementation of the Interim Poverty Reduction Strategy 2007 (iPRS) and the Poverty Reduction Strategy (2008-2011). In 2019, IFAD launched the Smallholder Agriculture Transformation and Agribusiness Revitalization Project that sought to increase agricultural productivity and commercialization on the part of smallholder farmers for vegetable, rice and oil palm value chains in selected counties of Liberia. Unfortunately, the project did not have an agritech focus although it did target youth and rural farmers in the country (see Table 5).

The adoption of agricultural mechanisation and technologies in Liberia is still nascent. Most Liberian farmers still use basic tools, such as the cutlass, axe, hoe, and knife for clearing bushes and for harvesting (Gobewole, 2020).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	138	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2018	3.88	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.65	WEF
	Entrepreneurship	Time required to start a business (days)	2019	18	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.12	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2018	3.33	WEF

HUMAN CAPITAL

The total adult literacy rate in Liberia is 48.3 percent (62 percent for males and 34 percent for females) as of 2017. The Liberian population is largely young with many unemployed youth. The literacy rates for young people (15-24 years of age) is 55.4 percent. School enrolment rates for Liberia have dropped between 2014-2017. For example, total primary school enrolment was 85 percent in 2017, down from its peak of 97 percent in 2014; total secondary school enrolment was 37 percent in 2015, down from 38 percent in 2014. Tertiary education enrolment was 11.9 percent in 2012, but more current data is not available. The Ebola virus disease-induced crisis in Liberia may partially explain this as schools were closed for some time during the crisis. USAID and the Ministry of Education begun working together to revitalise the education system after the effects of the Ebola disease crisis. Liberia's tertiary education is facing a number of challenges such as poor implementation of educational policies, lack of financial support for institutions of higher learning, and poor educational infrastructure. Due to this and other reasons, the capacity for Liberia to supply the agriculture and agritech sectors with needed skills is constrained and has led to critical 'brain drain'.

Liberia's agricultural training institutions are: the College of Agriculture (University of Liberia), the Central Agricultural Research Institute (CARI), the Forest Development Authority (FDA), the Liberia Rubber Research Institute (LRRI), Cuttington University, and the Booker T. Songhai Agro-Enterprise Center. Through the Excellence in Higher Education for Liberian Development (EHELD), USAID has worked with the government to improve agricultural training institutions in the country, although digital infrastructure still lags behind. There is a general need to integrate ICTs within the educational system. Through the Enhancing Liberia Teacher Education Project through ICT Pedagogy, UNESCO has sought to improve the ICT capacity of teachers and ICT facilities. There are other isolated digital skills capacity development initiatives, such as the National Builders and Girls in ICT Liberia Project initiated by ITU to train the girls and young women of Liberia in ICT, leadership and skills development for economic empowerment (ITU, 2017).

Youth in Liberia face many challenges. Historically, they were coerced into joining rebel factions as boys and girls. The United Nations has run programmes to reintegrate Liberian youth. For example, FAO ran a number of projects Libertian youth in agriculture, which included the promotion of aquaculture and employment for youth in Liberia. More youth-led initiatives in agriculture is a priority, as its increases literacy rates and digital skills (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2017	48.30	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2017	55.40	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2018	3.24	WEF
	Employment	Employment in agriculture (% of total employment)	2019	42.62	ILO
		Employment in agriculture, female (% of female employment)	2019	40.33	ILO
		Unemployment, total (% of total labour force)	2020	3.30	ILO

AGRO-INNOVATION

Between 2018–19, USD 8.3 million out of a total budget of USD 488.8 million was earmarked for the agricultural sector, representing 2 percent of the total budget. Data on research and development activities in the country is scarce. The Central Agricultural Research Institute (CARI) is Liberia's primary agricultural research institute, but almost half of the institute was destroyed during the war. Its recovery has been slow, but still CARI has developed the Strategic Plan 2015–2025, with a vision that partly seeks to have agriculture "propelled by research, technology transfer, innovations, knowledge" (CARI, 2014) (see Table 7).

Liberia has a few innovations, including UNICEF's Innovation Lab dedicated to young people. The lab piloted the U-Report, a social monitoring tool designed for youth to strengthen citizens' engagement. USAID's Feed the Future Innovation Lab is another example. However, Liberia's innovation space remains an untapped potential. A few agritech start-ups are active in the country, including Ezee Market Incorporated, Cookshop, Veenir, Beneya Corporation and the Artgeo Foundation. Available services include farm management and trading in food items. The GSMA reports of the existence of 58 mobile apps in the country's national language.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	1 214.67	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	91.66	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.23	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2011	0.42	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.07	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.34	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

MADAGASCAR

Madagascar is a low-income country with an estimated GDP of USD 13.7 million driven significantly by the service sector (52.4 percent). The country's population is estimated at about 27.7 million, 61.5 percent of whom live in rural areas. About 75 percent of the population lives below the international poverty line (see Table 1).

The agriculture sector contributed 23.3 percent to GDP, employed about 64 percent of the population, and provided livelihood for 60 percent of women in 2019. Agriculture land constitutes 70.3 percent of the country's land area. Rice, which is the most important food crop, accounts for half of the cultivated land. Vanilla is another important crop, while an estimated 60 percent of rural households are also engaged in livestock rearing.

The ICT sector is already transforming productivity in agriculture in the absence of an ICT policy. For example, in the province of Antsiranana, drones have made it possible to take stock of the different land use types in order to develop a local taxation policy. Also, the Malagasy government aims at acquiring ten tree-planting drones for a programme to restore more than 4 million hectares of forests and land by 2030.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	27 691 019	WBG
Urban population (%)	2020	38.53	UNPD
Rural population (%)	2020	61.47	UNPD
GDP (current millions of USD)	2020	13 721	WBG
Agricultural land (km^2)	2018	408 950	FAO
Agricultural land (% of land area)	2018	70.29	FAO

INFRASTRUCTURE

The energy sector of Madagascar is expanding as evident in the increase in access to electricity, from 12.9 percent to 26.9 percent of the total population in 2013 and 2019 respectively. While the rate of access to electricity in urban areas is 79.5 percent, the access rate in rural areas is relatively low. The government, in line with improving electricity infrastructure, has secured a USD 150 million loan from the World Bank to embark on the Least-Cost Electricity Access Development (LEAD) project targeting a minimum of 1.7 million people, including 10 000 enterprises and 750 health centres.

The telecommunication sector of Madagascar is still developing as evident by the increase in mobile network coverage from 50.6 percent in 2012 to 92 percent in 2015. Also, 3G and 4G population coverage reached 65 percent and 62 percent respectively in 2019 with a significant proportion of the population yet to be connected to a mobile network. Telma launched its 5G service in June 2020, but the Madagascar Communication Technology Regulatory authority (ARTEC) ordered its suspension. LTE services were made available in 2015 courtesy of Blueline mobile services.

Madagascar has a broadband speed average of 24.9 megabits per second, which is more than twice the global average. This is a result of the 10 000 km-long East African Submarine Cable System (EASSy).

A number of initiatives are underway to improve service delivery in the telecom sector. Madagascar and China have signed an agreement to transform the former's telecom sector. This will set up a new infrastructure for the telecom sector by establishing fiber optic links and data centres to revolutionize public services and bring down the administration's internal communication costs. Also, the project will contribute to the security of the city of Antananarivo, and improve the investment climate.

Between 2017-2019, Telma invested USD 250 million to expand fiber installations to 11 000 km, connecting the major cities and completing a network upgrade to LTE-A. This has spurred the roll-out of wireless access networks as the government in mid-2020 committed itself to deploy free Wi-Fi hotspots in a bid to expand Internet access to the poorest of society.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	N/A	WBG
		4G coverage (% of total coverage)	2019	61.89	GSMA
		Mobile (device) ownership (% of population)	2019	32.98	GSMA
		Secure access to Internet servers (per 1 million people)	2020	10.33	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.84	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2018	40.57	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2018	15.60	ITU
		Fixed broadband subscriptions (per 100 people)	2018	0.10	ITU

DIGITAL PENETRATION

Madagascar had 9.6 million mobile connections in January 2021 which was equivalent to 34.2 percent of the total population. The increase in Internet users was very much reflected in social media usage with a recorded 3 million users (an increase of 30 percent) during the same period. Also, active mobile broadband subscriptions increased from 2 million in 2016 to 4 million in 2018. Mobile cellular telephone subscriptions for post-paid/prepaid rose from 7 998 253 in 2016 to 10 654 710 in 2018. Telecom Malagasy is the sole provider of fixed line services in the country. But there are four mobile network operators: Orange, Airtel, Telma, and Gulfsat, with Airtel dominating a 40 percent of market share. Almost all network providers offer mobile money services except Gulfsat, with the country recording an increase in mobile money compared to traditional bank accounts. The GSMA (2019) affirmed the potential to increase electronic payments, by promoting mobile payment platforms.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	8.81	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	7.99	GSMA
		Number of apps in national language (quantity)	2019	16.85	GSMA
		Gender gap in social media use (%)	2019	66.70	GSMA
		Gender gap in mobile ownership (%)	2019	25	GSMA

POLICY AND REGULATION

There are a number of policies in the ICT sector that could promote the growth of the economy. The national ICT policy developed by the Ministry of Telecommunications, Posts, and Communication in collaboration with UNDP, seeks to turn Madagascar into a leader in providing high-quality ICT services, which will accelerate the country's economic, social, and cultural development (Isaacs, 2007). For the regulation of the ICT sector, Madagascar set up in 1996 the Malagasy Office of Studies and Regulation of Telecommunications (OMERT), whose main role is to ensure regulatory functions allowing all operators involved in the sector to develop their activities in compliance with the regulations in force, but at their own pace. Since 2015, OMERT has been replaced by ARTEC in the application of Decree No. 2006-213 establishing the Madagascar Communication Technology Regulatory authority. In 2019, ARTEC signed a cooperation protocol with the National Institute of Statistics (INSTAT) which aims at updating the indicators of the Telecommunications and ICT sector, in particular those concerning individuals, households, and establishment users, as well as legal and natural persons working in the field of telecommunications and ICT in Madagascar.

Integrating ICT into agriculture holds promise not only in increasing yields but improving living standards. National and external projects that touch on digital agriculture include Madagascar's Agriculture Rural Growth and Land Management Project. It seeks to improve rural land tenure security and access to markets of targeted farming households in selected agricultural value chains in the project areas. The project also aims at providing an immediate and effective response to eligible crises or emergencies. IFAD and the government through the Inclusive Agricultural Value Chains Development Programme seek to strengthen and secure the production base of family farms in a context of climate change. The programme

also aims at connecting them to production and marketing support services in order to sustainably transform the agriculture sector and the country's rural economy.

The Digital Governance and Identification Management System Project (PRODIGY) aims at strengthening the Identity Management (ID-M) system and government capacity to deliver services in selected sectors. Madagascar's World Economic Forum's score on the importance of ICT in the government's vision was 2.92 out 7 in 2016, reflecting the dearth of projects that incorporate ICT. The focus however is on the health and education sector. A lot of efforts are needed to roll out digital technologies in the agriculture sector to ensure development and sector growth. The policy landscape has prioritized ICTs as a tool to help transform the agriculture sector.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	2.92	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.12	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.58	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	69.5	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Even though FDI in Madagascar shrunk from 4.4 percent of GDP in 2018 to 1.6 in 2019, the government is unrelenting in its bid to attract more investors, particularly for the agricultural sector. New business registrations increased from 1 572 in 2016 to 1 881 in 2018, reflecting how the business climate is indeed conducive to investments. Apart from the investment law, Madagascar has signed a Foreign Investment Promotion and Protection Agreement with countries such as Canada, Mauritius, France, and Germany. This agreement gives legally binding rights and obligations that consider private property and unwarranted expropriation without appropriate compensation. Export-oriented companies can get the fiscal advantages spelled out in law 89-027 when they apply for export free zone status as well as new regulations that give tax breaks and avoid double taxation. Other fiscal incentives for other sectors are defined by the adopted annual financial law by parliament for all companies including those in the agriculture sector.

The private sector is also playing a key role in transforming the agricultural sector. In partnership with IFAD, the government is undertaking the Support Programme for Rural Microenterprise Poles and Regional Economies. The programme is aimed at setting up efficient business development services that are responsive to the needs of small and micro rural enterprises. It also aims at building the capacity of these enterprises to identify their individual requirements, as well as restructuring these traditional clusters into modern value chains that will have linkages to regional growth poles.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	227	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.56	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.34	WEF
	Entrepreneurship	Time required to start a business (days)	2019	8.00	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.03	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.04	WEF

HUMAN CAPITAL

Adult literacy in Madagascar increased by 15.9 percent from 2005 to its current rate of 76.7 percent in 2018, whereas youth literacy also increased by 23.6 percent from 2005 to 79.9 percent according to the World Bank. The gap between female and male youth literacy rates is small; the recorded values for 2018 being 80.7 percent and 81.7 percent respectively. Gross enrolment in secondary schools decreased by 3.5 percent from 2012 to 34.6 percent in 2019. Female students in secondary schools decreased by 2 percent to 35.2 percent, while male enrolment also dropped by 5 percent to 34 percent during the same period. However, gross enrolment in tertiary schools increased by 1.3 percent from 2012 to 5.4 percent in 2018. Female and male enrolment also increased over the years to 5.2 percent and 5.5 percent respectively.

The integration of ICT into the education curriculum offers hope for a more digitally literate population in the coming years. Even though the Human Capital Index decreased marginally by 0.02 percent between 2012 and 2017, the government through the World Bank is investing in human capital, which will help enhance the capacity of human resources in the education and health sector. It also places special emphasis on the legal protections for women and children.

The African Virtual University (AVU) established an ambitious teacher education project involving 10 African countries including Madagascar in partnership with the African Development Bank (AfDB) and the New Partnership for Africa's Development (NEPAD) in 2006. The project equipped teachers in the use of ICTs in teaching and learning mathematics and science, to enhance the capacity of teachers to deliver ICTs as a subject in secondary education, and to increase the number of mathematics and science teachers by expanding access to training through open, distance, and e-learning techniques.

The private sector has also undertaken several projects and initiatives that are targeted at developing and enhancing the capacity of the country's human resources. For example, Jirogasy, a start-up in Madagascar and its partners, have embarked on a similar move to bolster digital skills by providing learners in schools that do not have access to reliable power with solar-powered laptops. This is intended to empower younger generations with digital skills to fortify their economic future.

The private sector is also fully involved in the development of the agricultural sector by providing support in terms of agricultural education. Fert, a French association for international cooperation for agricultural development in developing and emerging

countries, in partnership with Conseil national de l'enseignement agricole privé (CNEAP), is supporting Fifata (a national Malagasy professional farmers' organization) in setting up an initial training programme targeted at young children of farmers. The project has engendered five agricultural colleges that offer a three-year boarding school course, which is now part of the Fekama federation.

With support from the African Development Fund, the government is also embarking on the Program for Promoting Youth Entrepreneurship in Agriculture and Agro-industry. The project seeks to create jobs and reduce youth unemployment as well as provide the required funding for young agricultural entrepreneurs along the agricultural value chain. Its strategy hinges on building the capacity of young graduates of higher education in trades along agricultural value chains and in business management.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	76.68	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	79.85	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.1	WEF
	Employment	Employment in agriculture (% of total employment)	2019	64.12	ILO
		Employment in agriculture, female (% of female employment)	2019	59.94	ILO
		Unemployment, total (% of total labour force)	2020	1.92	ILO

AGRO-INNOVATION

Research and development expenditure decreased from 0.11 percent of GDP in 2010 to 0.01 percent in 2017. According to ASTI (2014), agricultural research and development spending as a share of agricultural GDP was 0.14 percent less than the 1 percent recommended by the African Union. This situation has not hindered the government and other private sector entities from conducting research to develop agriculture. The National Center of Applied Research for Rural Development (FOFIFA) is the largest research agency in Madagascar, responsible for more than half the total agricultural research spending, and is mandated to unifying national agricultural research.

A small number of Madagascar's population has an account at a formal financial institution and this situation is particularly worrying as 70 percent of the population lives in rural areas. However, mobile network operators (MNOs) are leveraging digital financial innovation to bridge this gap. For instance, Airtel and Bank of Africa, through mobile banking, have partnered to manage the supply of credit to smallholder farmers and also offer loans for smoothing financial flows between seasons, equipment purchases, and storage costs. The MNO formed an alliance with FANAMBY (an NGO focused on educating farmers in the Northern part of Madagascar) to encourage mobile banking by opening a Bank of Africa account that was linked to an Airtel Money account. By September 2013, 405 of the 1 250 farmers directly involved in the operation had a bank account with the number of transfers made increasing by 10 percent.

The country's innovation capacity is estimated at 3.82/7 in 2018 according to the Economic and World Forum. This is reflective of public and private sector need to innovate new technology for agricultural development. A case in point is

the collaboration of the Japan International Research Center for Agricultural Sciences (JIRCAS) with the Agriculture Ministry and various research institutes in Madagascar to launch the project "Breakthrough in Nutrient Use Efficiency for Rice by Genetic Improvement and Fertility Sensing Techniques in Africa" commonly known as the FY VARY project. The project seeks to enhance technology development that can improve rice productivity in a stable manner, even with low nutrients from fertilizer and soils. And as part of the FY VARY Project, a demonstration test site was set up in the Vakinankaratra region for phosphorus dipping treatment (p-dipping) technology.

The Office Malgache des Propriétés Industrielles (OMAPI), is the regulatory authority for intellectual property rights. Its establishment reiterates the premium Madagascar places on inventions, and as such has established laws and regulations to protect the property rights of the individual. These laws and regulations are Ordinance No. 89-019 of July 31, 1989, establishing arrangements for protecting Industrial Property and implementing rules and regulations; and Decree No. 92-993 of December 2, 1992, implementing Ordinance No. 89-019 of July 31, 1989, establishing arrangements for the protection of Industrial Property in Madagascar (as amended by Decree No. 95-057 of January 17, 1995).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	3 181.10	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	104.25	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.39	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	0.14	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.34	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.82	WEF
		ICT goods imports (% of total imports)	2019	2.10	UNCTAD

MALAWI

Malawi is a low-income country with a GDP of USD 11.9 billion in 2020. The country has a population of 19 million people, of which 82.6 percent were still living in rural areas and more than half were living below national poverty lines (World Bank, 2016). The poverty rate of Malawi has declined only 3 percent from 73.4 percent to 70.3 percent between 2004 and 2016 (World Bank, 2020) (see Table 1).

Agriculture is the main pillar of the country. It employs 76.4 percent of the total population and contributes to 25.5 percent of GDP. With a fast-growing young population, Malawi has huge potential and rich labour resources to develop its agriculture sector. Currently, the majority of the rural population relies on small-scale farming with low productivity that hardly meets domestic demand. Rain-fed maize is dominant, and tobacco has been the main cash crop contributing to over 50 percent of total export earnings, followed by tea and sugar. Meanwhile, the agriculture sector in Malawi is vulnerable to climatic shocks, particularly recurring droughts. Unstable food production and supply leads to 82 percent of its population experiencing moderate or severe food insecurity while 18.8 percent are undernourished (World Bank, 2018).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	19 129 955	WBG
Urban population (%)	2020	17.43	UNPD
Rural population (%)	2020	82.57	UNPD
GDP (current millions of USD)	2020	11 962	WBG
Agricultural land (km^2)	2018	56 500	FAO
Agricultural land (% of land area)	2018	59.93	FAO

INFRASTRUCTURE

The overall electricity access rate is low at 11.2 percent in 2019, with 45.5 percent access in urban areas and 4.1 percent in rural areas. However, the mobile sector has experienced rapid growth over the past decade, reaching 99.6 percent of mobile coverage in 2016 (WEF, 2016). Facilitated by telecom companies, both 3G and 4G coverage is steadily increasing. It is estimated that 3G covers 92 percent of the population and 77.5 percent for 4G (see Table 2). Nevertheless, due to high taxes and prices, only 36.6 percent of Malawians own mobile devices, and 52.3 per 100 habitants have mobile cellular subscriptions (see Table 2).

The government of Malawi has a goal of "providing access to modern energy services for all by 2030" through SEforAll Action Agenda (2017). It has carried out a number of projects, some of which were supported by various development agencies. For instance, the Government of Malawi facilitated the access to international submarine cables via neighbouring countries, while the World Bank implemented Electricity Access Project to improve accessibility.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	4.09	WBG
		4G coverage (% of total coverage)	2019	77.53	GSMA
		Mobile (device) ownership (% of population)	2019	36.54	GSMA
		Secure access to Internet servers (per 1 million people)	2020	16.94	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.50	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	52.30	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	31.85	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.06	ITU

DIGITAL PENETRATION

Low electricity access in Malawi leads to low ownership of fixed devices like computer and low usage of fixed broadband services. As a result, in 2018, only 6.3 percent households owned a computer and 11.1 percent had Internet access. Fixed broadband subscriptions were even lower with 0.06 per 100 inhabitants (ITU, 2018).

Malawi has a high level of mobile penetration. The mobile sector is dominated by two operators, Airtel Malawi Limited and Telekom Networks Malawi Limited (TNM) that provide the majority of data services. In terms of fixed telephony services, Malawi Telecommunications Limited (MTL) and Access Communications Limited (ACL) are in the lead, but the market is relatively small compared to the mobile sector.

There is a clear gender disparity to the disadvantage of women in terms of mobile phone ownership. Women have low control over phone use, and lack of income and digital literacy also hinders the increase of female subscribers.

Despite high mobile network coverage, mobile data is costly at USD 27.41 for 1 GB (see Table 3), resulting in low usage of Internet-based apps. Consequently, GSMA reports that only 4 apps are available in the country's national language and citizen engagement on social

media platforms is also very low (2.6 percent) (see Table 3). As such, radio remains the main channel of receiving news and information, particularly in rural communities.

It is important to note that with increasing mobile penetration, mobile-based payment services are emerging that allow users to send and receive money with their mobile phones. This ensures a modicum of digital inclusion for unbanked and underserved populations. Khusa M'manja and Mpamba, provided by Airtel and TNM, are the two leading mobile payment products in Malawi (Madise, 2014).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	27.41	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	20.02	ITU
		Fixed broadband prices as a % of adjusted per capita income	2016	108.10	ITU
	Willingness	Mobile social media penetration (%)	2019	2.67	GSMA
		Number of apps in national language (quantity)	2019	4	GSMA
		Gender gap in social media use (%)	2019	20.73	GSMA
		Gender gap in mobile ownership (%)	2019	54.02	GSMA

POLICY AND REGULATION

The ICT Policy adopted in 2005 and revised in 2013, has set ICT as one of the priority sectors with huge potential and aims at leveraging ICTs in all sectors toward socio-economic development.

With the support of UNDP, Malawi approved a National ICT Master Plan (2014–2031) (UNDP, 2014), divided into four implementation phases with four main pillars covering ICT infrastructure, innovation and human capital development, ICT industry development and e-business, as well as e-government services and growth sectors development. Developed by the National Planning Commission (NPC), Malawi's five-year Digital Economy Strategy aims at boosting access to connectivity by 2026 and making Internet access more affordable, reliable and available. To further encourage ICT development, the Government of Malawi has waived import taxes on computers and accessories. Meanwhile, the Malawi Communications Regulatory authority (MACRA) was set up and is responsible for regulating the country's communications sector and the implementation of Universal Access Programs, while the National Commission for Science and Technology (NCST) was established to lead science and technology development.

Projects and initiatives have been implemented and piloted. For example, the Digital Malawi project is supported by the World Bank and has an overall objective to improve access to ICT infrastructure, strengthen the country's digital ecosystem, as well as create digital platforms and service portals to modernize government operations.

In terms of policies and regulations in the agriculture sector, the Ministry of Agriculture, Irrigation and Water Development developed the National Agriculture Policy of Malawi (2016–2020), which seeks to transform the sector from subsistence to one with a market-oriented focus to increase local production and income levels in the sector. A key policy objective was to "increase by 60 percent the number of new technologies under development and being demonstrated to farmers". Even though there is neither a particular strategy nor a national plan for digital agriculture, the favourable policy environment raises the awareness of digital transformation and encourages digital innovations applied in agriculture.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.16	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.21	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.81	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.47	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	87	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Malawi has a relatively stable political environment and well-functioning legal framework. Moreover, the country is free of violence and conflicts, making it easy and attractive for investors to enter the country and start their businesses. The country in general is quite open to investments and grants, and attracts FDI through policies, official assistance as well as forums. However, Malawi's infrastructure, especially its limited power supply, undermines investments and remains a significant impediment.

Doing Business 2020 reported that Malawi scored 77.9 out of 100. It takes 37 days to start a business, with no disparity between men and women. The most time-consuming procedure is applying for a registration of the workplace, which takes 28 days in total; while the costliest procedures are more linked to company registration and licensing fees. Therefore, despite the Malawi Investment and Trade Centre's (MITC) one-stop service, lack of efficiency is a main obstacle for investors. Investments in agriculture seem to be promising and given that agriculture accounts for 80 percent of Malawi's exports, agribusiness and agro-processing are likely to be the most attractive market segments.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	98	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	3.72	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	1.79	WEF
	Entrepreneurship	Time required to start a business (days)	2019	37	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.60	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.26	WEF

HUMAN CAPITAL

It is reported that 62.1 of Malawi's adult population of 15 years of age and older have a literacy rate of 62.1 percent The rate was higher among youth at 72.9 percent as of 2015, with 73.4 percent for youth females and 72.5 percent for youth males (UNESCO, 2015). Education expenditure accounted for 15.8 percent of the total budget, contributing 4.7 percent of GDP in 2018. To further guarantee people's right to accessing education, the ongoing National Adult Literacy and Education Policy (2020-2025) has a goal to reduce the number of illiterate adults by 300 000 annually.

Seeing the huge potential of ICT and its cross-cutting influence in other sectors, improving digital skills is considered a way to mitigate the digital divide in the country, particularly by enhancing digital capacities for agriculture development, which accounts for 42.2 percent of total employment (see Table 6).

A number of organizations have undertaken literacy programmes in rural areas to improve literacy and numeracy capacities. For example, mHub, a technology hub that provides digital skills training using the BBC's micro:bit (a pocket-sized computer that introduces you to how software and hardware work together). Students are encouraged to provide innovative solutions covering certain social and environmental issues during coding hackathons. The SOAR Learning Centers, supported by CARE Malawi and Team4Tech, deploy tablets for teaching and school management, and provide special training to adolescent girls to access educational opportunities. The DAPP Malawi Farmers' Clubs offers community-based adult literacy classes.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2015	62.14	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2015	72.94	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.84	WEF
	Employment	Employment in agriculture (% of total employment)	2019	76.36	ILO
		Employment in agriculture, female (% of female employment)	2019	82.00	ILO
		Unemployment, total (% of total labour force)	2020	5.99	ILO

AGRO-INNOVATION

Due to a slowdown in its economic growth, the expenditure on agriculture research in Malawi has been in a slow decline, and accounts for 0.53 percent as a share of agricultural GDP (IFPRI, 2016. Until 2014, of all agriculture researchers, 81 percent held master's and doctoral degrees, but only 20 percent were female (IFPRI, 2016). The Department of Agricultural Research Services (DARS) is the national institute that conducts agricultural research and generates technologies to improve productivity. However, noting the decline of R&D expenditure and suspension of donor funding, many researchers of DARS have left and moved to the higher education sector for better benefits and higher salaries. In 2015, approximately 37 percent of agricultural researchers worked in educational institutes.

In terms of the application of digital solutions, a numerous innovative practices have been undertaken in Malawi. For instance, the World Bank supports the Agricultural Productivity Program for Southern Africa (APPSA), a regional programme aiming at releasing 367 technologies to farmers, including in

Malawi. In response to recurring droughts and irregular rainfall, Feed the Future Malawi AgDiv promotes drip irrigation kits to improve the quality and quantity of agricultural products. Meanwhile, the private sector's engagement is worthy of note. For example, Microsoft provides information via SMS and voice platforms to farmers with the help of National Smallholder Farmers Association of Malawi. Noble Agri Tech is a young start-up that develops agriculture automation systems for horticultural farmers.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	2 046.86	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	129.22	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.59	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	0.53	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.71	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.25	WEF
		ICT goods imports (% of total imports)	2019	6.34	UNCTAD

MALI

The Republic of Mali is a low-income country with a GDP of USD 17.39 billion in 2020. The poverty headcount ratio at national poverty lines (percent of the total population) was reduced from 43.8 percent in 2018 to 42.1 percent in 2019. Poverty in Mali is declining through an integrated set of initiatives that increase food security, agricultural productivity and incomes (see Table 1).

Cotton and cereals are the dominant crops in Mali. The agriculture sector serves as a source of livelihood for about 62.4 percent of the country's population. Several initiatives are being undertaken to empower rural dwellers and to transform rural economies across the country. One such initiative is the partnership between the Government of Mali and IFAD to execute the Rural Youth Vocational Training, Employment and Entrepreneurship Support Project. Launched in 2013, the project aims at facilitating rural young people's access to job opportunities and attractive, well-paying jobs in agriculture and related enterprises. And by so doing, shaping them to become actors in modern agricultural value chains that are responsive to market demand.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	20 250 834	WBG
Urban population (%)	2020	43.91	UNPD
Rural population (%)	2020	56.09	UNPD
GDP (current millions of USD)	2020	17 394	WBG
Agricultural land (km^2)	2018	412 010	FAO
Agricultural land (% of land area)	2018	33.77	FAO

INFRASTRUCTURE

The country currently has about 310 MW of on-grid installed generation capacity to provide electricity. This is supplemented by importing 27 MW and about 70 MW of off-grid production. The increase in access to electricity for the total population from 34.8 percent in 2017 to 48 percent in 2019 demonstrates the country's commitment to develop its energy sector. A similar trend also exists in the access rate for urban and rural areas, where urban access rose from 74 percent in 2010 to 91.2 percent in 2019, while rural access was below 16 percent in 2019. The surge in energy demand in recent times prompted the government to set up the Agency for the Development of Household Energy and Rural Electrification (AMADER) that gives concessions to villages to enable the private sector to produce and distribute electricity.

The telecom sector of Mali is making great strides in building infrastructure to deliver quality services. Mobile networks for voice and data services dominate. They account for about 99.8 percent of all telecom connections.

Figures from GSMA (2019) showed an improved network coverage with 2G reaching 100 percent while 3G and 4G coverage reaching 71.8 percent and 43.7 percent respectively. In 2016, unique subscriber mobile penetration stood at 60.4 percent, whereas mobile penetration by connections rose over 95 percent; the difference attributed to many customers having more than one mobile phone (GSMA, 2017).

Internet penetration in Mali is low even though Orange and Malitel launched their 4G/LTE service in 2018. Internet penetration in the country stood at 27.9 percent in January 2021. 3G connections for data are enjoyed only in the capital of Bamako and some regional centres.

Mali's landlocked location makes it dependent on neighbouring countries for international bandwidth, which has kept prices high. Several infrastructural projects are underway to improve telecommunication services. Orange has launched a new fiber optic network in West Africa that will cover Mali and seven other countries to offer superfast broadband and other high-speed telecom services. The network couples a 10 000 km cross-border terrestrial fiber optic network with 10 000 km of undersea cables to provide high-speed broadband transmission and seamless connection to Orange's international networks (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	15.27	WBG
		4G coverage (% of total coverage)	2019	43.64	GSMA
		Mobile (device) ownership (% of population)	2019	55.01	GSMA
		Secure access to Internet servers (per 1 million people)	2020	10.72	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.14	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	125.01	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	35.07	ITU
		Fixed broadband subscriptions (per 100 people)	2020	1.20	ITU

DIGITAL PENETRATION

Mali recorded 20.93 million mobile connections in January 2021 equivalent to 101.8 percent of the total population. The number of mobile connections increased by 3.9 percent between January 2020 and January 2021. Internet users increased by 18 percent between 2020 and 2021 to the figure of 5.74 million in January 2021. The increase in Internet users had an effect on social media users, which increased by 24 percent during the same period to 2.1 million in January 2021.

Active mobile broadband subscriptions in Mali increased from 5.8 million in 2018 to 6.9 million in 2019, rising from 30.3 to 35.1 of the population. Mobile cellular telephone subscriptions by post-paid/prepaid rose from 21 955 565 in 2018 to 22 925 482 in 2019. According to Cable (2020), the average price of 1 GB of mobile data is USD 4.12 compared to USD 9.22 in 2019. ITU also reports that the price of local mobile cellular calls per minute has increased from USD 0.18 in 2016 to USD 0.19 in 2017 (see Figure 3).

Orange Mali and Sotelma are the two fixed line operators in Mali. The duopoly of Orange Mali and the national operator Malitel continued until 2017 when Alpha Telecom started mobile services as the third operator. Mobilis, owned by Algeria Telecom joined as the fourth mobile network operator in 2019. According to GSMA (2017), Orange Mali has become the dominant provider with a market share of 65.2 percent in 2016. Mobile money is a growing service offered in Mali and could be a major opportunity to advance financial inclusion, especially in rural areas where mobile money penetration is only 30 percent. Promoting mobile payment platforms could potentially increase the use of electronic payments especially in rural areas (see Table 3).

The Sénèkela, which means "grower" in Malian, is an initiative by Orange that provides a call centre available 24/7 that is dedicated to farmers' concerns. It enables them to talk directly to agronomy experts, in French or in Bambara, the local language. The service provides information and advice on plantation methods, seeds, seedling duration, fertilizers, animal husbandry, fishing, fish farming and forestry. Through a USSD service, farmers are able to check prices - farm gate (minimum price guaranteed for the producer by the government), retail, and wholesale - of all the markets across Mali for goods such as millet, corn, rice or potatoes.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.12	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	8.56	GSMA
		Number of apps in national language (quantity)	2019	14.32	GSMA
		Gender gap in social media use (%)	2019	0.48	GSMA
		Gender gap in mobile ownership (%)	2019	18.80	GSMA

POLICY AND REGULATION

Mali has a national policy and strategic plan for ICT, administered through the Agence des technologies de l'information et de la Communication (AGETIC). One of its core objectives is the use of ICT in education and capacity building for the formal and non-formal sectors.

However, while there is no available data on an ICT policy for the development of agriculture in Mali, there are various policies to enhance agricultural productivity and development in the country. With an objective of improving food security and advancing socio-economic development, the following documents among others have contributed to achieving food sustainability: the Growth and Poverty Reduction Strategic Framework 2012-2017 (CSCRP); the National Food Security Strategy (SNSA); the Strategic Framework for Economic Recovery and Sustainable Development in Mali 2016-2018; and the Agricultural Orientation Law (LOA).

The Agricultural Orientation Law (LOA), drawn up in 2006, is the main legislative instrument governing Mali's agricultural sector, which comprises representatives of the public and private sectors, local authorities, agricultural industry and civil society, working together to formulate and implement agricultural policies. The Ministry of Agriculture formulates agriculture and livestock development programmes and strategies, in collaboration with farmers' organizations and development partners.

In 2019, Mali rolled out a comprehensive climate-smart agriculture investment plan in which digital agriculture in the form of remote sensing and monitoring offers great potential to increase the climate-smart potential of the landscape and farms. And in partnership with international organizations including but not limited to the World Bank, IFAD, and UNDP, Mali is working to strengthening its agricultural productivity. For example, the current Develop Local Extension Capacity Project is being implemented by Digital Green in coordination with USAID, International Food Policy Research Institute (IFPRI), CARE, and Global Forum for Rural Advisory Services (GFRAS) to mobilize communities around improved advisory services.

In terms of funding for the agricultural sector, the Government of Mali has been at the forefront of playing a vital role in creating agricultural markets through the support of policy development, research, subsidies and by owning some major agricultural companies. Over the years, agriculture consistently accounted for approximately 15 percent of the government's yearly budget and only lower than the allocation to the education sector. For instance, in 2018, of the government's allocated budget of CFA 56 billion for the agricultural sector, 15 percent of it was grant subsidies for the acquisition of agricultural inputs. International bodies such as the World Bank, USAID, and the Canadian International Development Agency (CIDA) are among the key donors to Mali's agricultural sector (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	3.69	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	4.06	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	3.29	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/extremely well developed)	2016	3.17	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	80.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Foreign direct investment is considered an essential catalyst of economic transformation, a tool the Government of Mali does not take for granted. To attract the inflow of investment, Mali has set up a series of one-stop shops under the Investment Promotion Agency of Mali (Agence pour la Promotion des Investissements or the API) to assist with the procedures of doing business in the country by offering information on regulated activities. An increase in new businesses registrations from 3 020 in 2017 to 3 130 in 2018 demonstrates Mali is enjoying a stable political atmosphere and a conducive business environment for investments.

Although the country is not very competitive in the business world, even in Africa, it has made steady progress in the World Bank Doing Business rankings. Mali scored 84.3 out of 100 in the ease of starting a business. It takes 11 days to complete procedures to have the legal right to operate a business in the country (World Bank, 2020).

To further boost investor confidence, the Malian government in 2012 passed the Investment Code and its enforcing decree No. 2012-475 that governs investments. It ensures fair treatment of foreign and local investors, grants protection against nationalization and expropriation or any requisition of the company, ensures stability and free access to raw materials and land. The code also offers the liberty to transfer funds or to undertake capital and financial transactions, such as share transfer or transfer of business. As a result of ongoing economic reforms, the government has recently reduced many export taxes and duties. Further incentives for investors include tax exemptions on the use of local raw materials.

Faced with the lack of available finance for agricultural businesses from traditional banks and coupled with the limited chance of securing initial capital support for digital transition, innovative entrepreneurs are giving priority to digital technology to access investment. Babyloan Mali is a participatory financing initiative implemented by IFAD and its partners. It aims at ensuring that remittance flows are used to sustain productive agricultural activities in rural communities by providing rural youth with financial support to start or develop their own agricultural activities, as well as career development planning.

To support farmers and agribusinesses in Mali, IFAD is implementing a project from 2018 through 2024 to improve financial inclusion for smallholders and small and medium agri-food enterprises in Mali.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	494	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.56	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.71	WEF
	Entrepreneurship	Time required to start a business (days)	2019	11	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.43	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.53	WEF

HUMAN CAPITAL

Adult literacy in Mali increased from 33 percent in 2015 to 35.5 percent 2018. Youth literacy also increased from 49 percent in 2015 to 50 percent in 2018, however dropped to 46.2 in 2020. The youth literacy rate for females rose from 39 percent to 43 percent but the rate for youth males declined from 60.5 percent to 57.8 percent within the same period.

Gross enrolment in secondary schools decreased from 41.5 percent in 2017 to 41 percent in 2018. Similarly, the rate for males reduced from 45.8 percent to 44.9 percent while the rate for females also reduced from 37.1 percent to 37 percent in 2017 and 2018 respectively.

Recognizing the importance of ICT to the growth of the economy, it has been integrated into the education system in the first years at the basic level to allow Malians to cope with the challenges of the information age. The government has instituted some statutory incentive measures to increase Internet cafes and Internet usage in the country. Through the SchoolNet project, USAID has equipped some Malian high schools with computer materials that give students an opportunity to have access to computers for the first time.

Digital skills are yet to increase despite efforts to scale up the use of ICT. In 2006, the French Development Agency and Orange Mali, through the support of Aide et Action, launched the Learning by ICT project to enhance the professional skills of 840 fundamental teachers and the quality of primary education in the Sikasso region. The project aims at establishing an online and offline educational resource on mathematics and other sciences, while improving pedagogical supervision strategies and approaches of primary schools.

The private sector plays an active part in building the capacity of youth and agricultural entrepreneurs to help improve their businesses. For instance, the Farmers' Hub project, which is supported by CTA and the Syngenta Foundation for Sustainable Agriculture (SFSA), is an initiative aimed at improving the productivity and quality of fruit and vegetable farming through the use of greenhouses. The project provides training sessions in greenhouse farming and business management and has given agricultural entrepreneurs 13 greenhouses, technical equipment such as seedling trays and machinery, and agricultural inputs and plants. The project aims at building the digital skills of farmers. Youth are also trained by local incubation centres in management and entrepreneurship. About 342 farmers and 100 university students in Mali have so far benefited from field days hosted by the project to foster knowledge-sharing. The project has trained youth on the use of the mobile platform e-Hub, which allows data collection and transaction management. Agricultural entrepreneurs can input their data and monitor their activities using tools such as mobile phones and tablets (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2020	46.16	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	50.13	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.60	WEF
	Employment	Employment in agriculture (% of total employment)	2019	62.44	ILO
		Employment in agriculture, female (% of female employment)	2019	62.58	ILO
		Unemployment, total (% of total labour force)	2019	7.5	ILO

AGRO-INNOVATION

Three main institutions are engaged in agricultural research in Mali: the Institute of Rural Economy, the Central Veterinary Laboratory, and the Rural Polytechnic Institute of Training and Applied Research in Katibougou. The Institute of Rural Economy is the country's leading agricultural research agency, predominantly focusing on livestock production, postharvest, food technology and socioeconomic research. Research conducted is mainly financed by donors and a modest level of public funding. In time, the funding system coupled with the over-reliance on short-term projects with funding from development banks and donors causes fluctuation in research spending.

A number of innovations exist that support productivity in the agriculture sector. In addition to Sénèkela referred to above, other innovations include the OKO crop assurance, an initiative to facilitate payment for services rendered to farmers. It is integrated in Orange Mobile Money's USSD menu, allowing users to access specific information on payments. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has also set-up a research station at Samanko with facilities such as cold seed stores, labs and experimental fields.

In terms of intellectual property rights (IPRs), Mali is a member of the African Intellectual Property Organization (OAPI) created by the Bangui Agreement. Its regulations on IPRs are based on the relevant provisions in the Bangui Agreement, which was revised in December 2015. The country also ratified the Berne Convention for the Protection of Literary and Artistic Works, the WIPO Copyright Treaty (WCT) and the WIPO Performances and Phonograms Treaty (WPPT). The use of mobile telephony and other digital services has enhanced farmers' access to advisory services, business contacts, market information systems, although the start-up ecosystem of Mali is still in its infancy.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	6 427.30	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	121.06	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.59	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.44	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.32	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.69	WEF
		ICT goods imports (% of total imports)	2017	4.09	UNCTAD

MAURITIUS

Mauritius is an island state, classified as an upper-middle-income country with a GDP of USD 10.9 billion in 2019 (World Bank). The country has a population of nearly 1.3 million, of whom 40.8 percent liven in urban areas and 59.2 percent in rural areas (see Table 1).

The agriculture sector contributed 2.9 percent of the total GDP and employs only 6 percent of the total population. With a steady growth of the service sector, the share of agriculture sector has declined year after year. Severe poverty is rare in Mauritius, however, as a country with a high dependence on food imports, food supply is largely affected by global prices and climate change. Of all the domestically produced products, sugar cane is dominant, and 90 percent of its production is exported, making Mauritius a sugar-based monoculture for a long time since independence. Mauritius has a comparative advantage in fruit production, led by banana, pineapple, lychee and mango, as well as fisheries, which employed 29 172 people in 2018 (FAO).

Mauritius has also evolved into a diversified economy with textiles, tourism, finance and information technology showing strong growth and potential. It is aiming at transforming into a knowledge-based country by developing its ICT sector through a "cyber island" strategy, which positions ICT as the third pillar of the economy. The share of ICT industry increased to 5.6 percent of GDP in 2016. Around 600 ICT-related enterprises have set up in the country on account of a favourable technology ecosystem.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	1 265 740	WBG
Urban population (%)	2020	40.76	UNPD
Rural population (%)	2020	59.24	UNPD
GDP (current millions of USD)	2020	10 914	WBG
Agricultural land (km^2)	2018	860	FAO
Agricultural land (% of land area)	2018	42.37	FAO

INFRASTRUCTURE

Mauritius has made significant advances in infrastructural development in recent years. It remains one of the few African countries to achieve 100 percent electricity distribution in rural areas (see Table 2). The country boasts excellent Internet connectivity with 99 percent 4G coverage as of 2019 and is the only one in the region that has sizeable and potential market opportunity for 5G application across the country (GSMA, 2019). In Mauritius, 64 percent of the population had access to Internet, and 24.2 percent per 100 inhabitants subscribed to fixed broadband services. In terms of mobile ownership, about 79.3 percent of the country's residents own mobile devices, resulting in a high mobile penetration of 147 percent in 2019, an increase of almost 10 times since 2000.

Mauritius values the importance of developing its broadband services. A National Broadband Policy (2012–2020) was adopted, aiming at positioning the country as "intelligent Mauritius" or the "cyber island". Currently, LTE and fiber broadband can be accessed across the country and Wi-Fi connections are generally available (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	100.00	WBG
		4G coverage (% of total coverage)	2019	99.00	GSMA
		Mobile (device) ownership (% of population)	2019	79.28	GSMA
		Secure access to Internet servers (per 1 million people)	2020	914.88	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.86	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	150.41	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	87.39	ITU
		Fixed broadband subscriptions (per 100 people)	2020	25.33	ITU

DIGITAL PENETRATION

With a high mobile penetration and well-developed digital infrastructure, Mauritius has become a telecommunication pioneer in the region. The mobile market is dominated by three main operators: Mauritius Telecom (in partnership with Orange Group), Emtel and Mahanagar.

Mobile and Internet services have over time become relatively affordable. The average price of a Gigabyte of mobile data stands at USD 2.48 (see Table 3). The increasing use of mobile data has facilitated the growing use of mobile Internet-based apps and social media. Mauritius has expanded its scope in digitalization with 61.48 percent of mobile apps existing in the country's national language. The GSMA also reported that about 66.9 percent of the country's population actively engaged with social media platforms as of 2019 (see Table 3).

The financial and insurance sectors are becoming one of the key priority areas of the Mauritian economy. To that end, mobile and online transactions are increasingly required by businesses and individuals. As of 2017, 89.9 percent of adults owned an account at a financial institution or with a mobile money service provider. Growing demand gave rise to various cashless services in digital form like the Mauritius Central Automated Switch (MauCAS), my.tmoney, JuicebyMCB, etc. (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	2.48	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	0.67	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	1.37	ITU
	Willingness	Mobile social media penetration (%)	2019	66.86	GSMA
		Number of apps in national language (quantity)	2019	61.48	GSMA
		Gender gap in social media use (%)	2019	74.42	GSMA
		Gender gap in mobile ownership (%)	2019	52.90	GSMA

POLICY AND REGULATION

Paving the way toward a knowledge-based Mauritius, the country is aiming at building an "intelligent and smart" economy through its Mauritius Vision 2030. To better achieve the vision and build an innovation-driven society, the Digital Mauritius 2030 Strategic Plan concentrates on five pillars, namely: digital government, ICT infrastructure, innovation, talent, and cybersecurity to drive digital transformation to build an innovative public sector and establish a favourable enabling environment for business.

Meanwhile, Mauritius has adopted a series of policies to improve its digital ecosystem. Two national ICT strategic plans had been adopted to provide guidance for its ICT sector development, particularly aiming at: creating smart cities and technology parks; building ultra-high speed and safe telecommunication infrastructure; building a globally competitive workforce for technology and communication; developing a National Innovation Programme; and transforming the country into a regional hub and gateway to Africa. Mauritius is making headway in ensuring safe and sustainable ICT development by enacting cybersecurity legislation such as the Data Protection Act, and the Electronic Transaction Act and the Center of Excellence on Cybersecurity and Cybercime. Additionally, specific strategies targeting different domains have been launched. For example, the Artificial Intelligence Strategy 2018, the Digital Government Transformation Strategy 2018-2020, and the Open-Source Software Strategy.

The importance of ICT in food and agriculture is being recognized despite the lack of a national digital agriculture strategy. In its Strategic Plan 2016-2020 for non-sugar crops, the adoption of technology is highlighted as a critical way to improve productivity and overall competitiveness. The Ministry of Agro Industry and Food Security supports the work of the Food Technology Laboratory to ensure food safety and quality (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.44	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.66	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.73	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	4.28	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	80.8	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

According to the Bank of Mauritius, gross direct investment flows in 2019 was estimated at MUR 21 337 million (USD 427 million according to UNCTAD). Of that total, information and communication attracted 0.6 percent while agriculture, forestry and fishing received only 0.01 percent. Mauritius has a favourable business climate for investment and is considered one of the best locations for business thanks to its stable political environment, comprehensive legal framework as well as its open economy. According to Doing Business 2020, Mauritius scored 94.5 out of 100 in terms of starting a business. Overall, it takes 4.5 days and four steps to complete all procedures to register a business, thanks to registration applications being online and the use of electronic certificates. There is no disparity in the ease of doing business between men and women. Furthermore, financial and insurance activities ranked in second place in terms of investment inflow.

The government values the role of local SMEs and start-ups and supports them through assistance schemes and entrepreneurship programs led by SME Mauritius Ltd. Apart from doing business, the Government of Mauritius also encourages profitable enterprises to take social responsibilities to address poverty issues. Despite a low poverty rate of 10.3 percent based on national poverty lines, funding from the Corporate Responsibility Program has helped a large number of households move out of poverty (ITU, 2012).

Mauritius has adopted a variety of projects and initiatives to facilitate the participation of women and youth entrepreneurs in digital transformation. For instance, Mauritius launched the 50 Million African Women Speak Platform to encourage women entrepreneurs to learn and exchange ideas and knowledge using online tools. Business Without Borders is a digital mentoring programme that strengthens the business capacity of women entrepreneurs.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	472	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.80	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.13	WEF
	Entrepreneurship	Time required to start a business (days)	2019	4.5	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	4.21	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.96	WEF

HUMAN CAPITAL

In Mauritius, 91.3 percent of adults above the age of 15 years are literate while youth aged 15 to 24 years of age have a literacy rate of 99 percent. The 11-year compulsory education of Mauritius has equitable gross enrolment for males and females alike. On the other hand, females occupy a higher percentage in tertiary education enrolment, marking progress in gender equality and the empowerment of women.

Reflecting the country's solid education foundation and the government's awareness of the importance of building digital capacities, antiquated educational facilities have over time been replaced by digital tools, such as the use of e-books, computers and projectors. Basic ICT skill training is becoming part of the school curriculum.

For the general population, the National Computer Board (NCB) has carried out a series of projects to e-power people and improve digital literacy. Examples of this include the Digital Youth Engagement Programme (DYEP), which aims at introducing coding to primary and secondary school students; and the Citizen Engagement Programme (CEP) focusing on ICT skill training in communities, particularly for senior citizens. The NCB also provides services to digital start-ups to enhance the capacities of ICT entrepreneurs. The government has also launched the National Skills Development Program (NSDP) to train 4 000 unemployed people aged 16 years or older on ICT skills (HRDC).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	91.33	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	99.04	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.34	WEF
	Employment	Employment in agriculture (% of total employment)	2019	5.97	ILO
		Employment in agriculture, female (% of female employment)	2019	3.93	ILO
		Unemployment, total (% of total labour force)	2020	7.11	ILO

AGRO-INNOVATION

Mauritius values the importance of agriculture R&D. This is reflected in the country's Strategic Plan 2016-2020 which emphasized research and the adoption of new technologies, aiming at increasing agriculture land productivity and ensuring food security. As a result, Mauritius has invested in its agriculture R&D with an expenditure accounted for 4.8 percent of agricultural GDP. Of all researchers, 74 percent hold master's and doctoral degrees. The gender gap is also gradually declining. In 2016, 58 percent of researchers were male, and 42 percent were female, compared to 66 percent male and 34 percent female in the past.

In terms of R&D institutions, the Food and Agricultural Research and Extension Institute (FAREI) plays a leading role in non-sugar agricultural research. The Mauritius Sugarcane Industry Research Institute (MSIRI) is responsible for sugarcane-related research. Absorbing only 4.9 percent of total researchers, the capacity of higher education remains low. In this context, the University of Mauritius has launched a series of research-focused projects in partnership with innovative companies to further enhance R&D capacity. Agritech Park is a prominent digital agriculture incubator.

Mauritius scored 4.27 of 7 interms of capacity for innovation that presented an increasing role of the private sector in innovation. Even though the contribution of agriculture is declining, digital agriculture practices are on the rise. Both the public and private sectors play an important role in promoting digital solutions. For example, the government launched a Centralised Digital Land Bank using the Electronic Data Management System to match supply and demand for agricultural land. AgriTech Mauritius promoted new technologies in agriculture. The mobile application Mokaro was developed to provide guidance on field activities and climatic information to farmers. And drone technology has been applied to monitor cane fields.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	390.97	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	94.11	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.73	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	4.82	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.20	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	4.27	WEF
		ICT goods imports (% of total imports)	2019	5.79	UNCTAD

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MOZAMBIQUE

Mozambique is a low-income country, with a gross national income per capita of USD 460 that has been rapidly growing over the last two decades. The poverty rate has declined slowly on average by 1 percent per year, from 60.3 percent in 2003 to 48.4 percent in 2015, but rural areas continue to lag behind. Mozambique's rural population was reported at 62.93 percent in 2020 (World Bank, 2020).

In terms of the agricultural sector, more than 70 percent of poor households live in rural areas and smallholders still dominate agricultural production, accounting for 94 percent (IFAD, 2018). Although their productivity is low, agriculture is the main source of food and income for smallholder farmers. From 2010 to 2013, the agricultural sector accounted for around 30 percent of GDP and 25 percent of total exports (food and agricultural raw materials). Agriculture is the main source of income for more than 70 percent of the population and employs 70.2 percent of the workforce (see Table 1).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	31 255 435	WBG
Urban population (%)	2020	37.07	UNPD
Rural population (%)	2020	62.93	UNPD
GDP (current millions of USD)	2020	14 021	WBG
Agricultural land (km^2)	2018	414 138	FAO
Agricultural land (% of land area)	2018	52.66	FAO

INFRASTRUCTURE

According to the World Bank, only 4.9 percent of the rural population had access to electricity in 2019, which may explain the country's low 4G coverage that stood at 12.4 percent (see Table 2). Increasing investment to modernize its network and introduce high-quality mobile services allowed the leading telecom operator in the country, Mozambique Telecom, to launch 4G services in 2019.

The mobile cellular subscription per 100 inhabitants has dropped considerably from 70.31 in 2014 to 48.65 in 2019. Unlike active mobile broadband subscriptions per 100 inhabitants, which increased from 2.1 in 2013 to 17.7 in 2019 as shown in Table 2. Regarding the fixed line infrastructure there are 0.2 per 100 inhabitants for fixed Internet subscriptions, which cannot meet the growing household demand for broadband connectivity.

With the support of donor funding, the Government of Mozambique is currently investing in several ICT projects to improve the infrastructure construction. These include the eGovernment Communication Infrastructure Project, Mozambican Mobile Unit, Provincial Digital Resource Centers, among other initiatives to build basic infrastructure support for the improvement of institutional and human capacity as well as rural access to information (IST-Africa) (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	4.94	WBG
		4G coverage (% of total coverage)	2019	12.44	GSMA
		Mobile (device) ownership (% of population)	2019	49.42	GSMA
		Secure access to Internet servers (per 1 million people)	2020	29.37	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.71	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	48.65	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	17.67	ITU
		Fixed broadband subscriptions (per 100 people)	2019	0.23	ITU

DIGITAL PENETRATION

Mozambique has a relatively low 40 percent mobile phone penetration and 10 percent Internet penetration rates (IDRC, 2018). In cooperation with two leading mobile operators, the government's telecommunications division has delivered several dozen sites to each operator. The new sites on which the relay antennas will be installed will allow operators to extend their coverage and improve the quality of their network across the country.

By investing in high-speed mobile broadband, Mozambique Telecom can compete in this market segment with Vodacom and Movitel, which have been present there respectively since 2018 and 2021 respectively, but still only cover the capital city Maputo and a few surrounding localities.

Table 3 demonstrates the average mobile price of a 1 GB at USD 3.3 in 2020, down sharply from USD 12.82 in 2019. This reflects the government's effort to facilitate access of the population to the Internet. However, there is a low mobile penetration of social networks despite efforts

made by the government. According to the GSMA, this rate has increased over the past five years, from 3.1 in 2015 to 7.98 in 2019. Meanwhile the gender gap in Internet use is still large at 50 percent, indicating that women are missing out on the benefits of ICTs (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.33	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	7.98	GSMA
		Number of apps in national language (quantity)	2019	35.62	GSMA
		Gender gap in social media use (%)	2019	38.58	GSMA
		Gender gap in mobile ownership (%)	2019	43.62	GSMA

POLICY AND REGULATION

Mozambique's government was one of the first in Africa to promote ICTs and to integrate them into a national policy. The country's ICT Policy Commission was set up in 1998 and the first National ICT Policy was adopted in 2000. Special focus was given to the empowerment of women and youth through basic computer skills training. Agriculture is not one of the six priorities but was nevertheless given special attention. Following this, a series of policies such as the National Poverty Reduction Action Plan and the Rural Development Strategy were approved and adopted.

Mozambique's National Institute of Communications (INACOM) launched its rural Internet connectivity project, also known as "digital squares," on September 3 2020 with a goal to provide free Internet access to rural communities. To date, 27 districts have already been selected and 73 "digital squares" will be deployed across the country until 2025 (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.57	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.38	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.49	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.96	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	57.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Mozambique enjoys a comparative advantage and vast potential due to its geographic location and its natural resources. In 2013, the country was the second highest recipient of foreign investment in Africa. The country's legislation helps protect investor property with no discrimination in the treatment of investors or restriction on loans. On the contrary, local SMEs find it difficult to access financial support because they are considered risky investments.

The private sector remains informal in Mozambique. Starting a business takes longer and costs more than the average of other SADC economies. According to the World Bank, the time required to start a business has decreased over the past five years from 21 days in 2015 to 17 days in 2019. The World Bank notes that this decrease has more or less spurred the creation of innovative companies in Mozambique.

As reported by the World Bank 2017 Doing Business Report, Mozambique ranked number 137, dropping 9 places compared to 2015. Hindered by the debt crisis and the COVID-19 pandemic, the business climate has become arduous for entrepreneurs who are struggling to keep their businesses alive (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	2 212	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.49	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.18	WEF
	Entrepreneurship	Time required to start a business (days)	2019	17	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.92	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.35	WEF

HUMAN CAPITAL

Mozambique's adult literacy of people aged 15 years and older was reported at 61 percent in 2017, skewed in favour of males at 72.6 percent for males compared to 50.3 percent for females. Low literacy rate has a significant impact in rural areas, preventing rural populations from accessing decent jobs. According to Mozambique's Education Policy Data Center, of all the students enrolled in primary and secondary education, 83 percent are enrolled in primary education, but with a low complete rate of just 14 percent. The complete rate is even lower at secondary and post-secondary with 2 percent and 1 percent separately (EPDC, 2011). Low literacy and lack of secondary and higher education prevent youth from understanding, let alone mastering digital skills. To improve digital literacy and assist girls in accessing education opportunities, various initiatives have been implemented. This includes SchoolNet Mozambique and the NEPAD eSchools Initiative supported by the Ministry of Education, as well as UNESCO's Family Learning Program and Africa Code Week.

In terms of the labour market, This statement has to be more accurate: the total unemployment rate slowly increased and remained between 3-4 percent since 2009, based on ILO estimate. However, the World Bank, also estimates that the rate of employment in agriculture decreased slowly from 81.9 percent in 2000 to 70.2 percent in 2019 (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2017	60.66	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2017	70.91	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	2.74	WEF
	Employment	Employment in agriculture (% of total employment)	2019	70.22	ILO
		Employment in agriculture, female (% of female employment)	2019	79.78	ILO
		Unemployment, total (% of total labour force)	2020	3.39	ILO

AGRO-INNOVATION

Over the past two decades, the government has implemented trade reforms such as the removal of exchange controls and restrictions on imports and exports. This was in accordance with the Washington Consensus based on the principles of market liberalization, fiscal discipline and privatization. As part of these reforms, the prices of agricultural products and services have been liberalized. Most policies in Mozambique aim at improving the agricultural sector as a whole rather than focusing on specific crops. Mozambique's Agrarian Intensification and Diversification Program addresses the structural cereal deficit by distributing agricultural inputs, disseminating technology and developing credit to farmers in areas with high agro-ecological potential. It seeks to increase domestic supply and reduce the country's dependence on imports.

Emerging technologies are being applied in the country but at a limited scale, such as precision agriculture projects where low-cost drones are used to advise farmers on production decisions.

The government provides the main funding sources of agriculture research and development at 60 percent, with the remaining 40 percent being sourced from donors. High dependence on donor funding leads to unstable R&D input and contributions to the sector. The gender gap in R&D is also obvious with males accounting for 69 percent and females 31 percent (IFPRI, 2011) (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	4 143.94	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	124.77	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2016	2.68	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	0.36	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.23	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.58	WEF
		ICT goods imports (% of total imports)	2018	2.74	UNCTAD

NAMIBIA

Namibia is an upper-middle-income country with a GDP of USD 10.7 billion in 2020 (see Table 1). Despite a stable growth rate of over 5 percent between 2010 and 2015, the COVID-19 pandemic exerted extra pressure on its recovery leading to a negative growth of -8 percent in 2020. The country has a total population of about 2.5 million, 36 percent of whom are youth (Namibia Statistics Agency, 2018). About 52.6 percent of the total population lives in urban areas while 47.4 percent live in rural areas (see Table 1). The country's poverty rate was 17.4 percent in 2016, down from 28.7 percent recorded in 2009-2010.

Even though the percentage of agriculture's contribution to GDP has declined over the past five years, the sector remains crucial as it employs 22 percent of the total population and supports 70 percent of people's livelihoods directly or indirectly as of 2019. Agriculture in Namibia is largely affected by erratic weather conditions. Drought is becoming a serious constraint for its agricultural output particularly between 2013 and 2016, leading to the lowest contribution of agriculture. Apart from crop farming, livestock contributes to almost two-thirds of agricultural production and two-thirds of agricultural exports by value, thus making it an important source of foreign exchange.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2021	2 550 226	NSA*
Urban population (%)	2021	52.6	NSA
Rural population (%)	2021	47.4	NSA
GDP (current millions of USD)	2020	10 700	WBG
Agricultural land (km²)	2018	388 100	FAO
Agricultural land (% of land area)	2018	47.14	FAO

**Data come from Namibia Statistics Agency (NSA)*

INFRASTRUCTURE

The overall rate of electricity access in Namibia was 55.2 percent in 2019, a steady increase from 36.5 percent in 2000. A similar trend is seen in rural access to electricity, which increased from 18.9 percent to 35 percent over the past two decades. However, the internal electricity supply is still far less than the rising domestic demand, leading to a high dependence on purchased power from other countries, mostly from South Africa. To achieve energy self-sufficiency, Namibia has committed to enhancing its own power generation capacity through projects led by NamPower. The country is also exploring its potential in renewable sources like solar and wind.

In 2020, 40.5 percent of the population had access to 4G services (see Table 2). Leading operators like Telecom Namibia and Mobile Telecommunications (MTC) have invested in improving network infrastructure to extend 3G and 4G services to both rural and urban areas with 22 mobile sites and the erection of 10 new bases across country. The Communications Regulatory Authority of Namibia (CRAN) is developing a 5G strategy while an environmental assessment is being conducted by the Ministry of Environment, Forestry and Tourism for the introduction of 5G technology.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	34.97	WBG
		4G coverage (% of total coverage)	2020	40.5	CRAN*
		Mobile (device) ownership (% of population)	2019	68.51	GSMA
		Secure access to Internet servers (per 1 million people)	2020	214.10	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.89	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	102.11	CRAN
		Active mobile broadband subscriptions (per 100 inhabitants)	2020	72	CRAN
		Fixed broadband subscriptions (per 100 people)	2020	2.80	ITU

**Data is sourced from the Communications Regulatory Authority of Namibia (CRAN)*

DIGITAL PENETRATION

Namibia has a high level of mobile cellular subscriptions with 102.11 per 100 people. The number of mobile connections was equivalent to approximately 113 percent of the total population as of January 2021. In rural Namibia, information is acquired mostly through radio and television, while in urban areas social media is one of the most popular channels and largely accepted by youth. About 68.5 percent of the population owns mobile phones whilst users who are actively engaged with social media platforms reached 28 percent in 2019 according to GSMA.

However, a gender gap exists with 47 percent of females having access to the Internet.

Mobile and mobile Internet services are relatively expensive in Namibia. The cost of mobile data was USD 4.78 per 1 GB (see Table 3), accounting for 8 percent of the average monthly income. The cost local cellular calls per minute was USD 0.04 and USD 9.67 for pre-paid mobile broadband services (see Table 3).

With 88 percent of market share, MTC is the largest mobile operator and is developing a

mobile money service. Namibia has witnessed a sharp increase in the use of mobile money, reaching 1 055 per 1 000 adults who use mobile banking and have bank accounts, with an average annual rate of 160.8 percent between 2010 and 2019.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.78	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	2.54	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	8.60	ITU
	Willingness	Mobile social media penetration (%)	2019	27.97	GSMA
		Number of apps in national language (quantity)	2019	13.00	GSMA
		Gender gap in social media use (%)	2019	85.55	GSMA
		Gender gap in mobile ownership (%)	2019	100	GSMA

POLICY AND REGULATION

The Namibia Vision 2030 was launched in 2004, which sets up the foundation for the country's policy framework and long-term development and links to the process of implementing five-year National Development Plans (NDP2-NDP7). Sustainable agriculture and technology are two of the key driving forces for achieving the objectives.

To further develop its ICT sector, Namibia adopted the Information Technology Policy 2008 to stimulate its economic progress, particularly the development of ICT skills of the younger demographics. The government recognises the importance of deploying ICT in multiple domains, such as education in terms of developing quality human capital and IT literacy and skills, and e-government with better information provision and service delivery to its constituents. Namibia scored 3.91 of 7 in the importance of ICTs to the government's vision (see Table 4).

In terms of digital agriculture, the Namibia Agricultural Policy 2015 set up an overall goal for the sector, which a solid step for the future development of the country's digital agriculture. Sustainable agriculture is the core of this policy, and special focus is placed on agricultural R&D, adaptation of appropriate technology, as well as the provision of agriculture management information systems. The policy also suggested the establishment, equipping and operationalization of Agriculture Technology Centers to develop and ensure access to technology. With funding from the Government of Germany and support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Namibia aims at increasing its agricultural competitiveness and improving its climate resilience.

Though digital agriculture policies are still absent, some initiatives are undertaken to spur the digital transformation process. Microsoft and AGRA are working together in 11 countries including Namibia to apply technology solutions like Big Data and Artificial Intelligence in the agricultural sector.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.91	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.72	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.51	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.60	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	70.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

According to Doing Business 2020, Namibia scored 72.2 out of 100. It takes 54 days (the sub-Saharan African average is 21.5 days) to start a business, with no evident disparity between men and women. The most time-consuming procedures are linked to company registration through an online platform, obtaining the certificate, as well as employees' registration.

Namibia is making efforts to provide a stable business environment and good infrastructure to attract foreign investment and stimulate domestic employment. In this context, two Acts (Foreign Investment Act of 1990 and Namibia Investment Promotion Act of 2016) constitute the legislative framework. The Namibia Investment and Promotion Board (NIPB) was set up to provide services covering all operational stages. As a result, the overall business climate in Namibia is quite positive and is continuously being improved. The mining sector remains a key sector that attracts most investments.

Namibia has a well-developed financial system making it the second largest in Southern Africa. About 60 percent of Namibians own a bank account. The country scored 3.9 of 7 in terms of accessibility to loans. Compared to individuals, enterprises face more difficulties in accessing finance, particularly working capital financing. There are also insufficient financial products for MSMEs (World Bank, 2016). For the agriculture sector, project financing can be accessed from state-owned banks such as the Development Bank of Namibia and Agribank. However, farmers and SMEs still face financing constraints, including collateral issues, heavy paperwork and the risk of seasonality leading to unfulfilled demand for agriculture-related activities.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	-17	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.87	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.83	WEF
	Entrepreneurship	Time required to start a business (days)	2019	54	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.90	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.18	WEF

HUMAN CAPITAL

In Namibia, 88.3 percent of people aged above 15 years of age are literate (88.8 percent for males and 87.8 percent for females). Education has been one of the country's top priorities since independence. Launched in 1992, the National Literacy Programme in Namibia (NLPN) has helped most learners obtain basic literacy competencies and improve the overall literacy rate of the country. As a result, people are more prone to participate in entrepreneurial activities and run business independently. Even though the national school enrolment rate is relatively favourable at 124.3 percent for primary and 65.8 percent for secondary, in rural areas, only 1 out of 100 will graduate from grade 12.

Given the importance of ICT in education, some initiatives have been launched to improve the digital skills of women and youth. For example, the "Do Like Edu" e-learning platform provides students in rural areas with access to open educational resources. The Internet Society Namibia Chapter identified ways to empower women through digital inclusion to close the gender gap. GIZ, in partnership with the Ministry of Industrialization, Trade and SME Development, the Ministry of Higher Education, Technology and Innovation, and the City of Windhoek set up a start-up incubation and innovation centre with mobile outreach units as part of the Start-Up Namibia programme (2019-2022), aiming at creating new job opportunities in the start-up space.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	88.3	NSA
		Literacy rate, youth total (% of people ages 15-24)	2018	92.8	NSA
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.63	WEF
	Employment	Employment in agriculture (% of total employment)	2019	21.85	ILO
		Employment in agriculture, female (% of female employment)	2019	20.10	ILO
		Unemployment, total (% of total labour force)	2020	20.35	ILO

AGRO-INNOVATION

The main agency conducting agricultural research in Namibia is the Directorate of Agriculture Research and Training (DART) which is funded mainly by the government. The agriculture research expenditure accounted for 3.1 percent of agricultural GDP in 2014, with a slow but steady growth of number of researchers. Of all the researchers, 58 percent have master's and doctoral degrees, with doctoral degrees being about 4 percent less. This reflects a lack of qualified researchers working on agriculture R&D, mainly due to uncompetitive salaries and limited opportunities for career growth in research agencies.

In Namibia, digital solutions are emerging and are starting to be applied to agriculture. This includes, for example, a fully-automated drip irrigation system for the production of blueberries. Start-ups such as Farm4Trade have also made solutions available for livestock data management.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	716.68	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	100.43	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2016	2.74	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	3.09	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.28	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	4.00	WEF
		ICT goods imports (% of total imports)	2019	2.32	UNCTAD

THE NIGER

The Niger is a low-income country with a GDP of USD 13.6 billion. The country has a population of 24 million, of whom 83 percent live in rural areas (see Table 1). The economy depends primarily on agriculture, which accounts for about 40 percent of gross domestic product (GDP) and employs roughly 72.5 percent of the workforce. In 2019 and prior to the COVID-19 pandemic, the share of agriculture in the Niger's GDP was 38.2 percent. Data available estimates agricultural land area constitutes 36.8 percent of the country's area (see Table 1).

The Niger's economy has been robust over the last few years. For instance, in 2019, the economic growth that was mainly driven by agriculture amounted for 6.3 percent. The Niger has made significant strides towards decreasing its poverty rate that hovered at 41.4 percent as of 2019, or in excess of 9.5 million, 6.8 million of whom were food insecure in 2018 (WFP, 2019).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	24 206 636	WBG
Urban population (%)	2020	16.63	UNPD
Rural population (%)	2020	83.37	UNPD
GDP (current millions of USD)	2020	13 678	WBG
Agricultural land (km^2)	2018	466 000	FAO
Agricultural land (% of land area)	2018	36.79	FAO

INFRASTRUCTURE

The Niger has made significant progress over the past few years in some areas of its infrastructure. Its ICT sector in particular has witnessed boosted performance due to notable addition of infrastructural capacity. Increased competition in the ICT market has also contributed to the rapid expansion of mobile services. The Niger has made tremendous efforts to be digital-age ready. It has adopted a holistic and inter-sectoral approach to leverage digital technologies to achieve the SDGs, encompassing the needs of all segments of society to ensure no one is left behind.

Power generation and distribution is still a major challenge with only about 18.8 percent of the entire population as of 2019 being connected to electricity. The Niger's urban areas have below average coverage access to electricity at 49.9 percent. Figures suggest that only 12.6 percent of over 80 percent of the country's population living in the rural areas have access to electricity. One of the many factors responsible for low electricity coverage is the country's vast land area, which requires a lot of infrastructural resources.

Closely related to electricity coverage is mobile and broadband connectivity. Sonitel, the state-owned fixed line operator merged with its wholly owned mobile unit SahelCom in late 2016 to form a new entity, Niger Telecom. As of 2019, the mobile telephony service in the Niger has four GSM mobile operators: Celtel Niger, Sahelcom, Atlantique Télécoms and Orange Niger. Niger Telecom is the dominant player with the fixed-telephone line market, with wireless CDMA constituting the majority of subscriptions. Similarly, most fixed Internet is through fixed-wireless. With the national coverage of 3 812 km of fiber optic cable, the Niger connects to border crossings into Nigeria, Benin, and Burkina Faso to access undersea cables. It is estimated that 4G coverage in 2019 stood at 7.2 percent of the territory (GSMA, 2019). At the same time, the number of secure Internet servers per 1 million inhabitants increased from 0.30 to 1.45 over the period 2015 to 2020.

Mobile subscriptions increased from 32.8 percent to 40.64 percent between 2014 and 2017. According to ITU, the number of active mobile broadband subscriptions per 100 inhabitants increased from 0.3 percent in 2013 to 3.9 percent in 2017. The same applies to international Internet bandwidth used that increased from 850 bit/s in 2013 to 7 399 bit/s in 2017. However current data available estimate the number of mobile connections as of January 2021 to be equivalent to 43.2 percent of the total population.

Efforts to improve digital infrastructure is evident in the collaboration between the Niger National Agency for the Information Society (ANSI) and ITU with the launch of the Smart Villages project. With the Agence Nationale pour la Société de l'Information (ANSI) taking the lead, the Niger Smart Village project aims at drastically improving the lives of rural people through the provision of digital services, particularly in the health, agriculture and education sectors. This is intended to bolster the country's efforts to meet the SDGs. Under the Smart Villages initiative, the Smart Villages Blue Print was also developed as a practical tool to provide lessons learnt and a step-by-step approach on how to establish and manage a smart village for sustainable development (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	12.62	WBG
		4G coverage (% of total coverage)	2019	7.20	GSMA
		Mobile (device) ownership (% of population)	2019	37.29	GSMA
		Secure access to Internet servers (per 1 million people)	2020	1.45	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2017	40.64	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	3.93	ITU
		Fixed broadband subscriptions (per 100 people)	2017	0.04	ITU

DIGITAL PENETRATION

The digital infrastructure development and systems in the Niger is a key factor responsible for the increased use of digital technology for various activities. The increasing use of platforms such as WhatsApp, LinkedIn, Facebook, and Skype is largely due to the increase of mobile penetration in recent years, reaching 51.9 percent in 2019 (ARCEP, 2019). The influx of smartphones and other digital devices have as a result increased significantly. Records available as of January 2021 estimate the total number of Internet users in the Niger to be 3.36 million, which was equivalent to 13.6 percent of the population.

Airtel is the Niger's largest wireless operator by subscribers with a 2G/3G network that as of 2018 covered approximately 18 000 villages in 264 communities out of the total 266 across the country. The second largest operator in the country is Orange Niger with a mobile market share of 29 percent. It is the leading provider of broadband mobile. The third player in the Niger telecommunication sector with 10 percent share of subscribers is Moov, which was acquired by Maroc Telecom from Etisalat in 2014. Since then it has provided 2G and 3G coverage in many towns and villages across the country. The fourth player is the state-owned fixed and mobile provider Niger Telecoms, which officially launched operations, including 3G mobile voice and data services in 2017. Niger Telecoms provides 3G network in parts of all regions and account for less than 5 percent of all mobile users.

According to Cable (2020), the average price of 1 GB of mobile data is USD 3.30 compared to USD 2.92 in 2019. The ITU also reports that the price of local mobile cellular calls per minute is USD 0.21 in 2017. The country's penetration of mobile social networks is estimated to be 2.1 percent (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.30	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	2.08	GSMA
		Number of apps in national language (quantity)	2019	10.95	GSMA
		Gender gap in social media use (%)	2019	0.00	GSMA
		Gender gap in mobile ownership (%)	2019	0.00	GSMA

POLICY AND REGULATION

Through ANSI, the Niger aims at promoting the use of information and communication technologies to achieve the SDGs. To this end, the Niger 2.0 strategic plan has been drawn up with the goal of achieving 100 percent Internet coverage in the country.

This plan aims at attaining a quality basic education, a population that is rapidly taken care of in terms of health, quality agriculture, financial and social inclusion, and the provision of sustainable solutions that are likely to revolutionise the lives of rural populations and the state executives in these areas.

The Niger 2.0 strategic plan has four main pillars, namely, e-government services, the creation of a "Technopole" (a city of innovation and technology), the promotion of digital technology and the Smart Villages project (ITU, 2019).

In December 2020, ANSI launched the Smart Villages Project for Rural Growth and Digital Inclusion (PVI) to leverage digital technology to develop the agricultural sector of the country. The government plans through this project to finance digital infrastructures, the organization of digital and financial education campaigns, the modernization of the means of payment for farmers and livestock cooperatives to develop dematerialized transactions and the creation of data platforms for farmers and ranchers. The project also aims at facilitating the installation of digital financial transaction services in the rural areas with the highest demand.

Created in 2018, the Electronic Communications and Post (ARCEP) is the regulatory authority responsible for electronic communications. ARCEP monitors communication services, ensures fair prices, ensures quality service, supports the development of enhanced sectors and mediates disputes in the postal and electronic communications industries. According to the National Telecommunication Regulation Authority (ARTP), the precursor to ARCEP, the telecommunications sector has entered an era of technical transformation and impressive growth, mainly due to technological transformation and the globalisation of the operation of networks and services (see Table 4)

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	74	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The Niger has taken different steps to attract foreign investment that is intended to boost the local economy as well as put measures in place to improve the country's business environment. These steps include reforms to liberalize the economy, foster privatization and increase imports and exports. According to the World Bank's Doing Business 2020 report, the Niger is one of twenty countries that implemented reforms to improve credit information systems by expanding the coverage of firms and individuals by credit registries or bureaus.

In 2016, the Niger's Chamber of Commerce created a special unit to assist both foreign and local investors. The chamber lists the benefits of doing business in the Niger as: political stability, economic freedom, an active chamber of commerce, and a waiting time of no more than three days to start a business. Further steps were taken in 2017 to create the High Council for Investment whose primary task is to provide support and attract foreign direct investments. A World Bank Report (2019) estimated the time needed to start a business in the Niger to be 10 days whereas the investment rate in the Niger was 29.3 percent in 2018 according to the National Institute of Statistics of Niger (INS) (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	593	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	10	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

In May 2017, the government adopted the Stratégie de Développement Durable et de Croissance Inclusive (SDDCI) Niger 2035 (Strategy for Sustainable Development and Inclusive Growth, Niger 2035). The first plan for the implementation of the SDDCI, the Plan de Développement Economique et Social 2017-2021 (Plan for Economic and Social Development, [PDES]) was adopted in September 2017. The overall strategy seeks to address the main constraints to development, including national security, public administration, human capital (education and health), population growth as well as economic growth, rural development, and private sector development.

The government has prioritized the education and training sectors in its budget. For instance, in 2016, public spending on education accounted for 20.7 percent of the total budget and 5.2 percent of GDP. Data provided by UNESCO on the literacy rate of the country shows some improvement but far from the ideal rate. In 2018, literacy rate of youth (15-24 years of age) was 43.5 percent (51.1 percent for males 35.6 percent for females). For adults (aged 15 years and older), the literacy rate was 35 percent (43.6 percent for males and 26.7 percent for females). For those aged 65 years and above, the literacy rate was the lowest at 15.8 percent (22.8 percent for males and 9.2 percent for females). In terms of education, the Niger's population of primary school children (7-12 years of age), secondary school (13-19 years of age) and tertiary school (20-24 years of age) are about 4 million in total. Being one of the few countries in the world without compulsory primary education, only 65 percent of the primary school age children and 20 percent of secondary school age children attend school (23 percent male and 17 percent female). In 2018, only 4.4 percent of tertiary school age children were enrolled in a school (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	35.05	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	43.46	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	72.54	ILO
		Employment in agriculture, female (% of female employment)	2019	69.47	ILO
		Unemployment, total (% of total labour force)	2020	0.69	ILO

AGRO-INNOVATION

In partnership with the international non-profit association CORAF, the national agricultural research systems of the Niger and the livestock Regional Centre of Specialization work hand-in-hand to devise science and technology solutions that assist agriculture actors. This includes assistance to generate high-performing agricultural innovative technologies, increase agricultural productivity through the provision of high-yielding varieties, construction and rehabilitation of agricultural research, the development infrastructure, and improved access to innovations and technologies by producers. To facilitate R&D and innovation in the agriculture sector through ANSI, the government has collaborated with the International Crops Research Institute for the

Semi-Arid Tropics (ICRISAT) to set-up an innovation and technology city at ICRISAT's Sadore facility. The centre is expected to focus on key sectors including health, agriculture and education. The facility will host small and medium enterprises and will incubate start-ups. Drones for agriculture, AI-based image recognition for crop health, and mobile-based platforms will all be utilised to collect and collate farm data.

Some innovative start-ups in the Niger worth mentioning include: TECH-INNOV Niger (digital transformation of agriculture in Africa), CSAN Niger (e-extension of traditional agricultural extension through digital technology), Dev4Smart, Drone Africa service Niger, Agri Business Consulting (ABC), etc.

Notable digital innovations in agriculture include Tele-Irrigation which allows farmers to use control a farm's irrigation system remotely, independently of time and space via IOT cell phone sensors following an intelligent distribution of water (needs, quantity, time, speculation, vegetative cycle). Receiving meteorological and hydrological data in real-time is an important innovation (Patent no. 16025 OAPI / BOPI / 07/13). ReCA is a mobile application for smartphones and tablets in Hausa, Zarma and French providing remote agricultural advice. It was designed by the National Network of Chambers of Agriculture (RECA) and the Regional Chambers of Agriculture (CRA) of the Niger. ReCA is aimed at technicians, advisers and the creators of agricultural advisory systems as well as producers. It provides access to useful and educational information on the problems encountered by producers or relayed by advisers, and how to solve them.

E-KOKARI is an interactive voice response (IVR) platform developed locally to aid farmers, breeders and buyers to access information, advice, alerts and market prices in the field of agriculture and livestock. AGRITECH is a web and mobile platform developed by ITECH CENTER to bring together stakeholders in the agricultural world through digital technology. It focuses on plant production, breeding, poultry farming, forestry and fish farming. Its objective is to serve as a framework for direct exchange between producers/processors and experts; a sales channel between producers/processors and consumers, as well as providing support for rural producers.

The Orange application Labaroun Kassoua provides farmers with information on prices of crops (onion, sesame, cowpea, peanuts, potatoes) and livestock (cow, goat, ram, camel, bull, heifers, sheep). Finally, AGRITECH SHOP is an e-commerce platform providing home delivery services for assorted products that can be purchased online.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	4 385.93	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	119.94	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.07	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.32	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2018	2.66	UNCTAD

NIGERIA

Nigeria is a lower-middle-income country with a GDP of USD 432 billion. The country accounts for 47 percent of West Africa's population, while half of the country's population of 206 million people are under the age of 30 (see Table 1).

Nigeria currently has 66 million smallholder households with 30 million hectares under cultivation. Although 80 percent of its land is arable, only 40 percent of it is cultivated. Nigeria remains a net food importer as the agricultural trade deficit widened by NGN 689.7 billion in 2019 compared to NGN 549.3 billion in 2018.

Agriculture's contribution to Nigeria's GDP in 2019 was 26 percent, while 34.97 percent of the labour force was engaged in agriculture. About 72 percent of smallholder farmers live below the poverty line of USD 1.9 or less a day. The agricultural sector grew by 1.6 percent (year-on-year) in the second quarter of 2020, a regression of -0.21 percent points to the corresponding period of 2019, and -0.62 percent points from the preceding quarter.

Nigeria's ICT sector expanded in the last decade: its contribution to GDP doubled during 2010-2017 and accounted for 12.2 percent of the GDP in 2018. In 2018, the sector contributed 9.7 percent to GDP growth. However, in 2017, only 5 percent of Nigeria's exports were in the ICT sector.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	206 139 587	WBG
Urban population (%)	2020	51.96	UNPD
Rural population (%)	2020	48.04	UNPD
GDP (current millions of USD)	2020	432 294	WBG
Agricultural land (km^2)	2018	691 235	FAO
Agricultural land (% of land area)	2018	75.90	FAO

INFRASTRUCTURE

In Nigeria, 55.4 percent of the population have access to electricity in 2019. The situation is even more dire in rural areas, where only 25.6 percent of inhabitants have access to a centralized power source. Gillwald et al. (2018) found 66 percent of Nigerian households were connected to the main electricity grid, 33.1 percent did not have an electricity connection at all, 11.4 percent depended on generators, while less than 1 percent had access to solar power.

From a connectivity perspective, according to ITU, 2G network connectivity covers 89 percent of the entire population, 3G reaches 78.3 percent of the population and LTE/WiMAX covers 50.8 percent. By 2016, 88.7 percent of the population had access to mobile phones of which 93 percent were in urban areas, and 86 percent in rural areas. About 59 percent of the population owns a mobile phone (74 percent in urban areas and 48 percent in rural areas). Nigeria has a 94 percent phone penetration, with smartphones at about 30 percent penetration and feature phones at 70 percent penetration (Adepetun, 2017).

According to the State of ICT in Nigeria 2018 report, there is also an important digital gap of mobile broadband, with just over 20 percent of Nigerians owning a smartphone, 44.8 percent a feature phone, and 32.2 percent a basic phone. In addition, the report reveals that males are more likely to own a smartphone than females, while females are more likely to own a feature phone and basic phone (Gillwald, et al., 2018).

The establishment of the sector's independent regulator in 1999, the Nigerian Communications Commission (NCC), ended the monopoly of M-Tel, the mobile subsidiary of fixed line incumbent, NITEL. The liberalization process was kick-started with the awarding of three GSM spectrum licenses, via an auction, to MTN, CIL (now GLO), and Econet Wireless Nigeria Ltd. The deployment of the high bandwidth cables has increased competition in the mobile industry with operators now focusing on rolling out 4G/LTE technologies. Currently there are four GSM operators: Airtel (a subsidiary of the Indian mobile group); MTN (a subsidiary of the South African MTN Group); 9mobile, which was formerly EMTS (a subsidiary of Etisalat of the United Arab Emirates); and Globacom (owned by a privately held Nigerian group). There are also two operators using CDMA technology, Visafone, and Multilinks, but their market share is negligible. NatCom acquired the assets of the bankrupt incumbent operator NITEL in 2015, including its mobile licenses, and launched under the brand Ntel (ITU, 2018). Nigeria is connected to high-speed Internet via five undersea international links: Main One; Glo; West African Cable System (WACS); SAT-3/WASC; and ACE submarine cable system.

Due to several factors, Internet access today in Nigeria is 99 percent through wireless mobile networks and less than 1 percent through fixed wireless (Agboje et al., 2017). Furthermore, fixed broadband penetration had a household penetration rate of 0.04 percent at the end of 2018. Nigeria does not have a national backbone network through which high-speed Internet connectivity can be extended across the entire country. As a result, mobile broadband has become the most common and popular way through which people in Nigeria access the Internet.

Mobile wireless Internet access is limited by coverage, number of users per site and scarcity of devices with 4G capability. These limitations are overcome where there is access to fixed wired/wireless facilities. The 4G wireless is still limited to cities, such as Lagos, Abuja and Port Harcourt (Agboje et al., 2017). According to the ITU, in 2018, 19.9 percent of the population used their cell phones to connect to the Internet. Overall Internet usage in Nigeria stands at 27.7 percent (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	25.55	WBG
		4G coverage (% of total coverage)	2019	45.20	GSMA
		Mobile (device) ownership (% of population)	2019	55.24	GSMA
		Secure access to Internet servers (per 1 million people)	2020	73.94	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.26	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	99.07	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	35.90	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.03	ITU

DIGITAL PENETRATION

Urban Internet access increased to 29 percent, while in rural areas the rate was 9.8 percent in 2016. The percentage of those who owned/subscribed to Internet services among urban respondents was 75.5 percent and rural subscription is 77.5 percent. An ICT survey reveals that of those unconnected, 50 percent stated they cannot use the Internet because they cannot afford the devices required to access it. Over 25 percent cited lack of electricity as the reason, while over 20 percent cited lack of signal (mobile coverage) (Gillwald, et al., 2018). For example, a recent survey of smallholder farmers in Nigeria found that 77 percent of mobile phone users use basic phones without Internet capability, 88 percent of them have never used the Internet to access information for business purposes, and 49 percent never use cell phones and SMS services for business purposes (Anderson, et al., 2017).

A report by the GSMA in 2019 points to the existence of about 53 mobile apps in the country's national language. Statcounter (2020) also reports that approximately 43 percent of Nigerians use Facebook, 39.88 percent use Twitter, 9.8 percent use Pinterest, 3.7 percent use Instagram and 0.3 percent use LinkedIn. The GSMA also reported that about 13.3 percent of the country's population actively engaged with social media platforms as of 2019.

Cable in 2020 posited that the average price of a 1 GB of mobile data stands at USD 1.39. According to ITU, the mobile broadband prepaid handset-based price (500 MB) was 1.9 percent of Gross National Income (GNI) per capita. Gillwald et al. (2018) found that 32 percent of non-users of the Internet cited high data cost.

The top use of the Internet was to send/receive emails in urban areas (46.3 percent), rural areas (45 percent) and nationally (45.8 percent).

The use of Internet for banking services was quite low among urban areas (0.4 percent), rural areas (0.5 percent) and nationally (0.4 percent). Out of the 99 million financially eligible adults in Nigeria, about 36.8 percent are excluded from the financial system. The proportion of rural adults who have made or received a digital payment in 2017 in Nigeria was 22 percent. Almost 40 percent of people aged 15 years or older hold an account at a financial institution or through a mobile money provider. Mobile phones are owned by 67 percent of unbanked men in Nigeria and 53 percent of unbanked women. Nearly 1 in 10 unbanked adults works in the private sector and receive wages in cash, and 77 percent of them own a mobile phone.

Around 37 percent of government transfers have been digitized, mostly through mobile

money and/or bank transfers. There is potential to digitize the remaining 63 percent of transactions that are still cash-based (World Bank Global Findex).

In 2018, e-commerce spending in Nigeria was estimated at USD 12 billion and was projected to increase to USD 75 billion in revenue by 2025. Digital commerce was provided, among others, by 87 Nigerian platforms, employing 2.9 million people in the country, of which 66 were homegrown (76 percent), and the remaining were from the U.S. (10 percent), Europe (6 percent), the rest of Africa (3 percent) and other places (5 percent). The major e-commerce retailers have over 1 million customers and receive an average of 300 000 unique visits per day.

The Lagos ICT Services Cluster has been valued at over USD 2 billion with around 400 to 700 active start-ups. In Nigeria, 80 agritech companies and start-ups have emerged over the last decade. Crest Agro-processing project, AgroMall, Beat Drone, Kitovu, Paga, Kiakia, Thrive Agric, Hello Tractor, Farmcrowdy, Releaf, Mysmartphone, DSI Technologies Limited, E-Farms, Crop2Cash, Quick Leap, Payfarmer and Cellulant to cite a few. For example, Farmcrowdy and Thrive Agric offer platforms for the general public to crowdfund farmers while Hello Tractor offers a shared tractor service. AgroMall uses farmer data to generate economic identities for farmers while Crop2Cash's solution digitizes entire value chains and provides digital payments.

From a public perspective, the government has recently launched the Central Portal for Government Services to provide a single point of entry to government information and services, enhancing accountability and improving the delivery and quality of public services. However, data from 2018 show that only 2 percent of citizens use e-government services because mobile technology (which is a predominant channel for access in Nigeria) is still short on data services, especially in rural areas. As a result, many citizens are caught up in a digital divide. In addition, the National E-Agriculture Web Portal is a strategic initiative of the National Information Technology Development Agency (NITDA) in collaboration with the Federal Ministry of Agriculture and Rural Development (FMARD) to showcase the essential features and key aspects of the food and agriculture industry in Nigeria.

The Kano State Agricultural Development Authority (KNARDA) maintains an agricultural radio station that broadcasts about four hours daily. NAERLS and Sasakawa Global 2000 also air radio programs, and Fadama has worked on establishing community radio stations. NAERLS also provides a weekly 15-minute broadcast on commodity prices. Airtel Nigeria and Human Network International (HNI) launched the 3-2-1 Service in November 2016 as a free service that provides information to mobile phones on-demand, on agriculture, commodity prices, weather and other information in five national languages (see Table 3).

To address inefficiencies, the government of Nigeria established the Growth Enhancement Support Scheme (GESS) in 2011 as part of efforts to liberalize the input subsidy system. The GESS provides subsidised fertilisers and seeds directly to farmers through an electronic wallet system. Currently, e-Wallet has 15 million subscribers, several million of whom are women farmers (Adesina, 2017). In 2014, 7.22 million farmers received a total subsidy transfer of NGN 82.4 billion (USD 420 million) via their mobile phone.

Community Resource Centers (CRC), funded by the Universal Service Provision Fund (USPF), aims at extending voice and ICT training and other e-services to unserved communities on a shared basis to bridge the digital divide across communities.

The National Agricultural Payment Initiative (NAPI) was developed as part of the second phase of the GESS. NAPI involves the distribution of chip-based national identity cards that provide access to financial services such as loans to farmers, in addition to holding subsidy information.

Oyinbo, et al. (2020) found that about three quarters of extension agents were proficient in the use of smartphones and/or tablets but

only 44 percent owned a smartphone and only 2 percent owned a tablet. Also, the majority of extension agents (87 percent) were affiliated to the public extension system. About 30 percent of the extension agents have ICT-based extension experience.

Sterling Bank Nigeria has two block-chain enabled solutions. SABEX 1 caters to agro-dealers with input provision and credit. SABEX 2 provides farmers with credit against harvests, market linkages, and warehouse storage services to reduce post-harvest losses.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.39	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	1.71	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	22.08	ITU
	Willingness	Mobile social media penetration (%)	2019	13.34	GSMA
		Number of apps in national language (quantity)	2019	53.00	GSMA
		Gender gap in social media use (%)	2019	45.43	GSMA
		Gender gap in mobile ownership (%)	2019	77.31	GSMA

POLICY AND REGULATION

In 1992, the National Broadcasting Commission (NBC) Decree 38 and the Nigerian Communications Commission (NCC) Decree 75 changed the ICT environment permanently. Both decrees began to open the broadcasting and telecom markets. Nigeria produced a national ICT policy in 2012 through the Federal Ministry of Communications (FMC). It formulates policy on communications, while the Nigerian Communications Commission (NCC) implements telecommunications policies.

In 2015, the Nigeria Communications Commission's (NCC) 8-Point Agenda proposed the transition of Nigera into a digital economy through investment in digital infrastructure, and more specifically broadband.

The Rural Broadband Initiative (RUBI), also funded by USPF, provides subsidies to operators for the deployment of a network to support the establishment of core delivery mechanisms for broadband services in the rural/semi-urban areas of Nigeria (Universal Service Provision Fund, 2015b).

The Nigeria Open Data Policy presents a great opportunity to increase access and improve accountability. Although the policy is still in the process of being adopted, the draft already contains elements of Open Data principles, including data completeness, timeliness, data propriety, and licensing. Nigeria does not have a Privacy and Data Protection Act. This has limited the growth of e-commerce and the data economy. Nigeria has a Cybercrimes and Cybersecurity Act (2015), which provides a framework for the prevention, detection and punishment of cybercrimes and the protection of critical national information infrastructure.

The recent Nigerian Data Protection Regulation, passed in January 2019 is a step toward improving data compliance (Salami, 2019). The Intellectual Property (IP) protection policy is outdated, and the Cybercrimes Prevention Act is not effectively implemented.

The National Information Technology Development Agency (NITDA) was created in April 2001 to implement the Nigerian Information Technology Policy and co-ordinate general IT development in the country. It recently developed the Nigeria Digital Agriculture Strategy (NDAS) as a ten-year (2020-2030) plan that provides purpose and direction for

adopting digital technologies in agriculture. It is inspired by the Economic Recovery and Growth Plan (ERGP) of the Federal Government and the Agriculture Promotion Policy (APP). It is an offshoot of the Nigeria Smart Initiative and the Nigeria Digital Economy Policy and Strategy (NDEPS). An implementation governance framework to be anchored by the National Information Technology Development Agency (NITDA) and supervised by the Federal Ministry of Agriculture and Rural Development (FMARD) and the Ministry of Communications and Digital Economy.

In the agriculture sector, from 2011-2015, the Nigerian government implemented the Agricultural Transformation Agenda (ATA), which sought to support agriculture by introducing business-like practices to the sector. Following the ATA, the government launched the Agriculture Promotion Policy (2016-2020) in 2015, as well as several agricultural development initiatives. These include: The Anchor Borrowers Program (ABP), the Presidential Fertilizer Initiative (PFI), the Youth Lab, the Presidential Economic Diversification Initiative (PEDI), the Food Security Council and the Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL).

In an attempt to enhance local trade and exports, the government has introduced some policies and programmes: Nigeria-Africa Trade and Investment Promotion Programme; Presidential Economic Diversification Initiative; Zero Reject Initiative and Economic and Export Promotion Incentives.

Digital entrepreneurship (including agriculture) is a government priority, as outlined in the Economic Recovery and Growth Plan 2017-2020 (ERGP). The government also adopted the Nigeria ICT Road Map 2017-2020 and the Nigeria ICT Innovation and Entrepreneurship Vision (NIIEV) released in 2018 (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	3.37	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	3.54	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	2.53	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	2.86	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	78.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2018, Nigeria attracted the highest number and amount of Africa's digital investment deals. The African Tech Start-ups Funding Report shows that Nigeria emerged as the premier investment destination on the continent in 2018, with 58 start-ups raising a total of USD 95 million (Disrupt Africa, 2018). Investment funding for Nigerian start-ups, including agritech, was more than USD 100 million in 2016, increasing to USD 117 million in 2018.

Nigerian agribusiness economy has 3 300 agricultural microenterprises, 1.5 million agricultural SMEs that represent 9 percent of all MSMEs in the country.

As part of efforts to boost job creation, particularly among the youth, the Central Bank of Nigeria (CBN), in collaboration with the Bankers' Committee, introduced the Creative Industry Financing Initiative (CIFI) with a view to improving access to long-term low-cost financing for entrepreneurs and investors in the Nigerian creative and information technology sub-sectors. However, lending to the agricultural sector accounts for only 3.4 percent of all bank lending in Nigeria (as of 2019).

The government's Smart Nigeria Digital Economy Project is a digital-led strategy initiative centred around the establishment of an ICT ecosystem in Nigeria through the Special Agro-Industrial Processing Zones (SAPZs) aimed at boosting productivity, integrating production and enhancing the processing and exporting of select commodities (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	3 299	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.18	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	1.80	WEF
	Entrepreneurship	Time required to start a business (days)	2019	7.2	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.58	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	5.19	WEF

HUMAN CAPITAL

Literacy levels in Nigeria are low: 62 percent for adults and 75 percent for youths. The levels are relatively lower in rural areas, and slightly lower for women. Out of a total population of 190 million, the Nigerian labour force is estimated to be in the region of 59 million, with a literacy rate of 51 percent.

The vocational training sector in Nigeria is regulated by the National Board for Technical Education (NBTE), which operates under the Ministry of Education. In March 2020, the NBTE cited some 557 TVETs, including 33 colleges of agriculture (19 federal, and 14 state); 134 federal, state and private polytechnics, of which only seven have agricultural programmes; 31 specialized institutions; 158 mostly private Innovation Enterprise Institutions (IEIs), offering National Innovation Diplomas (NIDs); 78 mostly private vocational enterprise institutions offering national vocational certificates; and 123 (mostly public) technical colleges that mostly focus on sectors other than agriculture. At the same time, the Nigerian Universities Commission currently lists 171 accredited universities, of which four are specialized federal universities of agriculture, 30 federal universities, 28 state universities, and seven private universities all have agricultural faculties, schools or colleges. In addition, a number of business schools in Nigeria offer specialized programmes in agribusiness. Of the TVETs listed above, three federal and three state polytechnics have agriculture or food-related schools or departments; 18 are federal colleges of agriculture, livestock, forestry, fisheries, and land resources colleges; two are federal cooperative colleges; and 17 are state colleges of agriculture. The annual turnover

of students in federal and state agricultural colleges is reported at 27 000. Nevertheless, the current agricultural TVET system does not provide specialized public training in agriculture at a grassroots level. The NBTE currently lists 15 national diploma programmes under agriculture and related technologies.

From a digital economy perspective, institutions like the Abu Bakar Tafawa Balewa University (ATBU) or the Federal University of Technology Minna (FUTM) offered TVET programmes that include electronics, automobile and mechanical production, agriculture and business education, and building and woodwork (Ismail & Sale Mohammed, 2015).

There is an estimated 3 000 NGOs active in agriculture in Nigeria. They provide farmer training via short courses, as well as farmer field schools. Prominent examples include Sasakawa Global 2000 (SG2000), Technoserve and ACDI-VOCA.

The government-supported Knowledge for Development without Borders (KFDWB) programme provides basic ICT training for underprivileged youth in Nigeria. The state government of Osun partnered with RLG Adaulawo Technology City, Ilesa and Omoluabi Holdings (OYESTECH I) to provide ICT training to more than 10 000 youth as of 2012. In 2018, the group trained an additional 5 000 youth in the second phase (OYESTECH II), aiming at ultimately addressing youth unemployment and equipping youth with the requisite skills for the job market and digital transformation (ITU, 2018).

Investors in Nigeria have committed to building the capacities of youth to fill the skills gap and ensure digital transformation. Paradigm Initiative (PIN) partnered with UK Trade & Investment, Goggle, Ashoka and Intel to launch the ICT LIFE school, which targets underserved Nigeria communities by leveraging digital inclusion and youth development.

PrepClass is a tutoring marketplace that connects students and tutors through an online platform. Under the School Knowledge Centres (SKC) 396 public secondary schools have been provided with connectivity, computers, and power backup. Teachers and students are taught how to use ICT as part of the project, as well as one-year technical support, warranty, and remote ICT management. The Basic Digital Education Initiative (BDEI) organized by Tech4Dev and Microsoft is expected to train 500 000 young Nigerians (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	62.02	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	75.03	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.42	WEF
	Employment	Employment in agriculture (% of total employment)	2019	34.97	ILO
		Employment in agriculture, female (% of female employment)	2019	23.57	ILO
		Unemployment, total (% of total labour force)	2020	9.01	ILO

AGRO-INNOVATION

Only about NGN 40 billion has been earmarked by the government for agricultural research and development in 2019. The overall agriculture budget represents 1.8 percent (or NGN 183 billion) of the total 2020 budget.

Budget allocation for agriculture has fluctuated in recent times. For instance, the budget allocation for the sector increased from 1.25 percent in 2016 to 1.8 percent in 2017 and a significant 2.2 percent in 2018. But by 2019, the budget allocation dropped to 1.6 percent.

Only a small number of Nigerian firms (13.8 percent) invest in R&D. Among digital industries, only software developers have significant R&D expenditure amounting to 23.4 percent (Ernst & Young: Nigeria, 2018).

Eleven of the Federal Colleges of Agriculture (FCAs) in Nigeria come under the Agricultural Research Council of Nigeria (ARCN), and by extension the Federal Ministry of Agriculture and Rural Development. The ARCN was established in 2006 with a mandate to coordinate, supervise, and regulate agricultural research, training, and extension in Nigeria. It became the apex organization for 15 (of a total of 18) mostly commodity-oriented or thematically focused Agricultural Research Institutes (ARIs).

Nigeria is home to several high-growth digital companies that provide hopeful examples of the country's digital potential. Lagos is a mature and active ecosystem with dynamic incubators, venture capital companies, and digital start-ups. Digital entrepreneurship ecosystems are also growing in the cities of Abuja and Port Harcourt, with a potential for expansion to other cities. Although urban SMEs are increasingly using digital platforms for trading, digitalization of firms in traditional industries and rural locations remains limited. As of 2018, Nigeria has 55 active tech hubs, and over 100 digital hubs (incubators, co-working spaces, and accelerators) across the country. Nigeria has also attracted several multinational companies including Google, Microsoft, and Facebook, which have set up their own incubators/accelerator programs.

Notable new initiatives that help tackle the gender gap include innovation hubs (e.g. She Leads Africa), women-focused acceleration programs by mainstream hubs (e.g Venture Garden Group's Greenhouse Lab and Impact Hub), and networking events (e.g. African Women in Technology Conference and Tech Women Lagos). The two recent players, Network of Incubators and Innovators in Nigeria (NINE) and Hubs Nigeria Network (HNN), connect over 75 hubs, and support knowledge sharing and standards setting.

To improve innovative capacities of young entrepreneurs, set ups such as Agri Lab are creating the avenue for idea incubation and training.

L5Labs is a business incubator focused on building outstanding businesses in Africa. The focus is on the rapidly expanding mobile and Internet technology space in Nigeria. L5Labs works with start-ups and early stages businesses led by teams, comprising individuals with outstanding leadership potential who are aiming at tapping into very large identifiable markets. The Technology Incubation Centre in Benin City has a broad mandate to assist small-scale budding entrepreneurs to overcome the initial hurdles of bringing viable R&D results and other technologies into profitable enterprises. The Venia Business Hub in Lagos was established to render conducting business in Nigeria practical, affordable and flexible for start-ups, SMEs, corporate organizations and multinationals, as well as linking growing businesses to a pool of companies for financial support as and when required. Cocreation Hub Nigeria, or CcHUB, is Nigeria's foremost open living lab and pre incubation space. It is designed to be a multi-functional, multipurpose space, where work to catalyse creative social tech ventures takes place. The Hub allows technologists, social entrepreneurs, government, tech companies, impact investors and hackers in and around Lagos to co-create new solutions to the numerous social problems in Nigeria. In addition, Technology Incubation Centre G-led, The Tinapa Knowledge City (TKC) project and Minna Tech Incubation Centre are governmental-led hubs.

Angel investors are common in Nigeria and often provide early-stage funding even from the outset before a start-up joins an incubator or an accelerator programme. International donors providing concessional finance, such as GIZ, UK Aid Direct and USAID, are also active in the agritech space in Nigeria. Nigerian agritech start-ups raised USD 2 million in 2019 (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	112 451.14	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	106.65	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.53	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	0.22	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.52	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.94	WEF
		ICT goods imports (% of total imports)	2019	3.72	UNCTAD

RWANDA

Rwanda is a low-income country with a GDP of USD 10.3 billion as of 2020. Rwanda has experienced an economic boom over the past decade with an annual average growth of more than 7 percent between 2000 and 2019. The majority of the population still lives in rural areas. Though the percentage of rural population decreased between 1991 and 2002 from 94.5 percent to 83.2 percent, it remained stable until 2019 at 82.6 percent. Moreover, 42 percent of its urban population lives in slum areas (World Bank, 2018). The poverty rate has declined from 77 percent in 2001 to 55 percent in 2017, reflecting progress in Rwanda's social performance attained through strong leadership implementing social policies (see Table 1).

Agriculture remains a crucial sector contributing 31 percent to GDP and employing 62.3 percent of the total population. Almost 61 percent of Rwanda's land is fertile and suitable for agriculture (Rwanda Development Board, 2020). Tea and coffee are the top export products while cassava, potatoes, maize, and rice make up the main food crops. However, Rwanda's agriculture faces many constraints like land distribution, low productivity and limited capacity. ICT is therefore considered a potential enabler in the process of addressing some of these challenges in order to drive rural development and reduce poverty, considering its increasing contribution to Rwanda's economy with an annual average growth of 21.1 percent.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	12 952 209	WBG
Urban population (%)	2020	17.43	UNPD
Rural population (%)	2020	82.57	UNPD
GDP (current millions of USD)	2020	10 334	WBG
Agricultural land (km^2)	2018	18 117	FAO
Agricultural land (% of land area)	2018	73.44	FAO

INFRASTRUCTURE

As of 2019, 37.8 percent of Rwanda's population had access to electricity. The access for rural areas is 26.2 percent (see Table 2). Compared to below 10 percent years ago, the improved access is largely due to government interventions. Rwanda is rich in energy resources including solar, thermal, hydro, and methane. The government aimed at ensuring 100 percent electricity access by 2020 as announced in its 2016 Rural Electrification Strategy (FAO).

3G and 4G services play an important role in Rwanda, with a high coverage of 90.3 percent and 99 percent (see Table 2) respectively. 4G was mainly supported and upgraded by Korea Telecom Rwanda Networks (KTRN) under public-private partnerships (ITU, 2018). In addition to KTRN, which is a dominant player in the 4G/LTE market, MTN and Airtel Rwanda are also the key players in providing 2G and 3G services, covering more than 95 percent of the population (Rwanda Utilities Regulatory authority, 2019).

Both the public and private sectors have undertaken efforts to enhance connectivity in Rwanda. In 2019, the Ministry of ICT and Innovation announced that the first communication satellite was successfully launched to improve Internet connectivity across the country. The Rwanda Utilities Regulatory Authority (RURA), jointly working with ITU, is undertaking a broadband expansion project to increase rural connectivity and low-cost Internet access. The local broadband provider Liquid Telecom launched in 2020 a new range of fiber broadband products to provide fast and reliable connections, targeting households in selected areas of the capital city Kigali (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	26.21	WBG
		4G coverage (% of total coverage)	2019	99.00	GSMA
		Mobile (device) ownership (% of population)	2019	54.80	GSMA
		Secure access to Internet servers (per 1 million people)	2020	81.92	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	5.07	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	81.95	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	42.30	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.14	ITU

DIGITAL PENETRATION

According the Rwanda Utilities Regulatory Authority's (RURA) Annual Report (2019-2020), Internet subscriptions per 100 inhabitants increased to 62.3 percent as of June 2020. Fixed broadband subscriptions remain low at 0.07 per 100 inhabitants because Internet access is primarily concentrated in the capital city. Low income and awareness as a result of poverty hinder Internet access in rural communities. There is a variety of sector players in Rwanda. The main mobile network operators are MTN Rwanda and Airtel Rwanda while 26 Internet Service Providers (ISPs) are competing in the market (RURA, 2020).

On the contrary, mobile cellular subscriptions are much higher at 82 percent, seeing a sharp

increase compared to 35.3 percent a decade ago (see Table 3). Rwanda has relatively cheap mobile data, with USD 1.48 per 1 GB (see Table 3). However, only 4.7 percent of the population is active on social media (see Table 3). To further increase the penetration of smartphones as a basic tool to access digital services and bridge the digital divide in rural areas from their current level below 20 percent, the Connect Rwanda campaign was launched in 2019 to pledge smartphones to vulnerable households and individuals who cannot afford them.

The expansion of smartphone use is due to Rwanda's booming mobile payment services. There are currently six mobile money services, three of which are offered by MNOs and three by banks (International Finance Corporation, 2020). This is also in line with the government's vision of building a "cashless society" (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.48	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	6.88	ITU
		Fixed broadband prices as a % of adjusted per capita income	2016	48.14	ITU
	Willingness	Mobile social media penetration (%)	2019	4.69	GSMA
		Number of apps in national language (quantity)	2019	28.00	GSMA
		Gender gap in social media use (%)	2019	19.59	GSMA
		Gender gap in mobile ownership (%)	2019	7.10	GSMA

POLICY AND REGULATION

Reflective of the importance of the ICT sector as a pillar of the country's development strategy, Rwanda scored 5.77/7 in the recognition of the importance of ICT in national policies. It also scored a high 6.05/7 in the proliferation of ICT (see Table 4). The Ministry of Youth and ICT (MINICT), which is responsible for ICT policy and strategy development launched a Smart Rwanda Master Plan 2015-2020. The government has demonstrated strong ambition to go cashless and paperless as well as offering 24-hour self-service. The plan also highlighted the importance of ICT in terms of generating job opportunities driven by the private sector.

Digitalization of agriculture is gradually taking shape in Rwanda's national policies. The 2017 National Agriculture Policy indicated that overall digitalization brings opportunities for agriculture, which could be integrated in skill development, data collection and analysis. The National ICT4Rag Strategy (2016-2020), aligned with the national ICT strategy as well as the Smart Rwanda Master Plan, further illustrates the importance of enhancing farmer-centric agriculture and rural development through concrete implementation plans, pursuing a poverty reduction goal of less than 30 percent by 2020. Moreover, the Government of Rwanda is currently developing a national digital agriculture strategy in partnership with FAO for its upcoming five-year schedule (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	5.77	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	6.05	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	4.72	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	4.67	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	82.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Investment in Rwanda is mostly public sector-led, which results in large amounts of external borrowing. Government debt stood at 51.4 percent of GDP in 2019. The government has adopted a series of policies to reform and reduce dependency by attracting more foreign investments and improving its business climate. For instance, the 2015 Investment Code aims at boosting FDI through incentive. It also protects the intellectual property rights of investors, particularly relevant to technology transfer.

Rwanda currently has a relatively high score of doing business, at 93.2 of 100. It takes just four days to start a business with zero cost thanks to the efficient and fast online processes offered by the Rwanda Development Board (RDB). SMEs can also benefit from 2018 property tax law to obtain a two-year exemption for tax trading license. Rwanda also created the Chamber of Women Entrepreneurs to encourage women's participation in the economy and to promote gender equality in business and investments.

However, some limitations for businesses to maintain their operations still exist, such as strong government interventions, limited access to affordable credit, inconsistent application of tax incentives and import duties, unstable supply of electricity and water, and so on.

Favourable policies also motivate investors to target opportunities in agriculture. Rwanda has built up an attractive enabling environment including duty-free importation of inputs, tax exemption for equipment, reduction in corporate income tax as well as a one-stop centre for process facilitation (Rwanda Development Board). Furthermore, sub-sectors such as food processing, horticulture, livestock, distribution and cold chain offer huge investment opportunities (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	420	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.33	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.24	WEF
	Entrepreneurship	Time required to start a business (days)	2019	4	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	4.06	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.42	WEF

HUMAN CAPITAL

The total literacy rate of Rwanda has been continuously improving, reaching 73.2 percent in 2018. Meanwhile the literacy gender gap has decreased particularly between youth males and females, at 84.3 percent and 88.5 percent respectively. However, digital literacy is less than 10 percent, which largely affects the promotion and adoption of ICT tools.

Given the importance of ICT particularly in the increased uptake of mobile payments, the government is aiming at improving the country's digital skills and literacy both in terms of quality and quantity, with a particular focus on education as a sector and vulnerable groups as a target. This goal was particularly underlined in the National Digital Talent Policy launched by MINICT and followed by actionable programmes like the Digital Ambassadors Programme (DAP). Selected digital ambassadors will acquire digital skills through boot camp and training, whose digital capacities will further influence their communities. Higher learning institutions also offer ICT related courses through academic programs to enhance students' digital skills (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	73.22	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	86.49	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.96	WEF
	Employment	Employment in agriculture (% of total employment)	2019	62.29	ILO
		Employment in agriculture, female (% of female employment)	2019	70.98	ILO
		Unemployment, total (% of total labour force)	2020	1.35	ILO

AGRO-INNOVATION

The total R&D expenditure in Rwanda contributed to 0.7 percent of GDP. Agricultural R&D accounted for only 0.44 percent of total agricultural GDP (IFPRI). UNESCO reported that the majority of R&D activities were led by the government at 70 percent, while higher education, the private sector and non-profit institutions contributed only a small proportion. With this government-led nature, 64.5 percent of R&D funds were government-sourced while the rest was mainly from external funds.

As the only government agricultural research centre, the Rwanda Agriculture Board (RAB) employs 63 percent of total researchers. In terms of qualification, a master's degree is the minimal requirement to become a researcher in RAB, while doctoral degrees are held by only a small proportion of researchers. A gender gap is also evident with only 24 percent of researchers being female (IFPRI).

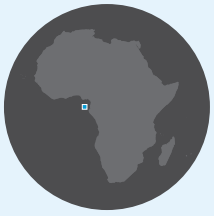
With a growing youth population and faced by persistent challenges in agriculture, digital agriculture is a way out for Rwanda. It can create job opportunities and increase income. In this context, the government in partnership with international development organizations and the private sector has made great efforts in deploying digital solutions in agriculture. The Rwanda Development Board (RDB) has taken the lead in partnering with FAO in a five-year programme aiming at digitizing agricultural value chains by development local suppliers' capacity and promoting e-commerce in agricultural value chains. A range of digital agriculture solutions have already been applied across the value chains, such as the eRwanda project, funded by the World Bank. The Esoko Rwanda project aims at enhancing interaction between the Ministry of Agriculture with farmers and traders and to train farmers on the use of the eSoko System. The International Institute of Tropical Agriculture (IITA) Rwanda promotes a phone-based tool to banana farmers and promoters, agricultural mobile applications supported by FAO are aiming at enhancing access to digital services, and N-Frnds offers a range of solutions for digitizing agricultural value chains.

Local innovative start-ups in Rwanda have benefitted from various opportunities, such as the Innov8Agric Challenge, the Rwanda Open Innovation Challenge, and the Envisage Youth Agribusiness Incubator (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	2 480.71	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	123.33	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.97	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2015	0.44	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.53	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	4.32	WEF
		ICT goods imports (% of total imports)	2019	5.26	UNCTAD

SÃO TOMÉ AND PRÍNCIPE



São Tomé and Príncipe is a lower-middle income, twin-island country with a population of 219 161 people as of 2020, and a GDP of almost USD 473 million as of 2019. Tourism, agriculture and fisheries are the main drivers of the economy. The island has about 440 km^2 of agriculture land area, representing 46 percent of the land. Plantation agriculture of cacao trees (for cocoa beans) dominates the cultivated land and to a lesser extent, coffee and palm trees. The economy is more oriented to services with agriculture contributing 11 percent of the GDP.

Since 2018, São Tomé and Príncipe's economy was affected by negative shocks that influenced all sectors of the economy. Coupled with agricultural pests and power shortages, the agriculture and fisheries sector have been negatively affected. Moreover, weak cocoa prices have affected many people spurring rural-urban migration. To date, 74.35 percent of the population lives in urban areas while 25.64 percent lives in rural areas, which is a unique demographic breakdown compared to most African countries. About 68 percent of the population lives in poverty, 22 percent of whom live in extreme poverty.

The country is strategically located along undersea cable routes such as the ACE submarine cable. This has improved Internet access and offers the potential for a strong digital economy. The ICT sector is improving with Internet access costs decreasing. Telecoms contribute an estimated 7 percent of GDP.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	219 161	WBG
Urban population (%)	2020	74.35	UNPD
Rural population (%)	2020	25.65	UNPD
GDP (current millions of USD)	2020	473	WBG
Agricultural land (km^2)	2018	440	FAO
Agricultural land (% of land area)	2018	45.83	FAO

INFRASTRUCTURE

São Tomé and Príncipe has limited infrastructure. Total electricity access as of 2019 was 75.2 percent of the population with 77.6 percent access in urban areas and 68.5 percent in rural areas. The country generates 58 percent less electricity than its installed capacity due to ageing generation assets and lack of maintenance. The coverage of electricity is mostly in the capital city and towards the north-western part of the country. In 2011, the government began to develop network infrastructure through public-private partnerships. For example, the government and Companhia Santomense de Telecomunicações (CST- subsidiary of Portugal Telecom), jointly worked to build access to the Africa Coast to Europe (ACE) submarine fiber optic cable. This improved network infrastructure, contributing to a decline of Internet and telecommunication service prices. This investment helped the government attract a second mobile operator and service provider. This initiative was timely because until 2013 São Tomé and Príncipe relied on satellite for international communications. After launching ACE with support from the World Bank, the government awarded the Angolan mobile phone company Unitel the license to operate as the country's second major telecom. The impact of a second mobile operator and ceding of government shareholding from STP-Cabo led to further price reductions, enabled competitiveness in the sector, and increased government revenue (World Bank, 2015).

São Tomé and Príncipe has access to the Central African Backbone, a joint fiber optic Internet backbone developed by the Economic Community of Central African States (ECCAS).

With two mobile network operators – São Tomé Company for Telecommunications (CST) and UNITEL – the country has good coverage. In 2015, CST's 3G network covered 90 percent of the population and 80 percent of the territory. According to the General Regulatory authority (GRA), in 2018, CST dominated the market with an 85 percent share compared to UNITEL's 15 percent.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	68.51	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	N/A	GSMA
		Secure access to Internet servers (per 1 million people)	2020	31.94	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	79.49	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	34.34	ITU
		Fixed broadband subscriptions (per 100 people)	2020	1.15	ITU

DIGITAL PENETRATION

In 2020, the country's mobile cellular subscriptions reached 79.5 percent while fixed broadband subscriptions stood at 1.15 percent, due to a relatively high price, accounting for approximately 20% of the per capita income. Currently, service provider in the country has planned to launch LTE services and 4G network and is waiting for official regulatory permission to roll out.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2019	28.26	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	6.11	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	18.60	ITU
	Willingness	Mobile social media penetration (%)	2020	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

The Ministry of Public Works, Infrastructure, Transport and Communications is responsible for driving the country's ICT policies. The Autoridade Geral de Regulação de São Tomé e Príncipe (AGER) is the general regulatory authority, established by Law No. 14/2005. AGER also manages the universal service fund and provides technical assistance for the transition to digital broadcasting (ITU, 2018). There is no separate ICT policy in the country; however, the Second National Poverty Reduction Strategy II (NPRS-II) recognizes the value of promoting access to ICTs by citizens and governments within education and health. Policy measures include the development of universal services, the definition of a sectoral legal and regulatory framework to ensure the promotion of investments, and the development of new services provided by ICTs (IMF, 2014).

The World Bank supported the country to prepare an ICT Strategy Plan in 2014, as part of the Central African Backbone Program (APL2). The draft strategy had established objectives, roles, responsibilities and monitoring measures in the implementation of the country's ICTs. However, at the time of the project reporting in 2015, the strategy was not adopted by the government.

The government also operates the Institute of Innovation and Knowledge (INIC), whose responsibility is to establish an information and knowledge society. INIC formulates and executes strategies for the integration of new ICTs in numerous fields including agriculture. There is insufficient information on the role and function of this agency.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2016	75	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The country has legal and policy conventions for establishing and running a business in all sectors of the economy. Like all small island states, São Tomé and Príncipe lacks economies of scale while the distance to markets is a particular challenge. That said, according to the World Bank, the time required to start a business is seven days (see Table 5). This is due to the adoption of a straightforward single electronic window registry for opening a business. However, some processes are arduous, such as acquiring construction permits, paying taxes and dealing with insolvent companies.

While the economy of São Tomé and Príncipe is driven by agriculture and tourism, the country receives foreign direct investment in oil while the government relies on aid and government borrowing. The São Tomé and Príncipe 2030 development agenda seeks to attract more foreign investment and improve sectors that can enhance the labour market.

There is insufficient data published on current agritech investments (see Table 5). However, UNDP has supported young people in the development of innovative business solutions and tackling different aspects of developmental challenges. In 2019, UNDP launched a nationwide initiative to invest in the country's youth with the participation of Yunus & Youth, a local youth-operated business.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	57	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	7	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

São Tomé and Príncipe's population is young, with 54.8 percent aged 15-64 years, while those 65 years and older account for only 3 percent. About 93 percent of people aged 15 years and older are literate, while youth aged 15-24 years literacy have a literacy rate of 97.8 percent (World Bank, 2018). School enrolment figures suggest the country enjoys adequate education (see Table 6).

The University of São Tomé and Príncipe was established in 2014, and formerly was known as the Higher Polytechnic Institute of São Tomé and Príncipe (ISPSTP). The university offers degrees in Agronomy, Computer Engineering, Engineering, Computer Science, and Telecommunications Engineering. Not much is known on the capacity of training institutions to support agriculture. AfDB and IFAD have supported Sao Tome Principe to improve its agricultural research institute and also rural farmers to mitigate the effects of climate change. AfDB through the Infrastructure Rehabilitation for Food Security Support Project (PRIASA) modernized agriculture in the country. Amongst other things, this included modernizing and equipping the Centre de Recherche Agronomique et Technologique (Agricultural Research and Technology Centre, CIAT). There is lack of data on the impact of these investment or state of human capital needs and levels of knowledge in the country.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	92.82	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	97.78	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	19.14	ILO
		Employment in agriculture, female (% of female employment)	2019	8.56	ILO
		Unemployment, total (% of total labour force)	2020	13.86	ILO

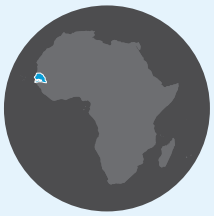
AGRO-INNOVATION

In terms of Agro-innovation, there is insufficient data on the agritech space in the country, however, the government values the importance of ICT and started to set the goal of improving access to ICT especially in the areas of Science, Technology, Engineering and Mathematics. This will set up the foundation for a more favourable enabling environment for the country's digital transformation (MAIO, 2019).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	37.63	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	107.41	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.65	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	3.77	UNCTAD

SENEGAL



Senegal is a lower-middle-income country. Its GDP increased from USD 23.3 billion in 2019 to USD 24.9 billion in 2020. The agriculture sector is important for the country as it contributed to 15.8 percent of GDP in 2020. Also, in 2019, the sector employed around one-third population and the proportion of females employed in the sector accounted for 24.8 percent. Smallholder farmers are still dominant in the country on a subsistence basis. The dominant crops grown are groundnuts (cash crop), rice, and millet. Regardless of the relative importance of rice to the sector, the country still imports about 70 percent of the rice it requires for domestic consumption.

The poverty headcount ratio at the national poverty line declined from 48.3 percent in 2005 to 46.7 percent in 2011. Geographic disparities exist in poverty between rural and urban areas. For instance, 66 percent of rural residents are considered poor compared to 23 percent of residents of the capital city Dakar. Due to the incidence of poverty there, the rural population keeps declining. According to the World Bank, the rural population reduced from 52.8 percent in 2018 to 51.8 percent in 2020.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	16 743 930	WBG
Urban population (%)	2020	48.12	UNPD
Rural population (%)	2020	51.88	UNPD
GDP (current millions of USD)	2020	24 911	WBG
Agricultural land (km^2)	2018	88 780	FAO
Agricultural land (% of land area)	2018	46.11	FAO

INFRASTRUCTURE

National access to electricity increased to 70.4 percent in 2019. By West African standards, Senegal is considered to have high access to electricity. Nevertheless, vast inequalities exist between urban and rural areas as well as significant geographic disparities. Senegal is gradually inching toward achieving a 100 percent access rate in urban areas. Registered at 95.2 percent in 2019, urban access to electricity increased by 3 percent from 2018. Although low, the rural access rate has shown progress with an increase to to 47.8 percent in 2019 from 41.4 percent in 2018.

Regional disparities exist, with regions like Kaffrine, Kolda, and Kédougou having an estimated 9–12 percent rural access to electricity, while other regions like Diourbel and Thiès enjoying rural access rates of 55 percent and 76 percent respectively. The government is embarking on a rural electrification project with support from the World Bank to increase access to electricity and at the same time cut down on global GHG emissions by adopting sustainable energy sources such as grid extension, solar/diesel mini-grids, solar home systems, and solar lanterns in rural areas across Senegal. The carbon-linked results-based payment scheme will be used to support the government's plan to accelerate rural electrification by private concessionaires and other project operators. Also, the Millennium Challenge Corporation (MCC) compact was signed in December 2018 and was expected to go into force in 2021. It aims at decreasing energy costs by modernizing the power sector, increasing access to electricity in rural Senegal, strengthening the electrical transmission network in Dakar, and improving the governance of the power sector.

Telecommunication has been cited as instrumental to the growth of the Senegalese economy. Efforts are being put in place to expand infrastructure in the telecom sector. This is supported by a 91.6 percent mobile network coverage as of 2016. Digital connectivity stands to benefit from higher mobile penetration rates, which in turn has substantial implications to the country's economic and human development. A significant proportion of Senegalese people have access to mobile phone services as well as mobile broadband Internet. About 98.7 percent of users access the Internet through mobile phones, which emphasizes the importance of mobile broadband Internet in the country (ARTP, 2019). With almost 100 percent 2G coverage as of 2019, the Senegalese economy boasts 95 percent 3G coverage and 73.7 percent 4G coverage. However, broadband coverage remains persistently uneven across the country as rural and urban areas demonstrate a significant gap in 3G coverage, which is mostly concentrated in the main urban centres. Similarly, Senegal's Internet penetration also has a huge gap in urban and rural areas, standing at 41 percent and 17 percent respectively as of 2017.

Several initiatives to expand Senegal's telecom infrastructure are underway. These include Orange's plans to build a new international backbone network that will run from Senegal to other countries in West Africa, constructed around a terrestrial fiber network combined with subsea cables. It will then connect to the rest of the world through additional subsea cables and will link up all the main regional capital cities like Dakar, Bamako, Abidjan, Accra, and Nigeria's largest city of Lagos.

The construction of a government cloud in Diamniadio has been launched by the Agence de l'Informatique de l'Etat (State Informatics Agency). The cloud will serve as the core of the government's broadband administrative network by interconnecting all relevant administrative buildings, such as local governments and agencies, universities, schools and health centres. This offers an avenue to integrate, in size and project structure, all of the state's IT storage needs, including those of ministerial data centres.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	47.82	WBG
		4G coverage (% of total coverage)	2019	73.65	GSMA
		Mobile (device) ownership (% of population)	2019	57.66	GSMA
		Secure access to Internet servers (per 1 million people)	2020	26.34	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.87	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	113.95	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	54.25	ITU
		Fixed broadband subscriptions (per 100 people)	2020	1.06	ITU

DIGITAL PENETRATION

Senegal has witnessed a spectacular growth of digital technology in recent years. Even though the number of mobile connections in Senegal declined by 2.4 percent between January 2020 and January 2021, Internet usage increased by 2.7 percent between 2020 and 2021. Internet users in January 2021 stood at 7.81 million, and the rise in Internet users also caused a 15 percent surge of social media use (500 000 users) between January 2020 and January 2021.

Active mobile broadband subscriptions per 100 inhabitants in Senegal increased from 42.1 in 2018 to 54.3 in 2019. A similar increasing trend was experienced in post-paid/prepaid mobile cellular telephone subscriptions, which rose from 15.7 million to 17.8 million between the same period.

Senegal's fixed line sector has two operators: Orange Senegal (Sonatel) and Expresso, which was introduced as the second national operator in 2009. The mobile sector however has three operators: Sonatel, Free Senegal and Expresso. Orange Senegal (Sonatel) is the dominant player in both the fixed line and mobile sectors, commanding more than half of the market share (53.2 percent) in the mobile sector. Free Senegal and Expresso have 24.6 percent and 22.2 percent market share respectively. Orange and many other partners offer information and advice to farmers via USSD, SMS, call centres, IVR, and websites or mobile applications (chatbots).

Digital technologies have increased financial inclusion in Senegal, especially for rural populations, with mobile money services being a major contributing factor to this. Unlike other countries, there gender awareness gap slim at 93 and 90 percent for men and women respectively. The use of mobile money is rapidly scaling up growth in bank account ownership. The percentage of the adult population with one or more financial accounts rose from 15.4 percent in 2014 to 42.3 percent 2017. It is also considered an easy avenue to credit with most of the population accessing credit and savings through informal methods rather than transacting with the formal financial system. In 2017, the adult percentage that saved or borrowed from the formal financial system was 7.3 percent and 7.8 percent respectively, while 23.8 percent saved, and 29.9 percent borrowed through informal methods (World Bank, 2019).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.30	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	20.46	GSMA
		Number of apps in national language (quantity)	2019	24.43	GSMA
		Gender gap in social media use (%)	2019	26.78	GSMA
		Gender gap in mobile ownership (%)	2019	88.32	GSMA

POLICY AND REGULATION

The country has adopted several policies and action plans to develop its agriculture sector. Agriculture sector policies include the National Agricultural Development Plan (PNDA) (2015–2025), which seeks to promote a modern, competitive and sustainable sector through the development of plant sectors with strong potential for growth. The National Strategy of the Sector Rural (SDSR) horizon 2025, the National Food Security Strategy (SNSA) vision 2030 are other complementing policies. The Emerging Senegal Plan (2019–2023) aims at modernizing agriculture by strengthening food security and through the country's Digital Senegal Strategy (2016–2025).

Meanwhile, in a bid to eradicate rural poverty, a number of development projects have been undertaken to improve rural living standards. For instance, IFAD is embarking on two projects that support rural development. The Support to Agricultural Development and Rural Entrepreneurship Programme - Phase II aims at reducing poverty for people living in the programme's focus area by integrating them with profitable, diversified value chains. The Rural Youth Agripreneur Support Project aims at enabling rural youth to become agricultural entrepreneurs.

ICT also plays a cruicial role in the success of the Senegalese economy. The National ICT Policy and the Digital Senegal Strategy (2016–2025) are the country's main ICT policies. The National ICT Policy does not refer directly to agriculture. However, the Digital Senegal Strategy (2016–2025) acknowledges the importance of agriculture, conceding that ICT adoption in agriculture is relatively low. Promoting digital technologies across all priority sectors is critical to the provision of new sources of growth, improving the economy's productivity and competitiveness, all of which can foster sustainable development, facilitate technological transformation and improve digital access.

IFAD and the government are also implementing the second phase of the Support to Agricultural Development and Rural Entrepreneurship Programme, which aims at sustainably improving the food security and incomes of smallholder crop and livestock farmers by integrating them into profitable, diversified value chains that are resilient to climate change. To contribute to food and nutrition security and improve the livelihoods of farmers, the Sorghum and Millet Compact activities were launched in Senegal. This is part of the African Development Bank's plan to transform agriculture in Senegal and six other Sahelian countries through the Technologies for African Agricultural Transformation (TAAT) programme. It targets about 40 to 50 percent of African farmers with technologies that include improved seeds, water harvesting, and integrated soil fertility management, with the goal of boosting agricultural productivity and self-sufficiency by 2025. As part of the programme, a compact seed multiplication site (Sorghum Breeder at the Centre National de Recherches Agronomiques de Bambey) has been set up in Bambey.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.10	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.43	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.91	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.85	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	80	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Senegal has a favourable stock of FDI compared to other countries in Africa. The UNCTAD 2020 World Investment Report noted that FDI in the country increased from USD 848 million in 2018 to a record high of USD 983 million in 2019, with a total stock of FDI registered at USD 6.4 billion at the end of 2019. The 2020 edition of the World Bank's Doing Business report showed that Senegal has advanced nearly 20 rankings for ease of doing business. With the country's score of starting a business recorded at 91.2/100, it only takes four procedures and six days to start a new business. Senegal is positioning itself as investor-ready, with the number of new businesses set up increasing from 3 712 in 2017 to 4 003 in 2018.

In a bid to attract FDI, Senegal has made progress in giving access to credit information by increasing the credit bureau coverage and offering credit scoring as a value-added service. The tax collection system has improved through the implementation of an electronic filing and payment system with reduced cost by merging several taxes. As part of the overall business climate and competitiveness reforms, tangible improvements have been made in the process of business creation and contract enforcement.

Start-ups in Senegal often receive support from the government and other donors. Four Senegalese start-ups have received coaching and help in drawing up business growth plans from Ernst & Young (EY), as part of the AgriHack Talent initiative. The companies were guided to draw up a one-year business growth plan as well as explore the challenges they faced in accessing funding after the execution of the plan, as well as proposing areas where strategy could be improved. The initiative included several schemes to help businesses access finance, including the Pitch AgriHack, where start-ups competed for between USD 5 700 and USD 17 000 of seed capital.

The Syngenta Foundation plans to roll-out the e-Farmers' Hub (e-Hub) project in Senegal. It is a mobile, digital platform, designed to help entrepreneurs keep track of daily transactions while offering the Syngenta Foundation for Sustainable Agriculture (SFSA) an opportunity to monitor progress in real-time. The project aims at bringing a new dimension to agritech, increasing efficiency and strengthening the agricultural value chain. This technology facilitates the smooth management of Farmers' Hubs (FHs), agricultural input-output marketplaces for smallholder farmers and also allows for sound business and data-driven

investment decisions to be made. The project was initiated in Bangladesh in 2017. Following a successful proof of concept, the Syngenta Foundation intends to scale the platform to other countries such as Senegal.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	983	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.05	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.57	WEF
	Entrepreneurship	Time required to start a business (days)	2019	6	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.27	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.75	WEF

HUMAN CAPITAL

Senegal's adult literacy rate increased from 43.5 percent in 2013 to 51.9 percent in 2017. Similarly, youth literacy rose from 65.9 percent in 2013 to 69.5 percent in 2017. A slight disparity existed in the youth literacy rate for males and females with 75.6 percent and 63.5 percent respectively. However, gross enrolment in secondary schools remained below 50 percent in 2019, while that of teritiary schools was even lower, at 13.1 percent.

The digital skills evaluation of the WEF global competitive index of the Senegalese population dropped from 4.38 in 2018 to 4.21 in 2019. However, among the sub-Saharan African countries, this secore is above average.

Senegal is yet to fully integrate ICT into its education sector through any kind of formal policy, even though a national ICT policy exists. The government does recognize the role of ICT in national development, and as such the Ministry of Education and several institutions have taken steps to launch and sustain activities that would modernize the education system.

Some initiatives that were undertaken to increase digital skills include UNESCO and the Korea Funds-in-Trust cooperation: ICT Transforming Education in Africa project that was launched in 2015. Phase two of the project runs from 2019 to 2023 and includes Senegal with the aim of increasing access and quality of basic education through innovation ICT solutions. Additionally, the USAID Senegal through the support of Chemonics International has embarked on a technical assistance project called Lecture Pour Tous (LPT). The project aims at complementing national reforms spearheaded by the Ministry of Education to improve early grade literacy. As part of the LPT programme, SIM cards will be provided to teachers and directors for free communication among recipients to receive text messages about pedagogical and evaluation techniques.

In Senegal, other forms of digital training also exit, for example,the start-up Mlouma offers actors in the agri-food value chain digital education on agricultural practices. This includes training on the use of inputs, creation of databases, and dissemination of information on pricing, soil monitoring, weather conditions, etc. The Senegal Virtual University, an electronic platform established by the Ministry of Higher Education and Research, has facilitated efficient and accessible higher education through a digital open space across country.

This teaching platform commenced in February 2014 with over 2 000 students enrolled for the first academic year.

The government and the private sector provide various support mechanisms to young entrepreneurs in the agricultural sector. One example is the partnership between the International Cocoa Organisation (ICCO) Cooperation and the Mastercard Foundation to implement a five-year (2017–2021) programme called the Strengthening African Rural Smallholders (STARS). Using the market systems development approach, STARS aimed at improving access to finance and markets for over 200 000 smallholder farmers with special emphasis on women and youth in Senegal and other countries in the region.

Developing the capacity of the youth is important to any development agenda. To that end, the African Development Bank and Microsoft have launched the Coding for Employment digital training platform, an online tool offering digital skills to African youth to foster a continuous learning culture wherever they are across the continent. The ultimate goal of the programme, which was piloted in Senegal and four other countries, is to scale it up to 130 centres of excellence across Africa over a 10-year period.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2017	51.90	UNESCO
		Literacy rate, youth total (% of people ages 15–24)	2017	69.48	UNESCO
		Digital skills among population (index ranking 1–7: not at all/ to a great extent)	2019	4.21	WEF
	Employment	Employment in agriculture (% of total employment)	2019	30.10	ILO
		Employment in agriculture, female (% of female employment)	2019	24.75	ILO
		Unemployment, total (% of total labour force)	2020	7.10	ILO

AGRO-INNOVATION

Senegal has nine public bodies that undertake agricultural research and development. The Senegalese Agricultural Research Institute (ISRA) is Senegal's principal agricultural research agency that falls under the Ministry of Agriculture and Rural Equipment. It focuses on crop, livestock, forestry, fisheries, and socio-economic research. The Institute of Food Technology (ITA) is another governmental agency whose research mandate focuses on storage, conservation, and processing of agricultural products. Furthermore, universities in Senegal collaborate with other research institutes to find solutions to the many challenges that affect the agricultural sector. A case in point is the Plant Breeding Programs, which is a series of plant breeding activities for crop development that is undertaken on oil plants, cereals, vegetables, fruit trees, and some forest species.

Several initiatives are geared toward increasing agricultural productivity utilizing digital technology in Senegal. For instance, FAO is supporting the National Agricultural and Rural Advisory Agency (ANCAR) in the development of an e-council and applications through its Agricultural Services and Digital Inclusion in Africa (SAIDA) project, to provide real-time information with the help of modern tools.

Senegal's digital ecosystem is made up of private companies that develop applications offering digital solutions. In the agricultural sector, Orange

has given access to its customers to the Mlouma digital platform, which connects agricultural sellers to the agricultural industry, production buyers, equipment vendor and agro-inputs that are needed on their farms. This useful and timely information helps strengthen the efficiency of agricultural value chains. Also, Mlouma, in partnership with ICCO Cooperation and OCP Africa, launched its newest digital innovation called Xam Sa Mbay, which means Know the Agricultural World in Wolof. It is an agricultural information system that facilitates interaction between all actors in the agricultural value chain, reducing information asymmetry between producers, input suppliers, banks, and buyers.

Regarding digital ecosystem for start-ups, there are also some initiatives and practices existing in the country. For example, WAZIUP is a European Union-Africa project developing Internet of things (IoT) technologies in Africa. It engages the ICT ecosystem by encouraging new tools and good practices among entrepreneurs and start-ups. The WAZIUP consortium comprises seven partners from four African countries and five partners from four EU countries that bring together business developers, technology experts, and local African companies operating in agriculture and ICT.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	3 351.65	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	153.45	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.25	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.89	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.56	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	4.26	WEF
		ICT goods imports (% of total imports)	2019	3.25	UNCTAD

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SEYCHELLES

Seychelles is a high-income country with a population of 98 462 people, of whom 57.5 percent reside in urban areas and 42.5 percent dwell in rural areas. According to the 2017 Seychelles Food Insecurity Experience Scale Survey, 9 percent of households experienced moderate to severe food insecurity in 2017 (see Table 1).

Seychelles boasts the highest GDP per capita in Africa, and a GDP USD 1.12 billion in 2020. Although agriculture is not a key contributor to the country's GDP growth, tuna fishing and processing accounts for close to 5 percent of total GDP, 7 percent of total employment, and around 35 percent of export goods. Over the last ten years, Seychelles has been importing up to 70 percent of its food requirements. The economy is driven by tourism, fisheries and financial services (AfDB, 2020). Tourism accounts for almost 25 percent of the total national GDP, 25 percent of total employment and 70 percent of foreign exchange earnings.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	98 462	WBG
Urban population (%)	2020	57.55	UNPD
Rural population (%)	2020	42.45	UNPD
GDP (current millions of USD)	2020	1 125	WBG
Agricultural land (km^2)	2018	16	FAO
Agricultural land (% of land area)	2018	3.37	FAO

INFRASTRUCTURE

Seychelles has made significant strides in infrastructural development in the recent past. It is one of very few African countries that have achieved 100 percent electricity distribution in rural areas.

There are two mobile operators in Seychelles: Cable and Wireless and Airtel, a subsidiary of the Indian mobile group. Mobile penetration is high, with 94 percent of households having mobile phones and 90 percent of the population covered with 3G (ITU, 2018). Mobile broadband has been available since 2006 with the launch of 3G networks and has been upgraded to the latest LTE technology. To further improve Internet connectivity, the government partnered with Internet service providers to develop and strengthen Cable and Wireless services. This led to the launch of 4.5G services in 2020 (see Table 2).

Cable and Wireless Seychelles offers prepaid and post-paid copper landline telephone service. Other providers include Intelvision, which offers fixed telephony over its fiber optic network, and Kokonet, which offers voice-over-Internet Protocol (VoIP). Fixed broadband is available through ADSL, fiber optic and fixed wireless technologies. Fixed-broadband penetration is high by regional standards.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	100.00	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	N/A	GSMA
		Secure access to Internet servers (per 1 million people)	2020	61 109.87	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.98	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	186.58	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	91.98	ITU
		Fixed broadband subscriptions (per 100 people)	2020	35.56	ITU

DIGITAL PENETRATION

Seychelles enjoys good Internet connectivity and services. The landing of the Seychelles East Africa System (SEAS) submarine cable in mid-2012 transformed Internet access through a dramatic increase in international bandwidth and a consequent drop in prices. In Seychelles, 58.8 percent of the population uses the Internet, 58.7 of households own a computer, and 57.9 percent of households have Internet access (ITU, 2018). Almost 94 percent of the population has a bank account.

However, mobile and Internet services are comparatively expensive. Cable in 2020 posited that the average price of a 1 GB of mobile data was at USD 11.4. Also, ITU reported that the cost of local mobile cellular calls per minute was USD 0.29 as of 2017 (see Table 3).

A number of agritech use cases exist in Seychelles. These include Isle Exotic Flavour, Point2Point, SpillerFruit Co and Insite Traders, which provide services ranging from data management, e-commerce, advisory, financial and marketing linkages.

From a public perspective, the National Institute of Science, Technology and Innovation (NISTI)

and the Seychelles Agricultural Agency (SAA) in 2018 started the Farmers Digital Engagement Platform (FDEP) to promote, market and sell their products to a wider target audience (both individuals and businesses).

While Seychelles has developed a Geographical Information System (Seychelles WebGIS) and digitalization of titles has started at the Registrar-General, the databases of different public institutions are not interconnected, which makes it difficult to assess availability.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	11.43	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

In 2019, Seychelles launched its 15-year vision (Vision 2033) and the first National Development Strategy (NDS 2019-2023), the latter being the first of three NDSs that will enable implementation of the goals of the Vision, which include digital transformation and innovation in the agriculture sector. The National ICT Policy, the STI Policy and Strategy, the SME Policy and Strategy as well as the ICT in Education and Training Policy consider ICT and science, technology, and innovation (STI) as the building blocks of growth.

The National ICT Policy has five focus areas: (a) promotion of affordable, modern and high-quality ICT infrastructure and services; (b) fostering an enabling legal and regulatory framework to ensure growth of the ICT sector; (c) development of human resources with appropriate ICT skills; (d) leveraging ICT to attract investment and stimulate economic growth; and (e) enabling online government services. The main legislative document is the Broadcasting and Telecommunication Act of 2000. In addition, the National Broadband Policy and Cyber Security Policy were enacted to promote (i) digital transformation of the public sector; (ii) digital access; and (iii) digital inclusion.

From an agriculture perspective, the four-year Agriculture Strategic Plan (2016-2020) sought to create decent employment through inclusive growth and the transformation of rural economies through food security. Correspondingly, the five-year Seychelles National Agriculture Investment Plan (2015-2020) sought to harmonise, consolidate and accelerate the implementation of the agricultural policy to create inclusive growth and the transformation of rural economies through food security. All these policies provide direction to realising positive outcomes in the digitalization of the agriculture sector. In addition, the government endorsed in 2013 the country's National Food and Nutrition Security Policy (NFNSP), and the Seychelles National Agricultural Investment Plan (SNAIP), which define agricultural priorities, goals and outcomes including digitalization of the agriculture sector.

Other related policies are the National FinTech Strategy on mobile payments, e-commerce and digital finance and the Tourism Master Plan that recognizes the need and potential for backward and forward linkages in the sector, in particular for agricultural products (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.00	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.06	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	4.43	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.90	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	62	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Start-ups that target the digital agriculture market face difficulties in obtaining initial capital support such as loans. The Seychelles SME Strategy and Policy specifically mentions the linkages between local entrepreneurs and FDI. However, no structured business linkages programme exists. On the other hand, the National Education Financial Strategy 2017-2020 underlines that "entrepreneurs are often not business literate, cannot put together bankable business plans and do not have the required collateral" (Piprek and Jacquin, 2017).

The Development Bank of Seychelles (DBS) has also adjusted its lending policies to finance working capital for up to 50 percent of the loan amount (DBS, 2019). With the exception of the Blue Grant, the Blue Investment Fund and, to some extent, the SME Scheme and the DBS Scheme, access to finance schemes do not form an integrated chain of loans to support the gradual growth of businesses. In addition, grants such Programme de Promotion de l'Entreprenariat des Jeunes (PPEJ) are available for youth entrepreneurs to grow their start-ups and businesses including those on digital agriculture (see Table 5).

The Agricultural Development Fund (ADF) is currently the only source of relatively cheap financing to farmers, with roughly SCR 17 million in capital. The government has already taken measures to allocate more land to the agricultural sector, in order to increase the scale of output and to provide local farmers with opportunities to grow their businesses. Furthermore, in 2019 an exempt order was approved for registered fishermen and farmers not to pay business tax.

The government has exerted additional efforts to allocate SCR 30.8 million and SCR 41.1 million to the National Biosecurity Agency and Seychelles Agricultural Agency respectively from the 2020 budget, targeting enhancement of infrastructure and smart irrigational facilities. Moreover, the government partnered with the EU in 2019 for a new Sustainable Fishing Partnership Agreement and a new Protocol worth EUR 5.3 million. All these initiatives are targeted at improving productivity through innovative and strategy investment in the agricultural sector.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	126	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.10	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.29	WEF
	Entrepreneurship	Time required to start a business (days)	2019	32	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.13	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.55	WEF

HUMAN CAPITAL

Seychelles has a fairly literate and youthful population (99.06 percent). The adult population has a 95.9 percent literacy rate. Basic digital skills are acquired at the secondary level. While the Internet connectivity of schools has improved in recent years, specialized teachers with advanced digital skills remain scarce (Republic of Seychelles, 2019). Since 2016, an important inclusion and promotion effort has been carried out, through the annual ICT Week, and the commemoration of the International Girls in ICT day (an initiative of the International Telecommunication Union) with SYAH-Seychelles. Other initiatives include the SIDS Youth AIMS Hub, a youth led NGO that promotes and advances youth-led sustainable development projects (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	95.87	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	99.07	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	4.59	WEF
	Employment	Employment in agriculture (% of total employment)	2019	N/A	ILO
		Employment in agriculture, female (% of female employment)	2019	N/A	ILO
		Unemployment, total (% of total labour force)	2020	N/A	ILO

AGRO-INNOVATION

The government remains resolute in its quest to improve the agriculture sector. It has allocated SCR 115.9 million in 2019 to accomplish new initiatives to improve R&D in the agri-food sector through a new agriculture diagnostic centre in Grand Anse Mahe. However, academic research institutions are limited in Seychelles and R&D expenditure is mostly funded by the government. The University of Seychelles was established in 2009 and has three research institutes, two of which target social sciences and one the blue economy. Other

academic institutions related to ICT and STI do not have research institutes. While non-governmental organizations are active in the blue economy sector, their research activities are seldom integrated within the activities of universities. In addition, no active effort is conducted to target investors and entrepreneurs in innovative activities Although they are referenced in the NDS and in the STI Policy, no accelerator programmes, business incubators or science parks exist in Seychelles.

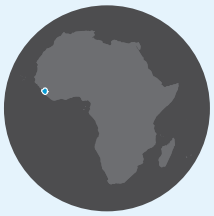
In 2019 Seychelles took part in the Global Entrepreneurship Week. The Entrepreneurship and Industry Department (EID) organizes an entrepreneurship competition involving pupils and students at the secondary and post-secondary levels, in collaboration with the Ministry of Education and the Seychelles National Youth Council. The country also organizes the World IP day, and an ICT Day is organized annually. Additionally, the University of Seychelles and the Wildlife Clubs Seychelles have engaged in a joint initiative to bring together science and agricultural innovation to Seychelles.

A three-year project involving the Department of the Blue Economy, the EID and NISTI was launched with support from the AfDB. It includes the establishment of a business incubator. Also, the Climate Smart Agriculture pilot Val d'Endor Project aims at rolling out the Water Smart Farms concept to improve water management in farming communities by reducing water and energy consumption in agriculture (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	34.51	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	92.25	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	N/A	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	2.67	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.68	WEF
		ICT goods imports (% of total imports)	2019	2.33	UNCTAD

SIERRA LEONE



Sierra Leone is a low-income country with a GDP of USD 3.8 billion (see Table 1). The total population as of 2020 was 7.9 million, of whom more than half live in rural areas, although this is slowly decreasing. The World Bank estimates that the rate of people living below the extreme poverty line (USD 1.9 or less a day in 2011 PPP) decreased to 40.1 percent in 2019.

Sierra Leone has a land area of 72 180 km^2, of which 1 584 000 hectares (21.9 percent of total land area) is arable. About 54.7 percent of Sierra Leone's agricultural land is under-used. Agriculture, including livestock and forestry, is a key driver of the national economy, accounting for almost 50 percent of GDP (SLIHS, 2018) and employs 54.5 percent of the working force (ILO). This is mainly due to favourable land, soil, water and weather conditions in the country. Sierra Leone's agriculture is dominated by smallholder farmers with low-level mechanized commercial agriculture. The main food crops include rice, cassava and millet. Cash crops like cocoa, coffee and palm oil are also grown. Sierra Leone also has abundant fishing resources, which contribute more than 10 percent of GDP and generate substantial direct and indirect job opportunities.

The ICT sector in Sierra Leone is on the rise. The government recognizes the importance of ICT's role in multiple sectors such as education, health, agriculture and so on. However, the Internet and mobile sector development is still an urban phenomenon from which rural areas are mostly underserved. Relatively limited digital literacy and low income also hinder the uptake of digital tools. ICT can generate more future job opportunities of the future for the country's young population.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	7 976 985	WBG
Urban population (%)	2020	42.92	UNPD
Rural population (%)	2020	57.08	UNPD
GDP (current millions of USD)	2020	3 865	WBG
Agricultural land (km^2)	2018	39 490	FAO
Agricultural land (% of land area)	2018	54.71	FAO

INFRASTRUCTURE

In Sierra Leone, 22.7 percent of the total population have access to electricity, with a huge gap between urban and rural, at 51.4 percent and 1.5 percent respectively (see Table 2). The country has limited generation capacity that largely affect households and businesses accessing services and operating normally, especially in rural areas.

The Government of Sierra Leone has launched a series of projects and initiatives to improve its infrastructure. Power Africa is supporting Sierra Leone through the Millennium Challenge Corporation's Threshold Program with USD 18 million to enhance energy sector's institutional capacity. The country has joined the SEforALL initiative, aiming at reaching 92 percent access to electricity by 2030 while more than 90 percent will be produced by hydro sources. Also, a USD 50 million grant from the International Development Association was approved to support the Enhancing Sierra Leone Energy Access Project to provide electricity access for post-Covid recovery.

As of 2019, 3G coverage reached 62.5 percent and 4G covered 42 percent. More than half of the population (53.7 percent) owned mobile devices as of 2019 (see Table 1). In terms of national fixed broadband services, since connecting to the ACE system, the country had its first submarine fiber optic cable link in 2012. It also constructed a 400 km network as part of the ECOWAS Regional Backbone initiative (ITU, 2018) (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	1.50	WBG
		4G coverage (% of total coverage)	2019	42.00	GSMA
		Mobile (device) ownership (% of population)	2019	53.68	GSMA
		Secure access to Internet servers (per 1 million people)	2020	6.52	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.03	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	86.30	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	14.75	ITU
		Fixed broadband subscriptions (per 100 people)	2020	N/A	ITU

DIGITAL PENETRATION

Sierra leone has a high mobile penetration rate at 86 percent (ITU). The mobile market is competitive and mainly dominated by Orange and Africell. 3G was introduced in 2011 by Africell, followed by Orange and SMART (ITU, 2018). 4G was launched relatively late by the state-owned operator Sierratel in 2018 and followed by Orange in 2019. Compared to the increasing trend of mobile services, the penetration of fixed broadband services is quite low, with less than 1 percent of households connecting to the Internet via fixed broadband due to low level of electrification (see Table 3).

As mobile subscriptions and connections are increasing rapidly, digital financial services are gradually playing a critical role in people's lives. According to the State of the Digital Financial Services Market report jointly published by the Bank of Sierra Leone and the United Nations Capital Development Fund (UNCDF) in 2018,

30 percent of adults have an active digital financial services (DFS) account, with a total of 10 providers in the market, including two mobile operators (Africell and Orange Money) and eight banks. The report also identified the potential of applying DFS in rural areas to meet the specific demand of farmers and rural households who are currently not able to access formal financial services. In 2015, the country's first mobile money regulation was launched to ensure financial inclusion, especially of the poor, women and youth.

Sierra Leone has expanded its scope in digitalization as 13 percent of mobile apps are in the country's national language, and about 8.8 percent of the country's population are actively engaged with social media platforms as of 2019 (see Table 3), with over 70 percent using Facebook, according to the 2020 Statcounter report.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	3.69	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	15.60	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	8.78	GSMA
		Number of apps in national language (quantity)	2019	70.00	GSMA
		Gender gap in social media use (%)	2019	45.28	GSMA
		Gender gap in mobile ownership (%)	2019	13.58	GSMA

POLICY AND REGULATION

The ICT sector is mainly regulated by the Ministry of Information and Communication. Developed in 2009, the National ICT Policy proposed a strategic vision and legal framework for the development of ICT. Eleven pillars were identified as areas in which ICT can play a key role. Agriculture and food security is one of them. As a follow up to the National ICT Policy, the government has drafted the National Cyber Security and Data Protection Strategy (2017–2022) to ensure a safe and secure environment to deter and defend against cyber threats in the digital domain.

Policy actions entailed in the Medium-Term National Development Plan (NDP) 2019–2023 include improving the productivity and commercialization of the agricultural sector and moving up value chain into industrial agriculture activities. Special targets have been set by 2030, to i) achieve 90 percent food self-sufficiency; ii) increase youth and women's participation; and iii) develop the value chains for at least two agricultural products. Followed the NDP, the National Agriculture Transformation Programme 2023 has identified five strategic interventions to further improve rice and other crops, livestock, forestry development, as well as fostering an enabling environment. In fisheries, the government signed a USD 29.8 million partnership agreement in 2019 for the construction of a fish harbour complex with a reefer quay and transhipment facilities. To date, digital agriculture policies did not exist, just references to it in the country's National Innovation and Digital Strategy (2019–2029). For example some initial ideas such as the "Country-as-AI-Lab" model are mentioned in the context of agriculture (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2014	3.90	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2014	4.12	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2018	2.97	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2014	3.10	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	56	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Doing Business 2020 scores Sierra Leone 91.3/100 in terms of starting a business. It takes eight days to complete all the procedures with no disparity between men and women. However, the overall business climate is challenging to businesses and investors due to a shortage of power supply, difficulties in accessing loans or credit, and difficulties in obtaining permits. As the country relies largely on foreign aid leading to high external debts, the government seeks to reduce this dependency through economic diversification and attracting more FDI.

The agriculture and fishing sector in Sierra Leone has low levels of technology and mechanization adoption and lacks processing and preservation, thus leading to low productivity and post-harvest losses. Given the challenges in the country, agriculture and fisheries have been considered as sectors with high-investment potential. For example, there are already a few commercial agriculture farms producing palm oil, rice and timber. Moreover, more investment opportunities are arising in the processing and marketing for adding value to a range of food and cash crops, fruits, vegetables, livestock and fishery products, as well as relevant supporting functions such as input supply, storage facilities, agri-machinery contracting services, etc. The Commercial Agricultural Producers and Processors Association (CAPPA) was set up to integrate those commercial agribusiness companies to facilitate modern farming techniques and innovation (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	368	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2018	3.59	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.37	WEF
	Entrepreneurship	Time required to start a business (days)	2019	8	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.71	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2018	3.35	WEF

HUMAN CAPITAL

Only 43.2 percent of adults above 15 years of age in Sierra Leone are literate, with a disparity between male and female, at 51.7 percent and 34.9 percent respectively. Also, the drop-out rate remains quite high. About 70 percent of youth between 15 and 35 years of age are unemployed or underemployed, mainly due to lack of education and adequate skills to apply for jobs. It is even more challenging for women as only 9.5 percent have received a secondary and higher education (UNDP, 2021).

The country also faces a number of constraints in improving its digital literacy. Intermittent electricity supply, slow Internet and high cost of services all prevent youth from using computers or other digital tools to enhance their digital capacities.

In the National Development Plan (2019-2023) human capital development is recognized as one of the key pillars. Moreover, providing quality education is a critical way to "improve the uptake of modern farming practices and allow fishermen and fish traders to move up the value chain". Policy actions include establishing additional universities and improving the ICT infrastructure of universities. Some projects and initiatives have been undertaken to improve education within the country, as well as enhance digital capacity. For example, the REDiSL project supported by the World Bank helped more than 1 800 schools improve the quality of education and provided remote education through radio during the Ebola disease crisis. A joint initiative that has been agreed to by the government and UNICEF and ITU, connects schools to the Internet and provides youth with access to ICT (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	43.21	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	66.65	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2018	3.15	WEF
	Employment	Employment in agriculture (% of total employment)	2019	54.49	ILO
		Employment in agriculture, female (% of female employment)	2019	51.47	ILO
		Unemployment, total (% of total labour force)	2020	4.60	ILO

AGRO-INNOVATION

Sierra Leone investment in its agricultural research stands at a low 0.24 percent of its agricultural GDP. Of all researchers, 73 percent hold master's and doctoral degrees, but female researchers accounted for only 20 percent. The main research institution is the Sierra Leone Agricultural Research Institute (SLARI), which was established in 2007 and employs nearly 90 percent of the country's agricultural researchers. The Njala University School of Agriculture and Fourah Bay College Institute of Marine Biology and Oceanography (IMBO) are the two other higher education institutes. However, poor infrastructure, insufficient qualified researchers, low adoption of research technologies have always been critical issues faced by national research institutes and universities.

Hubs and incubators have been established in recent years for start-ups and youth entrepreneurs with support from development organizations. Examples include the Human Capital Development (HCD) incubator in Freetown, which is used for local start-ups, the private and public sectors as well as academia for innovation in health, agriculture and education, and to collaborate, share data and access services. The Sensi Tech Hub aims at creating employment through innovation and entrepreneurship. Several other promising start-ups in agri-technology operate in the country, such as Jalimi Farms for smart farm solutions, and Born to do Business.

Innovation Axis Sierra Leone was launched in March 2017 as an entrepreneurship support and innovation and technology management entity. It focuses on developing growth-oriented start-ups and building a dynamic and well-functioning ecosystem that supports entrepreneurship and innovation in agritech solutions. The company works closely with the UNDP accelerator Lab in providing agritech solutions by identifying, nurturing and coaching innovators. The Accelerator Lab is a support unit that provides information and recommendations on local solutions available in country and across the lab networks. They have successfully completed one experiment that relates to agriculture auto-irrigation and are now preparing to deploy the next batch of six experiments that cover efficient energy, agriculture as well as other sectors (UNDP, 2019).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	2 973.32	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	104.56	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.08	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2013	0.24	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	2.78	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.32	WEF
		ICT goods imports (% of total imports)	2018	2.16	UNCTAD

SOMALIA

Somalia is a low-income country with a GDP of USD 4.9 billion. The country has a total population of almost 15.9 million people, of which 43 percent is in urban areas and around 54 percent in rural areas. The country has 441 250 km^2 of agriculture land but is considered one of the world's most fragile countries having suffered violence, political instability, and environmental and economic shocks over the past 20 years (FAO, 2020).

Since 2012, the government has made progress toward realising the country's political, security, and economic development agenda. Due to the absence of a central government over the years, current national statistics on the economy are lacking.

The Somali economy still relies heavily on agriculture and livestock sectors. The pre-conflict agricultural production system in Somalia was divided into (i) subsistence farming, often part of agro-pastoral production system; (ii) small scale irrigation and oasis farming; and (iii) commercial farming (FAO, 2015). The Global Report on Food Crises 2020 notes that around 69 percent of the population lives in poverty and are food insecure due to conflict and political instability. The situation is worsened by extreme weather conditions. Between 2019–2020 for example, torrential rains caused widespread flooding, affecting 547 000, of which 370 000 were displaced (OCHA, 2019). Yet, agriculture remains key to the country's food security and central to its economic recovery (see publication by FAO and the World Bank on rebuilding Somali's agriculture; [Gianni, et al., 2018]).

The Somali telecommunications sector has endured despite the absence of central government guidance or regulation. The country has many competing operators that have reduced the Internet cost in Somalia compared to regional averages (ITU, 2018). The cost of 1 GB of data is USD 0.5, reportedly one of the lowest in the world. The government has created the National Development Plan (2019–2024), which seeks to influence policy planning and programming, while supporting the country to realise its political, security, and economic development agenda.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	15 893 219	WBG
Urban population (%)	2020	46.14	UNPD
Rural population (%)	2020	53.86	UNPD
GDP (current millions of USD)	2020	4 918	WBG
Agricultural land (km^2)	2018	441 250	FAO
Agricultural land (% of land area)	2018	70.34	FAO

INFRASTRUCTURE

Two decades of conflict destroyed most of the country's infrastructure and whatever remains is dilapidated. Restoration of infrastructure systems is a priority and will have to include economic, social and institutional clusters.

The country has no centralized electricity grid. About 70 percent of the population lives without any electricity connection. According to the World Bank (2019), only 36 percent of the population had access to electricity, while in rural areas the rate was just 11.1 percent. Households that do have access to electricity pay a premium for it; electricity is supplied by privately owned diesel-powered mini-grids. In rural areas, charcoal and firewood are major energy sources depleting the country's forests at an alarming rate.

In contrast, the country's telecommunications sector is thriving under a self-regulated private sector regime. There are 11 operators, five of which dominate the market, including: Golis Telecom Somalia, Hormuud, Nation Link Telecom, Somali Telecom Group and Galkom. Many of these operators started launching 3G services in the unrecognized state of Somaliland, and soon expanded to other regions. In 2015, the global satellite service provider O3b Networks signed satellite connectivity contracts with three Somalia telecommunication operators (ITU, 2018) (see Table 2).

Somalia has access to the East Africa Submarine Cable System (Internet) which connects Mogadishu and Bosaaso. Although Somalia is a coastal country with proximity to several major undersea cable networks, this strategic proximity has not been exploited. Examples of these undersea cable networks include those that connect Europe, (the Europe-India-Gateway (EIG) and India-Middle East-Western Europe, I-ME-WE.

The National Development Plan 2020-2024 prioritized the telecommunication sector as a strategic one. The self-regulation of private players has also indirectly contributed to the development of the telecommunications infrastructure in Somalia. Post-2017 initiatives are expected to open markets and create a more competitive mobile sector in the country. The government drafted the Somali National Infrastructure Strategy (SNIS) 2019-2063 as a guide of investment to resuscitate infrastructure across all sectors. Meanwhile, the African Development Bank, the World Bank, the European Union and many other multilateral institutions are supporting various infrastructure projects in Somalia.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	11.12	WBG
		4G coverage (% of total coverage)	2019	N/A	GSMA
		Mobile (device) ownership (% of population)	2019	93	GSMA
		Secure access to Internet servers (per 1 million people)	2020	4.47	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2018	50.99	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2017	2.45	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.67	ITU

DIGITAL PENETRATION

Internet penetration in Somalia is estimated at 12.1 percent while the number of social media users hovered at 13 percent as of January 2021, with 99.8 percent of access being made via mobile phones. Mobile cellular subscriptions per 100 inhabitants stands at 51 while active mobile broadband subscriptions per 100 inhabitants is 2.5 (ITU, 2018). The statistics reflect the huge challenges of accessing the Internet in Somalia. An examination of mobile networks coverage by locations indicates that the southern part of the country has less coverage compared to the north (See GSMA Coverage Maps).

The cost of mobile services is one of the cheapest on the continent due to competition among service providers and low tariffs. Mobile money has also become widespread in Somalia. Almost 55 percent of the population aged 16 years and older use mobile money with a high penetration rate in both rural and urban areas (World Bank, 2018). Due to the unique political environment, Somalia relies more on mobile money than any other African country (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	0.50	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	N/A	GSMA
		Number of apps in national language (quantity)	2019	N/A	GSMA
		Gender gap in social media use (%)	2019	N/A	GSMA
		Gender gap in mobile ownership (%)	2019	N/A	GSMA

POLICY AND REGULATION

Ideally, the Ministry of Post and Telecommunication (MPT) should oversee the ICT and telecommunication sector in Somalia. However, there is no regulation or taxation, and no service obligation (ITU, 2018: 166). The absence of any regulation has "resulted in uncertainty, creating vulnerabilities for the development and scalability of ICTs across the country" (World Bank, 2017). In 2017, the president signed into law the Communications Act after it was passed by both houses of parliament. The new law aimed at establishing the legal, regulatory, and institutional frameworks for the telecommunication sector, and the creation of an audio-visual authority. The absence of state control, regulatory laws on operations and licensing created a deregulated market with illegal operators inducing lost tax revenue (see Table 4).

Due to the collapse of Somalia's institutional capacities, the fate of the country's agriculture was the same as that of its policies. FAO, the World Bank and other partners are supporting the new administration to resuscitate the country's agricultural sector (Gianni, et al., 2018) (see Table 5).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1-7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1-7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1-7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1-7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	67	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Somalia is ranked 190 among 190 economies on the World Bank's ease of doing business scale. This means it is the most difficult country in the world to conduct business in. The country receives remittances from Somalis living abroad (considered FDI), which was estimated at USD 447 million in 2019.

In 2020, the country received debt relief under the Heavily Indebted Poor Countries (HIPC) Initiative, with the hope that this could unlock more resources for the Somali people. Through the Somalia National Development Plan 2020-2024, the government aims at improving the business environment through reforms in policy, and the institutional and regulatory frameworks. New investors in Somalia have to endure a long and potentially unknown process of establishing a company within the country. The absence of relevant institutions has implications on the days required to complete procedures to legally operate a business, with a recorded 70 days in 2019; one of the highest in Africa.

There is currently no available data on the government's actual policies to support business.

In 2018, the World Bank launched the Somali Business Catalytic Fund (SBCF) aimed at spurring economic growth in the country by supporting SMEs and entrepreneurs. The programme selected around 101 SMEs (in South Somalia, Puntland and Somaliland) to receive financial and technical support. Other international organizations are seeking to support SMEs in Somalia, including the European Union and the International Organization for Migration.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	447	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	70	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

Although latest statistics are not available, the overall literacy rate in Somalia is relatively low with gender inequality. Access to education in rural area is quite limited, particular for school age children. Due to years of conflicts and civil unrest, Somalia's educational system has faced great challenges in providing quality education, needless to say advanced digital skills. One of five school-aged child is displaced (USAID, 2021). Meanwhile, more than 80% of employment are involved in agriculture but still difficult to maintain household food security.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	N/A	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	N/A	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	80.28	ILO
		Employment in agriculture, female (% of female employment)	2019	83.89	ILO
		Unemployment, total (% of total labour force)	2020	13.10	ILO

AGRO-INNOVATION

The absence of a central government also affected the agricultural R&D, as well as the vibrance of the private sector and agritech industries. However, despite these tough economic circumstances, local entrepreneurs work to foster high quality innovation in Somalia. New start-ups and innovation hubs are emerging with solutions (see Table 4).

According to the StartupBlink Global Startup Ecosystem Rankings 2020, Somalia ranked among the top 100 countries, landing at position number 95 in the global country rankings. In the same report, Mogadishu proved to be by far the most prominent start-up ecosystem in Somalia. The city ranks 14 out of the 36 African cities that were assessed. Significant investment has been made in renewable energy, while agriculture is the country's most important sector. However, Mogadishu is not the only example. Hargeisa is another city with a budding innovation hub that has a lot of activity and growth. Through fundamental policies and a few key initiatives, Hargeisa has developed a significant start-up ecosystem that is expected to continue blossoming in the future.

The Somali Response Innovation Lab (SomRIL) is an inter-agency partnership of World Vision, Action Against Hunger, ADRA, Care, COOPI, Danish Refugee Council and Oxfam. It aims at using innovation to enhance the impact of humanitarian and development interventions to improve the resilience of the Somali people.

iRise is the first innovation and technology hub in Mogadishu aiming at unlocking the potential of Somalia's talent and accelerating change and economic development. From 2017, iRise has become a launch pad for new ideas, a space for civil and social entrepreneurs to connect, and an enabling environment where technology professionals, innovators, digital-doers, and investors can connect and co-create a sustainable ecosystem for Somalia and beyond.

FAO and other partners are using digital innovation to support agriculture in Somalia. One prominent example of that is the Somali Water and Land Information Management (SWALIM) project. SWALIM uses technologies to support land, water and natural resources for Somali people, by helping in the management of ground water, surface water, flood and drought forecasting. The project also uses remote sensing technologies to help collect data on vegetation, floodwater management and infrastructure projects (see Table 7).

Emerging digital technologies are enhancing outreach to Somali farmers who are burdened with infrastructural challenges, lack of electricity and extreme weather conditions (flash floods and droughts). Examples include, Ari-farm, an app that allows anyone with a smartphone to purchase and invest in livestock. M-Dalag is a mobile-based market information system for easily connecting farmers to market.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	867.75	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	96.81	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.21	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

SOUTH AFRICA

South Africa is an upper-middle-income country with a population of 59.3 million people, 33 percent of whom live in rural areas. South Africa has the second largest economy in sub-Saharan Africa. While agriculture contributes around USD 21 billion of the country's GDP of USD 301.9 billion, South Africa's economy is largely supported by the manufacturing, mining and services industries (see Table 1).

Agriculture employs around 5.3 percent of the active population. South Africa's agricultural sector consists of commercial farmers and subsistence smallholder farmers, both of whom are involved in crop cultivation and animal production.

South Africa is a net agricultural and food exporter. For example, the agricultural sector contributed around 10 percent to South Africa's total export earnings in 2019 at a value of USD 10.7 billion. The main agricultural produce includes maize, wheat and to a lesser extent sugarcane, sunflower, potatoes, groundnut, citrus, and grapes (FAO, 2016). Animal production constitutes about 48 percent of the total value of agricultural production.

However, in 2019 nearly 11 percent of the population experienced hunger according to Statistics South Africa, amid increasing concern about food insecurity in the country. In the same year, an estimated 19 million people lived in rural areas, many of whom experienced food insecurity. The government is systematically carrying out a land reform programme to address land ownership for South Africans who had been previously disadvantaged under the country's former apartheid system.

South Africa has a mature digital ecosystem across sectors, with both public and private players actively investing in various technologies. Digital solutions in agriculture are emerging in the following areas: (i) digital advisory services; (ii) agri-digital financial services; (iii) digital procurement; (iv) agri-e-commerce; and (iv) smart farming (precision agriculture) across sub-Saharan Africa. The country is one of the leading 5G network implementers in Africa.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	59 308 690	WBG
Urban population (%)	2020	67.35	UNPD
Rural population (%)	2020	32.65	UNPD
GDP (current millions of USD)	2020	301 924	WBG
Agricultural land (km^2)	2018	963 410	FAO
Agricultural land (% of land area)	2018	79.42	FAO

INFRASTRUCTURE

South Africa has one of the most advanced telecommunication infrastructures in Africa due to a strong investment by the government and the private sector. The national utility company Eskom dominates the South African market for generation, transmission, and more than 79 percent distribution of electricity in rural areas. The following are the mobile network operators and their respective 4G coverage: MTN (89.5 percent); Cell C (81 percent); Vodacom (83.6 percent) and Telkom (88.6 percent). Vodacom and MTN launched 5G service in Johannesburg and Cape Town in December 2020, and coverage will eventually to be rolled out to the rest of the country. The telecom operators have equally sought to expand both fiber and LTE networks (see Table 2).

South Africa has good Internet connectivity, mobile network infrastructure and more than 80 percent electricity distribution in rural areas. The country is a beneficiary of Mobile Internet of Things services recently deployed in 33 countries (GSMA, 2019). South Africa's availability of the latest technologies was ranked 5.6 out of 7. Meanwhile, a study by Research ICT Africa (RIA) in 2018 confirmed disparities in urban and rural Internet use in the country, which has a likely bearing on the use of mobile phones and Internet services among smallholder farmers in rural areas. By comparison, 87.8 percent of South African households exclusively use cellular phones.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	79.23	WBG
		4G coverage (% of total coverage)	2019	95.70	GSMA
		Mobile (device) ownership (% of population)	2019	74.70	GSMA
		Secure access to Internet servers (per 1 million people)	2020	11 421.82	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	5.16	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	161.80	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	102.22	ITU
		Fixed broadband subscriptions (per 100 people)	2020	2.20	ITU

DIGITAL PENETRATION

In 2019, 56 percent of the population had access to the Internet and the country had 2 135 fixed broadband subscriptions per 100 people. The General Household Survey (2019) noted that 63.3 percent of South African households had at least one member who had access to or used the Internet at home, work, place of study or Internet cafes. However, this access is mainly in urban and peripheral areas while some areas have reduced or no access.

According to the survey mentioned above, national Internet access using mobile devices at 58.7 percent was much more common than access at home (9.1 percent), at work (18.6 percent) and elsewhere (10.7 percent). Moreover, the use of mobile Internet access devices in rural areas (44 percent) still lags behind its use in metropolitan cities (67.8 percent) and urban areas (59.5 percent). The most common mode of access in rural areas is via mobile Internet. Network operators are

keen to extend network coverage in rural areas. For example, Vodacom invested EUR 16 million to bring broadband connectivity to the KwaZulu Natal area.

According to the independent technology market research organisation World Wide Worx (2016), approximately 25 percent or 13 million South Africans used Facebook in 2016 while Instagram saw the fastest growth. The cost of data is expensive for 65.4 percent of the population aged 18 years in rural areas who earn below USD 70 a month (see Table 3).

GSMA (2019) reports that South Africa has the highest mobile social media penetration rate in the region with 61.1 percent of the content found to be locally relevant. Gender disparities in social media use was high (78.2 percent) as of 2019 and mobile social media penetration was below 50 percent among the population. The average price of 1 GB of data is currently USD 2.67 (Cable, 2020).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.30	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	36.99	GSMA
		Number of apps in national language (quantity)	2019	57.27	GSMA
		Gender gap in social media use (%)	2019	96.33	GSMA
		Gender gap in mobile ownership (%)	2019	78.27	GSMA

POLICY AND REGULATION

South Africa has a number of legal, policy and regulatory frameworks that guide the telecommunications sector. The government's ICT priorities are clearly stated in the National Development Plan (NDP). The National Broadband Policy, Cybersecurity Policy framework and Integrated ICT Policy are core policies, which collectively prioritise three pillars - digital transformation of the public sector, digital access and digital inclusion.

The Department of Communications and Digital Technologies is the policy-maker of the sector while the Independent Communications Authority of South Africa (ICASA) is the regulator of telecommunications. A number of policy mechanisms were put in place to liberalize and improve private participation and investment in the digital economy. For example, in 2019, the government proposed amendments to the Communications Act whose goal was to improve the ability of new entrants to access networks (section 2[d]) and further develop a competitive market landscape (section 2[f]). The bill however was withdrawn and never enacted. Furthermore, in the same year, the South African parastatal telecommunications company Telkom was partly privatised in 2003 to open up the market. The ending of Telkom's monopoly on submarine fiber optic cables also reduced the cost of services with the arrival SEACOM in 2009 (see Table 4).

The government also created Broadband InfraCo, a national infrastructure company to provide affordable backbone network capacity to service providers. The major mobile network operators have also moved to fixed line and fiber sector. The Universal Service and Access Agency of South Africa (USAASA) strives to achieve universal service and access to ICTs by all citizens. However, it seems policies are lagging behind in implementation of broader population access. For example, the South African Broadband Policy (2013) aims at

ensuring that: broadband reaches a critical mass of South Africans; access to broadband is affordable; demand-side skills are developed to ensure usage as well as supply-side skills. But to date, the policy has not been fully implemented. The South Africa Broadband Policy (SABP) proposed a four-pronged approach to close the access gap and rollout broadband, which are: (i) digital readiness; (ii) digital development; (iii) digital future; and (iv) digital opportunities.

In 2019, the Department of Communications and Digital Technologies launched SA Connect, an implementation model that was previously published on 6 December 2013 in the Government Gazette No. 37119. SA Connect aimed at delivering widespread broadband access to 90 percent of the country's population by 2020, and 100 percent by 2030. However, the DTPS and Universal Service and Access Agency of South Africa (USAASA) reported in a 2020 parliamentary committee a number of challenges in delivering services and meeting their goals.

Meanwhile, within the National Development Plan, agriculture plays an important role in eliminating poverty by 2030. The National Policy on Food and Nutrition Security was enacted in 2013 to ensure the availability, accessibility and affordability of safe and nutritious food at national and household levels. The National Broadband Policy, the Cybersecurity Policy framework and the Integrated ICT Policy are the guiding policies that support investment in digital agriculture.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.22	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.41	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.55	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	4.36	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	71.3	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The South African business environment comprises mostly locally-owned emerging enterprises and foreign multinational companies. The percentage of agricultural contribution to GDP in 2019 was 2 percent, compared to 26 percent from industry and 61.2 percent from services. According to the World Bank and the International Finance Corporation (2019), South Africa ranks 84 out of 189 countries in the ease of doing business scale. However, registering a business requires a complex process of registering and getting regulatory approvals, although some processes can be completed online while others require a specialist.

The South African government has a stable legal framework to support existing and new businesses. Some of these laws include the Broad-Based Black Economic Empowerment Act (BEE Act) of October 2014; the Protection of Investment Act of 2015; the Competition

Amendment Act 2018; the Special Economic Zones Act 2014; the Companies Act 2008 and a number of employment laws. In terms of investment, data from the World Economic Forum (2019) points to the country creating an enabling environment for the growth of new innovative companies. South Africa was second in the region with a score of 4.36 in 2019. Reforms have also resulted in reduction in the number of days required to complete procedures to legally operate a business to 40 days in 2019.

The South African legal system guarantees protection of investments and the resolution of disputes. With constitutional guarantees of private property ownership, both foreign and domestic investors can participate in most sectors of the economy (see Table 5).

South Africa has attracted most of the FDI inflows into Africa. FDI stocks in 2019 increased to USD 151 billion, well above USD 127 billion in 2018 (UNCTAD, 2019). South Africa spends close to 10 percent of GDP on ICT goods and services, representing a huge market potential for the digital economy. Additionally, the privatisation of Telkom has opened up the sector for investment by private players.

When it comes to investments in digital agriculture, the model of WEF value-at-stake framework was deemed the guide to investment in South Africa. In that report, five aspects of the agricultural value chain (input, production, processing, distribution and purchasing) were identified as potential areas for digital investments. Four specific areas where digital agri-technologies have potential are: i) precision farming; (ii) connected supply chain; (iii) digital marketplace; and (iv) autonomous operation (WEF, 2016). In order to unlock this value, the agricultural sector must acknowledge the benefits of digitalization in agriculture, while addressing the lack of access to infrastructure, high cost and lack of connectivity in rural areas.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	4 624	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.36	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.87	WEF
	Entrepreneurship	Time required to start a business (days)	2019	40	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.95	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.27	WEF

HUMAN CAPITAL

South Africa's national adult literacy rate is 95 percent and 98.4 percent for young people aged 15 years and older. The country has a positive school enrolment rate of 98.5 percent and 101 percent for primary and secondary schools, respectively. The Department of Basic Education is responsible for primary school education, while the Department of Higher Education and Training (HET) is responsible for tertiary education and vocational training. South Africa's education system seeks to produce ICT and agriculture graduates with skills needed for the economy. One report estimated that 90 percent of South African business are engaged in digital transformation and suggests the need for increased digital skills (see Table 6).

South Africa has a number of agricultural training colleges that include private colleges and universities. Some notable ones include Elsenburg Agricultural Training Institute, Fort Cox College of Agriculture and Forestry, Grootfontein Agricultural Development Institute, Lowveld College of Agriculture, Marapyane College of Agriculture, University of Cape Town and the University of Free State.

South Africa's unemployment rate has slowly increased from a decade ago and reached 28.74 percent in 2020. While agriculture employs five percent of the population, it is estimated that digitization could result in a net gain of more than 1 million jobs by 2030 (Ndzena, 2018). The government, businesses, and individuals must invest in emerging digital skills to support digital transformation in the country as stated in the National Digital and Future Skills Strategy published on 23 September 2020 in the Government Gazette No. 43730. Furthermore, the Department of Higher Education and Training (DHET) identifies occupations and skills that are needed to meet the NDP and industry needs. In 2020, the most needed skilled professions were data scientists, web developers, electrical engineers, crop produce analysts and agricultural scientists. The department foresees artificial intelligence (AI), big data, cybersecurity, digital modelling, internet of things (IoT), machine learning, and robotics as impactful technologies.

Young people in disadvantaged backgrounds in South Africa lack digital skills and lag behind due to poor infrastructure the high cost of mobile data. As a result, they cannot actively participate in the digital economy. To that end, the government has produced strategic policies to address the digital divide and lack of infrastructure in schools. For example, a draft white paper on e-education sought to transform learning and teaching through ICTs. In 2018, The National Infrastructure Management System allocated communication facilities and computer centres in schools. That digital technology content is not available in local languages is also another challenge.

About 44 percent of South African companies report finding difficulties in recruiting staff with the right digital skills. The private sector telecommunications sector, with its need for digital skills, has instated on-the job training in digital technologies. Vodacom and its partners launched an initiative to train youth in ICT skills such as A+, N+ and 3G connectivity. Microsoft South Africa collaborated with Afrika Tikkun to train about 50 000 job seekers as part of their Global Skills Initiative to transfer critical digital skills.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2019	95.02	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2019	98.41	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.27	WEF
	Employment	Employment in agriculture (% of total employment)	2019	5.28	ILO
		Employment in agriculture, female (% of female employment)	2019	3.79	ILO
		Unemployment, total (% of total labour force)	2020	28.74	ILO

AGRO-INNOVATION

South Africa has a strong innovation ecosystem that includes research institutions, academia, and public sector entities such as national innovation agencies and public sector financing. The Agricultural Research Council (ARC) is the country's principal agricultural research agency. As of 2014, South Africa ranked second regionally after Nigeria in agricultural research investment and capacity levels (ASTI, IFPRI & ARC, 2018). And while the government does invest in R&D, the budget for R&D in 2018 was just 0.8 percent of GDP.

South Africa has embraced the following in agriculture: precision farming, GIS-based applications, IoT, mobile-based systems, machine learning and other emerging technologies. These technologies can alleviate some of the challenges faced by agriculture in South Africa, including: the lack of appropriately adaptable seeds and fertilizers; limited access to finance, skills, and training; the lack of infrastructure such as storage facilities; and the lack of access to market information.

Innovation in agriculture and agro-processing value chains can solve some of these and other agricultural challenges. In South Africa, as in other African countries, smallholder farmers lack access to technologies. But this is further exacerbated by limited network coverage, exorbitant data costs, and low digital literacy. However, mobile money payments and e-commerce initiatives are also emerging and have been boosted by the COVID-19 pandemic. That said, well-financed large commercial farmers can easily afford to implement the new technologies.

Digital agricultural service and applications have been applied in agriculture and forestry and across the value chains. The Digital Agriculture Profiles by FAO and partners (FAO et al, 2019) notes that the most common digital solutions address credit applications, instructional resources, market and inputs access, decision support, field management and data management. Examples include: (i) precision farming: Aerobotics, a South African ag-tech company developed a precision pesticide application product to ensure compliance with export standards; John Deere and Massey Ferguson precision tractors are now available in South Africa; (ii) input services: Khula is a mobile app that connects smallholder and emerging farmers with the formal marketplace; and (iii) market and input value chains: The Farmer2Market project prepares smallholder and emerging farmers to access high-value markets by offering training on food safety standards and good agricultural practices (see Table 7).

South Africa's start-up market is one of the most competitive in the continent, and agro-innovation ventures are emerging. Popular upcoming venture include, 3DIMO, a local start-up in a joint venture with the University of Cape Town. 3DIMO developed the Thola infrared imaging tool, which helps small and medium scale farmers who are at the most risk of losing their income. Another start-up called swiftVEE uses artificial intelligence to match buyers and sellers of livestock globally. Buyers can acquire livestock at the most optimal times.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	6 401.43	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	101.73	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	3.38	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	2.78	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	4.38	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	4.87	WEF
		ICT goods imports (% of total imports)	2019	8.01	UNCTAD

SOUTH SUDAN

South Sudan is a low-income country with a population of almost 11.2 million people, 79.8 percent of whom reside in rural areas. The country has approximately 1.76 million internally displaced persons (IDPs), 2.45 million refugees in neighbouring countries, and 5.1 million food insecure people (see Table 1).

Although about 45.2 percent of total land area is suitable for cultivation in South Sudan, only 4 percent is currently used for agriculture (Diao et al., 2011). About 85 percent of the population is engaged in non-wage work, largely subsistence agriculture, which accounts for around 15 percent of the country's GDP.

South Sudan's ICT sector is under-developed due to high operating costs with heavy tow on the investment of two key Operators: Zain South Sudan and MTN South Sudan.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	11 193 729	WBG
Urban population (%)	2020	20.20	UNPD
Rural population (%)	2020	79.80	UNPD
GDP (current millions of USD)	2015	11 998	WBG
Agricultural land (km^2)	2018	285 332	FAO
Agricultural land (% of land area)	2018	45.15	FAO

INFRASTRUCTURE

Only 6.7 percent of South Sudan's population has access to electricity. The country's power sector is faced with challenges ranging from poor infrastructure, frequent power outages and high cost of service delivery. There is no national interconnected network of transmission grids. Grid electricity is produced mainly through diesel generators and provided by SSEC (South Sudan Electricity Corporation). In rural areas, 90 percent of the population relies on firewood and biomass for energy.

Zain and MTN's mobile service coverage and update remain low due to limited incomes and the country's precarious security situation. Nevertheless, both operators offer 3G coverage, while MTN has launched 4G to meet growing mobile broadband demand. Fixed-telephone services are virtually non-existent due to under-deployment before independence.

According to the Digital 2019 report, only 14 percent of the population has a mobile subscription and less than 20 percent of the population in the major towns owns mobile devices.

Current subscribers to mobile networks have poor services in the absence of good broadband and Internet connectivity. Whatever services exist make any attempts to leverage digital solutions to transform rural agriculture expensive and difficult. Most Internet access is via mobile phones, although there are some fixed wirelesses and VSAT operators. South Sudan has 16 licensed ISPs mostly in urban rather than rural areas (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	5.13	WBG
		4G coverage (% of total coverage)	2019	0.00	GSMA
		Mobile (device) ownership (% of population)	2019	14.67	GSMA
		Secure access to Internet servers (per 1 million people)	2020	4.11	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	20.09	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	5.95	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.00	ITU

DIGITAL PENETRATION

Being a landlocked country, and with a poor existing infrastructure, South Sudan is challenged with costly mobile and digital services. The country's mobile broadband price is one of the highest in the region. The GSMA also reports of low engagement with social media among its populace and the limited presence of digital apps.

In addition, there is a significant rural-urban divide in terms of access to media and telecommunications. Very few households own televisions or computers and Internet access is limited at 8 percent in 2020. Only 2.5 percent of the population uses social media. Among those with Internet access, 53 percent accessed Internet at home and 47 percent from the places of work. When it comes to gender gap in Internet use and access to digital media, only 5 percent of women in five states of South

Sudan used the Internet to access news and information, compared to 14 percent of men. Male youth are the most likely to have used the Internet (17 percent) while adult women are the least likely(3 percent). Only one percent of South Sudan's population have bank accounts.

All that said, digital agriculture penetration in the country is slowly taking pace. AGRA, with support from the Feed the Future Developing Local Extension Capacity (DLEC) introduced digital extension approaches in the county. AGRA has also partnered with Digital Green to roll out a digitally enabled extension services in South Sudan. The FEWS NET in 2015 established an early warning system to educate decision-makers who are responsible for creating and funding humanitarian response plans and assessing their food security. FAO introduced a new digital tool to fight the fall armyworm and distributed electronic tablets to 220 villagers to monitor and transmit information. FAO also helped combat locusts with digital tools such as eLocust3 that has been using drones and data for surveillance of locust intensification since 2020 (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	N/A	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	2.49	GSMA
		Number of apps in national language (quantity)	2019	3	GSMA
		Gender gap in social media use (%)	2019	0.00	GSMA
		Gender gap in mobile ownership (%)	2019	3.23	GSMA

POLICY AND REGULATION

The South Sudan Vision 2040: Towards freedom, equality, justice, peace and prosperity for all is the foundational document of all government policies. Drafted in February 2011, the vision acknowledged the need to diversify the economy away from oil and noted the huge economic potential of agriculture and animal resources. The Local Government Act (2009) established the powers, structure, and functions of local governments, which includes land administration and management and broad functions to improve agriculture and community livelihoods. The Agricultural Research Policy was finalized in July 2012 with the objective of promoting the generation, acquisition, adaptation, and dissemination of new knowledge and improved technologies and policies necessary for transforming farming in South Sudan from subsistence to commercial.

The Agriculture Sector Policy Framework (ASPF) (2012-2017) was one of the key strategic frameworks aimed at accelerating food and agricultural production; improving agricultural markets and trade through investment in infrastructure and institutions; enhancing human and institutional capacity; and pursuing agricultural growth through social development.

In the absence of a new national ICT policy, the activities of key institutions such as the National Communication Authority are aligned to the country's vision 2040, the constitution and the Communications Sector Policy 2012. The Telecom and Postal Services Policy and Strategic Work Plan 2008, the Communication Sector Policy and South Sudan National Communication Authority Act of 2012 provide the establishment of a Universal Service and Access Fund, the oversight of which lies with the South Sudan National Communication Authority.

Moreover, South Sudan has several national policy documents on private sector development, none of them operational due to the absence of an operational framework and lack of resources. These include: the South Sudan Private Sector Development Strategy; the South Sudan Investment Climate Reform Programme; the South Sudan Access to Finance Programme; and the South Sudan Enterprise Fund (SSEF). However,

From a human capacity perspective, the General Education Sector Plan (GESP) 2017–2022, called the Planning for Safety, Resilience and Social Cohesion, is an effort to alleviate the stress on the system, and to direct education toward stability based on data, evidence and financing outlays (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	54.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

South Sudan has not yet developed an entrepreneurial culture, likely due to the limited development of its private sector. Investing continues to be challenging due to the economic concentration in the oil sector. There is also a lack of clarity among federal, state and county jurisdictions over business licensing, taxes and customs.

The private sector faces many issues that constrain its competitiveness, including in delivering agricultural services. In 2018, South Sudan had 10 microfinance offerings that had reached only about 5 percent of the potential clientele in the capital Juba, and less than 1 percent of the potential clientele in the entire nation (Fortune of Africa, 2018).

In 2016, UNDP launched a national entrepreneurship and enterprise development programme that trained 110 young entrepreneurs in numerous areas including IT services. The World Bank's South Sudan Youth Start-up Business Grant Program launched in 2014 provided seed capital between USD 1 000 and USD 1 200 to small businesses and developed the business skills of participants to start their own enterprises. The South Sudan Jobs Creation and Trade Development (JCTD) project aims at providing integrated and holistic assistance for the development of micro, small and medium-sized enterprises (MSMEs) in the fruits and vegetables value chains to create economic and employment opportunities financed by EUR 4.8 million from the EU. Nonetheless, enterprises still have to spend about 13 days to complete legal registration processes (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	18	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	13	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

South Sudan's adult literacy rate is low at 34.5 percent as of 2018, but slightly higher among the youth at almost 48 percent. According to UNESCO, female youth literacy rate was 28.9 whereas that of males was 48.2 in the same year.

In 2018, the Ministry of General Education and Instruction reported that the number of primary schools in the country rose to 3 848 and primary enrolment to 1.6 million. Of all enrolled primary school children, 42.9 percent were girls. About one-third of primary schools and over half of secondary schools were private (MGEI, 2018). Educational inequalities persist along rural and urban lines. For one, all 120 secondary schools are in South Sudan's towns.

Government sponsored higher education institutions in South Sudan have increased from three to eight while privately owned have risen from zero to over 35 universities, including the University of Juba, John Garang University and Catholic University of South Sudan. Yei Agricultural and Mechanical University provides courses in agriculture science and ICT related topics. Vocational education is currently offered at public secondary technical schools under the Ministry of Education, Science and Technology. These include technical secondary schools in Juba and Wau, commercial secondary schools in Juba and Wau, and an agricultural secondary school in Wau.

Private and missionary schools that are fully funded by organizations are more likely than public schools to have laptops/desktops, even in major towns.

Initiatives such as the 10-day Youth Mobile workshop organised in 2014 on mobile app development by UNESCO for 40 university students in South Sudan aim at preparing the youth for transformation in the agriculture sector. The ICT Society South Sudan was formed to represent players and stakeholders in South Sudan's ICT sector who provide ICT services. This includes targeting the agriculture sector to elevate the standards of ICT professionals in South Sudan. GoGirls ICT mentors women and girls in ICT and science, technology, engineering and mathematics (STEM). In addition, The South Sudan STEM Initiative brings computer hardware and learning software to schools in need throughout South Sudan, as well as a solar-powered computer lab in Jonglei in 2019.

The NGO SPARK in partnership with Premium Agro-Consult Ltd. (the HUB), developed training materials for and trained 350 illiterate entrepreneurs. In phase II of the South Sudan Agribusiness Development Programme, a consortium of NGOs (Cordaid, Agriterra and SPARK) launched a project to support 10 000 farmers and their agribusinesses including in the uptake of technologies. The South Sudan Agribusiness Development Project (SSADP) created 900 jobs over the past years through 457 farmers who employed one or two additional workers (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	34.52	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	47.90	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	60.38	ILO
		Employment in agriculture, female (% of female employment)	2019	73.16	ILO
		Unemployment, total (% of total labour force)	2020	12.66	ILO

AGRO-INNOVATION

The current research and development institutions in the country are limited in capacity. The Ministry of Agriculture and Food Security continues to work with NGOs as well as regional and international research institutions to develop technology, especially seed technology.

RIL Country Labs fosters partnerships that develop, pilot and scale innovations that overcome context-specific problems or barriers to the delivery of aid and community recovery or resilience. Jubahub (jHUB) is an open knowledge and innovation hub; a community-based initiative established by like-minded youth based on identified gaps and potential solutions to community needs.

Despite South Sudan's challenges, efforts have been made to develop the innovative capacities of the youth in the country. The Peace Hack Camp was one of the first hackathons organised in the country in 2015. It hosted over 100 participants who were trained in the design of mobile applications, entrepreneurship skills and sustainable agriculture (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	200.56	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	106.52	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	N/A	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	N/A	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	N/A	UNCTAD

TOGO

Togo is a low-income country with a population of 8.2 million people, 57.2 percent of whom live in rural areas and 42.8 percent in urban areas. The agriculture sector employs 32.4 percent of the population. In 2020, Togo's GDP was USD 7.5 billion, and agriculture contributed 41 percent of GDP. Togo's agriculture is both subsistence and commercial based. The country's major agricultural produce includes coffee, cocoa and cotton (see Table 1).

Most rural communities practice subsistence agriculture and use rudimentary techniques and tools. The biggest challenge over the years has been consistently low food crop yields. The performance of the main export crops (cotton, coffee and cocoa) has also been deteriorating. Animal production and fisheries are not performing well either. WFP notes that 22 percent of the population require humanitarian assistance while over 200 000 people are at risk of being food insecure. Poverty is still high in rural areas with female-headed households suffering the most. The country is committed to increasing agricultural productivity and the incomes of farmers. Togo's National Development Plan (2018-2022) outlines the government's key developmental focus areas.

In the National Development Plan, the government identified the digital economy as of strategic importance to the country. Actions to enhance digital services have been strengthened in the government's roadmap (2020-2025) defined to face the major challenges accentuated by the COVID-19 pandemic. The plan aims at transforming Togo into digital service hub and an international centre for innovation and expertise. To achieve that, the government launched the Togo Digital 2021 strategic plan covering the next five years. The plan would ensure social inclusion, support enhanced competitiveness and growth potential of Togo's digital economy.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	8 278 737	WBG
Urban population (%)	2020	42.80	UNPD
Rural population (%)	2020	57.20	UNPD
GDP (current millions of USD)	2020	7 575	WBG
Agricultural land (km^2)	2018	38 200	FAO
Agricultural land (% of land area)	2018	70.23	FAO

INFRASTRUCTURE

Togo's infrastructure is generally in needs of substantial investments. The World Bank is supporting the country to develop its urban infrastructure. In 2019, about 52.4 percent of the population had access to electricity – with 23.6 percent access in rural areas compared to 91.8 percent in urban areas. In 2010, Contour Global, Togo's first independent power producer (IPP), started operations to augment the electricity grid. Despite that, Togo still needs to import electricity. To deliver electricity to rural areas, the government is privatizing the sector allowing off-grid power generation investments in rural areas.

Togo is connected to the African submarine cable (WACS) via Togocom. Togocom is the sole provider of international capacity in the country and ISPs and Moov Togo (rebranded recently as Moov Africa) can access this network on a wholesale basis. Meanwhile, Moov announced that it was granted authority for a new subsea cable, connecting Casablanca to Togo's capital city Lomé. The entry of the second Internet cable can potentially lower Internet prices significantly. Additionally, Togo launched the construction of its first data centre and Virtual Landing Point (VLP) in Lomé in December 2018. The data centre will make Togo a regional hub for connectivity (see Table 2).

Togocom is state-owned and the biggest player in the telecommunications market. It was formed from the merger of Togo Télécom, Togo's historical fixed-phone operator, and Togocel, the country´s mobile-network operator. Togocom and Moov are the two mobile network operators, both providing 3G and 4G network coverage, although the coverage is still not nationwide. In November 2020, Togocom engaged Nokia to develop its 5G network across the country, making Togo the first country in West Africa to launch a 5G network. Togo also has a fixed broadband Internet market with four facilities-based Internet service providers. Togocom (via PTO TogoCom, its subsidiary) has 90 percent of the fixed broadband Internet market share.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	23.63	WBG
		4G coverage (% of total coverage)	2019	12.44	GSMA
		Mobile (device) ownership (% of population)	2019	52.64	GSMA
		Secure access to Internet servers (per 1 million people)	2020	26.45	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	N/A	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	78.71	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	41.10	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.64	ITU

DIGITAL PENETRATION

In 2017, 12.3 percent of the population was using the Internet according to the World Bank. By 2020, there were 6.5 million mobile cellular subscriptions. During that same time, penetration rate of fixed broadband subscriptions was 31.89 percent. Due to investments in Togolese telecommunications infrastructure and likely reductions of Internet costs, there is an increase in the usage of mobile connections.

The mobile subscriber share between the two mobile network operators in Togo is 51.4 percent for Togocom and 48.6 percent for Moov, while the total revenue share is 63 percent for Togocom and 37 percent for Moov. TogoCom maintains a leading market share. According to GSMA Mobile Connectivity Index (2019), mobile connections was 72 percent and and 3G and 4G coverage reached 66.4 percent and 12.4 percent of the population respectively. Both figures indicate an expanded network and increased Internet coverage across Togo. But coverage has not reached most rural areas. One report suggests that in 2017 only 0.6 percent of rural areas had Internet access. About 96 percent of Togolese Internet users connect to social networks via their phone. The total rate of access to social media platforms in Togo is 7.7 percent (see Table 3).

According to Cable, the Average price of mobile data per 1 GB in 2020 was USD 4.5 compared to USD 11.76 in 2019. Through various reforms, the government has contributed to the reduction in costs of prepaid cellular calls (see Table 3).

With assistance from the African Development Bank (AfDB), the government has launched the AgriPME project, which plans to reach up to four million vulnerable farmers and users with its Agri-PmE scheme by 2030. The project connects distributors and farmers via an e-wallet system to facilitate agricultural input purchase. More than 250 000 farmers benefit from AgriPME. The project aims at providing efficient fertilizer grants and management systems for vulnerable farmers. In 2015, the Togolese entrepreneur Edeh Dona Etchri launched the e-Agribusiness platform to connect people and organizations across the country's agriculture sector and provided them with a local language call centre to facilitate access to valuable information they previously could not access.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	4.50	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	15.10	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	37.75	ITU
	Willingness	Mobile social media penetration (%)	2019	7.75	GSMA
		Number of apps in national language (quantity)	2019	32.85	GSMA
		Gender gap in social media use (%)	2019	11.64	GSMA
		Gender gap in mobile ownership (%)	2019	28.89	GSMA

POLICY AND REGULATION

Togo has a favourable policy and regulatory framework for digitalization. The Ministry of Posts and Digital Economy oversees this sector. The Telecommunications Regulatory Agency (ARCEP) is the regulatory body responsible for regulating mobile operators and Togo Poste (see Table 4).

The main telecommunications legislation is the Law on Telecommunications No. 98-005, later amended in 2004 by Law No. 2004-010 and Law No. 2004-011, and the law on Electronic Communications Law No. 2012-018 amended by Law No. 2013-003. In essence, these laws and subsequent decrees regulate the sector. More recently, these laws have also guided the framework for the liberalization of the telecoms market (World Bank, 2020:30). The government is also developing other laws to support the digital economy as guided by the Togo Digital 2025 strategic plan for the country's digital transformation. An example of that is the Cybersecurity, Electronic Transactions and the Information Society draft legislations.

Togo Digital 2025 supports a number of sector strategies, including the regulatory framework, market liberalization, institutional strengthening, infrastructure development and digital technology use across different sectors. The Togo Digital 2025 plan comes after the government successfully rolled out the e-Gouv project that implemented a government-wide network project that links all ministries in the capital city Lomé and is expected to extend to other areas across the country. The government has placed digital technology at the heart of its national strategy to accelerate the development of priority business sectors and modernize its administration.

The following are some of the decrees related to digital economy that have also been published: Decree No. 2016-161/PR, establishing the National Spectrum Agency for Radio frequencies; (Agence Nationale du Spectre pour les Radiofréquences, ANSR); Decree No. 2018-62/PR regulating digital and electronic transactions; Decree No. 2016-109/PR of 20 October 2016, on the National Frequency Allocation Plan (PNAF); Decree No. 2015-91-PR on the roles and organization of the regulator l'ARCEP; Decree No. 2014-088-PR on the legal framework for electronic communications; and Decree No. 2014-112-PR on interconnection and access to the digital infrastructure.

For example, Decree No. 2014-112-PR establishes the principle of interconnection, right of access, the handling of access requests, and service costs and tariffs.

In terms of agriculture, Togo was one of the first countries to sign the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) and immediately crafted its own agriculture policy in line with the CAADP. The policy is the National Agricultural Investment and Food and Nutritional Security Program (PNIASAN) 2016–2025, which is based on five pillars (Programme National d'Investissement Agricole et de Sécurité Alimentaire et nutritionnelle). That said, this policy does not mention any strategy on agribusiness or ICTs. However, the National Development Plan (2018–2022) identifies agribusiness as one of the sectors the government should prioritize. In terms of relevant digital agriculture policies, Togo is now drafting a strategy for the digitization of agricultural value chain management (Stratégie pour la numérisation de la gestion des chaines de valeur Agricole) with support from IFAD and FAO.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	N/A	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	N/A	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	N/A	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	N/A	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	69	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Togo ranked 97 out of 190 economies in the Ease of Doing Business scale by the World Bank, and ranked 15 in the ease of starting a business. The government of Togo's e-Citizen platform serves as a one-stop shop for accessing services. For now, it acts as an information portal for citizens on the offline process for dozens of services, ranging from renewal of licenses to applications for business permits. Additionally, commercial courts can now pay fees online, which streamlines a lot of bureaucratic processes of many commercial transactions. There is evidence of the impact Togo's digital investments are having on business. As a result, the time required to start a business in Togo in 2019 was 2.5 days compared to 10 days in 2015.

In 2019, Togo's FDI was equivalent to 2.4 percent of its GDP. According to UNCTAD's World Investment Report 2020, FDI inflows increased to USD 133 million in 2019, a turnaround from USD 183 million in 2018. E-commerce is slowly gaining pace in Togo, although most platforms are from foreign institutions (see Table 5).

Togo's agritech industry is still at its infancy. There are initiatives to engage youth in agri-businesss. In conjunction with the Technologies for African Agricultural Transformation (TAAT), the government organized a training session for youth on potential technologies that may present economic opportunities.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2020	133	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
	Entrepreneurship	Time required to start a business (days)	2019	2.5	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	N/A	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF

HUMAN CAPITAL

An estimated 60 percent of Togo's population is under 25 years of age. The total adult literacy rate is 66.5 percent as of 2019 while youth aged 15-24 have a literacy rate of 87.9 percent. There is gender disparity in literacy rates, with males being more literate than woman. Due to poverty rates, education in Togo remains stagnant with some education facilities in rural areas in need of improvement. Reducing literacy rates is a core pillar for the government's education strategy 2014-2025. Most students do not complete their education, while only 18.2 percent complete schooling up to the lower secondary level, as of 2011. Togo's Sector Plan for Education (PSE 2010-2020) seeks to promote access to ICTs in training in general. In 2014, the government launched the Digital Work Environment (DWE) Technical and Scientific High Schools Project as a means to spread the use of ICTs in schools. DWE falls under the Sector Plan for Education (PSE 2010-2020) (see Table 6).

Not much information is available on the state of agricultural training institutions in Togo. The University of Lomé has a higher school of agronomy, while the University of Kara has a higher institute of agricultural professions. Agricultural training institutions in Togo need

support. That said, some institutions like the University of Lomé, the University of Kara, the Catholic University of West Africa, and the Higher School of Computer, Science and Science Management (ESGIS) are reported to be advanced centres of learning.

Togo's National Development Plan 2018-2022 (PND) seeks to have 50 percent of public high schools and colleges equipped with networks and ICTs, all fully integrated in the training of pupils and students. Currently, there is no evidence of ICT integration in schools. A recent study by the World Bank (2020) assessed the extent that Togo's digital skills can drive its digital economy, specifically the installation of its digital infrastructure; growth of its digital entrepreneurship; and advancement of its digital platforms and services. The Togo Digital 2025 plan was a precursor to the following efforts to improve digital skills in the economy: the Optical Fiber Wi-Fi Campus project aims at improving the capacities of universities and vocational training institutes. The project connects five universities to the country's public hospital sites; and design of ICT modules to impart digital skills. The Ministry of Education and the Ministry of Posts and Digital Economy are jointly working on the curricular redesign.

The major challenges for the development of digital skills are a weak education system, lack of Internet access in public schools, and lack of skilled human resources and financial resources.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2019	66.54	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2019	87.89	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	N/A	WEF
	Employment	Employment in agriculture (% of total employment)	2019	32.38	ILO
		Employment in agriculture, female (% of female employment)	2019	26.87	ILO
		Unemployment, total (% of total labour force)	2020	4.05	ILO

AGRO-INNOVATION

Togo's National Development Plan and its policy statement on digital economy reflect the government's commitment to innovation. Togo has six public institutions in agricultural research, which include the Togolese Institute for Agricultural Research (Institut Togolais de Recherche Agronomique [ITRA]). ITRA operates research centres distributed in the four agro-ecological zones of the country. An IFPRI review (2014) identified a number of problems in research institutes including: shortage of researchers; fewer female researchers; lack of financial resources; and lack of technological innovations. There are no statistics on funding to research and development in agriculture and veterinary sciences. (see Table 7).

Various innovation initiatives such as innovation labs and centres of excellences have been reported, although not necessarily in agriculture. One example is the March 2019 Lomé Policy Hackathon, organized by local entrepreneurship stakeholders to use creativity/innovation methodologies to influence a favourable business environment. The US Embassy in Togo organised a Tech Camp (AgriTechCamp Togo) for 60 young agricultural entrepreneurs in the northern City of Kara. Participants included young people, farmers, inventors, agricultural experts and entrepreneurs. Three successful projects were chosen and received funding for further development. The German Development

Agency also runs the Green Innovation Centers in 14 African countries with a goal of supporting smallholder farmers' incomes through innovation in the agri-food sector. There a still ample room for growth of the Togolese agro-innovation industry.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	1 486.65	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	110.16	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.45	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.20	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	N/A	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	N/A	WEF
		ICT goods imports (% of total imports)	2019	3.84	UNCTAD

UGANDA

Uganda is a low-income country with a GDP of USD 37.3 billion. Growing by three percent annually, the population reached 45.7 million in 2020, while youth aged under 25 years accounted for more than 65 percent, making Uganda one of the most youthful nations in the world. The country still has a large rural population of 75 percent (see Table 1), of which 80 percent are youth (UNFPA, 2020). The fast-growing population exerts pressure on the domestic labour market as the demand for quality and decent jobs exceeds supply.

Measured in terms of the national poverty line, Uganda has made achievements in the past three decades. The proportion of people living below the national poverty line decreased from 56.2 percent in 1992 to 19.7 percent in 2012, but it increased to 21.4 percent in 2016 (World Bank, 2016).

Agriculture is the backbone of the country's economy, contributing to 25 percent of GDP, employing 72 percent of the total population and ensuring 89 percent of people are food secure. It is a key sector for income improvement and poverty reduction. Uganda produces a variety of food crops such as cassava, sweet potato, plantains, and corn, as well as cash crops like coffee, tea, sugar, cotton and tobacco. Uganda is among the leading exporters of coffee in Africa.

However, despite being rich in natural resources (fertile land and water resources), agriculture in Uganda has not yet reached its full potential. Only 35 percent of its arable land is being cultivated and the country has to cope with a range of challenges such as rain-fed dependency, climate conditions, low productivity as well as lack of access to necessary services. It is also important to note that women have contributed over 75 percent of farm labour and 90 percent of primary agro-processing, whereas smallholder households are generally male-dominated (World Bank).

Uganda's ITC sector contributed to 2.5 percent of GDP as of 2015 and employed more than 2 million people with a significant portion of them being youth. The key functions of Uganda's ICT sector include providing services and improving infrastructure. To date, the country has created a dynamic market for private service providers to actively engage in.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	45 741 000	WBG
Urban population (%)	2020	24.95	UNPD
Rural population (%)	2020	75.05	UNPD
GDP (current millions of USD)	2020	37 372	WBG
Agricultural land (km^2)	2018	144 150	FAO
Agricultural land (% of land area)	2018	71.89	FAO

INFRASTRUCTURE

About 41.3 percent of the population has access to electricity, with 70.8 percent in urban and 31.8 percent in rural areas. Uganda has launched the SEforALL initiative and set up a goal of achieving 99 percent electricity access by 2030.

Currently, the telecommunications market in Uganda is dominated by two large operators: MTN Uganda, with a 52 percent of market share, and Airtel Uganda, at 34 percent. Three other operators account for 12 percent market share collectively. 3G and 4G services have been promoted with rising mobile phone use in the country. 2G service is gradually being phased out. In 2019, 4G coverage in Uganda reached 63.9 percent (see Table 2). 5G trial has started in 2020 supported by China's ZTE and MTN Uganda. Given the relative dearth of broadband Internet connectivity in rural Uganda, the country's Communications Commission (UCC) decided to expand broadband access and deploy 3G wireless communications infrastructure via satellite with support from Intelsat and Gilat.

The country has also made efforts in improving the overall ICT infrastructure and encourages the engagement of telecom companies. The government of Uganda has invested over USD 105 million in the National Backbone Infrastructure (NBI) to lay out 5 110 km fiber optic cables. MTN has launched its fibre-to-the-home (FTTH) services in selected areas across Uganda. Facebook has partnered with Bandwidth & Cloud Services (BCS) Group and Airtel to deploy approximately 770 km of fiber infrastructure across north-western Uganda. Uganda is also connected to three marine fiber optic cables. All these investments have enhanced the digital infrastructure and strengthened the country's potential for digital transformation (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	31.80	WBG
		4G coverage (% of total coverage)	2019	63.88	GSMA
		Mobile (device) ownership (% of population)	2019	49.96	GSMA
		Secure access to Internet servers (per 1 million people)	2020	34.39	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	4.08	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	60.53	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2018	33.61	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.08	ITU

DIGITAL PENETRATION

Despite a low Internet penetration at 23.7 percent in 2019, the country has slowly improved the situation given that two decades ago Uganda had virtually zero Internet, and below 10 percent until 2010 (World Bank). The digital gap between rural and urban is still large, with only 9 percent of rural people with access to the Internet (Research ICT Africa, 2019).

Fixed broadband subscriptions are at 0.23 per 100 inhabitants while mobile cellular subscriptions perform relatively better at 60.5 percent. Around half of the population owns mobile devices (see Table 3). Even though the price for data, calls and SMS on the mobile cellular network may not seem costly (see Table 3), many Ugandans still face constraints in terms of affordability considering their low-income levels (Research ICT Africa, 2019).

The GSMA reported that about 5.5 percent of the country's population actively engaged with social media platforms as of 2019 (see Table 3). The most frequently used social media platform is Twitter, followed by Pinterest, Facebook and other platforms (Statcounter, 2020). The uptake of mobile phones did not result in high penetration of social media. This can be partially explained by Uganda's over the top (OTT) social media tax policy (social media tax) adopted in 2018, which charges an additional UGX 200 for major social media platforms including Facebook, WhatsApp, Twitter, and Instagram. Recently, this tax has been replaced by a 12 percent duty on Internet data (except for medical and education services) which has made the Internet relatively more unaffordable.

A similar tax is applied to mobile payments. Mobile money users have to pay 0.5 percent of withdrawal transactions. However, this has not impeded the growth of mobile money adoption. In 2020, the number of mobile money customers reached more than 30.3 million (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.62	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2016	8.49	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	5.50	GSMA
		Number of apps in national language (quantity)	2019	53.39	GSMA
		Gender gap in social media use (%)	2019	48.17	GSMA
		Gender gap in mobile ownership (%)	2019	42.72	GSMA

POLICY AND REGULATION

The Digital Uganda Vision guides the country's ICT development and implementation. It aims at empowering citizens and achieving "universal inclusion, sustainable development, economic progress and poverty eradication through digital innovation" (Ministry of ICT & National Guidance). The Uganda National Development Plan III (NDP III) is currently under development and continues to increase ICT penetration and services within the country through the Digital Transformation Programme, as well as leveraging advancements in the ICT sector. The 2018 National Broadband Policy also indicated the establishment of a "universal service and access fund" to target the development of ICT in rural areas. NDPIII also indicates that the agricultural extension system will be enhanced with the help of ICT, and access and use of digital technologies in agro-industry will be increased.

The National Agriculture Policy (NAP) is the foundational document that governs the country's agriculture sector. "Improving agriculture research, technology dissemination and adoption" is one of the main outcomes of the Comprehensive Africa Agriculture Development Programme (CAADP). The Extension Guidelines and Standards also target youth groups to consider ICT opportunities and technology and information needs for youth (see Table 4).

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.15	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.24	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.09	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.36	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	86	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

Uganda is one of the highest recipients of FDI in East Africa. According to UNCTAD, FDI inflows increased by nearly 20 percent to USD 1.3 billion in 2019, mainly due to the development of oil fields and projects in agriculture, manufacturing and construction (UNCTAD, 2019).

Uganda has consistently improved its political and economic stability to facilitate business operations within the country. The country provides a relatively liberalized and well-regulated business climate to attract investors and protect their rights. It takes 13 steps and approximately 24 days register a business in Uganda according to the Doing Business report.

Both ICT and agriculture have huge investment potential. Uganda's supportive legal framework, young labour resources and improved infrastructure enhance the growth opportunities of the country's ICT sector. In agriculture, Uganda is a large coffee and banana producer, and produces a wide range of food and cash crops. Opportunities include commercial agriculture, agro-processing for value-added products, cold chain as well as input supply (The State House of Uganda, 2021).

However, some constraints exist, including lack of adequate infrastructure, high poverty levels, as well as social insecurity in parts of the country that may reduce FDI appeal. The government has carried out a series of incentives to facilitate investment, such as a 75 percent import duty reduction on factory equipment, 100 percent tax deduction on research and training costs, depreciating start-up costs over four years, and a 10-year tax break for export-oriented production (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1 266	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.20	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.46	WEF
	Entrepreneurship	Time required to start a business (days)	2019	24	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	3.86	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.36	WEF

HUMAN CAPITAL

Uganda's education expenditures accounted for 2.6 percent of GDP, resulting in a literacy rate of 76.5 percent (see Table 6) with 74.8 percent for females and 82.7 percent for males. At the same time, the country faces challenges as 8.8 million young people in Uganda are not engaged in any form of education or training (UNFPA, 2020).

The low level of digital literacy is a key constraint of Internet use in Uganda. The country scored 3.42 of 7 for digital skills (see Table 6). Enhancing the country's digital capacities will have a net positive impact.

Various projects have been implemented by a number of institutions to reduce Uganda's digital divide. The eGranary Digital Portable Library provides a 750 GB hard drive with approximately 10 million educational documents (Samuel Andema et el, 2012). The Digital skills @ your local library project (EIFL-PLIP) raises awareness and provides digital literacy training to women and unemployed youth through 25 libraries. The Leaving No One Behind in the Digital Era project is implemented by UNCDF and aims at providing a digital literacy curriculum and training toolkit. Kampabits offers six-months of training on advanced ICT skills to help trainees access jobs and start ICT-related companies.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	76.53	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	89.40	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.42	WEF
	Employment	Employment in agriculture (% of total employment)	2019	72.13	ILO
		Employment in agriculture, female (% of female employment)	2019	76.77	ILO
		Unemployment, total (% of total labour force)	2020	2.44	ILO

AGRO-INNOVATION

The expenditure on agriculture research accounted for 0.6 percent of Uganda's agricultural GDP in 2016, falling nearly 0.4 percent from 2014–2015 due to completion of World Bank loans. However, the number of researchers is increasing; 81 percent of researchers have attained high levels of education that include advanced and higher degrees. However, there is still a noticeable gender gap, with 70 percent of researchers being male compared to 30 percent being female.

The National Agricultural Research Organization (NARO) is the leading institute in conducting agricultural research activities and implementing technologies and innovations in agriculture. This includes launching digital platforms, adopting dairy technologies, etc. Higher education has witnessed strong growth and plays an increasing role in agricultural R&D. The Makerere University Agricultural Research Institute Kabanyolo (MUARIK) carries out a range of agricultural research including food value chains and educational training. The university also has a strong connection and collaboration with the National Agricultural Research Organization (NARO) to exchange and showcase innovations within the country through joint scientific conferences. The International University of East Africa (IUEA) plans to be the first in the country to launch an education satellite to collect data for precision agriculture.

To better provide capacity building to youth and enable them to access job opportunities or start businesses, a variety of skill acquisition channels exist in Uganda. The CURAD incubation centre has supported more than 150 youth-led SMEs and generated over 2 200 jobs with a special focus on coffee and fruit/beverage value chain.

Innovation is also being boosted among new enterprises in agriculture through a number of platforms. GIST I-Hub and the Innovation Village build networks for young entrepreneurs. Venture Lab East Africa provided a platform for technology-enabled business ventures and start-ups. Outbox Hub organized challenges and hackathons to support young entrepreneurs using technologies that address social challenges (see Table 7).

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	6 851.20	FAO
		Gross Production Index for Agriculture (2014–2016 = 100)	2019	99.54	FAO
		Logistics Performance Index (index ranking 1–5: low/high)	2018	2.58	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.62	IFPRI
		University-industry cooperation in R&D (index ranking 1–7: no collaboration/ extensive collaboration)	2017	3.59	WEF
		Capacity for innovation (index ranking 1–7: not at all/ to a great extent)	2017	3.94	WEF
		ICT goods imports (% of total imports)	2018	4.01	UNCTAD

UNITED REPUBLIC OF TANZANIA

The United Republic of Tanzania is a lower-middle-income country with a population of 59.7 million as of 2020. The country's agriculture employs 65 percent of the workforce, 80 percent of whom are small farmers, of which 42 percent are youth. Agriculture contributes to 24.1 percent of GDP, 30 percent of export earnings, and 65 percent of raw materials for industries (URT 2013; Misaki et al., 2015; Barakabitze et al., 2015) (see Table 1).

Of the country's 885 800 km^2 of land, 45 percent is agriculture land. About 80 percent of agricultural production comes from rain-fed, low-input smallholder farms that are highly vulnerable to climate variability and change. Moreover, productivity is generally low. The agriculture sector has recorded an average growth of 0.4 percent between 2015 and 2017 (Tanzania National Bureau of Statistics, 2020).

Poverty is significantly higher in rural areas with 31.3 percent of rural people living below the poverty line, compared to 15.8 percent in urban areas. About 85 percent of smallholder households live below the poverty line, earning less than USD 1.9 a day.

Recognising the value of ICTs, the Government of the United Republic of Tanzania has introduced reforms and strategies to provide support for diverse initiatives aimed at boosting these tools across various sectors. The government has created an enabling environment through a predictable regulatory framework, competition and open access to backbone networks.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	59 734 213	WBG
Urban population (%)	2020	35.23	UNPD
Rural population (%)	2020	64.77	UNPD
GDP (current millions of USD)	2020	62 410	WBG
Agricultural land (km^2)	2018	396 500	FAO
Agricultural land (% of land area)	2018	44.76	FAO

INFRASTRUCTURE

The United Republic of Tanzania has an average of 19 percent electricity distribution in rural areas, compared to 73.2 percent in urban areas as of 2019. A total of 11 070 public institutions have been connected to electricity between 2015 and 2019, up from 3 200. A total of 9 001 villages in the country have been connected to electricity, of which 3 559 villages were connected through the first round of Phase Three Rural Electrification Project (REA III-1) The project is funded through the operational Rural Energy Fund, which is financed through levies, the national budget and donors. It aims at offsetting the USD 747 cost per new connection. The Songwe, Kigoma, Shinyanga, Simiyu, and Manyara regions all have less than 10 percent of rural households with access to electricity. Of these rural households with electricity, 34.5 percent were electrified through the grid, 0.6 percent through private entity/individual electricity generated from own sources excluding solar, and 64.8 percent using solar power.

There are seven mobile operators in the country, with the top three accounting for 81 percent of market share as of March 2021. The three market leaders are Vodacom, a subsidiary of the South African mobile group with the sane name; Tigo, a subsidiary of the Luxembourg-based Millicom mobile group; and Airtel, a subsidiary of the Indian mobile group. Other mobile operators include Zantel, operating on the island of Zanzibar, and a subsidiary of Millicom; Halotel, a subsidiary of the Vietnamese Viettel Group; Smile, owned by the Aga Khan Development Network and the Tanzania Telecommunications Corporation (TTCL).

Although 56 percent of the 52.8 million mobile subscriptions in the country are based on 2G, mobile broadband technologies are rising rapidly. In 2018, 3G and 4G connections reached 40 percent and 4 percent of total connections respectively. By March 2021, 2G, 3G and 4G networks covered around 93 percent, 68 percent and 45 percent of the country's population respectively.* All mobile operators have deployed 3G while Tigo, Smart, Zantel and Vodacom have also commercially launched LTE.

Tanzania Communications Regulatory Authority, 2021

TTCL's fixed broadband offerings include ADSL (up to 2 Mbit/s), fiber optic and fixed wireless LTE. It competes with other fixed broadband providers, primarily using fixed wireless broadband and a few offering fiber optic connections, mainly to businesses in urban areas. The National ICT Broadband Backbone (NICTBB) infrastructure - covering more than 7 500 km - has been operational since June 2012. It is structured as a public-private partnership between the government and operators, and the Fibre Consortium (comprising Airtel, Tigo, Vodacom and Zantel) constructed about 400 kilometres of metro fibre.

The government's fifth and last phase of the National Information and Communication Technologies (ICT) Broadband Backbone (NICTBB) project will extend broadband connectivity to the last mile in underserved rural and urban areas. Mobile operators through the UCSAF subsidization initiative and Halotel have collectively covered more than 90 percent of the geographic area of the country, where every local government area at least has 2G cellular network coverage.

Mobile operators have invested around USD 2.6 billion in the country's network infrastructure and new platforms that enable digital services like mobile money and M2M.

Some notable achievements include: the deployment of six Internet Exchange Points (IXPs) located in Dar es Salaam, Arusha, Mwanza, Zanzibar, Mbeya and Dodoma; the establishment of the country code top-level domain (ccTLD); and the landing of two submarine cables in Dar es Salaam, namely Eastern Africa Submarine Cable System (EASSy) and Southern and Eastern Africa Communication Network (SEACOM).

GSMA brings affordable GSM mobile connectivity to remote rural communities and areas previously unconnected. In partnership with Vodacom it provides Internet cafes using 3G HSPA technology that are managed by local entrepreneurs who charge a fee for the service (see Table 2).

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	19.00	WBG
		4G coverage (% of total coverage)	2019	28.00	GSMA
		Mobile (device) ownership (% of population)	2019	45.51	GSMA
		Secure access to Internet servers (per 1 million people)	2020	38.19	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.83	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2019	82.20	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	9.79	ITU
		Fixed broadband subscriptions (per 100 people)	2017	12 700	ITU

DIGITAL PENETRATION

Mobile and Internet services are inexpensive, which would explain the proliferation of mobile devices and the prevalence of social media use. Cable in 2020 reported that the average price of 1 GB of mobile data stands at USD 0.73. Also, ITU reported that the price of local mobile cellular calls per minute was USD 0.20 as of 2017. The country had 15.15 million Internet users in January 2021, which increased to 29.1 million in March of the same years. Internet penetration stands at 49 percent. About 86 percent of the rural population is connected to the Internet compared to just 44.6 percent in rural areas. Similarly, fewer women have access to and use the Internet compared to men. Smartphone penetration stood at 26 percent as of March 2021.

Two-thirds of smallholder farmers have their own mobile phone, and 82 percent have used a phone. The most common phone is a basic phone without Internet capability. The use of feature phones and smartphones is quite low at 13 and 7 percent respectively among smallholders. Eighty-four percent of men and 77 percent of women have their own mobile phones. Similarly, urban farmers are only 10 percent more likely to have a cell phone than rural farmers (87 percent vs. 77 percent). Close to half (47 percent) have made a financial transaction with their phone. The main reason cited by smallholders for not having a mobile phone is cost. Almost two thirds (65 percent) feel they do not have the funds to purchase one. Among smallholders who have an active, working SIM card registered in their name, 85 percent are men and 81 percent are women.

There were 5.40 million social media users in January 2021, reflecting an increase of 900 000 users from 2020. The figure of social media users represents 8.9 percent of the total population as of January 2021. The United Republic of Tanzania has expanded its digitalization scope with 53 mobile apps existing in the country's national language as of 2019.

Statcounter (2020) reported that 34.08 percent of Tanzanians use Facebook, 19.79 percent use Pinterest, 28.83 percent use Twitter, 14.2 percent use YouTube, 2.6 percent use Twitter and 0.3 percent using LinkedIn. The GSMA also reported that about 7.7 percent of the country's population actively engaged with social media platforms in 2019.

ICT interventions have also been used in the past, principally through village information centres and telecentres (Mtega and Msungu, 2013). A television programme for agriculture

called Shamba Shapeup is watched by 5 million viewers. Participatory Radio Campaigns (PRCs) and Farm Radio also have agriculture broadcasting programmes.

Only 10 percent of Tanzanian smallholders have a bank account registered in their name, but nearly 49 percent are considered financially included. This is primarily through mobile money, of which it is estimated there are 32.7 million accounts as of March 2021. Around 48 percent of smallholders under 30 have been financially excluded, and 36 percent of all smallholders access credit informally. Only three percent of rural smallholders have government-issued identification, compared to 18 percent of urban smallholders (eight percent overall).

The market has 28 digital agriculture products and service providers such as Kilimo Fresh, Agritechs, Fursa 101, MyAgro, WeFarm, providing marketing, logistics and farm intelligence. Agrimark started in 2015 as the first Tanzanian digital agricultural platform. NINAYO was launched in 2015 as an online trading platform for the Tanzanian agricultural market. The Mastercard Foundation and Kaderes provide a digital platform to deliver financial inclusion to farmers.

GSMA is developing mobile services for the use of agriculture, and it also promotes six projects listed in the mAgri deployment Tracker (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	0.73	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2017	6.75	ITU
		Fixed broadband prices as a % of adjusted per capita income	2017	21.46	ITU
	Willingness	Mobile social media penetration (%)	2019	7.69	GSMA
		Number of apps in national language (quantity)	2019	53.39	GSMA
		Gender gap in social media use (%)	2019	35.99	GSMA
		Gender gap in mobile ownership (%)	2019	64.41	GSMA

POLICY AND REGULATION

In 2001, the Tanzanian Rural Development Strategy (RDS) supported the introduction of ICT in rural areas through the creation of telecentres that offer a wide variety of public and private information-based goods and services, and which support local economic or social development. In addition, the National ICT Policy 2003 was developed and revised in 2016 to provide more affordable access to a range of ICT services to as many people as possible in urban and rural areas. Subsequently, the Tanzanian Development Master Plan outlined each village to be provided with ICT services by 2020 (Tanzania Development Vision 2025). Furthermore, The Universal Communications Service Access Act was enacted by the government to promote the participation of both the public and private sectors to ensure the availability of ICT services in under-served rural and urban areas. This was followed by the establishment of the Universal Communication Access Fund and five mobile phone operators (Tigo, Zantel, TTCL, Vodacom and Airtel) that signed a contract to enable telecommunications companies to construct Microwave towers to facilitate ICT services for rural Tanzanians.

Responsibility for the ICT sector falls under the Ministry of Works, Transport and Communications. It enacts policies and legal frameworks to promote digitalization and ICT services. Examples include; the Tanzania Domestic Broadband Infrastructure Policy,

the National ICT Policy and National Digital Strategy to promote (i) digital transformation of the public sector; (ii) digital access; and (iii) digital inclusion.

Phase II of the Agricultural Sector Development Programme (ASDP II) has been developed to propel the country's economic development and guide the implementation of prioritized interventions for the Tanzania Development Vision 2025 (TDV 2025). Other enabling plans aimed at the agriculture sector include: the Long Term Perspective Plan (LTPP 2012–2021); Phase II of the Five Year Development Plan (FYDP II 2011–2021), the Tanzania Agriculture and Food Security Investment Plan (TAFSIP) and the Agricultural Sector Development Strategy Phase II (ASDS II). The duration of (ASDP II) is ten years starting 2017/18 to 2027/28. It is complemented by the National Strategy for Growth and Reduction of Poverty I & II, known as MKUKUTA I and II and Kilimo Kwanza (KK).

In order to promote and enhance digitalization that encompasses the agriculture sector as well, the government bolstered its Rural Micro, Small and Medium Enterprise Support Programme (MUVI) with a USD 25 million budget implemented through the Ministry of Industry, Trade and Investment. The programme helps improve rural employment opportunities across the regions of Iringa, Manyara, Mwanza, Pwani, Ruvuma and Tanga. It provides rural entrepreneurs of SMEs with improved skills training, knowledge and access to markets, to help increase productivity, profitability and off-farm incomes. The Marketing Infrastructure, Value Addition and Rural Finance Support Programme (MIVARF) is co-financed by IFAD and AfDB for a total of USD 170 million. The programme is coordinated by the prime minister's office. It covers 26 regions, including the 21 mainland regions and the five regions of Zanzibar for a total of 141 rural districts. The East African Agricultural Productivity Programme (EAAPP) aims at supporting the regional centres of excellence (RCoE) to contribute to increased agricultural productivity and growth by strengthening and scaling up regional cooperation in technology development, training, and dissemination programmes.

In addition, the United Republic of Tanzania adopted the National Strategy for Youth Involvement in Agriculture, which aims at facilitating and building youth capacity for self-employment and creating an enabling environment for attracting youth to participate in agricultural economic activities along the value chain (see Table 4).

Table 4: Policy and regulations

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	3.59	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.80	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.76	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	3.17	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	85	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

The Tanzania Investment Centre (TIC) was established in 1997 by the Tanzania Investment Act as the primary agency of the government for the coordination, encouragement, promotion and facilitation of investment in the country. Favourable conditions for enabling digital agriculture were introduced, such as the elimination of import duties on project capital goods, computers and computer accessories, raw material and replacement parts for agriculture, animal husbandry and fishing. This is further complemented by 100 percent capital expenditure to agricultural sectors.

Tanzanian agricultural technology is attracting investment from non-traditional sources like wealthy individuals and private equity firms that have invested USD 25.5 million in 2015–2017. The average age of agritech company owners ranges between 29–32, suggesting enterprising and innovative youth are creating new tech-savvy value chains.

The number of days required to legally register and operate a business was reduced to 29.5 days as of 2019.

In the United Republic of Tanzania, almost all firms own mobile phones. About 81.9 percent own computers, 65.4 percent have landline telephones, and 47.3 have company websites. About 42.3 percent of Tanzanian firms have subscribed to Internet services, with 72 percent reporting that they frequently use ICTs to support their businesses.

The public and private sectors are actively working to enable a digital ecosystem for businesses to leverage. For instance, UNCDF is working with FAO, WFP and ITC to provide a digital platform through which farmers can access financial services with mobile network operators and a financial service provider, the Tanzania Postal Bank. Since the start of implementation, a total of 6 688 farmers have registered for services.

Mercy Corps' AgriFin Accelerate Program (AFA) funded by the Mastercard Foundation aims at supporting private sector actors to develop, prototype and scale digitally-enabled services for smallholder farmers across the United Republic of Tanzania.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	1 112	UNCTAD
		Growth of innovative companies (index ranking 1–7: not at all/ to a great extent)	2019	4.28	WEF
		Venture capital availability (index ranking 1–7: extremely difficult/ extremely easy)	2017	2.65	WEF
	Entrepreneurship	Time required to start a business (days)	2019	29.5	WBG
		Ease of access to loans (index ranking 1–7: extremely difficult/ extremely easy)	2017	3.29	WEF
		Attitude towards entrepreneurial risk (index ranking 1–7: not at all/ to a great extent)	2019	3.99	WEF

HUMAN CAPITAL

The United Republic of Tanzania has a fairly literate youthful population (85.8 percent) while the literacy rate of its adult population is about 77.9 percent. However, it is estimated that 5.1 million children between the ages of seven and 17 are not in school. Primary school enrolment reached its peak of 86 percent in 2016, and in that same year, lower-secondary level school enrolment plummeted to a low of 33.4 percent. Many Tanzanian children do not go on to attain a secondary education or vocational training. Most of the country's population remains condensed in rural areas far away from secondary schools. In response to the need to teach more soft skills in school curricula, the Tanzania Institute of Education (TEA) has altered the secondary school curriculum to include new subjects such as computer literacy, unified science and social skills.

Women hold only 25 percent of tech jobs nationally, while women and girls comprise just 10 percent of students earning degrees in computer science, according to government statistics.

Education beyond primary school is rare among Tanzanian smallholder heads of households. Only 9 percent advance to secondary school, and just 2 percent receive a higher education. There are numerous programmes (such as the Tanzania Beyond Tomorrow, e-Schools Project, etc.) that are aiming at increasing access to ICT infrastructure in schools. About 77 percent of secondary school teachers possess either a laptop, a smartphone or both. Public organizations like Costech have been instrumental in networking and providing information and ICTs to scientists. The current status of agricultural libraries and the potential of electronic communications to disseminate agricultural information in Tanzania have been affected by poor communications resulting in provision of inferior information services to users. This is particularly the case among information custodians like Sokoine National Agricultural Library (the largest in the country and relatively better resourced), Costech, the University Of Dar Es Salaam, International Democrat Union (IDU), and other research institute libraries (see Table 6).

The agriculture sector has several training organizations for researchers and extension services, which include universities and research institutes. The largest is the Sokoine University of Agriculture (SUA), which also runs projects on the role of mobile phones towards improving coverage of agricultural extension services funded by the Norwegian government to the tune of USD 11 million.

Microsoft partnered with AGRA via its 4Africa initiative to offer skills development support that leverages existing Microsoft programmes, including co-managing an internship programme as well as co-designing and developing technology solutions.

Farm Africa has been working with local partners Inades-Formation and Community Support Initiatives Tanzania (COSITA) to train Tanzanian sesame farmers to use smartphones loaded with training apps. In the central part of the country, around 10 000 smallholder farmers are set to benefit from the new technology, which will help them increase yields and profitability.

Don't Lose the Plot (DLTP) was a pilot agricultural support platform built around a weekly television programme that followed the lives of farmers. DLTP aimed at increasing youth interest and participation in agriculture as a viable business in the United Republic of Tanzania. The programme watched by 340 000 viewers.

The Upscaling Technologies in Agriculture through Knowledge Extension (UPTAKE) project uses mobile phone and radio technologies to provide information to small-scale farmers on proven agricultural technologies.

The ICT Commission provides courses on cloud computing, big data analytics, ICT project management and cybersecurity. Access Agriculture is a non-profit organization that showcases agricultural training videos in local languages. In May 2016, the Vocation Education

Training Authority of the Ministry of Education, Science and Technology partnered with Airtel and the Dar Teknohama Business Incubator to develop and implement a mobile e-learning platform called VSOMO, to expand the reach of the Vocational Education and Training Authority (VETA) in providing digital content to potential clients who cannot physically attend classes.

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2015	77.89	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2015	85.76	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.87	WEF
	Employment	Employment in agriculture (% of total employment)	2019	65.09	ILO
		Employment in agriculture, female (% of female employment)	2019	66.71	ILO
		Unemployment, total (% of total labour force)	2020	2.16	ILO

AGRO-INNOVATION

As of 2016, the United Republic of Tanzania invested only 0.17 percent of its agricultural GDP in agricultural R&D. The Tanzania Agricultural Research Institute (TARI) and the Tanzania Livestock Research Institute (TALIRI) have struggled to attract and retain well-qualified researchers. New recruits, even those with doctoral degrees, often have inadequate experience. As of 2016, most senior researchers were approaching retirement age. Overall, the share of female researchers rose from 21 percent in 2008 to 29 percent in 2016. However, the Tanzania Commission for Science and Technology (COSTECH) has set the direction and priority areas for research in science, technology and innovation (STI), which will propel socio-economic transformation.

The present structure of Tanzania's National Agricultural Research System (NARS) can be classified as public and private sector research. Public research is represented by the Division of Research and Development (DRD) under the Ministry of Agriculture Food Security (MAFS). It is the largest entity in the National Agricultural Research System (NARS). Privatization of agricultural research is relatively more advanced in tea and coffee, with each crop having a specialized research institute. The Tea Research Institute of Tanzania (TRIT) for tea and the Tanzania Coffee Research Institute (TaCRI) for coffee.

The Fair Competition Commission (FCC) is responsive to requests for assistance from private companies and acts against counterfeiters. Registration of patents and trademarks is on a "first in time, first in right" basis.

The Dar es Salaam based Buni Hub is a pre-incubator hosted by Costech. Most innovation spaces are incubators including the Dar Teknohama Business Incubator (DTBi), the University of Dar es Salaam Entrepreneurship Centre (UDEC), and the UDEC Business Incubator to name but a few.

Innovation spaces at different stages of development also exist such as the Microsoft Innovation Centre at the University of Dodoma in Dodoma; Twende-AISE, Kakute, NM-AIST, Carmartec, an d Obuntu Hub in Arusha; VSO International T-LED, Rlabs Iringa, Kiota in Iringa; the Anza Accelerator, and Kilihub in Moshi, VSO International T-LED in Mtwara; the Saint Augustine University, Ellimu Living Lab Sengerema, EQWIP Hubs, VSO International

T-LED in Mzanza; and EQWIP Hubs, ZTBI, Cube Zanzibar, Tanzania Youth Icon (TAYI) in Zanzibar.

Start-up accelerators (such as e-kilimo, BuniHub, Kinu Co-Creation Hub, Seedstars Dar es Salaam, Robotech, Vodacom Digital Accelerator, and Ennovate Hub) provide supportive platforms for early-stage ideas and start-ups in the sector through mentoring, technical support and seed funding.

In addition, Twiga is a bilateral initiative between South Africa and The United Republic of Tanzania for the promotion of collaboration and innovation between the start-up ecosystems and hubs in the two countries, particularly focusing on the digital health and food security sectors.

Implementation of the Tanzania ICT Technology Park started in 2010 with a memorandum of understanding signed with the Export Processing Zone Authority (EPZA) in May 2014. The Master Plan Development was completed in 2018 but a Special Purpose Vehicle to run the Technology Park has not yet started. The inauguration and call for investors for the Technology Park was planned for 2021/2022.

The Tanzania Commission for Science and Technology through Buni Innovation Hub has started an initiative to support the establishment and growth of innovation spaces, specifically those attached to public universities, with the aim of creating awareness about innovation in universities and R&D institutions. The first phase included six universities and a total of 50 people who can potentially run the spaces. This includes: the University of Iringa, Mbeya University of Science and Technology, the University of Dodoma, Nelson Mandela Institute of Science and Technology, Sokoine University of Agriculture, the State University of Zanzibar, Mwanza region - Innovation space and virtual incubator.

Huawei Tanzania has been organizing annual ICT competitions since 2018 to cultivate Tanzanian talent.

The Tanzania Youth Digital Summit (TYDS) is an annual event organized by DOT Tanzania in partnership with the ICT Commission, to support digital skills development among Tanzanian youth, and to inspire their innovation and active participation in the digital economy.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	15 778.22	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	107.19	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2016	2.99	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	0.17	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.50	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.60	WEF
		ICT goods imports (% of total imports)	2018	3.12	UNCTAD

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ZAMBIA

Zambia is a lower-middle-income economy with a GDP of USD 19.3 billion. About 44.1 percent of its 18.3 million population lives in urban areas while 55.9 percent lives in rural areas (ZamStats, 2020). Zambia has a youthful population, growing at 2.8 percent per year, which brings abundant labour forces but also increasing job demands. Employment in agriculture accounted for 49.6 percent of total employment in 2020, decreasing sharply from 2008 when it stood at 71.43 percent (see Table 1). According to the Labour Force Survey, employed persons aged 15 years and older in agriculture accounted for 35.3 percent (ZamStats, 2019)

As estimated by the Bank of Zambia, the real GDP growth rate in 2020 reached more than 3 percent, revised to -4.2 percent as projected. Despite the huge impacts of the COVID-19 pandemic on wholesale and retail trade, education, construction tourism, agriculture, forestry and fishing showed strong performance, growing by 17.2 percent attributed to improved maize output (Bank of Zambia 2020 Annual Report).

Preliminary data indicate that real GDP contracted by 3 percent in 2020 compared to a positive growth of 1.4 percent in 2019. This was less severe than the projected decline of -4.2 percent. Largely accounting for the recession was negative growth in wholesale and retail trade, education, construction as well as tourism sectors attributed to the COVID-19 shock (Bank of Zambia, 2020).

The positive growth in agriculture, forestry and fishing, information and communication (ICT), mining, as well as electricity, gas and water sectors moderated the overall contraction. Agriculture, forestry and fishing recovered strongly in 2020, growing by 17.2 percent and contributed 1.1 percentage points to overall growth. This was largely on account of improved maize output. Maize production increased by 69 percent to 3.3 million metric tonnes due to early delivery of inputs (fertilisers, crop chemicals and seeds under FISP) and favourable rainfall (Bank of Zambia, 2020).

Whereas Zambia is a landlocked and resource-rich country, the cultivated pattern in Zambia is still traditional and largely rain-fed, despite Zambia's abundant water resources. Only a few commercial farms own irrigated lands representing a small percentage. The lack of irrigation makes the country vulnerable and dependent on weather patterns. The agriculture sector (including forestry and fishing) contributed 1.1 percent to the overall growth in 2020 (Bank of Zambia 2020 Annual Report). Meanwhile, the ICT sector also witnessed a significant growth in 2020 in the era of COVID-19, by switching to digital solutions, contributing 0.7 percent to the overall growth and growing by 14.3 percent (Bank of Zambia 2020 Annual Report).

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	18 383 956	WBG
Urban population (%)	2020	44.63	UNPD
Rural population (%)	2020	55.37	UNPD
GDP (current millions of USD)	2020	19 320	WBG
Agricultural land (km^2)	2018	238 360	FAO
Agricultural land (% of land area)	2018	32.06	FAO

INFRASTRUCTURE

In Zambia, 4G services are available with 49 percent coverage while only 52.1 percent of the population own mobile devices. Electricity is a vital constraint in rural areas, with nearly 86 percent of rural population being impacted by limited supply of electricity (see Table 2).

To improve the country's ICT infrastructure construction, particularly in rural and underserved areas, the Zambian Government launched a project to construct over 200 Multipurpose Communication Towers with the Universal Access Fund across the rural parts of the country. Leading network operators such as MTN Zambia, Airtel and Zamtel have invested in infrastructure to improve access to 3G and 4G services, while the government has planned to upgrade the mobile infrastructure to 5G services.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	13.94	WBG
		4G coverage (% of total coverage)	2019	49.10	GSMA
		Mobile (device) ownership (% of population)	2019	52.14	GSMA
		Secure access to Internet servers (per 1 million people)	2020	40.52	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.98	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	103.92	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	51.07	ITU
		Fixed broadband subscriptions (per 100 people)	2020	0.45	ITU

DIGITAL PENETRATION

The number of mobile cellular subscriptions in Zambia has increased to 19.1 million as of 2020, with a mobile penetration rate increase from 96 to 104 per 100 inhabitants between 2019 and 2020. The COVID-19 pandemic has made mobile payments more popular with a doubling of transactions (Bank of Zambia 2020 Annual Report). The increase of mobile penetration is also attributed to cost reduction of data bundles regulated by parliament. The average price of 1 GB of mobile data is USD 1.36 as posited by Cable (2020), and improvement of Internet speeds, led by network operators MTN Zambia, Airtel Zambia and Zamtel, with dominant network coverage of 44.1 percent, 42.7 percent and 27 percent respectively.

However, there is a significant gap in computer ownership between rural and urban areas. According to ZICTA's 2018 survey, only 2.7 percent of rural households owned a computer. Meanwhile, the country has a low penetration of mobile social networks rated at 12.76 percent with a gender gap of 53.7 percent. This presents another key obstacle of accessing the Internet for women and girls. Lack of access to training, early marriage, as well as heavy household workloads prevent them from being qualified for ICT skills and limits their ability to access information (see Table 3).

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	1.36	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2015	3.65	ITU
		Fixed broadband prices as a % of adjusted per capita income	2015	18.26	ITU
	Willingness	Mobile social media penetration (%)	2019	12.76	GSMA
		Number of apps in national language (quantity)	2019	16.00	GSMA
		Gender gap in social media use (%)	2019	59.79	GSMA
		Gender gap in mobile ownership (%)	2019	53.70	GSMA

POLICY AND REGULATION

The Ministry of Communications and Transport launched the National ICT Policy in 2007 to reduce the development divide by building an information-centred society. Agriculture is one of the policy's 13 pillars, and the adoption of e-commerce by SMEs in agriculture is especially highlighted. To further improve access to ICT services, the government issued ICT (Universal Access) Regulations in 2012 based on the 2009 Act to encourage installation of electronic communications networks and provide electronic communications services in particular areas. In 2015, the government launched the Smart Zambia project to help national institutions and ministries establish viable and interoperable computing systems. The Zambia National Data Centre was set up in 2017 and has actively opened up to the private sector at a fee.

Although there is an emerging number of digital innovations and initiatives in the agriculture sector, the country is yet to develop a national policy focusing on digital agriculture.

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	4.11	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	4.03	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	3.09	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/extremely well developed)	2016	3.64	WEF
	Regulatory framework	ICT regulatory tracker (1-100)*	2018	71.7	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2020, unemployment in Zambia stood at 12.2 percent while among the youth, the the number was higher at 22.6 in 2019, showing a slow increase from 2012. A growing youth population puts extra pressure on creating jobs. Agribusiness has thus been identified as a way to unlock the potential in generating job opportunities to absorb youth labour forces.

Encouraged by the government, MSMEs are starting to thrive in the country. Evolving from Small Industries Development Organizations in 1991, the Small Enterprises Development Board in 1996, the Zambia Development Agency in 2016, the government continues to put emphasis on rural agribusiness development and encourages private investments in agriculture through business support services. However, the growth of innovative companies witnessed a decrease from 3.95/7 in 2017 to 3.81/7 in 2019 (WEF, 2019).

Particular focus is also given to female entrepreneurs and female-run businesses. Supported by Standard Chartered Bank Zambia, an incubator programme has been designed for women to develop entrepreneurial skills and leverage technology to grow their businesses (see Table 5).

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	753	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	3.81	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.16	WEF
	Entrepreneurship	Time required to start a business (days)	2019	8.5	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/extremely easy)	2017	3.10	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	3.87	WEF

HUMAN CAPITAL

Zambia had an adult (15 years of age and older) literacy rate of 86.8 percent (90 percent for males, and 83 percent for females). The literacy rate has increased due to the government's efforts in enlarging education expenditure from 5.65 percent of the total budget in 2008 to 17 percent in 2018. Primary school fees have also been eliminated. However, the transition rate remains low with 42.9 percent net secondary school enrolment, compared to 87.9 percent of primary school (UNICEF).

The country's digital literacy level remains low, scoring 3.5 of 7 according to WEF, particularly among youth. As a result, the government aims at improving digital literacy levels. This will be achieved through public and private investments to build digital schools that have computer libraries, smart boards to replace traditional blackboards, to enhance the ICT skills of youth. In 2015, the government also revised the education curriculum to include ICT learning in schools.

Investors and entrepreneurs have committed to building youth capacities to fill the skills gap and ensure digital transformation in Zambia. The New Hope Waves launched The Project for Young People Promoting ICT and Livelihood Skills Training (YPICTS) aimed at empowering vulnerable young people with ICT skills. BongoHive established innovation and technology hubs to deliver digital marketing and business training and in 2018 supported agro-processing entrepreneurs through the Zambia AgriBusiness BootCamp (UNCTAD, 2019) (see Table 6).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2018	86.75	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2018	92.09	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.50	WEF
	Employment	Employment in agriculture (% of total employment)	2019	49.64	ILO
		Employment in agriculture, female (% of female employment)	2019	54.66	ILO
		Unemployment, total (% of total labour force)	2020	12.17	ILO

AGRO-INNOVATION

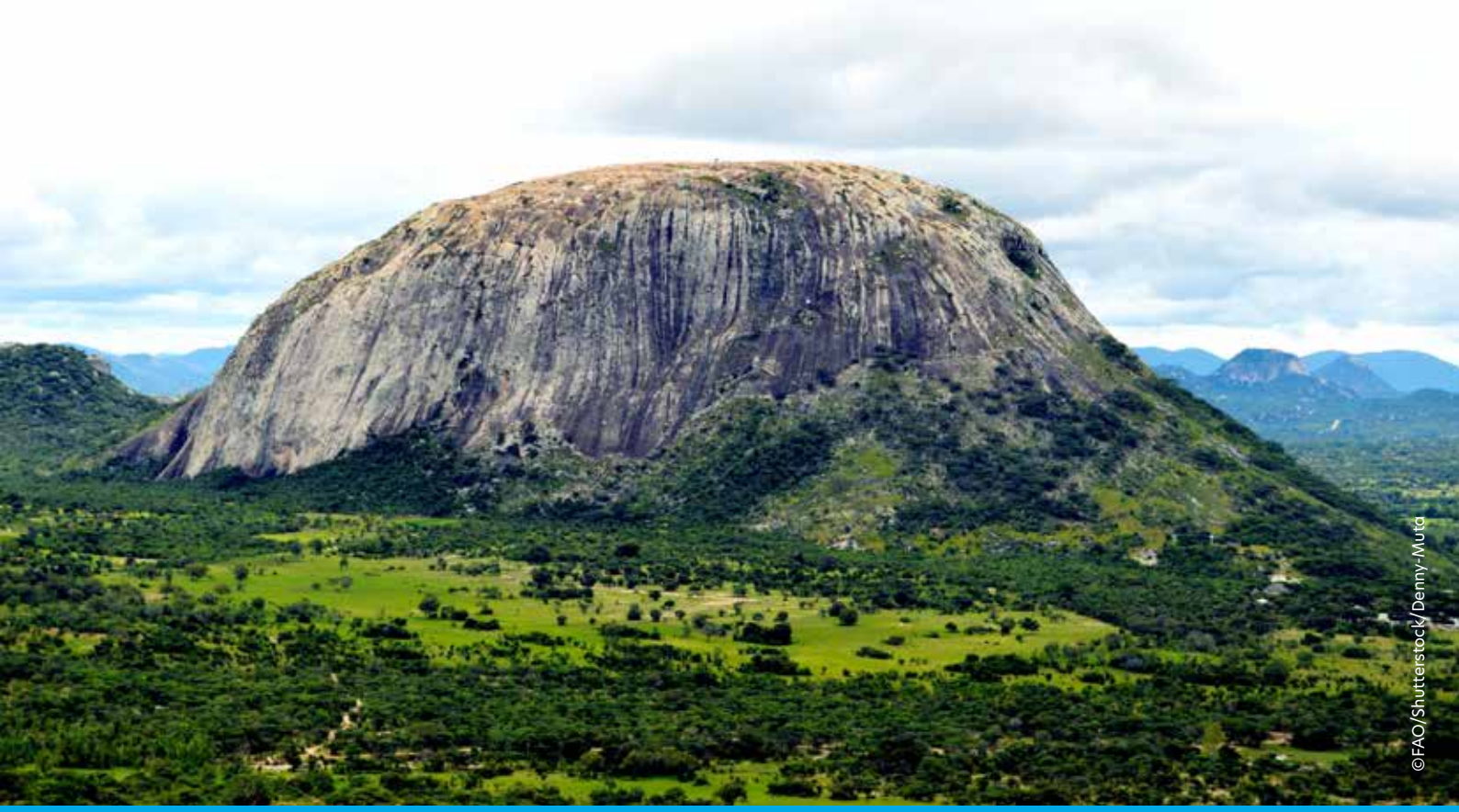
Agriculture development is still critical for Zambia in terms of poverty reduction, job generation and enhanced food security. With emerging technologies and start-ups, Zambia is witnessing a transformation of its food system.

A number of programs and projects supported by international and local organizations have helped Zambia increase agriculture digital technologies and services. The Agriculture Productivity Program for Southern Africa (APPSA) of the World Bank promoted 22 new technologies to farmers in Zambia. The Mercy Corps AgriFin Accelerate programme established a mobile-based digital banking service called AgriPay to smallholder farmers. And with the support of Feed the Future Innovation Lab, the government launched the E-FISP initiative to ensure farmers can benefit from e-voucher payment systems.

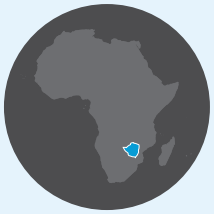
Within the country itself, university contribution to R&D stayed at a medium level, scoring 3.27 out of 7. In general, the government's involvement seems to facilitate progress. For example, with government support, the Zambia Open University signed a memorandum of understanding with the Southern Africa Telecentre Network and Zambia's Library and Information Association to establish a digital platform for the adoption of ICT in rural areas and across agriculture sector. The overall agricultural R&D capacity is largely reliant on government funding. Despite receiving limited support from donors, underinvestment is still a key constraint to have a pool of qualified researchers and to provide training.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	1 022.85	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	110.44	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.53	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2014	0.51	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	3.27	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.83	WEF
		ICT goods imports (% of total imports)	2019	2.99	UNCTAD



ZIMBABWE



Zimbabwe is a lower-middle income country with a population of 14.8 million people, 10 million of whom live in rural areas. Agriculture is the backbone of Zimbabwe's economy, and more than 80 percent of rural households depend on it for their livelihoods. Agriculture provides employment and income for 66 percent of the population, supplies 60 percent of the raw materials required by the industrial sector and contributes 40 percent of total export earnings. Agriculture contributes approximately 17 percent to Zimbabwe's GDP (FAO, 2021).

Over 60 percent of Zimbabwe's population is comprised of youth, who have the potential to drive the economy. This demographic is highly educated, skilled, but remains largely unemployed.

Zimbabwe is endowed with a wide variety of mineral resources, and there is extensive mining of coal, gold, platinum, copper, nickel, tin, clay, chromium ore, and iron ore (AFDB, 2019). However, the country has endured a decade of economic crises, which has affected food security, availability of farming inputs and increased unemployment rates. Extreme poverty is estimated to have risen to 34 percent in 2019.

ICT services have been affected by the political and economic crises of the past decade, as have all other sectors of the economy. Despite these challenges, ICT is one of the key drivers for growth and employment creation as identified in the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset). The agenda clearly spells out ICT as one of the pillars of national socio-economic development. The government is encouraging investment by the private sector for full exploitation of ICT opportunities. For example, in 2021 the government promised to roll out e-government services in the areas of health, education, agriculture and the judiciary. Digital agriculture investments in Zimbabwe are still low although pockets of projects are being launched.

Table 1: Basic facts

Basic facts	Year	Score	Source
Total population	2020	14 862 927	WBG
Urban population (%)	2020	32.24	UNPD
Rural population (%)	2020	67.76	UNPD
GDP (current millions of USD)	2020	16 769	WBG
Agricultural land (km^2)	2018	162 000	FAO
Agricultural land (% of land area)	2018	41.88	FAO

INFRASTRUCTURE

The infrastructure of Zimbabwe has also been affected by the economic challenges facing the country. The country has requested assessment support from AfDB to revive its infrastructure. Despite numerous dams and coal resources and the establishment of the Rural Electrification Agency in 2002, only 41 percent of the country's population has access to electricity, with 20.1 percent electricity supply in rural areas (see Table 2).

Zimbabwe's mobile sector has had long-standing competition, with three operators currently in the market. Net-One launched in 1997 and is the mobile arm of the incumbent. Econet Wireless Zimbabwe is a local company that successfully challenged the incumbent's monopoly and launched its GSM network in 1998. Telecel launched in 1998 and has gone through several ownership changes but is now majority-owned by a government investment holding.

Despite the rural population constituting 67.8 percent of the total population, it is only served by 29 percent of the country's base stations. Inversely, the 32.2 percent of the population located in urban areas has access to 71 percent of the country's base stations. This disparity contributes to the limited network coverage within rural communities. Most of the network base stations in rural communities only support second generation 2G mobile GSM networks. Urban communities are already accessing fourth generation 4G networks, including LTE (Potraz). According to ITU (2018), 3G coverage reaches 78.2 percent of the population and LTE/WiMAX 34.7 percent.

The Internet infrastructure in the country is overseen by the Postal and Telecommunications Regulatory authority (Potraz). According to Potraz's register, as of December 2015, there were 11 up-to-date internet access providers (IAPs); two public data service providers; one postal service general operator; three mobile cellular communications operators; one fixed telephony operator; and forty private network license holders.

There is one national television broadcaster and five national radio broadcasters, one of which has been privately owned since 2012. Zimbabwe has had 28 unlicensed community radio initiatives since 2011. The main service providers in the ISP market include M-Web (part of the South African based MIH Group), Zimbabwe Online, Africa Online, ComOne (operated by TelOne) and Ecoweb, which is part of the Econet Wireless group. There are also a significant number of smaller ISPs based in Harare, Mutare, and Bulawayo. The Universal Service Fund was set up in 2001 to provide funding for expansion of services to isolated communities.

As of 2018, 95 percent of Zimbabwean households had cell phones, while 77 percent had radios, 49 percent had televisions, and only 23 percent had computers. Cell phone service was available in almost all urban zones as of 2017, but 15 percent of rural areas did not have coverage. While almost 99 percent of urban areas had mobile phone service, about one in seven rural zones did not. Active fixed telephone subscriptions have been fluctuating over the past year. The total number of active subscriptions in rural areas declined by 0.9 percent to 11 434 subscriptions.

Table 2: Infrastructure

Themes	Sub-themes	Indicators	Year	Score	Source
Infrastructure	Availability	Access to electricity in rural areas (% of rural population)	2019	20.05	WBG
		4G coverage (% of total coverage)	2019	40.00	GSMA
		Mobile (device) ownership (% of population)	2019	55.41	GSMA
		Secure access to Internet servers (per 1 million people)	2020	74.48	WBG
		Availability of the latest technologies (index ranking 1-7: not at all/ to a great extent)	2017	3.87	WEF
	Connectivity	Mobile-cellular subscription (per 100 inhabitants)	2020	88.76	ITU
		Active mobile broadband subscriptions (per 100 inhabitants)	2019	52.69	ITU
		Fixed broadband subscriptions (per 100 people)	2020	1.37	ITU

DIGITAL PENETRATION

Broadband is mainly concentrated in urban areas and remains low in rural areas. This disparity is widening the urban-rural digital divide contrary to the principle of equitable access. There were just 176 280 fixed broadband subscribers in Zimbabwe at the end of June 2019 compared to 8.17 million mobile broadband subscribers, according to Potraz. The average price of 1 GB of mobile data is USD 75.2 according to Cable (2019). The average cost of local mobile cellular calls per minute was USD 0.16 as of 2017 according to ITU. Active Internet and data subscriptions declined by 2.5 percent in 2019. As a result, the Internet penetration rate declined by 0.7 percent to reach 59.1 percent. Less than half (43 percent) of cell phone owners and only 28 percent in rural areas, had access to the Internet.

On the other hand, mobile Internet and data traffic increased by 2.8 percent to record 6 661 TB. In-bundle data usage constituted 91.8 percent of total mobile Internet. WhatsApp usage constituted 40.5 percent of total mobile Internet and data usage, followed by YouTube at 11.4 percent and Facebook at 2.4 percent. Only one-fourth of Zimbabweans used the Internet every day, 11 percent a few times a week and 62 percent never went online.

Most households in Zimbabwe do not have mobile phones with Internet access, computers, or reliable electricity supply. Even among the youngest adults, only one in three regularly went online. Regular Internet usage was higher among younger respondents (34 percent), among men (29 percent), and particularly among urban residents (49 percent, versus 11 percent among their rural counterparts).

The household ownership of computers is far more prevalent in cities (51 percent) than in rural areas (7 percent) and among the highly educated (80 percent) compared to their less-educated counterparts (-19 percent). While about half of households in Bulawayo (53 percent) and Harare (48 percent) had computers, the same is true for only 7 percent of those in Masvingo and Manicaland. Radios are widely accessible within most socio-demographic groups, although more than one-third of residents in Masvingo (39 percent) and Matabeleland South (34 percent) households did not have a radio. Other groups in which radio ownership is less common include senior citizens (33 percent with no household access), rural residents (27 percent), and women (27 percent). Lack of access to a television shows a similar pattern, but at a much higher level, as more than half (51 percent) of Zimbabweans reported no TV set in the household. This is particularly common among rural residents

(74 percent), senior citizens (63 percent), and residents of Masvingo (75 percent) and Manicaland (73 percent) provinces.

The number of adults with transaction accounts in Zimbabwe has grown exponentially from one million in 2014 to 7.1 million as of September 30, 2019. As of the end of October 2019, there were about 7.2 million mobile wallet holders in Zimbabwe.

GSMA 2019 reported that about 47 mobile apps exist in the country's national language. The Statcounter (2020) reports that 30.8 percent of Zimbabwean were using Facebook, with over 22.6 percent using Twitter, 39.7 percent using Pinterest, 4.9 percent using YouTube, 1.4 percent using Instagram and 0.3 percent using Tumblr. Furthermore, the GSMA (2019) established that about 6.2 percent of the country's population is actively engaged with social media (see Table 3).

Zimbabwe's digital ecosystem is an emerging one with a few tried-and-tested digital solutions for the agriculture sector. These include GreenFingers Mobile (GFM) applications that include: Fresh in a box, Zagric, YouFarm, Kurima Mari, AgriShare and Umojalands. More recently, the Zimbabwe Farmers' Union (ZFU) has been working with Econet Wireless Zimbabwe to promote weather-based insurance and dissemination of farming tips and alerts through the ZFU EcoFarmer Combo programme covering 80 000 farmers at a cost of USD 1 per month. The cost is deducted from farmers' mobile money wallets (EcoCash) on their cell phones. Econet's EcoFarmer has a base of 1 million registered users, including small-scale farmers, large-scale farmers, farmer organizations, as well as industry at large.

The Turning Matabeleland Green launched in 2019. It is a digital agriculture programme that uses satellite technology to send weather information and farming advice to over 2 000 farmers via SMS. The Esoko platform and the Eco farmer platform uses SMS to disseminate information on prices, daily weather, new market and farming tips, credit ratings, financial linkages and other important information to guide farmers in their decision making. The INSPIRE project assists with agricultural information dissemination using simple technologies such as SMS and podcasts to enhance farming production.

Additionally, some government solutions were introduced to the sector. The Zimbabwe Revenue Authority (ZIMRA) is developing a 'single window' platform for its users to access its various services. The Ministry of Tourism combines registration, designation and regulatory services into one platform. The Agricultural Commodities Imports and Exports Administration System serves as a one-stop shop for all the activities involved in the assurance of all agricultural related permits and Agricultural Information Management Systems (AIMS). It is a pricing tool that connects buyers and sellers of agricultural goods.

The volume and value of mobile money transactionswitnessed an overall decline in the value of cash-in and cash-out transactions at the outset of 2020. On the other hand, there was considerable growth in cross-network value, airtime, and bill and merchant payments. The growth in the value of bill and merchant payments is attributed to the increase in the scope of services that can be paid through mobile money as well as the general increase in the prices of goods and services.

Table 3: Digital penetration

Themes	Sub-themes	Indicators	Year	Score	Source
Digital penetration	Affordability	Average mobile data price per 1 GB (USD)	2020	N/A	Cable
		Data-only mobile broadband prices as a % of adjusted per capita income	2018	N/A	ITU
		Fixed broadband prices as a % of adjusted per capita income	2018	N/A	ITU
	Willingness	Mobile social media penetration (%)	2019	6.20	GSMA
		Number of apps in national language (quantity)	2019	47.00	GSMA
		Gender gap in social media use (%)	2019	45.88	GSMA
		Gender gap in mobile ownership (%)	2019	100	GSMA

POLICY AND REGULATION

The Ministry of Information Communication Technology, Postal and Courier Services is responsible for oversight of the sector. The importance of ICT for is recognized in the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset), identifying ICTs as one of the pillars of national socio-economic development.

The National Policy for Information and Communication Technology from 2018 objectives include: a) Using ICTs to facilitate delivery of Zim!ASSET and other national developmental goals; b) Enabling access to and increasing use of ICT across all sectors of the economy; c) Bridging the digital divide and providing access to broadband for all; d) Managing challenges resulting from ICT development to ensure sustainability; and e) Leading, improving and adapting the changing ICT environment through innovation and partnership.

The key institutions driving public service digitization in Zimbabwe are the e-Government Unit in the Office of the President and Cabinet (OPC), and the Ministry of Information Communication Technology, Postal and Courier Services (MoICTPCS). In addition, the Ministry of Industry and Commerce chairs a newly formed National Committee for the Digital Economy.

Regarding digitalization and ICT services, the National Broadband Policy and Implementation Strategy was launched in 2018, complemented by the National Cybersecurity Policy and Strategy. The Digital Financial Services Policy was enacted to promote digital transformation in the public sector, digital access and digital inclusion. Essentially, all these policies point toward recognising progressive outcomes for the digitalization of the agricultural sector.

The SMART Zimbabwe 2030 Master Plan seeks to exploit the potential of ICTs building on the achievements of the Zimbabwe National Policy on ICTs. This is intended to further strengthen the country's economic base and improve its overall economic environment for accelerated growth towards achieving a digital government, a digital economy and a digital society by 2030.

Four separate pieces of legislation have a bearing on the regulatory environment for the ICT sector in Zimbabwe. These are the Postal and Telecommunications Act of 2000, the Broadcasting Services Act of 2016, the Access to Information and Protection of Privacy Act of 2002, the Interception of Communications Act of 2007 and the Computer Crime and Cybercrime Bill. At present, regulation of the ICT sector is divided between the Broadcasting Authority of Zimbabwe (BAZ), Potraz, and the Media and Information Commission (MIC).

Zimbabwe is making great progress in introducing various e-government services to its citizens. The Zimbabwe Agenda will use ICT as an enabler to achieve the objectives of the four Zim ASSET clusters for: food security and nutrition; social services and poverty eradication; infrastructure and utilities; and value addition and beneficiation. In addition, the NDS for 2021-2025 seeks to facilitate a digitally enabled economy where all sectors embrace ICTs to improve efficiency and effectiveness, in line with the global trends.

Zimbabwe has for many years operated without an updated standalone comprehensive agricultural policy. Instead, the country has been using the Zimbabwe Agricultural Policy Framework: 1995 to 2020, which was formulated in 1994. Given that this framework was outdated, the Ministry of Agriculture, Mechanization and Irrigation Development (MAMID), now known as the Ministry of Lands, Agriculture and Rural Resettlement (MLARR), with support from FAO and other stakeholders, undertook a process to update the 1994 framework. A draft Comprehensive Agricultural Policy Framework was completed in April 2012 to address issues concerning crop and livestock production, marketing and trade.

Unfortunately, this Policy Framework remained in draft form and was not adopted as the country's blueprint for guiding investments in the agricultural sector. Therefore, the NAPF will be linked to other policies, especially those focusing on infrastructural development, particularly in the energy, water, transport and ICT sectors. (see Table 4)

Table 4: Policy and regulation

Themes	Sub-themes	Indicators	Year	Score	Source
Governance	Policy and legal framework	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan)	2016	2.84	WEF
		Government's success in ICT promotion (index ranking 1–7: not successful at all/ extremely successful)	2016	3.09	WEF
		Legal framework's adaptability to digital business models (index ranking 1–7: not fast at all/very fast)	2019	2.51	WEF
		Laws relating to ICTs (index ranking 1–7: not developed at all/ extremely well developed)	2016	2.49	WEF
	Regulatory framework	ICT regulatory tracker (1–100)*	2018	74	EC/ITU

**According to Global ICT Regulatory Outlook 2020, the economies are classified in different generations of regulation (from G1 to G4). Countries with a Tracker score below 40 are considered to belong to the first generation of regulation (G1), a score between 40 and 69 to the second (G2), a score between 70 and 84 to the third (G3) and finally, a score above 85 belong to the fourth (G4).*

BUSINESS ENVIRONMENT

In 2009, Zimbabwe implemented a number of reforms designed to attract foreign investment. The introduction of a multicurrency monetary regime allowed the US dollar to act as a stabilising force, restoring business confidence in the economy as it removed the risk associated with the use of the domestic currency.

While Zimbabwe has not yet broken-out globally with ground-breaking digital innovation spurred by SMEs, the government recognises the socio-economic value of SMEs. Through the Ministry of Small and Medium Enterprises that was established in 2002, the country is seeking to enhance efficiency, development and competitiveness across SMEs through people-cantered policies (Bomani, Fields, & Derera, 2015).

Recently, Zimbabwe invested USD 6 million to improve rural connectivity. Potraz has launched the Passive Telecommunications Infrastructure Project, which will see 20 shared base stations deployed across eight of Zimbabwe's regions. The initiative is receiving support from the Universal Services Fund and will deploy network equipment in the provinces of Manicaland, Masvingo, Midlands, Matabeleland North and South, and Mashonaland Central, East and West.

The government also introduced some fiscal incentives to investors; local and foreign businesses are now exempt from paying corporate income tax in their first five years of operation in Zimbabwe and will pay only a 15 percent corporate tax rate thereafter. In addition, companies are now allowed to import duty-free capital equipment, raw materials and other intermediary products. All these measures are intended to make the country more competitive in attracting foreign investment in line with Zimbabwe's new economic diplomacy. The government is synchronising investment laws and policies to remove inconsistencies and make the country more attractive to FDI (see Table 5).

In the 2020 budget, the government announced the creation of a ZWD 500 million National Venture Capital Fund targeting youth entrepreneurs. However, as of yet, there are no local private funds investing in digital enterprises in Zimbabwe. A new network comprising 10 angel investors was founded in 2019. Still, the highly inflationary environment has made meaningful investment difficult, and no regulatory incentives exist for venture capital investments. So far, six privately-driven entrepreneurship support organizations include support for digital start-ups, though they are not exclusively focused on the agriculture sector.

Table 5: Business environment

Themes	Sub-themes	Indicators	Year	Score	Source
Business environment	Investment culture	FDI inflows (millions of USD)	2019	280	UNCTAD
		Growth of innovative companies (index ranking 1-7: not at all/ to a great extent)	2019	4.00	WEF
		Venture capital availability (index ranking 1-7: extremely difficult/ extremely easy)	2017	1.81	WEF
	Entrepreneurship	Time required to start a business (days)	2019	27	WBG
		Ease of access to loans (index ranking 1-7: extremely difficult/ extremely easy)	2017	2.82	WEF
		Attitude towards entrepreneurial risk (index ranking 1-7: not at all/ to a great extent)	2019	4.23	WEF

HUMAN CAPITAL

Affordability, accessibility and digital literacy are some of the key issues affecting Internet uptake. Zimbabwe's education policy resulted in a literacy rate of 88.7 percent among adults and 90.4 percent of youth aged 15-24 years (UNESCO, 2014). Children in urban and rural areas are equally likely to attend school. There are significantly more youth attending secondary school in urban areas compared to rural areas; and 99 percent of women aged 15-24 years in urban areas can read, compared to 95 percent in rural areas (see Table 6).

Zimbabwe has 11 Universities, 13 colleges and 11 training centres established for agricultural training at various levels. Some institutions were established before independence, others were established after independence, and the rest post- 2000, in the land reform era. Agricultural R&D is dominated by three faculties at the University of Zimbabwe, the largest being the faculty of agriculture. The faculty of science, department of biological sciences, and the faculty of veterinary science also conduct research. Research is also conducted by other state universities, and non-profit agencies like the African Institute for Agrarian Studies, the Institute for Rural Technologies, and the Ruzivo Trust. The Ministry of Primary and Secondary Education's (MoPSE) updated the curriculum of 2017 and introduced agriculture as a core subject in primary and secondary education, while the education reforms in the post-secondary education subsector also identify agriculture as one of the training courses that should be prioritized for reform processes.

Investors and donors have committed to building youth capacities to fill the skills gap and ensure digital transformation across Zimbabwe. For example, USAID launched the Local Works Zimbabwe Youth Program in 2020, which is a USD 5 million economic empowerment initiative to support youth-led local development initiatives. Additionally, the on-going AFDB Youth and Women Empowerment Project aims at empowering youth through food processing and business creation, institutional capacity building and support for project management.

2KO Zimbabwe offers onsite training for local farmers and farming organizations at the intersection of ICT and agriculture. The College IT Enhancement Programme (CITEP) is a local capacity building project supported by VVOB in ten Zimbabwean colleges. It focuses on developing capacity for effective use of ICTs. The Computer Society of Zimbabwe aims at educating the general public on the use and development of ICTs. In addition, during the 2018 Africa Code Week (ACW) activities in Zimbabwe, 24 000 students were trained in digital literacy and coding skills.

Potraz continues to work toward the establishment of about 87 community information centres across the country geared at promoting Internet access and free training to marginalized communities (Ministry of ICT and Cyber Security, 2019).

Table 6: Human capital

Themes	Sub-themes	Indicators	Year	Score	Source
Human capital	Digital skills/ literacy	Literacy rate, adult total (% of people ages 15 and above)	2014	88.69	UNESCO
		Literacy rate, youth total (% of people ages 15-24)	2014	90.43	UNESCO
		Digital skills among population (index ranking 1-7: not at all/ to a great extent)	2019	3.90	WEF
	Employment	Employment in agriculture (% of total employment)	2019	66.19	ILO
		Employment in agriculture, female (% of female employment)	2019	69.48	ILO
		Unemployment, total (% of total labour force)	2020	5.73	ILO

AGRO-INNOVATION

Agricultural R&D in Zimbabwe is primarily funded by the government, but for the most part, the support only covers salaries and not the operating costs or capital investments associated with conducting research.

The number of researchers with doctoral degrees rose substantially from 12 percent in 2009 to 23 percent in 2016. But in the agriculture sector specifically, only 12 percent of researchers in 2011 held doctoral degrees.

Of the sixteen agencies conducting agricultural R&D in Zimbabwe, the Department of Research and Specialist Services is the largest, employing 72 full-time equivalent (FTE) researchers in 2011. It accounts for approximately 40 percent of the country's agricultural researchers and focuses on crops. Other government agricultural R&D agencies include the Tobacco Research Board (24 FTEs in 2011), the Forestry Commission of Zimbabwe (16 FTEs), the Institute of Agricultural Engineering (7 FTEs), the Department of Livestock and Veterinary Services (4 FTEs), and the Pig Industry Board (0.3 FTEs).

Linkages and coordination within the national agricultural research system are not fully developed, and the research-extension interface is not clearly defined to facilitate effective information dissemination. Policies do not foster private participation. The government needs to formulate a framework for R&D to stimulate innovation and realise the full potential of ICT in entrepreneurship (Government of Zimbabwe, 2016). Recently, the Zimbabwean government disbursed over USD 40 million earmarked for innovation hubs at tertiary institutions. An additional USD 500 million was set aside in the 2020 national budget to encourage entrepreneurship and to support innovation from SMEs. To date, institutions such as the University of Zimbabwe, Midlands State University, and the National University of Science and Technology (NUST) have built state-of-the-art innovation hubs that are meant to strengthen ties between universities and the private sector, while serving as incubators for innovations created by students, faculty and researchers.

Although for-profit R&D is minimal, the Green Innovation Centre (SEWOH) launched Young Farmers Innovation Lab project aiming at developing ICT-solutions for and in partnership with young farmers and developers in 2016. Techno Serve has launched two innovative programs that aim at strengthening Zimbabwean businesses and creating new opportunities for smallholder farmers.

Several hubs like the Impact Hub in Harare operate in and serve major cities across Zimbabwe, although not in rural areas. They seek to assist entrepreneurs grow their business by focusing on technology, capacity building and education.

The Tech Village in Bulawayo is home to a number of sector- and cause-specific communities, which includes the Green Village (Green Innovators), ZimVR (AR/VR community), Mutambo (a gaming league,) GameOn (game development community), and the Bulawayo Open-Source Society. Muzinda Hub Harare is a training centre that develops skills required for the creation of high-quality websites and mobile applications. Tech Hub Harare is a start-up development platform, supporting early-stage start-ups with access to networking opportunities through events and one-on-one sessions with selected mentors. It organizes the Zim4AgriStartups debate on digital agriculture innovation.

All of the hubs mentioned above are committed to working with start-ups that are focused on the UN's SDGs, including the transformation of digital agriculture processes. Civil society organizations in Zimbabwe also operate their own hubs like the Sky Hub Initiative and the Hypercube Hub.

The Potraz Innovation Fund was launched in 2018. It called on all innovators across the country to utilize funding under its Innovation Drive, a programme meant to unlock business opportunity from ICT start-ups. In 2020, the call was re-launched seeking innovations to address the SDGs in a post-COVID-19 world.

Table 7: Agro-innovation

Themes	Sub-themes	Indicators	Year	Score	Source
Agro-innovation	Value chain performance	Value Added (Agriculture, Forestry and Fishing), USD at 2015 prices (millions)	2019	1 729.64	FAO
		Gross Production Index for Agriculture (2014-2016 = 100)	2019	112.60	FAO
		Logistics Performance Index (index ranking 1-5: low/high)	2018	2.12	WBG
	Research and technology development	Agricultural research spending (% of AgGDP)	2016	1.39	IFPRI
		University-industry cooperation in R&D (index ranking 1-7: no collaboration/ extensive collaboration)	2017	2.54	WEF
		Capacity for innovation (index ranking 1-7: not at all/ to a great extent)	2017	3.21	WEF
		ICT goods imports (% of total imports)	2019	2.26	UNCTAD

MAIN FINDINGS AND OPPORTUNITIES

Main findings in 47 countries

INFRASTRUCTURE

Most of the countries studied in this report have the adequate infrastructure in rural areas to enable digitalization. That said, the state of digitalization infrastructure needed varied across countries. Overall across the region, urban areas are better served with electricity than rural ones, even though a higher percentage of people live in rural areas are dependent on agriculture for their livelihood. Network coverage has increased, with 2G and 3G now more widespread across sub-Saharan Africa. Many countries in the region have also implemented 4G while a few are even testing 5G. In most countries, public and private operators play an active role in the telecommunication sector. Undersea cables are within the reach of most countries, but mostly coastal countries are nevertheless better connected while landlocked countries still face challenges.

DIGITAL PENETRATION

Mobile Broadband is the common mode of accessing the Internet across sub-Saharan Africa, yet its growth remains lower than mobile cellular subscriptions. In most countries, mobile broadband prices and Internet enabled mobile devices are out of reach of most people. This hinders digital adoption, especially in rural areas with lower incomes and higher dependence on agriculture for livelihood.

POLICY AND REGULATION

Most countries have enabling telecommunication regulatory frameworks although some existing national ICT policies are not up to date. Some countries in the region have agriculture policies that align with the Comprehensive Africa Agriculture Development Programme (CAADP). That said, digital agriculture is still not emphasized in these policies. Meanwhile, a few countries have started drafting digital agriculture strategies (for example, Benin, Rwanda, the Niger, Nigeria, etc.) and the African Union has published the Digital Transformation Strategy for Africa (2020-2030).

BUSINESS ENVIRONMENT

Most countries face constraints in creating a conducive business environment. These obstacles include high taxes, lack of credit facilities especially for women and youth, lengthy registration procedures, lack of institutional capacities, and limited entrepreneurial skills among rural and agricultural communities. There is also lack of a mature business landscape for small business and start-ups to thrive. However, digital financial services have extended to the larger population, leading to financial inclusion in sub-Saharan Africa. The establishment of the African Continental Free Trade Area (AfCFTA) agreement creates opportunities for digital agricultural entrepreneurs across the region.

HUMAN CAPITAL

Educational systems have improved across the region, with a notable increase in youth literacy. Overall digital literacy rates however remain low as most educational systems are yet to integrate ICT training in the curricula. Most schools in rural areas of sub-Saharan Africa have limited or no access to connectivity and IT infrastructure. Digital skills training is mainly provided by private educational institutions, mobile network companies and online platforms, or through programs and projects launched by development organizations, and mostly concentrated in urban areas. Gender divide is evident as girls and women lag in digital literacy in these 47 countries.

AGRO-INNOVATION

For most countries, the R&D ecosystem has not fully developed. Digital innovation in agriculture is available in some countries, but at a limited scale. Start-ups and innovation technology hubs work in silos, often lacking the requisite support and not many are related to agriculture. In general, national agriculture research institutions have inadequate financial and human resources, limited youth engagement, and in some cases high dependence on external funding to support agricultural research and innovation. Collaboration between research institutions and the private sector is low.

Opportunities for digital agriculture in sub-Saharan Africa

Infrastructure

The utilisation of the Universal Services Funds (USF) resources and cost-sharing of some services to connect to the last mile through public-private partnerships presents an opportunity for sub-Saharan Africa to make mobile devices affordable and the Internet accessible in rural areas.

Digital penetration

The rise of digital platforms, e-commerce and e-government services are triggering the potential for providing and disseminating agriculture content via these platforms for the benefit of smallholder farmers and rural communities.

Policy and regulation

Creating roadmaps in the form of national digital agriculture strategies as a conduit towards digital agriculture transformation remains a priority. These strategies can support countries in the identification of challenges and investment priorities towards modernizing the agri-food systems in the region.

Business environment

Increasing incentives to improve the business environment, and to attract investors to the digital economy, one who can deploy digital products and services across the agri-food systems.

Human capital

The rise of private educational institutions providing digital literacy and skills through mentorship programmes and training, could create a balance of inclusivity and promote education frameworks and policies that boost relevant digital agriculture education opportunities, especially among youth.

Agro-innovation

Currently, capacity development and financial support is mostly provided by international partners through various incubators, accelerators and labs. These initiatives can be further promoted to support digital agriculture and innovation through public-private partnerships. They can also be scaled up as digital public goods across the 47 countries and the region as a whole.

Opportunities for impactful investments

Based on the findings and the analysis done for the 47 countries featured in this study, below are some potential opportunities for impactful investments for consideration to foster and facilitate the adoption of digital agriculture in the areas of infrastructure, enabling environment, digital literacy and agro-innovation.

Infrastructure

- Enhancing digital infrastructure to foster the uptake of digital technologies in agriculture, especially in rural communities.

- Supporting the building of a digital economy across different sectors for digital transformation, with emphasis on the digital agriculture ecosystem targeting rural areas for increased food productivity and security.

Enabling environment

- Creating national awareness across programs for different stakeholders to promote digital agriculture transformation and adoption in the 47 countries.

- Developing national digital agriculture strategies and policies that are aligned to the regional objectives that spur growth and focus on digital agriculture.

- Establishing policy frameworks that take into consideration and foster digital agriculture transformation with monitoring frameworks to support evaluation and capture lessons learned for continuous improvement.

Digital literacy

- Identifying relevant digital skills required for digital agriculture transformation in the 47 countries.

- Integrating digital agriculture curricula in formal and non-formal education systems.

- Providing support for vocational education and training programs that enhance digital agriculture, especially in rural areas.

Agro-innovation

- Developing digital platforms for agriculture that provide value added services for farmers (such as market prices, weather-based services, etc.), as well as serving as a repository for relevant information in agriculture for farmers.

- Supporting and engaging local agritech start-ups for enhancing and scaling up digital innovations in agriculture and rural areas.

- Facilitating public-private partnerships through innovation incubators, accelerators and platforms for agricultural entrepreneurs to exchange experiences and for knowledge sharing among stakeholders to leverage good practices and resources.

Digital inclusion

- Accelerating the adoption of digital technologies in agriculture to drive inclusion of women and youth.

- Enabling financial inclusion for farmers through access to digital financial services to improve efficiency in service provision and to increase income.

CONCLUSION

Whereas the present study provides an overview of the status of digital agriculture in sub-Saharan Africa using against six themes, it is still inadequate to support countries and regional bodies in identifying gaps and priorities for further investments. A digital readiness index is necessary to assist countries in understanding and transforming their digital agriculture landscape toward policy formulation, targeted interventions, resource allocation, partnership establishment and informed decision-making.

This study notes that the digital ecosystem in each country is evolving with new policies, initiatives, innovations and stakeholders. However, the study could not cover in detail the aforementioned aspects due to limitations of time and scope. For example, regarding available digital agriculture solutions, a detailed study is essential for the creation of a database of digital public goods that could be scaled up. A similar approach could be applied for collection and dissemination of good and promising practices, as well as mapping innovation hubs and other programs.

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