Ref. Ares(2026)1156745 - 02/02/2026

STREAMING
Driving EU-African Trade by Food Chain Innovations

Sustainable Trade Regimes with Europe and Africa through Mapping Innovation, New-technology and Growth-mindset – STREAMING

D3.2: 1ST VERSION RECOMMENDATIONS ON DIGITAL ADOPTION AND SCALING-UP



Lead Partner: BITMi

Partners Involved: WU, GS1 Germany, Rwanda ICT Chamber

Dissemination Level: PU

Date: 31/01/2026

Summarizing Table

Author(s)/Organization(s)	Geraldine Schmitz (BITMi)
Contributor(s)	Ayalew Kassahun (WU), Cor Verdouw (WU), Juriaan Wolfers (WU), Tim Bartram (GS1), Ralph Tröger (GS1), Saskia Treeck (GS1), Andreas Füßler (GS1)
Work Package	Work Package 3
Delivery Date (DoA)	31/01/2026
Actual Delivery Date	01/02/2026
Abstract:	The digital transformation of African agrifood systems offers significant opportunities to strengthen food security, economic development, regional integration and compliance with international sustainability requirements, but remains constrained by structural, social and institutional barriers. This document presents preliminary policy recommendations developed within the STREAMING project, based on the African Digital Landscape Report, an initial survey, national and continental digital strategies, World Bank data and social-science research. The analysis highlights major gaps in infrastructure, skills, governance and inclusion, alongside growing regulatory pressures linked to international trade. At the same time, it identifies substantial potential for digital solutions to strengthen informal and formal markets, improve resilience and support regional integration under the AfCFTA, provided that digital systems are designed in a context-sensitive, inclusive and evidence-based manner.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Document Revision History			
Date	**Version**	**Author/Contributor**	**Change**
25/11/2025	V0.1	BITMi	Full first draft
04/12/2025	V0.2	WU/GS1	Feedback first version + layout changes
24/01/2026	V0.3	BITMi/WU	Incorporated feedback GS1, WU: Introduction/Executive summary + Annex I
25/01/2026	V0.4	BITMi/WU	Incorporated feedback WU, updated references, adding abstract, adding table of abbreviations
25/01/2026	V0.5	WU	Added references, layout (margins, header, footer)
26/01/2026	V1.0	BITMi/WU	Finalised version

Dissemination Level		
PU	Public Deliverable	☒
SEN	Limited under the conditions of the Grant Agreement	☐
EU-Classified (i.e. CO)	Confidential	☐

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

STREAMING Consortium

No.	Participant Organization Name	Short Name	Country
1	Hochschule Weihenstephan-Triesdorf	HSWT	DE
2	Wageningen University	WU	NL
3	Universytet Rolniczy IM. Hugona Kollatja W Krakowie	UAK	PL
4	Université de Gabes	UNIVGB	TN
5	Université du Sine Saloum El-Hadj Ibrahima Niass	USSEIN	SN
6	Université de Kara	UKARA	TG
7	Jaramogi Oginga Odinga University of Science and Technology	JOOUST	KE
8	Arsi University	ARSI	ET
9	University of the Free State	UFS	ZA
10	Vrije Universiteit Brussels	VUB	BE
11	Western Balkans Institute	WEBIN	RS
12	Bavarian Research Alliance	BayFOR	DE
13	Bundesverband IT-Mittelstand e.V.	BITMi	DE
14	Rwanda ICT Chamber	ICT	RW
15	GS1 Germany GmbH	GS1	DE

Disclaimer

This document reflects only the authors' view and not those of the European Community. This work may rely on data from sources external to the members of the STREAMING project Consortium. Members of the Consortium do not accept liability for loss or damage suffered by any third party as a result of errors or inaccuracies in such data. The information in this document is provided "as is" and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and neither the European Community nor any member of the STREAMING Consortium is liable for any use that may be made of the information.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Table of Content

List of Tables 6
List of Figures 6
Abbreviations 7
Executive Summary 9
Chapter 1 - Introduction 12
1.1 Motivation and objectives 12
1.2 Report Outline 16
Chapter 2 – Overview of the Digital Strategies of African States and Continental Frameworks 17
2.1 Continental Frameworks: AU Digital Transformation Strategy and Agenda 2063 17
2.2 Country Perspectives 19
2.3 Common Patterns 22
2.4 Central Differences and Implications for Policy Recommendations 23
Conclusion 23
Chapter 3 – Major Barriers 25
3.1 Structural Preconditions: Energy, Connectivity and Device Access 25
3.2 Digital Skills and Functional Literacy 26
3.3 Economic Barriers: Poverty, Uncertainty and Cost–Benefit Calculations 26
3.4 Social–Institutional Barriers: Trust, Informal Governance and Moral Economies 27
3.5 Fragmented Digital Landscapes and Lack of Interoperability 27
3.6 Regulatory Barriers: Tariff and Non-Tariff Measures and New EU Regulations 28
3.7 Informality as a Structural Reality — Not a Transitional Problem 28
3.8 Vulnerable Groups — Severe and Specific Barriers 29
Conclusion 31
Chapter 4 – Major Opportunities 32
4.1 Regional Integration, AfCFTA and Digital Trade Structures 32
4.2 Digitalisation as an Opportunity for Meeting New EU Regulations 33
4.3 Strengthening Informal and Local Markets 33
4.4 Local Innovation, Start-up Ecosystems and African Digital Competencies 34
4.5 Knowledge Systems, Data Spaces and Participatory Governance 34
4.6 Key Opportunities for Vulnerable Groups 35
Conclusion 36

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 5 - Recommendations 37
5.1 Infrastructure as a Foundation: Securing Energy, Connectivity and Device Access 37
5.2 User-Centred System Design: Respecting Local Market Logics 37
5.3 Strengthening Digital Skills – Decentralised, Everyday-Oriented and Gender-Sensitive 38
5.4 Stepwise Process Optimisation: A Gradual Approach to Interoperability 38
5.5 Strengthening Governance: Clear Responsibilities, Cooperation and System Integration 39
5.6 Digital Compliance-by-Design: Supporting the Fulfilment of EU Obligations 39
5.7 Inclusive Digital Transformation: Focus on Vulnerable Groups 39
5.8 Strengthening Local Innovation: Entrepreneurship, Start-ups and Cooperatives 40
5.9 Strengthening Knowledge Systems, Digital Data Spaces and African Sovereignty 41
5.10 More Research and Systematic Data Collection: Evidence as the Foundation of Digital Transformation 41
Conclusion 42
Bibliography 43
Annex 46
Annex I – Initial Questionnaire 46

List of Tables

Table 1: Questionnaire on Agriculture, Trade and Digitalisation in African Partner Countries 46
Table 2: Initial Questionnaire – Question Type 48
Table 3: Most Frequent Responses to Questions 6-48 50

List of Figures

Figure 1: Logos EU-funded sister projects (Source: foodsafety4africa.eu - fci4africa.eu – cta.int) 14
Figure 2: Included African Countries 19
Figure 3: Included African Countries Initial Survey 50

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Abbreviations

Abbreviation	Meaning
AfCFTA	African Continental Free Trade Area
A4AI	Alliance for Affordable Internet
API	Application Programming Interface
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CSDDD	Corporate Sustainability Due Diligence Directive
DE4A	Digital Economy for Africa Initiative
DPP	Digital Product Passport
DTS	Digital Transformation Strategy (African Union)
EPCIS	Electronic Product Code Information Services
EU	European Union
EUDR	EU Deforestation Regulation
FS4Africa	Food Safety for Africa
GS1	Global Standards One
ICT	Information and Communication Technology
ILO	International Labour Organization
ITU	International Telecommunication Union
LkSG	German Supply Chain Due Diligence Act (Lieferkettensorgfaltspflichtengesetz)
M24	Month 24 (Project Timeline)

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

NGO	Non-Governmental Organization
NTM	Non-Tariff Measure
QR	Quick Response (Code)
RISA	Rwanda Information Society Authority
RoO	Rules of Origin
ROSCA	Rotating Savings and Credit Association
SPS	Sanitary and Phytosanitary Measures
STREAMING	Sustainable Trade Regimes with Europe and Africa through Mapping Innovation, New-technology and Growth-mindset
TBT	Technical Barriers to Trade
WP	Work Package

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Executive Summary

Overview and objective

The digital transformation of African agrifood systems offers significant opportunities for economic development, food security, regional integration, and compliance with international sustainability and due diligence requirements. At the same time, it is constrained by complex structural, social, and institutional barriers. This is the second deliverable of work package 3 (WP3) of the STREAMING project (*Sustainable Trade Regimes with Europe and Africa through Mapping Innovation, New-technology and Growth-mindset)* and represents the output of Task 3.2, which maps existing continental and regional frameworks, identifies gaps and opportunities for the adoption and scaling-up of digital solutions in agri-food systems across Africa that support intra-African and Africa-EU trade. The objective of this task is to provide preliminary policy recommendations to address gaps and opportunities as identified in Task 3.1: African Digital Landscape Report, in line with the ambitions of the AfCFTA to establish a continent-wide free trade zone and the priorities of the AU-EU partnership. This document synthesizes the key insights from D3.1: African Digital Landscape Report, the STREAMING survey, relevant national and continental digital strategies, World Bank data, and central social science literature, and derives concrete, sector-specific recommendations from them. It should be noted that these recommendations are preliminary and will evolve throughout the STREAMING project as further research progresses.

The comparative analysis of digital strategies shows that many African countries have formulated ambitious digital development plans, but their implementation capacities vary widely. Countries such as Rwanda, Kenya, and increasingly Ethiopia and Togo have coherent, institutionally anchored digital strategies with clearly defined responsibilities, while states such as Nigeria, Ghana, Cameroon, Mali, or Malawi are hindered by fragmentation, unreliable energy supply, limited regulatory enforcement, and social inequalities. Continental frameworks such as the AU Digital Transformation Strategy (2020–2030), Agenda 2063, and the emerging digital regime under the AfCFTA set normative guidelines for digital sovereignty, integration, and inclusion, but their practical implementation depends heavily on national capacities and political priorities.

The largest barriers to digital transformation stem from fundamental infrastructural deficits (electricity, connectivity, device access), low levels of digital skills, economic uncertainty, distrust in digital systems, informal market logics, and institutional fragmentation. International regulations such as the EU Deforestation Regulation, the German Supply Chain Due Diligence Act, the Corporate Sustainability Due Diligence Directive, and technical trade barriers (SPS, TBT, RoO) further increase pressure on African producers and traders. Women, working children, older people, and persons with disabilities are particularly in vulnerable situations that face overlapping digital and social disadvantages.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

At the same time, significant opportunities emerge: digital systems can strengthen regional integration, simplify compliance processes, stabilize informal markets, accelerate innovation, systematize knowledge, and unlock new economic possibilities. Digital traceability systems enable African producers, traders, and companies to meet European sustainability requirements and access highly regulated export markets. Informal sectors can become more transparent, resilient, and equitable when digital tools build on existing social institutions. Investments in digital skills, local start-up ecosystems, participatory data spaces, and inclusive, user-centred system design significantly increase the effectiveness of digital transformation.

The recommendations presented here therefore emphasize a comprehensive approach combining infrastructural investment, user-centred design, gender-sensitive training programs, stepwise standardisation, institutional coordination, digital compliance-by-design, participatory governance, and African digital sovereignty. Newly highlighted is the need for significantly stronger quantitative and qualitative research that includes all relevant actor groups who play central roles across many value chains.

Results

The Policy Recommendations on Digital Adoption and Scaling-up in Africa is divided in the following sections: Chapter 2 – Overview of the Digital Strategies of African States and Continental Frameworks offers a structured first review of continental digital frameworks, followed by examining country-level digital strategies to identify common patterns, key differences and their implications for policy recommendations. Chapter 3 – Major Barriers analyses the major structural, economic, social, regulatory and technological barriers to the adoption and scaling-up of digital solutions in Africa. Chapter 4 – Major Opportunities identifies key opportunities for digital transformation by examining continental and regional integration efforts (including upcoming EU regulation), as well as local innovation systems, knowledge systems and inclusion opportunities. Chapter 5 - Recommendations synthesis the findings from chapter 2 – 4 and translates these identified barriers and opportunities targeted recommendations around infrastructure, governance, skills, interoperability, inclusion, and knowledge systems. It lays the groundwork for a revised edition of this document at the end of month 24 (M24) and subsequent project activities aimed at overcoming trade barriers and advancing digital solutions for trade in Agrican agri-food products.

Limitations

While this report aims to provide a comprehensive policy recommendations to accelerate adoption and scaling-up of digital solutions in African agri-food systems, the following major limitations should be noted:

- The African continent has a broad range of nations and regions and thus differ significantly in agricultural agri-food systems, digital readiness, and institutional context. Therefore, a single continental overview cannot fully capture local realities or fully capture local agricultural, technical and cultural contexts.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

- Due to the limited availability of peer-reviewed scientific literature, the report relies heavily on documents and online publications from sources such as the African Union (AU) and the European Union (EU). While the sources are reputable and capture the latest developments, the unverifiable nature of some documents limits the scientific rigor of the findings.
- Publications on digital trade facilitation in Africa are limited and concentrated in a few countries.
- This initial policy recommendation report presents a snapshot of the African Digital Landscape and does not capture potential future developments and/or innovations. In this context, there will be a revised edition of this document at the end of month 24 (M24) to address some of these limitations.

This document acknowledges that digital agriculture can only be fair and effective if it explicitly aims at an inclusive and non-discriminatory digital transformation. Vulnerable groups or people in vulnerable situations – women, working children, older people and persons with disabilities – are central actors in the agrifood systems of many African countries, yet at the same time particularly disadvantaged in digital terms. Many digital strategies remain superficial on this point. The recommendations presented here therefore place special emphasis on systematically taking these groups into account and ensuring that digital solutions do not lead to further exclusion or reinforce existing inequalities.

Finally, it is important to underline that the digital transformation of the agricultural sector is increasingly shaped by international trade and regulations. The EU Deforestation Regulation (EUDR), the German Supply Chain Due Diligence Act (LkSG), the forthcoming EU Corporate Sustainability Due Diligence Directive (CSDDD), new SPS standards, technical barriers to trade (TBT) and rules of origin (RoO) fundamentally alter the requirements for export capability and documentation. These provisions can place considerable burdens on African producers, while at the same time digital systems offer the possibility to reduce compliance costs, open up new markets and improve transparency along the value chain and go hand in hand with the development of best practice recommendations by business communities.

From an agrifood systems perspective, it becomes clear that digital transformation can be a decisive lever for strengthening food security, making production systems more resilient, increasing transparency in value chains, and organizing trade — both informal and formal, national and international — more efficiently. Digital solutions improve access to weather information, knowledge resources, financial services, and quality standards; they facilitate coordination and market integration and make it easier to meet demanding export requirements. Their success, however, depends on whether digital systems allow for realistic adaptation to local contexts and support, rather than displace, social institutions.

In sum, digital transformation can fundamentally improve African agrifood systems—but only if it is not treated as an isolated technological project. What is crucial are social embeddedness, institutional stability, regional cooperation, inclusive governance, and an evidence-based approach that takes local lived realities seriously. This integrated perspective forms the core of the recommendations developed in this document and will continue to be refined and updated throughout the STREAMING project.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 1 - Introduction

1.1 Motivation and objectives

The African continent holds a crucial position in global food systems, with over 60% of arable land and a rapidly growing population, agri-food systems play an essential role in ensuring food security, employment, and economic growth. In most AU member states, agriculture remains the primary source of income, employing more than half of the population. However, despite its dependence on agriculture, Africa not only lags behind other regions in terms of productivity and has become dependent on food imports, but it also faces complex trade regulations, non-tariff barriers, and high tariffs both within the continent and in trade with the EU and other international markets. Cumbersome customs procedures, stringent sanitary and phytosanitary standards, and inconsistent policies are further exacerbated by the lack of digitalisation, creating additional barriers to trade and growth in the agricultural sector.

A further structural obstacle to formulating comprehensive digital policies is the heterogeneous and often incomplete data landscape. Many African states publish digital-policy indicators only irregularly; national statistics offices are often underfunded, and existing data are frequently not disaggregated or not available longitudinally. The state of the literature is similarly uneven: countries such as Rwanda, Kenya, Ghana or Nigeria have extensive digital strategies and accompanying studies, whereas other states provide only fragmentary or outdated documents. For this reason, this document understands itself for now as a *living guideline* that will be continuously expanded, updated and enriched with new empirical insights over the course of the STREAMING project. In this context, it should also be understood that there will be a revised edition of this document at the end of month 24 (M24). This new edition will then include new findings and results from the work in STREAMING up to that point. In addition, a concise, reader-friendly version will be created and disseminated to summarise the main findings to extend the outreach and impact.

These policy recommendations were developed in the framework of the Horizon Europe project STREAMING and constitute a preliminary, continuously updated document. They are intended as guidance for policy makers, institutions, development organisations and practitioners involved in the digital transformation of African agrifood systems. At the same time, this document does not claim to be exhaustive: the African continent has a broad variety of nations and regions; thus the countries differ significantly in their economic structures, institutional performance, market organisation, socio-economic conditions, political stability and, not least, in their cultures. A single, uniform strategy can therefore neither adequately reflect the diverse political realities nor do justice to local agricultural, technological or cultural contexts in their entirety.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

1.1.1 Methodology

The recommendations presented here are based on a broad set of sources. Central among them are the results of the STREAMING survey (2025/2026), in which actors from agriculture, trade, public authorities, technology companies and civil-society organizations shared their assessments of digital infrastructure, usage, acceptance and barriers. Added to this are the findings of the Digital Landscape Report (D3.1), which provides a comprehensive analysis of existing digitization initiatives, technological systems and institutional frameworks in the project countries.

- **Desk research:** Analysis of academic and grey (governmental/institutional) literature to provide context on the current digital landscape in African agricultural value chains.
- **Survey study**: An online survey was conducted to key stakeholders and STREAMING partners to capture practical insights on digital solutions in the agricultural sector. Future surveys, presented in upcoming deliverables, will focus on capturing insights on local and international trade, (smallholder) farmers, traders and intermediaries, as well as the socio-cultural context (see Annex I – Initial Questionnaire).
- **Field research**: Anthropological field research in West Africa (mainly Ghana) on trade and informal practices has been conducted from 2011, as well as field research in Rwanda on digitalisation and trade from 2019 onwards.

This foundation is complemented by a systematic review of national digital strategies – including Rwanda (Smart Rwanda Master Plan; ICT Sector Strategic Plan 2018–2024), Nigeria (National Digital Economy Policy and Strategy, NDEPS; National Broadband Plan), Namibia (ICT in Education Policy), Kenya (Digital Economy Blueprint), Ghana (Digital Agenda and digital government strategies), Senegal (Stratégie Sénégal Numérique) and South Africa (National Digital and Data Policy) among others. Continental frameworks such as the African Union's Digital Transformation Strategy (DTS, 2020–2030) and the emerging Digital Trade Protocol under the African Continental Free Trade Area (AfCFTA) have likewise been incorporated.

Another key source is the World Bank, whose data on connectivity, affordability, digital skills, agricultural production, energy access and poverty structures are crucial for understanding the actual level of digitization in African states. Among other things, the World Bank shows that internet use in Sub-Saharan Africa averages only about 36 per cent (2023), that the costs of mobile data are among the highest worldwide, and that rural areas are significantly less well served than urban centers. This structural starting point is fundamental for any digital transformation in the agricultural sector.

In addition, economic, sociological, politological and socio-anthropological perspectives are integrated. These approaches make clear that economic systems – and agrarian markets in particular – are deeply embedded in social relationships, local norms, moral economies and historical path dependencies. Digital systems therefore cannot be understood as isolated technical interventions, but are embedded in existing market orders, networks of trust, trading relationships and social obligations. The anthropological perspective helps to conceptualize digital

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

transformation not as linear technological modernization, but as a complex process of social change that generates both opportunities and risks.

1.1.2 Scope and Purpose

The main research question this report addresses is:

How can the adoption and scaling-up of digital solutions and standards be improved to support intra-African and EU–Africa trade integration?

This interim report aims to provide initial insights into the question by presenting a preliminary analysis of current digital strategies from selected African countries, identified gaps and barriers, opportunities and policy recommendations.

As an interim output, this document will be continuously expanded, updated and enriched with new empirical insights over the course of the STREAMING project. It establishes an analytic foundation for consecutive deliverables, which will further refine and develop policy recommendations for adoption and scaling-up of digital solutions.

1.1.3 Links to other EU projects

Figure 1: Logos EU-funded sister projects (Source: foodsafety4africa.eu - fci4africa.eu – cta.int)

The report draws on a number of related sister projects, particularly the EU-funded Food Safety for Africa (FS4Africa) and Food Convergence Initiative for Africa (FCI4Africa), with which the STREAMING project has a memorandum of understanding. It also builds on past EU-funded initiatives, such as the CTA (Technical Centre for Agricultural and Rural Cooperation), where substantial work on digitalisation relevant for the goals of this project has been or is being carried out (see Figure 1).

FS4Africa: The FS4Africa project aims to improve food safety systems in Africa, particularly the informal sector, by strengthening food safety at the source with technology and innovation in local agricultural value chains (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). The project aims to support trade by strengthening food safety governance, traceability, and regulatory compliance across African agri-food value chains. It aims to lower costs for certification and conformity assessment, and to reduce non-tariff barriers that limit market access for informal and small and medium-sized enterprises. By addressing key hazards such as aflatoxins and pesticide residues, the project reduces rejections, increases market opportunities, and enhances trade readiness under the AfCFTA framework. WP3 of the STREAMING project builds upon these food safety improvements by enabling digital traceability. It aims to achieve this goal through the

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

adoption of digital interoperable standards, thereby enabling African countries to conform to international trade and traceability standards and guidelines, and scaling up intra-African and Africa–EU trade.

FCI4Africa: FCI4Africa, a sister project of STREAMING, pursues objectives similar to STREAMING but employs the Food Convergence Innovation (FCI) approach to address inequitable trade practices while enhancing the climate-neutrality of African products. Through this holistic FCI approach, the project integrates technical compliance for traceability and conformance to sanitary standards, while considering the associated social factors across multiple levels of societal hierarchies. The project aims to integrate knowledge, behavioural change, organisational transformation, and investment and policy frameworks to support scalable, evidence-based solutions for climate, economic, environmental, and social outcomes across multiple levels, from local communities to international markets. As in STREAMING, it builds on the FS4Africa project but complements it through its holistic FCI approach and the selection of a different set of use cases conducted in a different set of countries.

Related past EU initiatives: The STREAMING project builds on lessons learned from previous EU-funded initiatives, including the several digital innovation initiatives carried out by the Technical Centre for Agricultural and Rural Cooperation of ACP-EU partnership (CTA) and the outcomes of several projects funded under the AU-EU FNSSA and DeSIRA programmes. These initiatives not only contributed to the digitalisation of African agriculture but also supported the formulation of the AU's Digital Transformation Strategy and its recent Kampala CAADP Declaration. The WP3 of the STREAMING project aims to contribute to the realisation of the ambitions set out in the CAADP Declaration

1.1.4. Links to other deliverables

This report is the second of the four deliverables of WP3, and as such, it lays the groundwork for the remaining two deliverables (D3.3, and D3.4). It also contributes to the deliverables of other WPs. The most important linkages are outlined below:

- **D3.1**: This deliverable provides an outline of the current state of digitalisation relevant to trade in African agricultural and food (agri-food) products. This deliverable directly builds on the findings of D3.1.
- **D3.3**: This deliverable provides a digital innovation platform, which is a virtual collaboration platform to support networking of farmers, start-ups, and other stakeholders, and to facilitate the implementation and use of digital solutions and standards in Africa.
- **D3.4**: This deliverable provides training materials and the actual training to diverse stakeholders on capturing and sharing data for traceability.
- **D5.3**: This deliverable manages the second open call focussed on knowledge grants for building online courses. The grant specifications will be informed by the outcomes of this deliverable and its subsequent deliverable, D3.1.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Besides the direct linkages with the above deliverables, this report will serve as a useful foundational reference for other deliverables of the project.

1.2 Report Outline

The *Policy Recommendations on Digital Adoption and Scaling-up in Africa* is divided in the following sections: Chapter 2 – Overview of the Digital Strategies of African States and Continental Frameworks offers a structured first review of continental digital frameworks, followed by examining country-level digital strategies to identify common patterns, key differences and their implications for policy recommendations. Chapter 3 – Major Barriers analyses the major structural, economic, social, regulatory and technological barriers to the adoption and scaling-up of digital solutions in Africa. Chapter 4 – Major Opportunities identifies key opportunities for digital transformation by examining continental and regional integration efforts (including upcoming EU regulation), as well as local innovation systems, knowledge systems and inclusion opportunities. Chapter 5 - Recommendations synthesis the findings from chapter 2 – 4 and translates these identified barriers and opportunities into targeted recommendations around infrastructure, governance, skills, interoperability, inclusion, and knowledge systems.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 2 – Overview of the Digital Strategies of African States and Continental Frameworks

As shown in several national and continental strategies, the digital transformation has become a core component of African development strategies over the past ten to fifteen years. Nearly all states on the continent have adopted digital strategies, developed their specific ICT policies or set up individual sectoral plans that understand digital technologies as a lever for growth, government modernization and social inclusion. At the same time, analyses by the World Bank show that the actual use of digital services and the underlying infrastructure in African countries lag significantly behind global averages. In 2022, the share of people with internet access in Sub-Saharan Africa was around one third of the population, while the global average was about two thirds [1]. The costs of mobile data in many countries continue to exceed the internationally recognized affordability threshold of two per cent of monthly income [2]. This contradiction between high digital-policy ambition and limited structural preconditions runs like a red thread through the landscape of African digital strategies.

At the same time, there are examples in which African states are viewed as digital pioneers, whether in financial services, health or logistics. Kenya's experience with mobile money and Rwanda's innovations in medical logistics and pandemic management – for example through drone deliveries and the use of robots in hospitals and border crossings [3], [4] – illustrate that the continent is not merely the recipient of digital technologies, but also a site of innovation, adaptation and creative appropriation. And leap frogging by overcoming traditional pathways of development like in Europe is so to say the outstanding African innovation. Social-anthropological studies show that digital technologies in African contexts are integrated into existing social structures, networks and economic logics rather than simply replacing them [5], [6]. This applies in particular to financial practices and everyday ways of dealing with uncertainty.

For the agricultural sector, the divergent starting points are of central importance: while some countries have relatively coherent digital policy architectures and basic infrastructures, others are only at the beginning of systematic digitalisation. The following sections therefore provide a concise overview of the most important continental frameworks and national strategies that shape the environment for digital agriculture and digital trade. They highlight reference points but also gaps and tensions that STREAMING should take into account when formulating recommendations.

2.1 Continental Frameworks: AU Digital Transformation Strategy and Agenda 2063

At continental level, two documents form the most important reference framework for digital policy in Africa: the AU Digital Transformation Strategy for Africa (DTS) and the Agenda 2063. The DTS especially aims to make Africa a globally competitive, innovation-driven digital economy by 2030 and defines four core pillars: (1) digital infrastructure, (2) digital skills and human capacity, (3)

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

digital transformation of key sectors such as agriculture, health, education and trade, and (4) digital innovation and entrepreneurship [7].

For STREAMING, it is particularly relevant that the DTS explicitly identifies digital agriculture, digital trade and digital financial services as priority areas. The strategy links goals from CAADP (Comprehensive Africa Agriculture Development Programme), the Digital Economy for Africa Initiative (DE4A) and the integration ambitions of the AfCFTA. At the same time, it acknowledges that many states currently lack both robust digital infrastructures and strong regulatory authorities capable of effectively enforcing data protection, competition rules or consumer rights.

The World Bank points out in this context that in numerous countries less than 20 per cent of the rural population has access to the internet and many households cannot afford to purchase mobile data on a regular basis [1]. Digital strategies thus frequently assume preconditions that do not exist in large parts of the population. This gap between policy ambition and infrastructural reality is central to the question of what digital agriculture can realistically achieve in the short and medium term.

Financial practices play a crucial role in this regard. In many African contexts, formal banks are not the primary reference point for savings, credit and risk sharing. Instead, rotating savings and credit associations (ROSCAs), “susu” systems and other forms of collective financial organization form the backbone of everyday economic security. Classic studies by Ardener and Burman (1995), Geertz (1962), Guyer (2004) and Rutherford (2000), as well as more recent analyses of West African markets (Schmitz: 2018), show that these systems are not informal “residuals”, but efficient, socially embedded and economically needed financial institutions [8], [9], [10], [11], [12], [13]. Digital financial services – from mobile money to digital credit scoring – must therefore be designed in such a way that they connect to these existing, socially grounded systems instead of attempting to replace them.

A key finding of social science research is that the informal and formal sectors cannot be viewed as clearly separated. Hart (1973) and Hahn (2010) show that informal and formal economies are structurally linked, among other things because they are connected through money – that is, through state currencies and price systems [5], [14]. Schmitz (2018) emphasizes that market trade, price formation and credit practices take place in overlapping spaces in which formal companies, state regulations, ROSCAs and informal traders continually interact [13]. For digital strategies, this means that “informality” cannot simply be addressed as a deviation from formal models; rather, digital systems must take seriously the interweaving of formal and informal structures in African economies.

Agenda 2063 provides the normative umbrella and formulates long-term goals for prosperity, integration, peace and global influence for the African continent [15]. Digital technologies are referenced in various parts of Agenda 2063, including as instruments for modern governance, youth employment, industrialization and intra-African trade. The document explicitly links digital transformation with the objectives of the AfCFTA and the goal of building resilient, inclusive agrifood systems. For STREAMING, these continental frameworks are therefore important

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

orientation points, as they define normative goals and a continental policy architecture that national strategies and sectoral initiatives must take into account.

2.2 Country Perspectives

The heterogenous structure of the African continent and the vast phenomena of digital development make a country-by-country review of their equipment and procedures necessary. In the following overview a selection of countries are described, namely: Rwanda, Nigeria, Namibia, Kenya, Ghana, Senegal, South Africa, Angola, Cameroon, Tunisia, Mali, Malawi, Togo and Ethiopia:



Figure 2: Included African Countries

Rwanda is described in many reports as one of the most digitally ambitious countries on the continent. The Smart Rwanda Master Plan and the ICT Sector Strategic Plan 2018–2024 define clear responsibilities, cross-sectoral coordination mechanisms and concrete implementation paths for areas such as e-government, digital identity, education and innovation [16], [17]. The Rwanda Information Society Authority (RISA) plays a central role in coordinating the digital agenda and in building digital capacities at national and local level. For digital agriculture, this creates an environment in which pilot projects, data integration and standardization processes can be anchored in existing structures. At the same time, Rwanda's example must not be generalized, as other countries face very different starting conditions.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Nigeria, with the National Digital Economy Policy and Strategy (NDEPS) 2020–2030 and the National Broadband Plan 2020–2025, pursues comprehensive goals for the expansion of infrastructure, digital skills and digital innovation [18], [19]. However, implementation is hindered by pronounced socio-economic inequalities, an uneven energy supply and governance challenges. Digital strategies often encounter weak coordination between federal and state levels, limited regulatory enforcement and large informal sectors. For the agricultural sector, this means that digital policy ambitions are curbed in practice by governance and infrastructure deficits.

Namibia, with its ICT in Education Policy, focuses on education as a strategic entry point for digital transformation [20]. The goal is to equip teachers and learners with digital skills and to provide schools with appropriate infrastructure. The World Bank ranks Namibia more favorably than many neighboring countries in terms of connectivity and institutional capacity, but digital transformation in the agricultural sector is still at an early stage and is not spelled out in the same detail as in Rwanda or Nigeria [21]. In this context, digital agriculture is likely to initially evolve parallel to educational and administrative digitization processes rather than as a central strategic field.

Kenya has played a pioneering role in digital financial integration with the introduction of M-Pesa and other mobile financial services [22]. Official strategies such as the Digital Economy Blueprint and the Kenya National Digital Master Plan 2022–2032 link digital infrastructure and e-government with innovation promotion and the development of FinTech ecosystems [22], [23]. World Bank data show that a very high share of the adult population in Kenya uses digital or mobile financial services, providing an important foundation for digital markets and digital agriculture [1], [21].

Ghana pursues the development of an integrated digital administration and digital identities through a range of e-government and digitization programmes – for example under the umbrella of the Ghana Digital Agenda [24]. Digital ID systems, online public services and e-payment solutions are intended to increase transparency and efficiency in the relationship between citizens and the state. However, the World Bank shows that in practice implementation is uneven, internet access is still limited in rural regions and many digital services are not yet widely used [1]. For digital agriculture, this means that promising institutional building blocks exist, but must first be translated into accessible, context-sensitive solutions for agricultural actors.

Senegal, with the original Sénégal Numérique 2016–2025 and the more recent strategy Sénégal Digital 2025–2035 (New Deal Technologique), is positioning itself as an increasingly important regional actor in West Africa [25], [26]. Digital infrastructure, e-government and start-up promotion form the central axes. The country's digital ambitions are embedded in broader industrialization and diversification strategies. For the agricultural sector, there are a number of pilot projects and platforms, but systematic integration into core agricultural policy programmes is still at an early stage.

South Africa has a comparatively highly developed digital infrastructure and has adopted comprehensive strategies on data policy, cybersecurity and digital economic sectors [27], [28]. At the same time, social inequalities are pronounced, and there is a stark digital divide between affluent urban and marginalized rural populations. World Bank analyses indicate that digital

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

services are often concentrated where purchasing power and institutional density are high, while peripheral regions benefit only to a limited extent [1]. For digital agriculture, this means that innovative solutions exist in principle, but their reach and inclusiveness are uneven.

Angola has in recent years laid important foundations for digital transformation with the Lei de Bases das Tecnologias de Informação e Comunicação 2023–2027 (LBTIC) and the long-term vision Angola 2050 [29], [30]. These strategies emphasize infrastructure expansion, administrative digitization and the development of digital services in key sectors. However, the agricultural sector has so far been addressed only selectively, and there is a lack of specific digital agriculture programmes. In addition, vast rural areas, limited connectivity and institutional capacity constraints make implementation more difficult.

Cameroon, with the Plan Stratégique Cameroun Numérique 2020 and the National Development Strategy 2020–2030, formulates ambitious goals for digital infrastructure, e-government and the development of a digital economy [31], [32]. In practice, however, implementation is slowed by political instability, regional inequalities and financing constraints. For digital agriculture, this means that strategies exist on paper, but concrete programmes, platforms and extension structures are still underdeveloped.

Tunisia has, in recent years, developed an ambitious national pathway for digital transformation, which is being implemented in stages through the Programme National de Transformation Digitale 2025–2026 [33]. The focus is on administrative digitization, innovation promotion and skills development. While the foundations for digital services in various sectors are being laid, the integration of digital tools into agrifood systems is still selective and often limited to pilot initiatives.

Mali, with the Politique Nationale de Développement de l'Économie Numérique, has formulated a digital strategy that aims to expand infrastructure, promote digital skills and support e-government [34]. However, security crises, political instability and fiscal bottlenecks significantly impede implementation. In rural regions, access to energy, connectivity and public services is often so limited that digital transformation can only progress slowly.

Malawi, finally, is an example of countries that are still at the beginning of systematic digital policy but are increasingly recognizing the importance of digital education and digital inclusion. Studies such as Munthali et al. (2025) emphasize that digital education programmes in rural regions can contribute to reducing social and regional inequalities, provided they are context-sensitive and adequately resourced [35]. For digital agriculture, this means that the necessary human capital is only gradually being built up and that digital farming initiatives must be closely linked to educational programmes [1], [35].

Togo, with initiatives such as the Digital Transformation Center Togo [36] and national digital strategies, is increasingly focusing on the expansion of digital infrastructure, e-government and digital skills. The World Bank estimates that new financing of 100 million USD will significantly accelerate digital transformation and, among other things, create better conditions for digital services in sectors such as agriculture and trade [37].

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Ethiopia has in recent years adopted a comprehensive Ethiopia Digital Strategy 2020 and a Digital Agriculture Roadmap 2032 [38], [39]. These documents define concrete steps for the development of digital infrastructure, services and skills, including in agriculture. At the same time, political tensions, regional instability and limited institutional capacities pose major challenges. For digital agriculture, Ethiopia represents a country with high strategic ambition, but a complex implementation context.

Taken together, these countries illustrate the broad spectrum of African digital strategies: from relatively coherent, comprehensive approaches (e.g. Kenya, Rwanda, partly Senegal and South Africa) to fragmented orsector-based focused strategies (e.g. Ghana, Nigeria, Cameroon, Mali) to countries in which digital transformation to date has materialized primarily in individual pilot fields – such as education or e-government – and only gradually extends into agriculture (e.g. Malawi, Angola, Tunisia). For STREAMING, this means that recommendations for the digital transformation of agrifood systems must always be embedded in these very different strategic and institutional starting conditions.

2.3 Common Patterns

Despite this diversity, several common patterns can be identified:

First, virtually all strategies emphasize the expansion of **digital infrastructure** – particularly broadband, energy supply and device access. World Bank data underscores that investments in these areas are necessary for digital applications to be used at all [1]. Many states pursue ambitious plans for fiber optic networks, 4G/5G rollout and electrification, but implementation is often delayed by financing bottlenecks, regulatory hurdles and geographical challenges. Rural areas and marginalized regions remain significantly underserved.

Second, the development of **digital skills** plays a central role. Whether anchored in education policy, as in Namibia, or treated as a cross-cutting issue, as in Rwanda, Ghana or Nigeria – all countries recognize that mere availability of technology is not sufficient. At the same time, it frequently remains unclear how these skills are to be promoted in rural, informal contexts where formal education systems have limited reach. Many strategies remain general at this point and do not specify how farmers, traders or agricultural labourers can gain access to practical, context-relevant digital skills.

Third, there is an increasing emphasis on **digital inclusion** and the principle of “leaving no one behind”. Many strategies explicitly name women, youth, rural regions and, in some cases, people with disabilities as target groups. In practice, however, these concerns often remain programmatic and are not systematically backed up with resources, institutional anchoring or concrete indicators. This discrepancy between rhetorical inclusion and actual implementation is also evident in the STREAMING survey responses.

Fourth, there is a growing interest in **digital sovereignty**. Countries such as Kenya, South Africa or Ghana formulate explicit goals with regard to data sovereignty, regional cloud solutions and

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

regulatory autonomy. The DiploFoundation report points out that these states increasingly seek to strengthen their voice in global fora where norms for data flows, cybersecurity and digital trade policy are negotiated [40]. At the same time, many states are caught in structural dependencies on foreign platforms, hardware and service providers, which limits their opportunities for action.

2.4 Central Differences and Implications for Policy Recommendations

The differences between the strategies are particularly evident in three dimensions: (1) institutional coherence, (2) implementation capacity and (3) the linkage to agricultural and trade policy.

Rwanda illustrates a comparatively high degree of coherence: responsibilities are clearly assigned, digital strategies are politically supported at the highest level and extended into other sectors – including agriculture. Institutions such as MINICT and RISA have clear mandates and coordination functions. Nigeria, on the other hand, shows how federal structures, social inequalities and fragmentation can hamper implementation even of ambitious strategies. Namibia, in turn, illustrates that a strong focus on education may make sense in the long term, but in the short term does not yet provide a fully developed framework for digital agriculture.

Among the other countries considered, similar constellations can be observed: some states have adopted far-reaching strategies, but lack political stability, funding or administrative capacity; others rely heavily on donor-driven projects without fully integrating them into national strategies.

Kenya, Ghana, Senegal and South Africa represent different combinations of infrastructure strength, innovation ecosystems, social inequality and political steering capacity. What they have in common is that they are capable of bringing digital issues into international negotiations, while many other states have significantly fewer resources and less bargaining power [40].

Conclusion

First, every policy recommendation for the digital transformation of the agricultural sector must take into account the respective **national strategic architecture**. Where coherent digital strategies exist, they can serve as anchor points for sectoral initiatives; where strategies are fragmented or weakly implemented, work must be more strongly oriented towards intermediary institutions – such as business associations, cooperatives, municipalities or civil-society organisations.

Second, it is necessary to systematically **acknowledge the gap between strategy and reality**. World Bank data and the STREAMING survey consistently show that formal strategies often have little to do with the lived realities of smallholder farmers, informal traders or agricultural day labourers. Digital agriculture policies must therefore build bridges between political agendas and everyday practices and explicitly consider structural constraints such as energy supply, connectivity, poverty, informal work, remote rural areas and limited digital skills.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Third, the continental AU strategy, Agenda 2063 and the emerging digital regime of the AfCFTA create opportunities for **regionally coordinated standard-setting** in the fields of digital agriculture and digital trade systems. STREAMING can contribute to this by promoting interoperable, African-owned standards based on the GS1 system, open interfaces and adaptable data models, thereby creating the foundations for cross-border agrifood value chains and easing compliance with EU and regional regulations.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 3 – Major Barriers

The digital transformation of African agrifood systems is constrained by a wide range of structural, socioeconomic, cultural and regulatory factors. These barriers are complex and mutually reinforcing, explaining why digital technologies — despite their political prioritization — have so far scaled only to a limited extent. The World Bank emphasizes that the "digital divide" in Africa is not simply a problem of infrastructure, but a multidimensional configuration of energy access, cost structures, education, social institutions, market logics and trust relations [1]. Findings from the STREAMING survey and the Digital Landscape Report (see D 3.1) confirm this multi-layered problem structure and demonstrate that formal strategies often diverge significantly from real usage contexts as agriculture in Africa is mostly informal.

The following sections (1-8) systematically outline the most important barriers. A dedicated subsection focuses on vulnerable groups — women, working children, older people and people with disabilities — who are disproportionately affected by digital exclusion:

1. Structural Preconditions: Energy, Connectivity and Device Access,
2. Digital Skills and Functional Literacy,
3. Economic Barriers: Poverty, Uncertainty and Cost–Benefit Calculations,
4. Social–Institutional Barriers: Trust, Informal Governance and Moral Economies,
5. Fragmented Digital Landscapes and Lack of Interoperability,
6. Regulatory Barriers: Tariff and Non-Tariff Measures and New EU Regulations,
7. Informality as a Structural Reality — Not a Transitional Problem,
8. Vulnerable Groups — Severe and Specific Barriers.

3.1 Structural Preconditions: Energy, Connectivity and Device Access

Digital transformation requires basic physical infrastructure. Yet in many Sub-Saharan African countries, electricity supply, internet coverage and device access are so limited that digital services can only be used sporadically or not at all. Fewer than half of all people have access to electricity; in rural regions, rates are even lower [2]. Power outages are part of daily life in Ghana, Nigeria, Uganda and parts of Kenya, severely hindering the use of digital devices.

Connectivity remains one of the greatest barriers. The World Bank estimates that only about 36 per cent of the population in Sub-Saharan Africa uses the internet regularly, and fewer than 20 per cent of rural households have access to mobile broadband. At the same time, mobile data prices in Africa are among the highest in the world. In several countries, 1 GB of data costs more than 5 per cent of monthly income — far above the global affordability benchmark [2], [41].

Smartphone penetration remains low: in many agricultural regions, fewer than half of households own an internet-enabled device. Feature phones dominate everyday life in rural areas. STREAMING survey results show that even where smartphones are present, usage of digital applications is constrained by data prices, device maintenance costs and lack of reliable electricity.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

These structural limitations mean that digital agriculture technologies can only succeed if they are designed to be offline-capable, user-friendly, low-cost, device-agnostic and energy-efficient and the expansion and reliability of the digital network infrastructure is being consistently pursued.

3.2 Digital Skills and Functional Literacy

Digital competencies constitute the second fundamental barrier. Although all analyzed digital strategies emphasize the importance of digital skills, there are large gaps between formal objectives and actual competency levels. According to the World Bank, in many African countries fewer than 25 per cent of adults can complete basic digital tasks — such as installing an app, securing an account or sending a document.

The STREAMING survey further indicates that digital training opportunities are often limited by:

- training sessions concentrated in urban centres,
- lack of adaptation to local languages,
- text-based content ill-suited to low literacy environments,
- scheduling conflicts with agricultural labour cycles.

In addition, methodological barriers persist: many training programmes rely on “training-of-trainers” models that are poorly suited to socially heterogeneous agricultural systems. In informal markets, as described by Schmitz (2018), Clark (1994), Hart (1974) and Polanyi (1957) and others, knowledge transmission is often collective and embedded in social norms — dynamics that top-down training formats rarely reflect.

3.3 Economic Barriers: Poverty, Uncertainty and Cost–Benefit Calculations

Digitization is often described as a mechanism to increase efficiency, yet for many households the decisive question is whether a digital service offers immediate economic value. In contexts where income fluctuates, consumption is seasonal and prices are variable, households assess digital investments cautiously.

The World Bank notes that more than 60 per cent of household income in rural areas is spent on basic needs. Smartphones, mobile data and digital services compete directly with essential expenditures such as food, transport and school fees. Under these conditions, digital tools may be perceived as luxuries or risks — particularly when their benefits are unclear or poorly communicated.

Digital solutions therefore constantly compete with immediate survival logics. This explains why even useful digital tools are often not used consistently over time.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

3.4 Social–Institutional Barriers: Trust, Informal Governance and Moral Economies

A central finding of social science research is that African markets are deeply embedded in social relationships, authority structures, moral economies and informal institutions. Polanyi (1957) describes economies as social systems in which markets are regulated by norms and relationships [42]; Scott (1998) demonstrates how state-led modernization projects often fail when they ignore such local systems [43]. Schmitz (2018) shows how pricing, quality control and risk-sharing in West African markets are embedded in gendered roles, social networks and collective governance [6], [12].

Digital systems that disregard these social institutions are quickly perceived as surveillance tools or external interference. The STREAMING survey indicates widespread mistrust toward:

- government apps (“tax surveillance”),
- digital identities (“loss of autonomy”),
- traceability systems (“foreign interference”),
- digital payments (“bank control”).

In many informal markets, women’s committees, trader associations, market queens, middlemen and family networks perform key governance functions that digital systems cannot easily replace.

3.5 Fragmented Digital Landscapes and Lack of Interoperability

Many African states host a multitude of isolated applications, pilot projects and digital platforms. NGOs, international Organizations, tech start-ups and ministries deploy tools that are often not interoperable.

This results in:

- data silos,
- functional redundancies,
- limited scalability,
- multiple registration burdens,
- confusion and “digital fatigue” among end users.

STREAMING participants frequently reported being confronted with three or four different apps or platforms (f.e. iShamba for weather monitoring, Agri4All, an e-commerce platform), none of which provided visible value.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

3.6 Regulatory Barriers: Tariff and Non-Tariff Measures and New EU Regulations

International trade regulations are among the most significant external barriers. African agrifood systems are confronted with a growing number of requirements, including:

- EU Deforestation Regulation (EUDR)
- Lieferkettensorgfaltspflichtengesetz (LkSG)
- Corporate Sustainability Due Diligence Directive (CSDDD)
- Sanitary and Phytosanitary measures of the WTO (SPS)
- Technical Barriers to Trade (TBT)
- Rules of Origin (RoO)

The World Bank shows that non-tariff measures often impose greater costs on African exporters than tariffs or transport expenses. For smallholder farmers, these regulations translate into:

- documentation requirements,
- multi-step traceability,
- geolocation proofs,
- risk assessments,
- certification obligations.

Without digital systems, such requirements are virtually impossible to fulfil. Yet when poorly designed, digital compliance tools can themselves become new barriers — especially for informal producers.

3.7 Informality as a Structural Reality — Not a Transitional Problem

More than 85 per cent of employment in Africa occurs in the informal sector [21]. Agriculture is particularly affected. Informality is not an anomaly but a functional socioeconomic system with its own rules, safety nets and responsibilities [6], [13], [44], [45].

Digital systems that rely on formal registration, individual identification or fixed pricing models clash with:

- group-based organization,
- collective risk-sharing,
- flexible price negotiations,
- gendered market hierarchies
- religious and local norms,
- trust-based hierarchies.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

If digital transformation does not incorporate informal structures, the result is exclusion or avoidance strategies.

3.8 Vulnerable Groups — Severe and Specific Barriers

In the EU, people in vulnerable situations include those at risk of poverty or social exclusion due to unemployment, precarious jobs, low skills, disability, migration status, or being in a single-parent or large family. Other vulnerable groups are the elderly, ethnic and racial minorities, children, and LGBTQIA+ individuals. The EU addresses this through policies like the European Pillar of Social Rights, which emphasizes access to essential services, and through initiatives providing social services like counseling, social work, and personalized support. While EU and international frameworks recognise a broad spectrum of vulnerable groups, this report focuses on women, children (including working children), older persons and people with disabilities. This focus reflects empirical relevance within African agrarian and rural contexts rather than a normative exclusion of other groups. A substantial body of research shows that these four groups face the most systematic and measurable forms of economic and digital exclusion in agriculture and rural markets, particularly with regard to access to infrastructure, skills, markets and decision-making processes [46], [47], [48], [49].

Other vulnerability categories frequently used in European policy discourse — such as LGBTQIA+ identities or single-parent households — are often not systematically captured in agricultural or rural datasets, are socially underreported, or are analytically difficult to operationalise in contexts characterised by extended family systems and collective household arrangements [46], [50], [51]. The selection adopted here therefore represents a context-sensitive, evidence-based analytical decision grounded in data availability and sectoral relevance, rather than a denial of vulnerabilities experienced by other marginalised groups, which remain important subjects for future research.

Women

Women are central actors in agricultural trade but face significant digital disadvantages. World Bank data show that women in Sub-Saharan Africa are 30–50 per cent less likely to have access to mobile internet services. Reasons include:

- lower financial resources,
- limited decision-making autonomy,
- greater time burdens due to care work,
- reduced educational opportunities,
- cultural norms regulating access to technology.

Digital systems that are not designed in a gender-sensitive manner reinforce this gap. Several international studies demonstrate that the economic — and especially digital — exclusion of women generates substantial macroeconomic costs. The Alliance for Affordable Internet (A4AI) estimates that in 2020 alone, low- and middle-income countries lost approximately USD 126 billion in potential GDP because women were unable to participate in digital economic growth due to lacking digital inclusion [52]. The same report suggests that cumulative losses over the past

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

decade may amount to as much as USD 1 trillion [52]. The World Bank likewise confirms that digital and economic gender inequality constitutes a significant brake on growth, and that closing the digital gender gap could increase GDP in many African countries by several percentage points — particularly through higher labor-force participation, productivity gains and improved access to digital financial services for women [21]. These findings underscore that digital inclusion of women is not only a social imperative but also a critical economic necessity.

Children – especially working children

Child labour in Africa remains closely linked to agricultural production systems. The International Labor Organization estimates that approximately 60 per cent of all working children in Africa are employed in the agricultural sector — for example in crop farming, livestock, or seasonal harvesting – not including regular support to working in households [53]. Other analyses suggest even higher proportions: according to the UN Economic Commission for Africa (2025), up to 80 per cent of child labour in Sub-Saharan Africa consists of agricultural activity, amounting to approximately 74.4 million children. The forms of child labour vary widely, including:

- children contributing work within the family farm,
- children who move in with relatives and work,
- children engaged in wage labour,
- children circulated within extended family networks to be used as labour,
- child slavery.

[12], [54], [55], [56], [57]

These categories are fluid and represent only a subset of many further forms. Anthropological research (Nieuwenhuys 1996; Montgomery 2009; Schmitz 2018) shows that working children frequently hold central roles in agrarian systems [12], [58], [59]. Digital systems requiring individual registration, biometric capture or formal documentation can lead to criminalization or exclusion. Child labour does not disappear through digital monitoring; rather, it is pushed into more invisible or more dangerous spaces.

Elderly people

Older people often possess little to no digital literacy and frequently lack access even to basic mobile phones. At the same time, they serve as key knowledge keepers and labourers within cultivation systems and agricultural decision-making structures. Digital systems that rely on written text-based navigation systematically exclude them. Audio-visual assistance, including smart tools for voice control, could be a way out.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

People with disabilities

Very few digital agriculture tools incorporate accessibility features. Individuals with visual, auditory or physical impairments are often unable to use such systems — whether due to small font sizes, lack of audio functions or overly complex interfaces.

Conclusion

Digital transformation in African agrifood systems is less a technical issue than a socioeconomic, institutional and cultural one. The greatest obstacle lies in the gap between political visions and the lived realities of rural markets, household economies and social structures — a gap observable across all analysed countries, from Kenya and Ghana to Angola, Mali, Malawi, Togo and Ethiopia, albeit in varying forms. Successful digital transformation must take these real contexts seriously and in parallel recognize that existing social institutions, informal systems and local knowledge practices still form the foundation of nowadays agricultural decision-making. Digitalisation – while transforming the agricultural sector into an innovative food industry – cannot replace these structures; it can only be effective when designed and accepted as a complement to, and an extension of, functioning social systems.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 4 – Major Opportunities

Despite the significant structural, social and institutional barriers, the digital transformation of African agrifood systems holds extraordinarily high potential. The preceding analysis has demonstrated that digitalised agriculture cannot be understood as a purely technical modernization project or a simple efficiency gain. Rather, opportunities emerge where digital technologies are aligned with the specific social, cultural and economic conditions of African agrarian systems. Empirical data from the World Bank, insights from the STREAMING survey and national as well as continental digital strategies indicate that these opportunities extend far beyond the agricultural sector: they concern regional integration, trade, inclusion, knowledge circulation and institutional resilience.

Digital transformation can therefore play a central role in the economic development of Africa — but only if digital systems are designed to be inclusive, socially embedded and institutionally supported – thus, being effective and long lasting. The following sections outline the most important opportunities in detail.

4.1 Regional Integration, AfCFTA and Digital Trade Structures

One of the greatest opportunities of digital transformation lies in regional integration under the African Continental Free Trade Area (AfCFTA). African markets remain highly fragmented; cross-border transport is costly and burdened by complex customs and documentation requirements. The World Bank estimates that the costs of non-tariff measures (NTMs) in Africa are roughly twice as high as the costs of tariffs [60]. Digital systems offer transformative possibilities, such as:

- digital certificates of origin,
- automated SPS procedures,
- interoperable traceability systems,
- digital customs clearance,
- electronic quality seals,
- real-time delivery data.

For agricultural products — a central focus of AfCFTA — new export opportunities emerge. Digital systems can not only reduce costs and delays but also strengthen trust between trading partners and increase transparency along the value chain.

The DiploFoundation report highlights that African states are increasingly aligning their digital foreign policy to strengthen regional integration and their presence in global standard-setting fora [40]. Digital agrifood systems can significantly support this trend.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

4.2 Digitalisation as an Opportunity for Meeting New EU Regulations

At first glance, new EU regulations such as the 2023 EU Deforestation Regulation, the German Supply Chain Due Diligence Act (LkSG) and the upcoming Corporate Sustainability Due Diligence Directive (CSDDD) increase the burden on African export markets. Yet they actually hold enormous potential: digital systems enable cost-effective, scalable and reliable compliance and efficiency processes.

Digital traceability systems based on GS1 standards, EPCIS 2.0 or Digital Product Passports can:

- automate geolocated documentation,
- simplify reporting requirements,
- standardize risk assessments,
- digitalise certification processes.

This enables even micro-producers to retain or gain access to demanding export markets. The World Bank estimates that digital compliance solutions can increase the exportability of agricultural products by up to 30 per cent [2].

Here lies a powerful opportunity: digital compliance can become a leveller that enables small-scale producers to meet requirements that would otherwise be unattainable.

4.3 Strengthening Informal and Local Markets

Digital transformation carries enormous potential to make informal agrifood systems more resilient, transparent and monetizable. Informal markets constitute the backbone of economic life in most African countries. They rely on social networks, negotiation cultures, community-based regulation and gendered labor structures. Digital tools can significantly strengthen these systems — provided they support existing practices rather than impose formalistic models.

Digitalisation can:

- increase price transparency,
- reduce information asymmetries,
- improve market integration,
- make quality standards more visible,
- reduce risks in trade,
- strengthen trust between traders,
- facilitate coordination among producers,
- improve access to credit or mobile payments.

In this way, digital systems can stabilise informal economies rather than displace them or force them into rigid formal structures.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Anthropological literature shows that hybrid models — combinations of digital tools with existing social mechanisms — are particularly effective [13], [43]. Digital instruments that connect flexibly to social norms have especially high potential for adoption and long-term sustainability.

4.4 Local Innovation, Start-up Ecosystems and African Digital Competencies

Africa has a dynamic start-up landscape, particularly in agritech, fintech, mobility solutions and digital advisory services. Technology hubs such as Nairobi, Kigali, Lagos, Accra and Dakar foster digital innovation through incubators, accelerators, sandboxes and government innovation programs.

World Bank analyses show that investments in digital start-ups can increase agricultural productivity by up to 40 per cent [21]. Particularly important are:

- satellite imagery and remote sensing,
- mobile advisory systems,
- digital weather information,
- AI-based plant health diagnostics,
- sensors and IoT in agriculture.

These innovations can democratize access to advisory services and reach even remote areas — provided they are designed to work offline or under low bandwidth conditions.

4.5 Knowledge Systems, Data Spaces and Participatory Governance

Digital data spaces make it possible to systematically gather and use knowledge on cultivation, markets, climate risks, production volumes and supply chains. This applies to countries with already established data ecosystems, such as Kenya and Rwanda, as well as those still building them, such as Mali or Malawi. The World Bank emphasizes the importance of data-driven policy solutions for long-term planning, risk management and crisis response.

Key opportunities include:

- using open geospatial data for risk assessment,
- building African digital data spaces,
- linking government data with cooperatives and markets,
- strengthening African participation in global standardisation processes,
- creating sovereign data ecosystems to improve regional bargaining power.

Participatory data spaces enable producers and traders to take a more active role in governance processes.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

4.6 Key Opportunities for Vulnerable Groups

Women

Digital tools can significantly empower women by:

- facilitating access to markets,
- improving efficiency in transport and price negotiations,
- expanding access to digital financial services,
- making training and education more accessible.

A key opportunity of digital transformation lies in the economic empowerment of women — central yet structurally disadvantaged actors in African agrifood systems. As noted in Chapter 3, several studies show that digital inclusion has strong macroeconomic effects [21], [52].

Children and Youth

Africa has the youngest population in the world. Digital tools offer:

- access to education,
- digital upskilling programs,
- employment opportunities in agritech,
- tools for safety and early warning systems.

For working children, it is crucial that digital systems *protect rather than criminalize*. This aligns with the demands of the African Movement of Working Children and Youth [61].

Older People

Older people particularly benefit from:

- voice-based information services,
- non-text-based interfaces,
- digital weather and yield information,
- remote advisory services,
- social communication tools.

Digital agriculture can support intergenerational knowledge transfer.

People with Disabilities

Digital transformation creates new access points for people with disabilities, including:

- accessible agricultural advisory services,

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

- sensory assistive technologies,
- specialized training offers,
- digital tools that improve market access.

Many people with disabilities participate in agrifood systems; inclusive digital design can therefore produce significant social innovation.

Conclusion

Digital transformation in the agricultural sector offers far more than technical efficiency gains. It can integrate markets, empower vulnerable groups, secure export potential, stimulate local innovation and expand knowledge systems. The opportunities are greatest when digital systems are context-sensitive, inclusive, regionally integrated, socially embedded and institutionally anchored. While this report focuses on those vulnerable groups for which reliable empirical evidence is currently available, it does not seek to exclude other groups; rather, it reflects existing data gaps and research limitations in many agricultural contexts. Successful digital transformation in Africa does not arise from technological solutions alone, but from adapting these solutions to the complex realities of people, markets and institutions.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Chapter 5 - Recommendations

The analyses in the preceding chapters have shown that digital transformation in African agrifood systems is a multidimensional endeavour integrating technological, economic, social and institutional dimensions. Successful digital systems do not emerge from technological innovation alone, but from their embedding in local lived realities, social institutions, agrarian practices, informal market logics and international trade structures.
The recommendations are organized into ten thematic areas. A dedicated section focuses on recommendations for vulnerable groups.

5.1 Infrastructure as a Foundation: Securing Energy, Connectivity and Device Access

The first and fundamental prerequisite for digital transformation is access to energy, internet connectivity and suitable and affordable devices. Policy measures should aim not merely to *plan* digital services but to *enable* them. This includes:

1. Investments in decentralised energy infrastructure, particularly solar microgrids for markets, aggregation points and communities.
2. Subsidized data transfer packages for rural households, women and traders.
3. Digital kiosks at markets, operated by cooperatives or local groups.
4. Second-life programs for smartphones and local repair capacities.
5. Offline-first by design principles (cater for offline capability) for all applications.

The World Bank shows that more than 50 per cent of rural households in Africa use digital tools only when they function reliably under low-bandwidth conditions [1].

5.2 User-Centred System Design: Respecting Local Market Logics

Digital systems must be adapted to the functional realities of African agricultural and trading markets. Rather than designing tools based on formal, external models, the following principles should apply:

- Group-based identities instead of strictly individual IDs (to reflect cooperatives, family farming systems, etc.).
- Flexible price and quantity recording that does not undermine negotiation cultures.
- Voice-first and low-literacy design, especially for older adults and people with limited literacy., also local languages should be reflected
- Integration of informal rules (e.g., trust networks, rotational systems for market stalls).

Informal institutions and practices shape and stabilise economic order. Digital systems must not replace these social structures but support them. Over time, this can build trust, which in turn may lead to mutually desired forms of gradual formalisation.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

5.3 Strengthening Digital Skills – Decentralised, Everyday-Oriented and Gender-Sensitive

Digital training must correspond to real-world conditions. Large-scale training programs often fail due to urban bias, lack of language integration and unsuitable didactics.

Recommended measures include:

1. Decentralised training at markets, aggregation points and local administrative offices.
2. Women-led learning formats aligned with care responsibilities.
3. Voice- and video-based learning materials in local languages.
4. Peer-to-peer training.
5. Incentive systems for repeated use and learning progress.

The World Bank confirms that local, context-sensitive training can achieve adoption effects up to three times higher than conventional training models [2].

5.4 Stepwise Process Optimisation: A Gradual Approach to Interoperability

Because highly complex standards/norms and guidelines (e.g., EPCIS 2.0, Digital Product Passports) can overwhelm micro-producers, a stepwise approach is advisable:

Stage 1:
- Simple QR codes, batch IDs
- Paper-digital hybrid models

Stage 2:
- Migration towards GS1 standards
- Standardised product schemas

Stage 3:
- Full interoperability (embrace API-based data sharing)

This approach:

- lowers entry barriers,
- enables scalability,
- ensures compatibility with EU requirements.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

5.5 Strengthening Governance: Clear Responsibilities, Cooperation and System Integration

Digital transformation often fails due to institutional fragmentation. The following are essential:

- national coordination units for digital agriculture,
- institutional mandates for interoperability (e.g., Rwanda's RISA model),
- joint community multi-purpose platforms for state and non-state actors,
- binding monitoring and evaluation systems,
- regular reviews of digital strategies with participation from local groups.

The DiploFoundation report shows that states with clear responsibilities and international digital policy visibility — such as Kenya, Rwanda, Ghana and South Africa, but increasingly also Ethiopia and Togo — achieve significantly better implementation outcomes.

5.6 Digital Compliance-by-Design: Supporting the Fulfilment of EU Obligations

Digital systems must enable compliance with international and regional regulations, including:

- EUDR (Deforestation-free supply chains)
- LkSG (Due Diligence)
- CSDDD (Corporate Sustainability)
- SPS requirements
- Technical Barriers to Trade (TBT)

Recommended measures include:

1. Digital risk assessment systems based on a small number of clear parameters.
2. Automated geolocation combined with manual entry options.
3. Mobile tools (f.e. for tagging products with barcodes).
4. Group-based compliance mechanisms for cooperatives.
5. Open-source standards to avoid vendor lock-in effects.
6. African data spaces which fit EU systems.

Digital compliance can thus become a driver of transformation rather than a barrier.

5.7 Inclusive Digital Transformation: Focus on Vulnerable Groups

The inclusion of vulnerable groups is not optional — it is a central prerequisite for equitable digitalisation and economic growth.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Women

- subsidized devices,
- women-led training formats,
- digital safety modules,
- protected digital spaces,
- integration of care responsibilities into design processes.

Working Children

Digital systems must be designed so that they:

- do not criminalize,
- do not create unintended surveillance or security risks,
- support education and protection,
- acknowledge social realities (work as a contribution to household income).

Older People

- voice-based services,
- non-text-based navigation,
- reduced complexity,
- training delivered on site.

People with Disabilities

- accessible design,
- screen-reader compatibility,
- tactile/visual assistance,
- integrative training formats.

These measures are core elements of transformative digitization, strengthening both social justice and economic inclusion.

5.8 Strengthening Local Innovation: Entrepreneurship, Start-ups and Cooperatives

Recommended measures include:

- local innovation hubs at markets,
- joint research and development funds,
- government sandboxes for agritech,
- support for local developers of digital solutions,
- targeted training programmes for youth.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

World Bank data show that supported agritech start-ups can increase sectoral productivity by up to 40 per cent.

5.9 Strengthening Knowledge Systems, Digital Data Spaces and African Sovereignty

Digital data spaces offer tremendous potential:

- for monitoring,
- for crisis response,
- for trade data management,
- for open weather and risk data,
- for policy planning.

Recommended measures include:

- development of Africa-specific data spaces,
- participatory data models,
- open interfaces,
- integration of local knowledge systems,
- digital sovereignty strategies aligned with the AU Digital Transformation Strategy.

5.10 More Research and Systematic Data Collection: Evidence as the Foundation of Digital Transformation

Digital transformation in Africa's agricultural sector can only succeed sustainably if it is grounded in a broad, diversified and empirically robust knowledge base. Significant data gaps exist — both quantitative and qualitative — particularly regarding:

- digital usage patterns in rural areas,
- the effects of digital tools on labour organisation, risk and income,
- mechanisms of digital exclusion (gender, age, education, disability, social position),
- informal markets, price formation and governance structures,
- childhood and youth economies, including working children,
- impacts of new EU regulations on micro-producers,
- digital competencies across the value chain.

Research initiatives must systematically include *all* relevant actor groups: policymakers, CEOs and business associations, cooperatives, digital service providers, market traders, farmers, workers, transport operators, as well as youth and working children, who often play central roles in agricultural and trading chains.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Quantitative studies (e.g., panel-based impact assessments, digital usage data, price and risk analysis) must be complemented by qualitative approaches (ethnography, market observation, participatory research, user-experience studies). Only this combination enables a realistic understanding of how digital systems become embedded in everyday practices — and what unintended effects they may generate.

Comprehensive, systematic research is therefore not a peripheral issue, but a core requirement for evidence-based policymaking, sustainable digital strategy development and scalable agricultural digitalisation.

Conclusion

For the African agricultural sector, this means that digital transformation goes far beyond technological modernisation. It represents a strategic lever for food security, more efficient production systems, more resilient supply chains, and a more inclusive integration into local, national and international markets. Digital systems can improve access to knowledge, weather data, soil information, advisory services and quality standards, thereby strengthening productive decision-making at farm level. At the same time, they increase transparency across value chains, facilitate compliance with international trade requirements and open new market opportunities for micro-producers.

Particularly within informal trading structures — the backbone of African agrarian economies — digital tools can improve price formation, bargaining power and risk mitigation, if they build on existing social practices. However, for digital transformation to genuinely contribute to food security, more stable agricultural markets, and fair-trading opportunities, it must be designed in a context-sensitive manner, socially embedded and institutionally anchored. Only under these conditions can digital transformation unfold its full potential — from local markets to continental trade under the AfCFTA.

The recommendations demonstrate that digital transformation succeeds when it is understood as a broad, inclusive and institutionally grounded process. Technologies must be adapted to local contexts, respect social structures, integrate vulnerable groups, and ensure that international requirements can be met through digital systems.

In doing so, digital transformation becomes a lever that strengthens informal economic structures, promotes regional integration, meets global market requirements and opens new economic futures.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Bibliography

[1] World Bank, "World Development Indicators: Digital Adoption, Connectivity and Affordability." 2023. [Online]. Available: https://data.worldbank.org

[2] World Bank, "Digital Economy Diagnostic for Sub-Saharan Africa," Washington, DC, 2022.

[3] N. Burkhardt, "Drohnen, die in Ruanda Leben retten: Medizinlogistik 2.0," *ND-Aktuell*, 2023.

[4] Ministry of Health Rwanda, "Rwanda Launches Anti-Epidemic Robots to Boost the Fight Against COVID-19," Kigali, 2020.

[5] H. P. Hahn, "Die Aneignung des Mobiltelefons in Afrika: Interkulturelle Kommunikation, materielle Kultur und Globalisierung," in *Mobiltelefon – "libre"?*, H. P. Hahn and L. Kibora, Eds., Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), 2010.

[6] H. P. Hahn and G. Schmitz, Eds., *Market as Place and Space of Economic Exchange: Perspectives from Archaeology and Anthropology*. Oxford: Oxbow Books, 2018.

[7] African Union, "Digital Transformation Strategy for Africa (2020–2030)," African Union, 2020. [Online]. Available: https://au.int

[8] S. Ardener and S. Burman, Eds., *Money-Go-Rounds: The Importance of Rotating Savings and Credit Associations for Women*. Oxford: Berg Publishers, 1995.

[9] C. Geertz, "The Rotating Credit Association: A 'Middle Rung' in Development," *Econ. Dev. Cult. Change*, vol. 10, no. 3, pp. 241–263, 1962.

[10] J. I. Guyer, *Marginal Gains: Monetary Transactions in Atlantic Africa*. Chicago: University of Chicago Press, 2004.

[11] S. Rutherford, *The Poor and Their Money*. New Delhi: Oxford University Press, 2000.

[12] G. Schmitz, *Market Money: Handelsstrategien auf dem Tamale Central Market in Ghana zwischen lokalem Markt und globaler Ökonomie*. Berlin: Neofelis Verlag, 2018.

[13] G. Schmitz, *Market Money: Die unsichtbaren Regeln des informellen Handels*. Berlin: Neofelis Verlag, 2018.

[14] K. Hart, "Informal Income Opportunities and Urban Employment in Ghana," *J. Mod. Afr. Stud.*, vol. 11, no. 1, pp. 61–89, 1973.

[15] African Union, *Agenda 2063: The Africa We Want – Framework Document*. Addis Ababa: African Union, 2015. [Online]. Available: https://au.int/sites/default/files/documents/33126-doc-framework_document_book.pdf

[16] Government of Rwanda / MINICT, "Smart Rwanda Master Plan 2015–2020," Kigali, 2015.

[17] MINICT (Ministry of ICT and Innovation), "ICT Sector Strategic Plan 2018–2024," Kigali, 2018.

[18] National Communications Commission (NCC), "National Broadband Plan 2020–2025," Abuja, 2020. [Online]. Available: https://ncc.gov.ng

[19] Federal Republic of Nigeria, "National Digital Economy Policy and Strategy (NDEPS) 2020–2030," Government of Nigeria, Abuja, Nigeria, 2019.

[20] Ministry of Education, Arts and Culture Namibia, "ICT in Education Policy," Windhoek, 2019. [Online]. Available: https://www.nied.edu.na/assets/documents/05Policies/NationalCurriculumGuide/ICT_in_GRN_Policy.pdf

[21] World Bank, "Harnessing the Digital Economy for Inclusive Growth in Africa," Washington, DC, 2021.

[22] Government of Kenya, "Digital Economy Blueprint," Nairobi, 2019.

[23] Government of Kenya, "Kenya National Digital Master Plan 2022–2032," Nairobi, 2022.

[24] Republic of Ghana, "Ghana Digital Agenda," Accra, 2020.

[25] Republic of Senegal, "Sénégal Numérique 2016–2025," Dakar, 2016.

[26] Republic of Senegal, "Sénégal Digital 2025–2035 (New Deal Technologique)," Dakar, 2024.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

[27] Republic of South Africa, “South Africa Digital Economy and Data Governance Strategy,” Pretoria, 2021.
[28] Department of Communications and Digital Technologies South Africa, “National Data and Cloud Policy,” Pretoria, 2024.
[29] Government of Angola, “Lei de Bases das Tecnologias de Informação e Comunicação 2023–2027,” Luanda, 2023.
[30] Government of Angola, “Angola 2050: Long-Term Development Vision,” Luanda, 2025.
[31] Ministry of Posts and Telecommunications Cameroon, “Plan Stratégique Cameroun Numérique 2020,” Yaoundé, 2016.
[32] Republic of Cameroon, “National Development Strategy 2020–2030,” Yaoundé, 2020.
[33] Republic of Tunisia, “Programme National de Transformation Digitale 2025–2026,” Tunis, 2025.
[34] Republic of Mali, “Politique Nationale de Développement de l’Économie Numérique,” Bamako, 2015.
[35] L. Munthali and others, “Digital Education and Rural Inclusion in Malawi,” Lilongwe, 2025.
[36] BMZ, “Digital Transformation Center Togo,” Federal Ministry for Economic Cooperation and Development, Bonn, 2023. [Online]. Available: https://www.bmz-digital.global/en/initiatives/digital-transformation-center-togo
[37] World Bank, “Togo: $100 Million to Accelerate Digital Transformation.” Washington, DC, 2024. [Online]. Available: https://www.worldbank.org/en/news/press-release/2024/12/19/togo-100-million-in-funding-to-accelerate-digital-transformation
[38] Government of Ethiopia, “Ethiopia Digital Strategy 2020,” Addis Ababa, 2020. [Online]. Available: https://mirror.explodie.org/Ethiopia%20Digital%20Strategy%202020.pdf
[39] Ministry of Agriculture Ethiopia, “Digital Agriculture Roadmap 2032,” Addis Ababa, 2022. [Online]. Available: https://www.moa.gov.et/wp-content/uploads/2025/04/Digital-Agriculture-Roadmap-Ethiopia.pdf
[40] DiploFoundation, “Stronger Digital Voices from Africa,” 2023. [Online]. Available: https://www.diplomacy.edu/resource/report-stronger-digital-voices-from-africa/
[41] OECD, “Digital opportunities for trade in the agriculture and food sectors,” OECD Food, Agriculture and Fisheries Papers, No. 122, 2019. [Online]. Available: https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2019)7&docLanguage=En
[42] K. Polanyi, *The Economy as an Instituted Process*. Glencoe, IL: Free Press, 1957.
[43] J. C. Scott, *Seeing Like a State*. New Haven: Yale University Press, 1998.
[44] G. Clark, *Onions Are My Husband: Survival and Accumulation by West African Market Women*. Chicago: University of Chicago Press, 1994.
[45] M. Mauss, *Essai sur le don*. Paris: PUF, 1925.
[46] World Bank, *Inclusion Matters in Africa*. Washington, DC: World Bank, 2020.
[47] International Labour Organization, “Child Labour in Agriculture: Global Estimates and Trends,” International Labour Office, Geneva, 2021.
[48] R. Heeks, “Digital inequality beyond the digital divide: Conceptualizing multidimensional exclusion,” *J. Int. Dev.*, 2022.
[49] International Telecommunication Union (ITU), *An Assessment of Digital Inclusion among Vulnerable Persons in Developing Economies*. Geneva: ITU, 2022.
[50] European Parliament, “LGBTIQ+ Rights in Africa: Legal and Social Realities,” European Parliament, Brussels, 2025.
[51] ILGA World, “Bridging the Digital Divide for LGBTI Communities Worldwide.” [Online]. Available: https://ilga.org/

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

[52] Alliance for Affordable Internet (A4AI), “Affordability Report 2020,” Alliance for Affordable Internet, Technical Report, 2020. [Online]. Available: https://a4ai.org/wp-content/uploads/2020/12/Affordability-Report-2020.pdf
[53] International Labour Organization, “Annual Report 2021,” International Labour Organization, Annual Report, 2021. [Online]. Available: https://www.ilo.org/publications/annual-report-2021
[54] M. Liebel, “Do Children Have a Right to Work? Working Children’s Movements in the Struggle for Social Justice,” in *Reconceptualizing Children’s Rights in International Development*, K. Hanson and O. Nieuwenhuys, Eds., Cambridge: Cambridge University Press, 2013.
[55] E. Alber, *Soziale Elternschaft im Wandel: Kindheit und Verwandtschaft in Westafrika*. Berlin: Reimer Verlag, 2015.
[56] D. F. Lancy, *The Anthropology of Childhood: Cherubs, Chattel, Changelings*. in New Studies of Children’s Work. Cambridge: Cambridge University Press, 2015.
[57] International Labour Organization, “Annual Report 2017,” International Labour Organization, Annual Report, 2017. [Online]. Available: https://www.ilo.org/publications/annual-report-2017
[58] O. Nieuwenhuys, “The Paradoxes of Child Labor and Anthropology,” *Annu. Rev. Anthropol.*, vol. 25, pp. 237–251, 1996.
[59] H. Montgomery, *Buying Innocence*. London: Zed Books, 2009.
[60] World Bank, *The African Continental Free Trade Area: Economic and Distributional Effects*. Washington, DC, 2020.
[61] Mouvement Africain des Enfants et Jeunes Travailleurs (MAEJT) / African Movement of Working Children and Youth, “African Movement of Working Children and Youth (AMWCY).” 1994. [Online]. Available: https://maejt.org/en/about-us/

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

Annex

Annex I – Initial Questionnaire

Table 1 showcases the structure of the initial survey sent to partner institutes in Africa with its primary purpose to obtain basic information among 12 sections from the STREAMING project partners. In addition, the results will be used to create further questionnaires for specific target groups.

Table 2 lists the different question types, including the possible answer options in case of a multiple-choice question.

Figure 3 illustrates the included African partner countries who participated in the survey.

Table 3 provides a synopsis of the collected answers.

Table 1: Questionnaire on Agriculture, Trade and Digitalisation in African Partner Countries

Question No.	Section	Question
1	**Respondent & Background**	Date of response
2	**Respondent & Background**	Name
3	**Respondent & Background**	E-mail contact
4	**Respondent & Background**	Country
5	**Respondent & Background**	Institution
6	**General Agricultural Context**	How many farmers are living in your country? (approx.)
7	**Agricultural Production**	Which agricultural products are mainly produced in your country? (Multiple answers possible)
8	**Agricultural Production**	Are any products missing from this list? If yes, please list them.
9	**Trade & Distribution**	With which agricultural products does your country trade within the African Union? (Multiple answers possible)
10	**Trade & Distribution**	With which agricultural products does your country trade outside the African Union? (Multiple answers possible)
11	**Trade & Distribution**	Which languages are mainly used for trade?
12	**General Agricultural Context**	What is the main source of food in your country?
13	**General Agricultural Context**	Is there malnutrition in your country and if so, what reasons can you give?
14	**Finance & Payments**	Which payment methods are used in your country?
15	**Finance & Payments**	What percentage of the population has a bank account?
16	**Finance & Payments**	What percentage of the population has a smart phone?
17	**Trade & Distribution**	To which countries / regions are products distributed?

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

18	**Digitalisation & Technology**	In which areas are digital solutions used in agriculture? (Multiple answers possible)
19	**Digitalisation & Technology**	Which technologies are used? (Multiple answers possible)
20	**Digitalisation & Technology**	If there are online platforms used in the agricultural sector or in trade, please list them (with links):
21	**Digitalisation & Technology**	Is the content in those platforms locally developed or are they developed for international use?
22	**Digitalisation & Technology**	Are there online platforms for standardization, traceability, product information and trade? If yes, please list them.
23	**Digitalisation & Technology**	What percentage of farmers are using those platforms?
24	**Energy, Inputs & Resources**	Which energy sources are used? (Multiple answers possible)
25	**Energy, Inputs & Resources**	What kind of fertilizers are mostly used in your country?
26	**Energy, Inputs & Resources**	What kind of pesticide do you use?
27	**Sustainability & Ethics**	How important is organic farming in your country? Please describe briefly:
28	**Sustainability & Ethics**	How important is climate-neutral and sustainable agriculture in your country? Please describe briefly:
29	**Sustainability & Ethics**	How important is animal welfare in your country? Please describe briefly:
30	**Policies & Laws**	Are there initiatives and laws in your country that effectively support farmers? Please list them.
31	**Policies & Laws**	Are there laws and structural conditions that make agricultural production more difficult? Please list them.
32	**Agricultural Structure**	How many farms of what size are there in your country? (e.g. X Large farms with industrial production, X small farms for local trade etc.)
33	**Agricultural Structure**	Is the agricultural sector in your country rather formal or informal? Please elaborate briefly.
34	**Challenges**	In your opinion, what are the biggest challenges for sustainable, resource-conserving and climate-friendly production?
35	**Challenges**	In your opinion, what are the biggest challenges for high-yield, efficient production?
36	**Challenges**	In your opinion, what are the biggest challenges for profitable trade within the AU?
37	**Challenges**	In your opinion, what are the biggest challenges for profitable trade outside the AU?
38	**Social Issues & Inclusion**	In your opinion, what are the biggest challenges for fair working conditions and good wages?
39	**Social Issues & Inclusion**	In your opinion, what are the biggest challenges for animal welfare?
40	**Social Issues & Inclusion**	Is there child labor in agriculture? If yes, what kind? (Multiple answers possible)
41	**Social Issues & Inclusion**	Are there initiatives to involve vulnerable groups in agriculture? If yes, please specify:
42	**Solutions & Outlook**	Are there obvious solutions to agricultural challenges in your country?
43	**Solutions & Outlook**	Are there obvious solutions for more profitable trade in agricultural products?

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

44	**Solutions & Outlook**	What digital solutions do you think would improve yield, sustainability and profit in agriculture?
45	**Policies & Laws**	Would you say that existing EU laws are more helpful or more of a hindrance to your agriculture?
46	**Vision & Hypotheticals**	Let's say your country wins billions in the lottery and is only allowed to spend the money on agriculture. What would you buy? What would you change?
47	**Vision & Hypotheticals**	And now let's say it's not an institution, you or your country that would win the lottery, but the farmers and they would be allowed to spend their winnings on anything they want. What percentage would remain farmers?
48	**Final Feedback**	Do you think I have forgotten any important questions? Please add them here:

Table 2: Initial Questionnaire – Question Type

Question No.	Section	Type
1	**Respondent & Background**	Open
2	**Respondent & Background**	Open
3	**Respondent & Background**	Open
4	**Respondent & Background**	Open
5	**Respondent & Background**	Open
6	**General Agricultural Context**	Open
7	**Agricultural Production**	Multiple choice – Vegetables, Fruit, Flowers, Milk, Beef, Chicken, Pork, Goat, Mutton, Fish, Shellfish, Grains, Rice, Tubers, Soy, Spices, Animal feed, Biogas, Tea, Cocoa, Coffee, (Open) Other:
8	**Agricultural Production**	Open
9	**Trade & Distribution**	Multiple choice – Vegetables, Fruit, Flowers, Milk, Beef, Chicken, Pork, Goat, Mutton, Fish, Shellfish, Grains, Rice, Tubers, Soy, Spices, Animal feed, Biogas, Tea, Cocoa, Coffee, (Open) Other:
10	**Trade & Distribution**	Multiple choice – Vegetables, Fruit, Flowers, Milk, Beef, Chicken, Pork, Goat, Mutton, Fish, Shellfish, Grains, Rice, Tubers, Soy, Spices, Animal feed, Biogas, Tea, Cocoa, Coffee, (Open) Other:
11	**Trade & Distribution**	Open
12	**General Agricultural Context**	Open
13	**General Agricultural Context**	Open
14	**Finance & Payments**	Multiple choice – Cash, MoMo, Electronic, Others
15	**Finance & Payments**	Open
16	**Finance & Payments**	Open
17	**Trade & Distribution**	Open
18	**Digitalisation & Technology**	Multiple choice – Accounting, Logistics, Payment, Trade, Irrigation, Soil care, Weather monitoring, Milk production, Livestock registration, Fertilization, Herd monitoring, Measurement,

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

		Slaughtering (e.g. automatic weighing), Climate control (e.g. in greenhouses), Soil and air quality monitoring, Yield monitoring, Field monitoring, (Open) Other:
19	**Digitalisation & Technology**	Multiple choice – Mobile Apps, Online Platforms, AI, IoT, GPS, Robots, Tractors, Mowing machines, Milking machines, Drones, Automatic Slaughtering Machines, CSA (Climate-Smart Agriculture), GMO (Genetically Modified Organism), Biotechnology, Solar-powered irrigation systems, Blockchain, (Open) Other:
20	**Digitalisation & Technology**	Open
21	**Digitalisation & Technology**	Open
22	**Digitalisation & Technology**	Open
23	**Digitalisation & Technology**	Open
24	**Energy, Inputs & Resources**	Multiple choice – Electricity, Diesel, Petrol, Solar, Wind, Biogas, Hydropower, Geothermal energy, Gas, Charcoal, Oil, Nuclear, Biomass, (Open) Other:
25	**Energy, Inputs & Resources**	Open
26	**Energy, Inputs & Resources**	Open
27	**Sustainability & Ethics**	Open
28	**Sustainability & Ethics**	Open
29	**Sustainability & Ethics**	Open
30	**Policies & Laws**	Open
31	**Policies & Laws**	Open
32	**Agricultural Structure**	Open
33	**Agricultural Structure**	Open
34	**Challenges**	Open
35	**Challenges**	Open
36	**Challenges**	Open
37	**Challenges**	Open
38	**Social Issues & Inclusion**	Open
39	**Social Issues & Inclusion**	Open
40	**Social Issues & Inclusion**	Multiple choice – Support on the family farm, Wage labor, Work for food and shelter, Work for education, Forced labor, None, (Open) Other:
41	**Social Issues & Inclusion**	Open
42	**Solutions & Outlook**	Open
43	**Solutions & Outlook**	Open
44	**Solutions & Outlook**	Open
45	**Policies & Laws**	Open
46	**Vision & Hypotheticals**	Open
47	**Vision & Hypotheticals**	Open
48	**Final Feedback**	Open

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

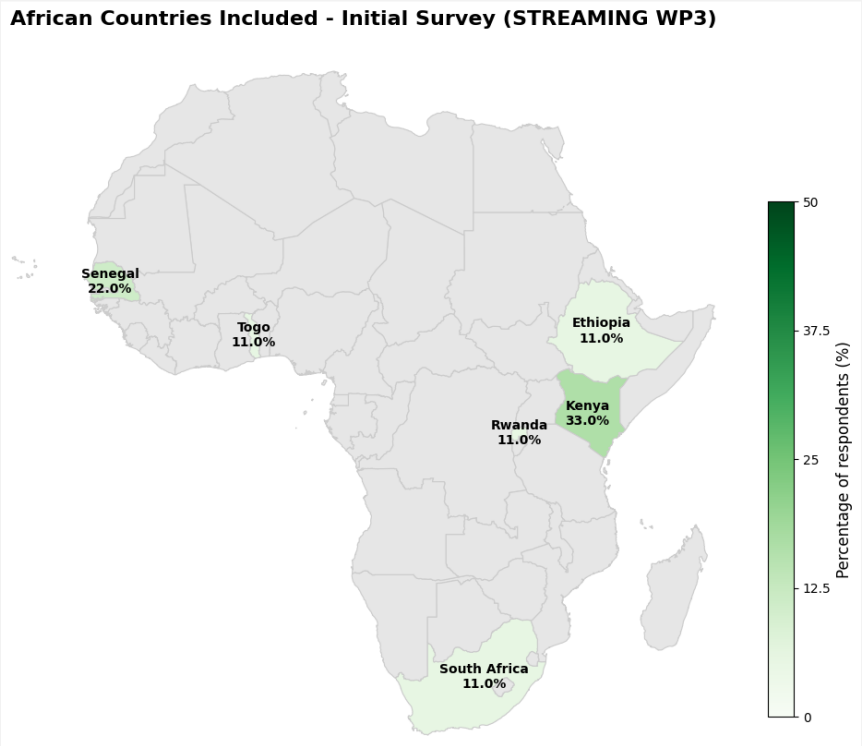


Figure 3: Included African Countries Initial Survey

Table 3: Most Frequent Responses to Questions 6-48

Question No.	Section	Question
1	**Respondent & Background**	-
2	**Respondent & Background**	-
3	**Respondent & Background**	-
4	**Respondent & Background**	-
5	**Respondent & Background**	-
6	**General Agricultural Context**	The estimated number of farmers per country most commonly ranged between 1 and 5 million.
7	**Agricultural Production**	The main agricultural products reported were maize, rice, grains, potatoes, beans, vegetables, wheat, coffee and cotton.
8	**Agricultural Production**	Frequently mentioned missing products included cashew nuts, tea and cocoa.
9	**Trade & Distribution**	Intra-African Union trade mainly involved coffee, tea, sugar, cotton, fruit.
10	**Trade & Distribution**	Trade outside the African Union focused primarily on coffee, tea, cocoa and sugar.
11	**Trade & Distribution**	English, French and Arabic were the most commonly used trade languages.
12	**General Agricultural Context**	The main food sources reported were maize, rice and wheat.
13	**General Agricultural Context**	Undernutrition was reported in many countries, mainly attributed to poverty, low agricultural productivity and climate change.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

14	**Finance & Payments**	The most commonly used payment methods were cash, mobile money and bank transfers.
15	**Finance & Payments**	Bank account ownership was most often estimated at between 20% and 50% of the population, with an outlier of 85%.
16	**Finance & Payments**	Smartphone penetration was generally estimated between 30% and 60% of the population, with an outlier of 91%.
17	**Trade & Distribution**	Agricultural products were mainly distributed to neighbouring countries and the European Union.
18	**Digitalisation & Technology**	Digital solutions were most frequently used for irrigation, crop monitoring and market information.
19	**Digitalisation & Technology**	Commonly used technologies included drones, sensors and mobile applications.
20	**Digitalisation & Technology**	Reported online platforms mainly consisted of local marketplaces and international trading platforms (e.g., HaloChoice, AgriKool, TonnUp, PrysWys, Trigga).
21	**Digitalisation & Technology**	Platform content was most often described as a combination of locally developed and internationally oriented material.
22	**Digitalisation & Technology**	Platforms for standardisation and traceability were reported, mainly at national level or through international systems.
23	**Digitalisation & Technology**	Platform usage among farmers was generally estimated between 10% and 30%.
24	**Energy, Inputs & Resources**	Energy use in agriculture relied primarily on solar energy, diesel and biomass.
25	**Energy, Inputs & Resources**	Both chemical and organic fertilisers were widely reported as being used.
26	**Energy, Inputs & Resources**	The use of both chemical and biological pesticides was commonly reported.
27	**Sustainability & Ethics**	Organic farming was generally described as growing in importance.
28	**Sustainability & Ethics**	Climate-neutral and sustainable agriculture was widely perceived as highly important.
29	**Sustainability & Ethics**	Animal welfare was reported as an increasingly relevant issue.
30	**Policies & Laws**	Farmer support measures mainly included subsidies, training programmes and technical assistance.
31	**Policies & Laws**	Bureaucratic barriers and insufficient infrastructure were the most frequently cited constraints.
32	**Agricultural Structure**	Most countries reported a mixed structure of large-scale and smallholder farms, with SA reporting 86 mln ha large farms / 14.5 mln ha smallholder farmers.
33	**Agricultural Structure**	The agricultural sector was commonly described as containing both formal and informal elements.
34	**Challenges**	Key challenges for sustainable production included climate change, water scarcity and limited financing.
35	**Challenges**	Efficient and high-yield production was constrained by limited technology, skills gaps and financing challenges.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256

36	**Challenges**	Intra-African Union trade was hindered mainly by trade barriers, infrastructure gaps and bureaucracy.
37	**Challenges**	Similar barriers were reported for trade outside the African Union.
38	**Social Issues & Inclusion**	Fair wages and working conditions were constrained by weak legal frameworks, limited enforcement and economic instability.
39	**Social Issues & Inclusion**	Animal welfare challenges were linked to regulatory gaps, enforcement issues and economic pressures.
40	**Social Issues & Inclusion**	Child labour was reported, mainly in the form of family-based agricultural work.
41	**Social Issues & Inclusion**	Inclusion initiatives for vulnerable groups mainly focused on training and financial support.
42	**Solutions & Outlook**	Proposed solutions to agricultural challenges centred on technological innovation and improved access to finance.
43	**Solutions & Outlook**	Solutions for more profitable trade focused on improved trade agreements and better infrastructure.
44	**Solutions & Outlook**	Mobile applications, sensors and drones were most frequently identified as promising digital solutions.
45	**Policies & Laws**	EU legislation was generally perceived as having both supportive and constraining effects.
46	**Vision & Hypotheticals**	Hypothetical investment priorities focused on infrastructure, technology and training.
47	**Vision & Hypotheticals**	Most respondents believed that a majority of farmers would remain in agriculture if financially empowered.
48	**Final Feedback**	Respondents generally considered the questionnaire to be comprehensive, with no major gaps identified.

This project is funded by the European Union under @HorizonEU research and innovation program under Grant Agreement number 101182256