

# IDRC - Scoping Study Making Digital Tools Work for Farmers

Final report

IDinsight

 IDRC · CRDI  
Canada

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**Final report**

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We extend our gratitude to all Key Informant Interview respondents who offered their time for in-person and virtual meetings, contributing their perspectives and expertise to this study on Digital for Agriculture (D4AG). While individual respondents are not directly mentioned in the report, we have included the list of their organizations in the appendix.

Our thanks also go to the local organizations in Kenya, Senegal, and Morocco that played an important role in organizing focus group discussions with local smallholder farmers. A special thank you to the farmers themselves, whose participation and insights were important to the discussions.

## **About IDinsight**

IDinsight uses data and evidence to help leaders combat poverty worldwide. Our collaborations deploy a large analytical toolkit to help clients design better policies, rigorously test what works, and use evidence to implement effectively at scale. We place special emphasis on using the right tool for the right question and tailor our rigorous methods to the real-world constraints of decision-makers.

IDinsight works with governments, foundations, NGOs, multilaterals, and businesses across Africa and Asia. We work in all major sectors including health, education, agriculture, governance, digital ID, financial access, and sanitation.

We have offices in Dakar, Lusaka, Manila, Nairobi, New Delhi, Rabat, and Remote. Visit [www.IDinsight.org](http://www.IDinsight.org) and follow on Twitter [@IDinsight](https://twitter.com/IDinsight) to learn more.

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# Executive Summary

## ***Context and methodology***

Under the scope of its Climate Resilient Food System Research Agenda, IDRC has asked IDinsight to conduct a scoping study titled "Making Digital Tools Work for Farmers." The collaboration between IDinsight and IDRC is a 5.5-month study from January to June 2024 which intends to explore digital tools' potential to enhance smallholders' livelihoods and boost gender equality and inclusivity in North and Sub-Saharan Africa.

This report presents the key findings of this study, with the insights designed to inform IDRC's research direction in the digital for agriculture (D4AG) sector. This study delves into critical research questions surrounding the D4AG ecosystem, offering a comprehensive synopsis of the current research trends. Importantly, it goes beyond summarizing existing knowledge by exploring crucial research gaps that demand further investigation. Specifically, the report pinpoints research gaps in North and Sub-Saharan Africa concerning how digital tools can:

- Improve the livelihoods of smallholder farmers (SHFs);
- Bridge the gender divide and mitigate inequalities in the agricultural sector; or
- Promote sustainable food security.

The study was conducted in two phases: (i) a high-level scoping phase aimed to establish a fundamental understanding of the D4AG landscape and dynamics on the African continent through Key Informant Interviews (KIIs) and a literature review; and a (ii) deep-dive scoping phase aimed to contextualize the identified research gaps by conducting in-depth analyses in three topical countries: Kenya, Senegal, and Morocco. The latter was done through engagement with local stakeholders, including researchers, governing bodies, producer organizations, as well as conducting focus group discussions with smallholder farmers.

In this scoping report, we first describe the state of digital tools in Sub-Saharan and North Africa summarizing our findings of the high-level scoping phase, including lessons from the literature around and then focus on deep-dive analysis of Kenya's, Senegal's and Morocco's D4AG ecosystem. We finally suggest a research agenda on digital tools for farmers for IDRC in each country.<sup>1</sup> The main takeaways are shared below.

## ***Key findings and implications for the IDRC research agenda***

The three case-study countries were selected to represent different regional contexts: Kenya for its mature digital agriculture ecosystem (Anglophone Sub-Saharan Africa), Senegal as an entrepreneurial hotspot (Francophone Sub-Saharan Africa), and Morocco for its emerging enabling environment (North Africa).

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<sup>1</sup> The key findings per country are highlighted in the summary boxes in sections 3.1-3.3, and the sections 4.1-4.3 present a potential research agenda per country based on the analysis.

## KENYA

- Kenya features a mature ecosystem with the most number of D4AG organizations (both private and public) on the continent, high-level funding activity, and strong government support fostering an enabling environment.
- Despite these strengths, the key findings suggest that many D4AG tools lack adequate tailoring to farmers' specific needs, especially concerning value chain specifications and local contexts. Local stakeholders asserted the need for more localized advisory services, leveraging networks of local institutions. Additionally, while extensive data is being collected, the lack of a data sharing system results in duplication and inefficiencies. Although there is significant funding activity, scaling ag-tech solutions remains limited, with stakeholders highlighting the need for viable business models aligned with farmers' willingness to pay. Emerging technologies such as AI and drones are generating significant interest but encounter challenges related to scalability. Additionally, social norms and gender biases present significant barriers that prevent Kenyan women farmers from fully accessing and benefiting from D4AG services.
- The resulting suggested research agenda focus on the following areas: (i) adapting D4AG tools to meet specific farmer needs, (ii) strengthening ecosystems for private-sector digital tools, (iii) exploring gender gaps in D4AG adoption, and (iv) investigating sustainable business models and farmers' ability to pay.

## SENEGAL

- Senegal D4AG ecosystem remains entrepreneurial with 20 to 30 private initiatives and digital projects integrated into donor-funded activities. While the government prioritizes agriculture in its development plans, it seems to have not significantly supported D4AG initiatives so far, hindering their growth.
- Key findings highlight a significant lack of government support in terms of funding, data sharing, and technical assistance. This void restricts the potential and growth of the D4AG ecosystem. Additionally, there is widespread mistrust among stakeholders towards publicly available data due to a perceived lack of transparency in government-collected data. The agricultural value chain's fragmentation further creates barriers for D4AG services to integrate and scale effectively. Additionally, gender-specific impacts of these barriers remain underexplored, necessitating further investigation into women's participation in D4AG services.
- Based on those findings, strengthening the D4AG ecosystem necessitates addressing barriers to its growth. The resulting suggested research agenda focuses on two key areas: (i) investigating data sharing practices within the ecosystem and (ii) understanding the impact of value chain fragmentation on the effectiveness of D4AG tools. Additionally, we'd recommend leveraging existing scoping studies pointing out the state of research with regards to gender in agriculture in Senegal to further explore gender dynamics in D4AG access in Senegal.

## MOROCCO

- The D4AG ecosystem in Morocco contrasts to that of Sub-Saharan Africa, being characterized by a majority of large farms, export-oriented agriculture, and advanced technologies such as drones and AI, with limited use cases for smallholder farmers. However, Morocco has placed digitalization of agriculture at the center of its strategy, particularly through the *Generation Green 2020-2030* plan, which aims to connect over 2 million farmers to digital platforms by 2030, and the creation of Pôle Digital in 2022 to coordinate all digital activities within the sector.
- D4AG initiatives are highly integrated within the ecosystem, with programs such as the network of digital farms ("Réseau de Fermes Digitales") serving as (i) a lab for testing and scaling digital tools and (ii) an integrated value chain model to ensure these tools meet farmers' needs. Despite these efforts, the initiatives are relatively recent. Therefore, the current focus may lie primarily on commercial or productivity metrics, neglecting a broader assessment of impact. There is some adaptation of low-tech solutions to reach more remote or less digitally literate smallholder farmers, but the practical implementation of these efforts requires further examination. Besides, scoping efforts reveal limited initiatives addressing gender within the D4AG ecosystem, with existing programs primarily targeting cooperatives. Furthermore, a dearth of comprehensive data on gender disparities hinders a nuanced understanding of the specific needs and challenges faced by women in this context.
- Based on these findings, the suggested research gaps include: (i) developing impact assessments of the existing tools promoted by Pôle Digital and government actors, (ii) assessing the inclusivity of Morocco's D4AG initiatives, ensuring that high-tech solutions are effectively translated into low-tech options to reach more remote and less connected farmers, and (iii) conducting more research to understand gender disparities in D4AG adoption in Morocco.

# Glossary

**Ag-tech:** Agri-tech, sometimes ag-tech, agtech or digital agriculture, is the application of technology and digital tools to farming. In this report, we use the term D4AG, but these terms could be used interchangeably.

**Bundled Services:** In this report, refers specifically to digital tools solutions that cover two or more D4AG products or services.

**Climate Resilience:** The ability to anticipate, prepare for, respond to, and recover from climate-related disturbances. In the context of D4AG tools, the types distinguished include:

- *Absorptive resilience:* Empowers smallholder farmers to resist and absorb immediate impacts of climate variability with D4AG tools.
- *Adaptive resilience:* Enables farmers to adjust their practices in response to observed climate changes using D4AG insights.
- *Transformative resilience:* Involves leveraging D4AG to fundamentally overhaul agricultural systems for sustainable practices amidst long-term climate change.

**D4AG:** Digital for agriculture (D4AG) is an encompassing term referring to a broad spectrum of digital solutions aimed at enhancing growth and improving the operations of entities within agricultural value chains, from smallholder farmers to large agribusinesses.

**D4AG Ecosystem:** Comprises stakeholders, technologies, and practices that collectively contribute to the progression and usage of digital solutions in agriculture.

**D4AG Ecosystem Maturity:** Describes the degree to which a country's agricultural sector has adopted digital tools and technologies. A "mature" D4AG ecosystem is characterized by widespread digital accessibility among farmers, comprehensive data infrastructure, conducive regulatory frameworks, and active engagement from multi-sectoral actors. Kenya and Nigeria are often cited as mature D4AG ecosystems.

**Data Governance:** The process by which data is managed, regulated, and protected throughout its lifecycle. This includes policies, procedures, and standards governing the collection, storage, and use of information.

**Digital Advisory:** Digitally delivered information on agronomic best practices, pest and disease management, weather, and market prices, along with tailored farm management software. These solutions help smallholder farmers make decisions to maximize output, improve production quality, and increase revenues by reducing costs, identifying markets, and achieving better prices.

**Financial Access Digital Solutions:** Digital financial services such as payments, savings, credit, and insurance tailored to smallholder farmers. These also include digitalization and data analytics services for financial institutions to serve farmers more cost-effectively. These solutions enhance financial access, improve yields and incomes, and support farm growth through better inputs, mechanization, and crop diversification.

**Frontier Technologies:** In the agricultural sector, frontier technologies refer to advanced innovations that can create more efficient, sustainable, and productive farming systems. Examples within D4AG tools include:

- *Precision Agriculture:* Utilizes various forms of Artificial Intelligence (AI) and Internet of Things (IoT), leveraging data from satellite images, and soil sampling to maximize land, water, and fertilizer use to increase crop yields.
- *Agricultural Drones:* Used for crop monitoring, planting, pest control, and irrigation, drones provide detailed aerial imagery and can target specific areas for treatment, conserving resources and time in particular.
- *Blockchain for Supply Chain Traceability:* Blockchain technology provides a transparent way to record transactions, allowing for traceability of agricultural products from farm to table.

**Market Linkages:** Digital Solutions: Digitally-enabled platforms that connect smallholder farmers with high-quality inputs (seeds, fertilizers, herbicides/pesticides), machinery and mechanization services (irrigation, tractors, cold storage), and off-take markets (agro-dealers, wholesalers, retailers, end-consumers). These solutions reduce production costs, transaction risks, and help farmers increase yields and incomes.

**Phy-gital:** (in the context of D4AG) This term refers to a hybrid approach that combines digital tools with offline, on-the-ground support such as with field staff. By integrating physical components like field visits, training sessions, and direct farmer engagement, the phy-gital approach aims to provide comprehensive support to farmers and ensure the successful adoption and practical application of digital tools in agriculture.

**Research Gap:** Identifies areas within a field where information is lacking or incomplete, guiding the direction for future research. Within this study, five specific types are considered:<sup>2</sup> knowledge gaps (unexplored topics), evidence gaps (lack of empirical data), methodological gaps (issues with previous research methods), empirical gaps (need to confirm preliminary findings), and theoretical gaps (inadequacies in existing theories).

**Smallholder Farmer:** Two or fewer hectares of land is what is generally considered to define a "small farm"<sup>3</sup> which depends predominantly on household labor. Smallholder farmers (SHF) or "small-scale" farmers are individuals who produce crops or livestock on a small farm. According to the FAO,<sup>4</sup> "Many are poor and food insecure and have limited access to markets and services. [...] Besides farming they have multiple economic activities, often in the informal economy, to contribute towards their small incomes".

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<sup>2</sup> Adapted from Miles (2017): "Research Methods and Strategies Workshop: A Taxonomy of Research Gaps: Identifying and Defining the Seven Research Gaps".

<sup>3</sup> Nagayet. (2005).

<sup>4</sup> Rapsomanikis. (2015).



# 1. Introduction

## 1.1. Objective of the study

IDRC intends to support locally-led applied research aimed at promoting sustainable, healthy, and equitable food systems that include women, indigenous peoples, and other marginalized communities in climate hotspots in low- and middle-income countries.

Under the scope of its Climate Resilient Food System Research Agenda, IDRC has asked IDinsight to conduct a scoping study titled **“Making Digital Tools Work for Farmers.”** The collaboration between IDinsight and IDRC is a 5.5-month study from January to June 2024 which intends to **explore digital tools' potential to enhance smallholders' livelihoods and boost gender equality and inclusivity in North and Sub-Saharan Africa.**

The primary objective of this scoping study is to prepare strong foundations for an in-depth body of research investigating how digital tools can improve smallholder farmers' lives, reduce gender gaps and inequalities in agriculture, and sustainably enhance food security. We are doing so by:

- Pinpointing key research questions for IDRC to invest in and for which answers could contribute to informing better and more gender-sensitive decisions and programs in AgTech;
- Identifying best-in-class research partners who are equipped with the local and/or sectoral expertise and network and could partner with IDRC to implement its climate-smart and inclusive food systems transformation research agenda;
- Listing stakeholders and donors who could be potential financial partners for IDRC and support this research agenda.

This report intends to present the findings of the scoping study, especially with regard to the research gaps regarding the use of Digital for Agriculture (D4AG) tools by smallholder farmers in North and Sub-Saharan Africa and its impact promise. The list of potential research partners and stakeholders is provided in a separate document directly to the IDRC for discretionary use.

### ***Definition of Digital for Agriculture (D4AG) and Digital tools***

D4AG, encompasses the application of digital technologies to transform agricultural value chains. This broad term covers a spectrum of digital innovations that address various bottlenecks in agriculture, from production, post-harvest handling, and market access, to

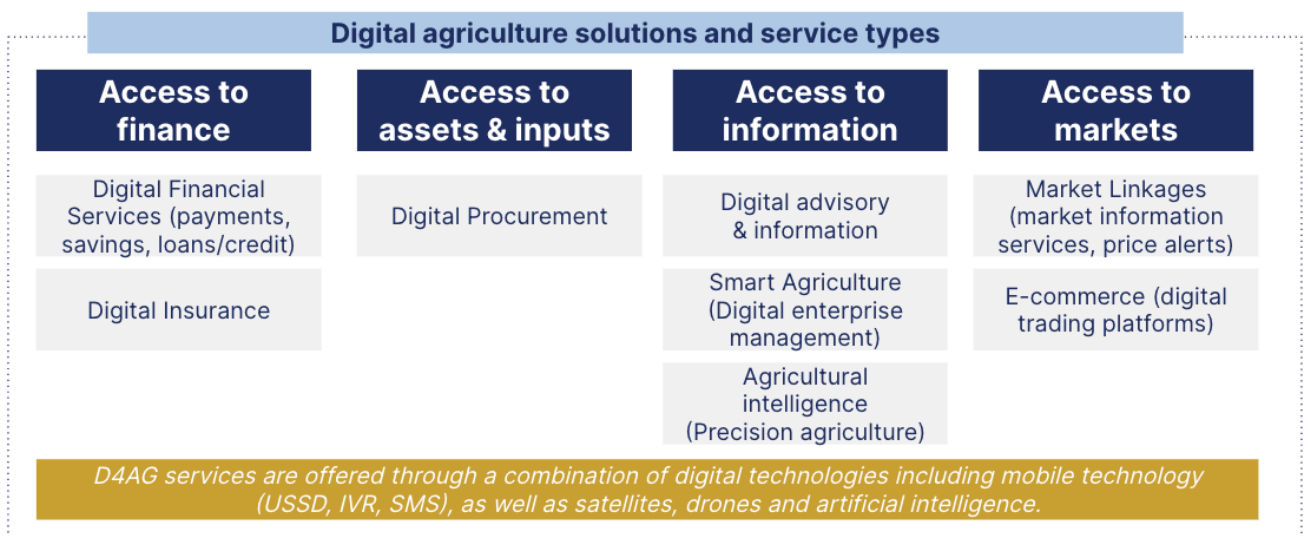
finance and supply chain management.<sup>5</sup> Their aim is to boost the income of smallholder farmers, enhance food and nutritional security, build climate resilience, and facilitate greater inclusion of marginalized groups such as women and youth in agricultural processes.

Within D4AG, "digital tools" refers specifically to the technologies and applications employed to achieve these objectives. These include, but are not limited to:

- Mobile applications providing agricultural advisories, market prices, weather forecasts, and direct market linkages;
- SMS and voice services offering tailored advice on farming best practices and alert systems for pest outbreaks;
- Platforms for digital financial transactions that ease access to credit, savings, and insurance for farmers;
- Sensor technologies that gather field data to inform precision farming techniques;
- Drones and satellite imagery for monitoring crop health and soil moisture levels to facilitate more effective water and crop management.

The Figure 1 below, provides an understanding of the range of digital agriculture solutions based on which value chain barriers are being addressed.

**Figure 1:** Digital agriculture solutions and service types



Digital tools in the context of D4AG are thus designed to be practical, accessible, and scalable solutions<sup>6</sup> that help farmers improve their agricultural practices, enhance productivity, and achieve sustainable livelihoods.

<sup>5</sup> CTA & Dalberg Advisors. (2019).

<sup>6</sup> Beanstalk AgTech. (2023).

## 1.2. IDinsight scoping approach

The scoping study conducted was divided into two distinct phases:

- A **“high-level” scoping phase** to establish a fundamental understanding of the D4AG landscape and dynamics on the African continent through:
  - **Key Informant Interviews (KIIs)** to map the digital agriculture services ecosystem in Sub-Saharan and North Africa. This involved discussions with 25+ stakeholders including digital tool providers, funders, researchers, innovation hubs, advisors
  - **Literature Review** to cross-review findings and initial gaps from KIIs drawing on academic research and reports from field practitioners.

The insights gathered from the high-level scoping phase enabled the identification of knowledge areas for further exploration, informed by the gaps in the KII and literature review. This phase also guided the selection of three countries —Kenya, Senegal, and Morocco— for an in-depth scoping analysis.

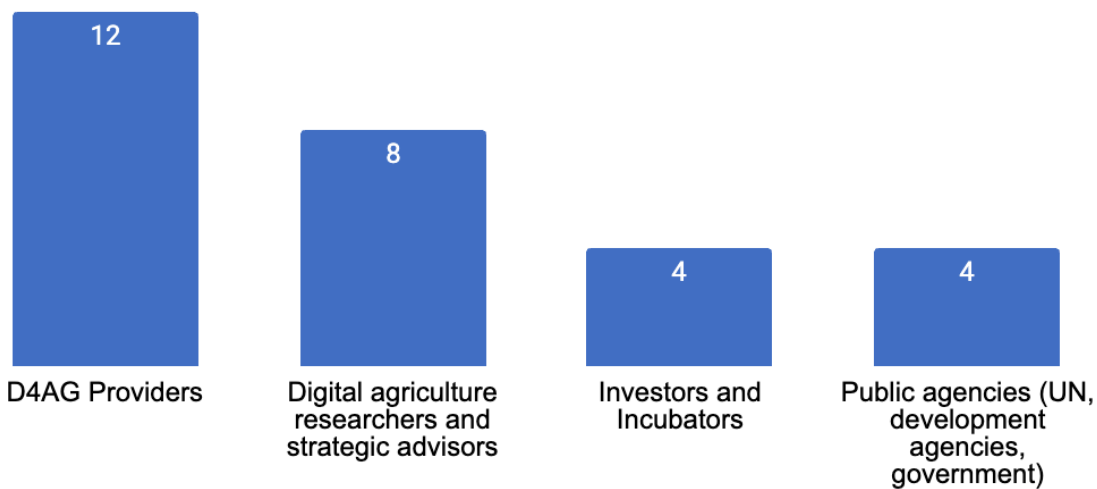
- A **“deep-dive” scoping phase** meant to confirm the accuracy of our preliminary findings, and to build on them through in-country visits across North Africa and both Anglophone and Francophone Sub-Saharan Africa. Within each distinct context, we engaged with a variety of local stakeholders, such as governing bodies, researchers, and producer organizations in three topical countries: Kenya, Senegal, and Morocco. Additionally, this phase aimed to list local research institutions, contributing to an analysis of the regional landscape.

### 1.2.1. High-level scoping methodology

The high-level scoping phase aimed to engage with actors to establish an understanding of the digital agriculture landscape and was complemented by a literature review synthesizing existing knowledge at agriculture-digital-gender nexus. While key informant interviews provided an overview of the digital agricultural services ecosystem in Sub-Saharan and North Africa through discussions with digital tools providers, as well as funders, researchers, innovation hubs, and advisors, the literature review served as a validation step of the initial findings through selected academic papers and practitioners reports.

KIIs included interviews with stakeholders within the D4AG ecosystem, ranging from D4AG providers, researchers & advisors, investors & incubators, as well as public institutions. Respondents operated in various countries within North and Sub-Saharan Africa, with the majority also based and/or from the region. All KIIs were focused on the learning objectives and were transcribed, summarized, and thematically coded. The Figure 2 below provides an overview of the interviews per type of stakeholder:

**Figure 2:** Number of Key Informant Interviews during high-level scoping per actor type (n=28)



The literature review aimed to validate the initial insights from the KII with a focused literature review, reflecting existing academic research on D4AG within the African context including:

- Sectoral reviews from leading organizations assimilating trends, challenges, and comprehensive quantitative data; and
- Solution-type academic papers discussing evidence on distinct D4AG solutions, including access to credit/insurance, market linkages, and general agronomy practices.

### **Gaps identification**

During the high-level scoping phase, the analysis uncovered specific research areas within the digital farming tools ecosystem, with a focus on the outlined learning objectives. These identified gaps are elaborated upon in section 2.2, and were used to structure the deep-dive scoping phase.

Research gaps encompass various types of deficits within the literature. Amongst a taxonomy of different research gaps, five are of interest for this study including (i) knowledge gaps where certain topics have yet to be fully explored (ii) evidence gaps indicating a lack of empirical data, (iii) methodological gaps that “deal with conflict with the research methods in the previous study”, (iv) empirical gap that aims to empirically verify initial findings, and (v) theoretical gap “that deals with the gaps in theory with the prior research.”<sup>7</sup>

### **Case study countries selection**

The second objective of the high-level scoping phase was to develop an understanding of regional variations in the D4AG ecosystem and identify three countries for detailed case studies in the subsequent deep-dive scoping.

This selection aimed to represent countries from Anglophone Africa, Francophone Africa, and North Africa to account for some of the most topical regional differences in the continent

<sup>7</sup> Miles. (2017).

as presented in a schematic way in Table 1.

**Table 1:** High-level key characteristics of the agricultural, D4AG ecosystem, and state of academic research on D4AG in Anglophone, Francophone, and North Africa<sup>8</sup>

	Anglophone Africa	Francophone Africa	North Africa (Francophone)
State of agriculture	Diverse. Predominantly featuring subsistence smallholder farms, with efforts to modernize. Challenges like productivity, and a developing export-oriented crop market.	Mostly traditionally based, beginning to embrace technological solutions, often with international support; Few countries (Côte d'Ivoire) focus on export cash-crops.	Larger farm size than in Sub-Saharan Africa and a focus on export-oriented commercial agriculture.
D4AG ecosystem	Mature ecosystems with market leaders: 69% of D4AG solutions in SSA located in the top four markets that are anglophone. Numerous startups are creating a competitive market and innovative ecosystem.	Developing ecosystem marked by a increase in D4AG tech solutions; Focus on low-tech solutions that solve farmers' specific challenges.	Technologically advanced region; D4AG is nascent but evolving with a focus on digital solutions such as ERP and irrigations aimed towards larger farm sizes; Limited SHF-focused solutions.
Academic evidence on D4G	Considerable research and data available, with a notable emphasis on the impact of mobile technology and financial inclusion in agriculture.	Emerging but limited body of evidence	Emerging but limited body of evidence

Following consultations with IDRC and based on a shortlist, the countries selected for in-depth analysis in the deep-dive scoping were chosen as follows:

- **Anglophone Africa:** Kenya, as a country with a mature digital agriculture ecosystem;
- **Francophone Africa:** Senegal, as an entrepreneurial hotspot within the Francophone countries on the continent;
- **North Africa:** Morocco, as an emerging country with a compelling enabling environment.

The selection of Kenya, Senegal, and Morocco reflects the diverse ecosystems within the continent, taking into account the variability across areas.

## 1.2.2. Deep-dive scoping methodology

<sup>8</sup> The tables provide a snapshot of regional differences drawing from insights gathered through KII and publicly accessible data. Within these regional overviews, there are distinct country-specific variations. The countries specifically considered are based on KII interviews during the high-level scoping including for Anglophone Africa - Ghana, Nigeria, Kenya; for Francophone Africa - Senegal, Côte d'Ivoire, Mali; and for North Africa - Morocco, Egypt.

The objective of the deep-dive scoping phase was to contextualize the research gap identified from the high-level phase within Kenya, Senegal, and Morocco. The research aimed to analyze the contextual relevance of these knowledge gaps to the specific settings of each country. Through an abductive reasoning, the approach is ought to discuss the validity of our initial findings with local organizations, prioritizing insights from researchers and governing bodies, as well as capturing the perspectives of the farmers through producers' associations and focus group discussions. This ensured a comprehensive view that incorporated both the top-down insights and the grassroots-level experiences.

### **Stakeholder Interviews**

Throughout this report, insights gathered from interviews are aggregated to maintain confidentiality. Except for specific case studies for which we have received formal consent, the identities of the respondents have been anonymized. The Table 2 below summarizes the anonymized interviews conducted as part of our country case studies, categorized by the types of actors in each country.

**Table 2:** Number of individual interviews conducted during the deep-dive per type of organizations and country

Type of organizations	Kenya	Senegal	Morocco
Governing bodies	2	1	5
D4AG providers or support institutions	6	3	3
Research organizations	6	5	3
Farmer associations	2	1	1
<b>Total number of in-country interviews</b>	<b>16</b>	<b>10</b>	<b>12</b>

### **Focus group discussions**

In each country, focus groups (FGDs) were also conducted with smallholder farmers in partnership with local organizations.<sup>9</sup> The aim was to gather firsthand perspectives on the use of digital tools, examining four specific areas: (i) digital tool usage, (ii) the impact of D4AG, its adoption and effectiveness, (iii) challenges including accessibility and training, and (iv) needs assessment. The local organizations were asked to mobilize a small group of farmers, with a strong preference for mixed groups in terms of gender and digital tools usage.<sup>10</sup> Each group was moderated by two IDinsight staff (a Senior Associate and an experienced field manager with command in local language).<sup>11</sup>

<sup>9</sup> These organizations typically include farmer associations, producers organizations or research institutions with a strong link to farmers and, which actively support digital initiatives amongst their members. Based on the relevance and insights gathered during the initial interview phase with their team members, IDinsight suggested proceeding to FGDs, thus ensuring the pertinence of the discussions.

<sup>10</sup> It is important to note that, while these discussions served to illustrate our preliminary findings, they involved small sample sizes which limits the ability to generalize results. This limitation has been carefully considered in the subsequent analysis and reporting.

<sup>11</sup> In Senegal, the field manager was recruited out of IDinsight's network of enumerators locally to meet the

In each country, the FGDs consisted of at least two cohorts of farmers including:

- **Female and male farmers** with the aim of highlighting gender differences in the usage of the digital tools; and
- **Users and non-users of digital tools** to understand the barriers and opportunities of using digital tools.

Those cohorts were split into smaller groups, mostly by gender to ensure the inclusion of diverse voices. The Table 3 below summarizes the farmer profile per country.

**Table 3:** Profile breakdown of focus groups discussions participants per country

Country	Supporting organization	Farmer Profile
Kenya	Kenya National Farmers' Federation (KENAFF) <i>Producers organization</i>	<i>10 farmers, including 5 female farmers.</i> Young, tech-savvy farmers under 30 years old from the Kiambu area, near Nairobi. Most were full-time farmers, though a few were new to farming or engaged in it part-time. Participants typically spoke English fluently and had some formal education. A minority were using digital tools on a regular basis.
Morocco	ENA-Meknès <i>Research institution</i>	<i>13 farmers, including 7 female farmers.</i> Participants came from the Meknès region. Age range between 25 and 50 years old. Predominantly agricultural entrepreneurs and cooperative leaders, engaged in agricultural activities ranging from horticulture to cereal cultivation, often on family-owned land. Participants mostly spoke Darija. A minority were using digital tools on a regular basis
Senegal	COLIER <i>Producers organization</i>	<i>10 farmers, including 5 female farmers.</i> Participants came from the Niayes region. Age range from twenties to sixties. All participants belong to the COLIER G.I.E (cooperative). They farmed various sizes of land holdings, with an average size of 2ha, predominantly growing vegetables like okra, pepper. While some had additional professions, such as teaching, members utilizing digital tools to varying extents and involved in commercial cultivation with a portion of the produce destined for animal consumption. A minority were using digital tools on a regular basis, including crop cultivation guidance and plant health monitoring, alongside weather alerts.
	National Agency for Agricultural and Rural Council (ANCAR) <i>Governing body</i>	<i>12 farmers, including 2 female farmers.</i> Participants came Bandé and Mbissao (Thiès region). Focused on onion cultivation on family-owned and rented lands ranging from 0.5ha to 4ha, mostly producing for sale and personal consumption. A majority were using digital tools on a regular basis, including ANCAR (Agence Nationale de Conseil Agricole et Rural)'s flagship digital e-commerce platform senlouma.

### Conferences and panel discussions

language and skills needed to run the focus groups.



To complement these insights, the team participated in conferences by D4AG stakeholders, aiming to deepen understanding of local challenges and opportunities.

Notable events include :

- **Senegal:** *"From Product to Market: Lessons Learned in the Digital Transformation of Agriculture"* organized by Development Gateway in partnership with International Fund for Agricultural Development (IFAD) (Dakar, January 2024), focusing on digital agriculture transformation in Francophone Africa; and
- **Kenya:** *"AgriTech4Kenya Consultation Workshop"* (Kenya, April 2024) organized by the Consultative Group on International Agricultural Research (CGIAR)'s Accelerate for Impact Platform fostering dialogue among a diverse set of stakeholders to fortify the agrifood and climate-tech sectors in Kenya.

These two events included panel discussions, as well as interactive workshops, with some observations and insights integrated as secondary data in the deep-dive scoping analysis.

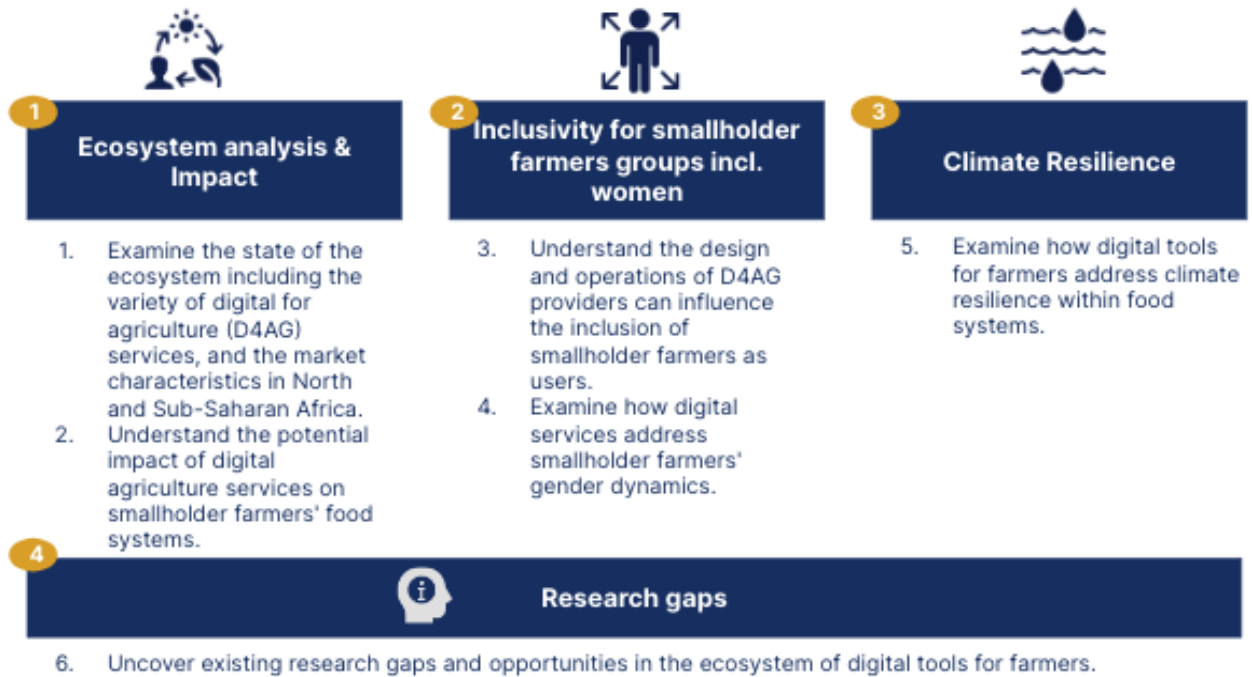
## 2. The state of digital tools in Sub-Saharan and North Africa

### 2.1. High level scoping results

High-level scoping phase was completed in March 2024. The high-level scoping findings were centered around six learning objectives, and four main categories. Figure 3 presents an overview of those, each learning goal corresponding to a distinct segment of the findings.

**Figure 3:** Learning objectives and themes explored in the high-level scoping findings





The sub-sections that follow present the takeaways from those findings primarily drawn from our KII and literature review, establishing the context for the subsequent deep-dive case studies on three main dimensions —impact potential, inclusivity of smallholder farmers, and climate resilience— and one cross-cutting “knowledge gaps” angle.

### 2.1.1. Ecosystem analysis and impact potential

#### ***D4AG Ecosystem analysis***

D4AG services in Africa are diverse and expanding. Their reach and impact are influenced strongly by regional variations in infrastructure, regulatory environments, and investment. However, across the continent, challenges remain in scaling these services.

- **Scale of D4AG services:** Over the past decade, D4AG services have experienced significant growth on the continent, supported by rising levels of funding and technical assistance.
- **Regional adoption and variations:** Significant regional variations emerged as a common theme across the interviews. East and Southern Africa, particularly Kenya, are frequently mentioned as “mature” digital ecosystems<sup>12</sup> with diverse offerings, while North Africa is recognized for precision agriculture and large commercial farming operations. Francophone Africa has a growing market share despite lagging behind compared to Anglophone countries.

<sup>12</sup> D4AG ecosystem maturity is based on the degree to which digital tools, technologies, and infrastructure are effectively integrated and utilized within a country's agricultural sector, with Kenya and Nigeria exemplifying high maturity through widespread tech adoption and supportive policies.

- **Market diversity and service variety:** The D4AG ecosystem comprises a wide range of products, services, and tools including, Ag-tech, fin-tech, and advisory services, as well as marketplace solutions and precision agriculture tools.
- **D4AG enabling environment:** In the D4AG business landscape, the maturity of technological infrastructure and regulatory environments varies significantly across regions, with countries like Kenya and Nigeria harboring robust startup ecosystems and favorable financial regulations that spur innovation. However, stark disparities in technological adoption between rural and urban areas, alongside divergent regulatory and cultural attitudes, shape the operational and expansion strategies of the D4AG enterprises.
- **Challenges impacting scale and adoption:** Commonly cited challenges include the scalability of digital services, and the necessity for services to be financially sustainable without ongoing donor funding.

### ***Review of literature of D4AG services impact outcomes based on service types.***

D4AG solutions have shown promise in fostering economic, social, and environmental benefits for SHF. Yet, the extent of impact still needs to be assessed through rigorous evaluation and by creating systems for monitoring evidence over the long-run.

Our literature review analyzed over 40 papers on D4AG's advisory, market linkages, and financial services. Broadly, on the outcomes these solutions aim to provide, we find that:<sup>13</sup>

- **Access to information:**
  - D4AG services have the potential to deliver agricultural advice and promote recommended practices. Fabregas et. al (2019) conducted a meta-analysis of rigorous impact evaluations and found that ICT-enabled extensions increased yields by 4% and adoption of recommended inputs by 22%.
  - These services are most effective when content is locally-relevant and interactive, tailored to individual needs of SHFs.<sup>14</sup> Models that combine ICT-enabled delivery of agronomic advice with an in-person extension component may be especially effective.
  - Even though digital solutions hold promise, take up is still low. Examining farmers in Ghana, Abdulai et al. (2023) find use of digital tools remains limited due to low digital competencies and access to digital resources. Similarly, Jellason et al. (2021) conclude that the adoption of digital tools is low due to gaps in knowledge, skills, finance, and infrastructure.
- **Access to markets:**
  - D4AG services aim to reduce information asymmetries and lower transaction costs faced by SHFs in both input and output markets.<sup>15</sup> However, varied

<sup>13</sup> The section only cites a selection of all papers amongst all reviews based on the relevance of the takeaways in terms of specific impact outcomes. The sources used for the review of literature are listed in the appendix.

<sup>14</sup> Van Campenhout et al. (2017)., Abate et al. (2023).

<sup>15</sup> Daum et al. (2021).

success of market interventions suggest a complex relationship between market participation and price negotiation power for SHFs.

- Digital marketing platforms show promise in reducing transaction costs but tend to benefit larger farmers and traders, with SHFs still facing participation barriers.<sup>16</sup>
- **Access to finance:**
  - The adoption of mobile financial services has increased farmers' access to banking services, credit, and insurance.<sup>17</sup> The effectiveness of digital financial services hinges on both prior trust and digital literacy, as well as access levels to mobile money by the users.<sup>18</sup>

## 2.1.2. Inclusivity for smallholder farmers groups, including women

**Smallholder farmers can face barriers in utilizing D4AG tools, with efforts from D4AG underway to enhance inclusivity and address persistent gender disparities.**

- **Barriers to smallholder farmers:** SHFs face various barriers when accessing D4AG tools, primarily due to technology access, affordability, and literacy as well as rooted cultural norms.
- **Towards inclusivity:** The KII discussions point out that in some areas D4AG innovators increasingly recognize the need to adopt an inclusive approach that encompasses user-centric design and leverages offline support.
- **Gender gaps:** Constraints facing women farmers remain a critical concern, with certain D4AG providers addressing these through targeted interventions. Yet, there is still significant progress to be made, including research examining the intersection of gender and social norms and the specific needs of women farmers that digital solutions could address.

## 2.1.3. Climate Resilience

**D4AG is focusing on climate resilience, offering innovative solutions for sustainable farming amidst gaps in climate data and research on the effectiveness of the tools.**

- **Growing emphasis on climate resilience:** D4AG is gaining traction in the climate-tech ecosystem, with solutions that range from localized weather information to weather-indexed insurance and soil testing. However, most are integrated as supplementary features rather than core business.
- **Nascent yet promising impact:** Early findings<sup>19</sup> point to D4AG's potential in mitigating

<sup>16</sup> Falcao Bergquist & McIntosh. (2021).

<sup>17</sup> Abdul-Rahaman & Abdulai. (2021).

<sup>18</sup> Chiwaula et al. (2020).

<sup>19</sup> These findings are predominantly derived from KIIs, with representatives from entities such as Catalyst Fund and Katapult Africa confirming the upward trend in digital climate-tech solutions within agriculture. EIT

the impact of climate variability and optimizing resource use, such as through digital advisories. However, this impact is still in the early stages of being understood and quantified.<sup>20</sup>

- We've identified a lack of high-quality localized climate data and validated research on the effectiveness of these digital tools in fostering climate-resilient farming practices, highlighting an area in urgent need of attention to ensure the scalability and effectiveness of D4AG interventions.

## 2.1.4. Research gaps

Within the high-level scoping themes, our transversal learning objective was to identify research gaps and opportunities to investigate further in the deep-dive phase. Those were identified through our literature review and KIs. During these interviews, each participant was prompted with the question: "Where do you see significant gaps within the D4AG landscape that, if bridged, could steer more effective investments and interventions?"

The interview responses revealed three types of gaps: (i) specific research areas that require deeper investigation, (ii) the need for actionable data to inform decision-making, and (iii) the development of practical toolkits or best practices for further testing and refinement of interventions. We systematically mapped these gaps against thematic areas, noting that the level of existing evidence varied across themes. Figure 4 is designed to synthesize the identified gaps, organized by their level of evidence strength, with section 2.2 providing a detailed description of each of those gaps.

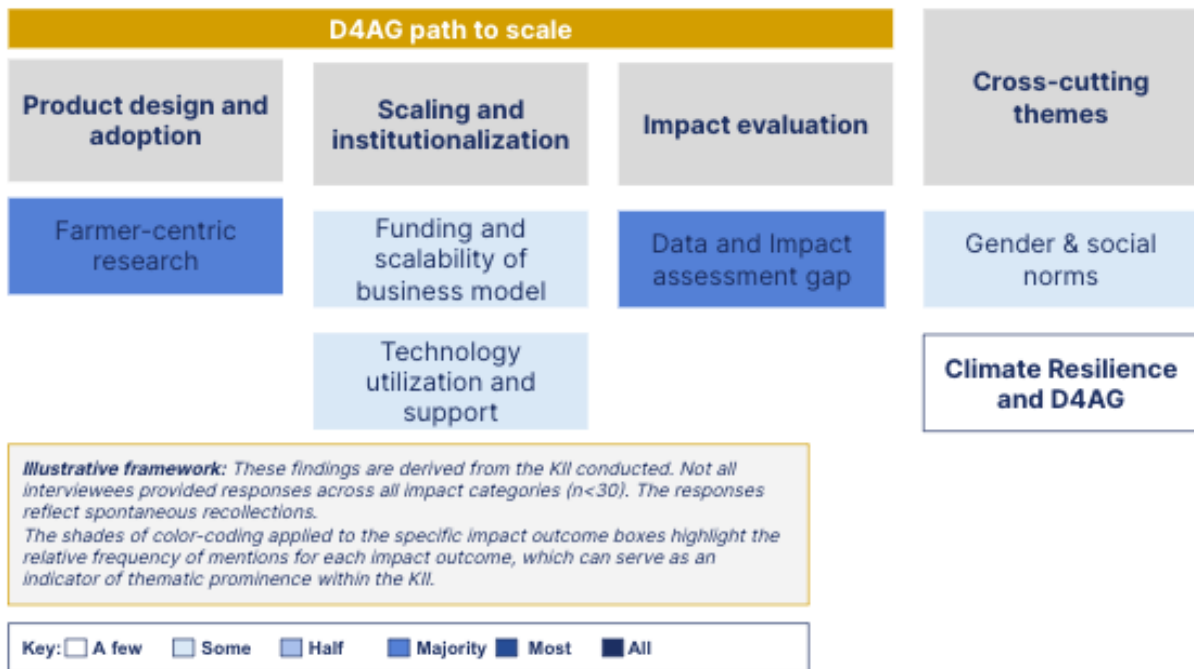
The insights evidence from KIs and the literature review points out that research on D4AG solutions is geographically biased, being skewed toward a few countries (e.g., Eastern Africa), with limited data on long-term outcomes of the tools.

### Figure 4: Synthesis of research gap themes

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Climate KIC (2022) reports indicate 500+ startups are active in climate-related technologies across Africa.

<sup>20</sup> CTA & Dalberg (2019) report notes less than 10 empirical evidence related to the impact of advisory & information on climate resilience—a gap similarly reflected in our own evidence review.



## 2.2. Overview of the research gaps of focus for the deep-dive scoping

This section presents an examination of the research gaps as identified during the high-level scoping. These gaps lay the groundwork for the structured deep-dive scoping across three case study countries, guiding the targeted analysis.

### 2.2.1. Data Gap and Impact Assessment

Through our initial inquiries, regional actors acknowledged a need for comprehensive, standardized data and robust impact assessments as fundamental challenges within digital agriculture.

- A. **Assessing the Data Need:** D4AG stakeholders require precise data to inform their operations, including the need for a standardized taxonomy, and open-source data.
- B. **Impact Measurement:** Long-term, independent studies are needed to capture the full scope of D4AG services' effectiveness. Our early findings suggested that the sector lacks robust methodologies to track and translate the impact of digital tools on smallholder farming outcomes.

- C. **Specific Impact Assessment of Bundled Digital Services:** While bundled digital services are believed to offer compound value, rigorous evidence distinctly validating the efficiency of these bundles over stand-alone services is limited. Furthermore, there remains uncertainty around which specific combinations within these bundles most effectively drive efficiency and impact.

## 2.2.2. Farmer-Centric Research

**Early findings highlighted that many digital agricultural tools are not deeply rooted in the nuanced realities of smallholder farmers.** There is a strong indication that digital tools could see greater adoption and impact if they were more aligned with farmers' daily challenges and designed with their active participation.

- A. **Smallholder Farmers' Focus:** There is a compelling call for more farmer-inclusive research to ensure that these tools are not only user-friendly but also tailored to the complex needs specific to smallholders.
- B. **Best practices on D4AG Tools Training for SHF:** Feedback indicates a lack of farmer education on the uses of digital tools, such as how to leverage D4AG services for financial and insurance services. Despite toolkits in recent years for the providers themselves, effective dissemination and support to structures grounded in the farmers' needs are missing.

## 2.2.3. Funding Mechanisms and Scalability of Business Models

**The currently limited scalability of digital agriculture solutions is tied to their business model and financial sustainability.** Early findings from our first phase pointed out that digital solutions face challenges in accessing funding, often due to their business model. The sector needs a better understanding of how to fund and scale innovative D4AG solutions.

- A. **Funding Mechanisms:** Key informants pointed out uncertainties about how digital solutions could access funding post-early stage.
- B. **Business Models for Farmer-Facing Technology:** With a pivot to business to business (B2B), sector experts pointed out that research is required to investigate how farmers interact with these models, especially in terms of their willingness and ability to pay.

## 2.2.4. Technology Utilization

Frontier technologies like AI and blockchain are emerging and **come with challenges regarding their application and the role of data governance in agriculture. Technological**

improvements in these solutions present the potential for breakthroughs in areas like supply-chain traceability, land titling, and warehouse receipts. However, there is a lack of practical application knowledge and data governance research.

- A. **Frontier Technologies:** There is a gap in understanding how these technologies can be adapted to practical, on-the-ground farming practices.
- B. **Data Governance:** As digital services grow, ensuring responsible management of personal and sensitive data, particularly in financial services, is emerging as a concern.

## 2.2.5. Cross-cutting Themes: Gender Dynamics & Climate Resilience

IDRC has a specific interest in investing in research that has gender and/or climate lenses in the context of food systems and digital tools. While these issues are not new, their intersections with digital tools in agriculture present unique challenges.

- A. **Gender and Social Norms:** In the first phases, key informants spotlighted the gender disparities in D4AG usage, influenced by social norms. There is a need to assess and understand the disparity in digital agriculture tool usage between men and women, influenced by social and cultural norms.
- B. **Climate Resilience and D4AG Tools:** There is also a gap in comprehensive studies on how digital tools can support farmers' climate resilience, especially through digital advisory. Informants have called for focused research on how these tools help or hinder the adoption of climate-smart practices.

## 3. Case study countries and evidence gaps

The following sections present case studies from Kenya, Senegal, and Morocco, organized to address specific evidence gaps and to narrate a unique story for each country. The data is derived from in-depth interviews and focus group discussions, enriched with detailed summaries and highlighted examples in dedicated boxes. We examine D4AG solutions comprehensively, covering advisory services, market linkages, and financial access, with particular emphasis where one of these areas is the primary focus.

### 3.1. Kenya

#### 3.1.1. Sector Overview

**Table 4:** Kenya country facts

	Indicators	Value
Country facts	Total population (M) <sup>21</sup>	54
	Rural population (%) <sup>22</sup>	71
	GDP (current M of USD) <sup>23</sup>	113.4
Digital infrastructure	Number of D4AG headquartered solutions <sup>24</sup>	121
	Mobile (device) ownership (% of population) <sup>25</sup>	57.51
Gender gap	Gender gap in mobile ownership (%) <sup>26</sup>	6
Governance	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan) <sup>27</sup>	4.9
	Role of government	Supportive with government-initiated digital tools.

<sup>21</sup> World Bank. (2022).

<sup>22</sup> *ibid.*

<sup>23</sup> *ibid.*

<sup>24</sup> Briter Bridges. (2023).

<sup>25</sup> ITU. (2022).

<sup>26</sup> GSMA. (2019).

<sup>27</sup> World Economic Forum. (2014).



## A. Agricultural Ecosystem in Kenya

Agriculture accounts for 33% of Kenya's GDP, with over 70% of the rural Kenyan population engaged in agriculture for living.<sup>28</sup> While yields are about 12% higher than the Sub-Saharan African average, agricultural productivity has stagnated in recent years.<sup>29</sup> This was highlighted through discussions with key informants during the deep-dive:

- **Reduction in land size:** Average farm size is falling and land distribution is becoming more concentrated, leading to significant constraints on production, particularly for smallholders, with only 20% of land suitable for farming.<sup>30</sup>
- **Climate change:** Climate change appears to be a major threat to Kenyan farming systems, with seasonal changes in precipitation and temperature disrupting production, and an increase in frequency of extreme weather events such as droughts and floods. In response, Kenya has implemented a number of policies aimed at fortifying agriculture against climate-related risks. Notably, the Kenya Climate Smart Agriculture Strategy (KCSAS), a national strategic framework has been designed to promote climate-resilient agricultural practices.<sup>31</sup>
- **Limited extension services support:** Information delivery struggles to reach all farmers. The proportion of farmers accessing extension services is limited, with government services supporting larger farmers. One research institute in the deep-dive mentioned "one extension officer for every 50 farmers."
- **Limited access to finance:** Over the past decade, the financial inclusion rate has seen considerable improvements, including among rural populations. However, it is noteworthy that a significant portion —42%— of those counted formally as financially included have access solely through a mobile money account.<sup>32</sup> This limitation has been identified as a substantive obstacle in mobilizing capital, as revealed in key informant interviews.

This consistency across "high-level scoping", supported by recent sector review by Udry and al.,<sup>33</sup> suggests a critical need for in-depth, localized research on solutions tailored to specific contexts.

Indeed, while climate change undoubtedly impacts all farmers, the most effective adaptation strategies will vary greatly depending on regional weather patterns, soil types, and existing agricultural practices. Similarly, "access to finance" is a universal need, but the most suitable financing models for smallholder farmers, especially in Kenya, will depend on factors like land ownership rights, cultural norms, and existing financial infrastructure.

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<sup>28</sup> USAID. (2023).

<sup>29</sup> K4AD. (2018).

<sup>30</sup> *ibid*

<sup>31</sup> Ministry of Agriculture, Livestock and Fisheries, Kenya. (2017).

<sup>32</sup> FSD Kenya. (2023).

<sup>33</sup> Yale's Economic Growth Center Podcast Voices in Development. (2024). *Building In-Country Partnerships in Development Economics: Chris Udry, Francis Annan, and Rohini Pande share insights from Ghana and Beyond.*

## B. Digital Ecosystem in Kenya

### ***Digital for agriculture solutions in Kenya***

Kenya stands out in Sub-Saharan Africa for its vibrant ecosystem of digital agricultural innovations. Various reports highlighted that the country is home to approximately 100+ digital solutions for the agricultural sector and even 200+ according to latest data available in the [Digital Agri Hub](#) platform,<sup>34</sup> including both private and public initiatives:

- On the private sector front, digital tools are operating across the entire value chain. Notable examples include: Pula, an digital agri-insurance company; Hello Tractor, a often referred to as the "Uber of tractors," which facilitates the hiring of farm machinery; or Apollo Agriculture, which leverages machine learning to provide financing, farm inputs, advice, and insurance to smallholder farmers.
- Parallel to these, public solutions are present through the Kenya Agricultural and Livestock Research Organization (KALRO) tasked with coordinating agricultural research in the country. As part of its strategic vision from 2017 to 2021, one of KALRO's objectives has been the development of technologies along agricultural product value chains. KALRO has introduced 14 agribusiness apps aimed at addressing farmers challenges<sup>35</sup> including access to crop advisory (KALRO Selector), access to markets (KARO Market Information System) and access to weather-information (KALRO Kenya Agricultural Observatory Platform app).

Despite these advancements, both the literature and key informant interviews (KII) have highlighted several challenges:

- A recent FAO study indicated that there is a noticeable gap in awareness of these digital services among smallholder farmers—a finding that was substantiated with a limited sample, during the focus groups discussions.<sup>36</sup>
- Additionally, there seems to be a disconnect between digital tools providers and the farmers they aim to serve, with the former often lacking a deep understanding of the farmers' specific needs and conditions.<sup>37</sup>
- The existing digital tool landscape suffers from uneven distribution. Donor-funded interventions and innovations, government initiatives (like KALRO), and farmer association-led promotion of digital tools often lack the geographic reach needed for widespread impact.<sup>38</sup>

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<sup>34</sup> Sources differ on the exact number of digital solutions in agriculture within Kenya, with counts from sources such as Briter (2013) and CTA & Dalberg (2019) reflecting this variance. Despite these discrepancies, there is a consensus that the number exceeds 100.

<sup>35</sup> KALRO. (n.d).

<sup>36</sup> FAO. (2022).

<sup>37</sup> Observed by Akuku, Haaksma, and Derksen. (2019).

<sup>38</sup> Leveraging mPesa's established infrastructure presents a promising opportunity. Integrating digital agricultural tools with mPesa's vast network could ensure wider accessibility and bridge the gap between existing tools and the farmers who need them most.

### **Existing digital and data policies and regulations**

The growth of the D4AG ecosystem in Kenya can largely be attributed to the country's conducive infrastructure and supportive policies. Kenya has positioned itself as a leader in digital innovation in Africa and its government has acknowledged the significant role digital technologies can play in agriculture. In 2019, it unveiled the Agricultural Sector Transformation and Growth Strategy (ASTGS) for the decade 2019–2029. The ASTGS expressly recognizes the pivotal role of innovation in advancing agriculture, and aims to embrace data and digital technologies.

Makini et al. (2020)<sup>39</sup> analyzed how Kenya national policies influenced the digital transformation of agriculture and found that despite significant investments from the Kenyan Government and the private sector in ICT infrastructure, there remains a gap in policy, as well as legal and institutional frameworks, tailored to the unique needs of the agricultural sector. While existing research recognizes the potential of digital tools in agriculture, a gap explored in this scoping report consisted of the lack of understanding regarding the interplay between digital tools and the data policies and regulations governing them. This gap hinders the effective implementation and utilization of these technologies.

A prime example is the Kenya Agriculture Data Sharing Platform (KADP). This initiative promotes collaboration and innovation by facilitating data exchange. However, the effectiveness of KADP hinges on clear, well-defined policies that address concerns raised by the Kenya 2019 Data Protection Act.<sup>40</sup> In this instance, the ambiguous regulations regarding data ownership, use limitations, and farmer consent seems to stifle innovation and discourage stakeholders from participating in digital agriculture initiatives.

### **Existing digital and data infrastructure**

Kenya's infrastructure, particularly in the telecommunications sector, has significantly facilitated access to digital services:

- The country's robust mobile network and mobile money operators, especially Safaricom with its M-Pesa service, have been central to this development. M-Pesa's success has accustomed Kenyan users to digital platforms, particularly for financial transactions, even if challenges to access financial services beyond mobile money have been noted during interviews.
- The uptake of D4AG has benefited from connectivity and high mobile penetration. Mobile ownership in the country stands at 57%.<sup>41</sup>

Despite this context, a critical research gap was brought by key informants related to understanding and addressing the disparities in farmers' access to digital tools:

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<sup>39</sup> Makini et al. (2020).

<sup>40</sup> The Kenya Data Protection Act enforces the proper handling and privacy of personal data, requiring consent for data collection and use, and provides individuals with rights over their data. It also establishes a regulatory authority for oversight and enforcement of these regulations.

<sup>41</sup> ITU. (2022).

- In fact, there remains a digital disparity between urban and rural areas, with the latter facing infrastructural hurdles like inconsistent electricity and internet access compared to the rest of the country; and
- Language barriers also present issues, as delivering agricultural content in local languages remains essential. While Kiswahili is prevalent in Kenya, there are numerous other languages to consider for effective communication with rural communities.

### 3.1.2. Data Gap and Impact Measurement

#### A. Assessing the Data Need & Data Governance

Despite extensive agricultural data collection efforts underway in Kenya, challenges like relevance, accessibility, and utilization remain prevalent. A more collaborative and transparent approach, potentially facilitated by open-source platforms, seems necessary to address these limitations.

While high-quality, granular data can be resource-intensive to collect and may fall outside the public sector capabilities, there is a shared recognition of the value in making agricultural data openly accessible. Open-source platforms could democratize data access and empower the development of effective and farmers-centric digital advisory services.

Interrelated with the availability of data collected, the Data Protection Act of 2019 signifies Kenya's initial step towards safeguarding personal information, but its effectiveness remains limited, especially for SHFs, due to weak enforcement mechanisms. Farmers express growing concerns over data privacy, frequent data collection, and the lack of transparency and informed consent, which undermines trust in digital tools. Additionally, the monetization of farmers' data without fair compensation exacerbates these issues. At the ecosystem level, enhancing institutional capacity, regulatory frameworks, and data-sharing policies is crucial for fostering a collaborative environment necessary for innovation and growth.

According to our findings in Kenya, the development of the D4AG ecosystem has resulted in a surge in data collection by various actors, including government agencies, private companies, and non-profit organizations. That includes agronomic, climatic, farmer databases through numerous methodologies, ranging from satellite imaging to field surveys and on-the-ground data collection.

Data collection and availability **suffer from a lack of coordination between public and private sector initiatives.** This fragmentation, as our findings show, leads to duplication of efforts and potentially hinders the overall value of the data. For instance, under a project

funded by the World Bank, the Kenya Agricultural & Livestock Research Organization (KALRO)<sup>42</sup> developed a digital database of 1.1 million farmers. This registry was initially conceived to facilitate the development of digital innovations that could improve outreach to farmers. A major shortcoming identified in the interviews is the *"lack of a centralized data-sharing system, which leads to duplicated efforts across the sector"* (Local researcher) with private actors collecting similar data as KALRO. While KALRO's long-term intent is to facilitate an open-source data ecosystem, interviews suggest that this goal has yet to be fully achieved. Furthermore, the collected data appears **to lack integration of on-the-ground farmer inputs, resulting in a perceived lack of relevance**. This has led surveyed farmer organizations to question the value of the data. As they stipulated, the absence of farmers' perspectives during data collection hinders the data's *"practicality and accuracy in being translated into tools addressing farmers' needs."* (Farmer organization)

Besides, **limited public access to specific data** emerged as a concern in the interviews. This includes:

- Data specific to value chains and or climatic zones, necessary for providing tailored advisory (good practices, weather alert) appears to be not widely available; and
- Detailed farmers' profiles, including demographics and farming practices, collected by KALRO but not available to the wider public.

The absence of comprehensive and relevant data in multiple key areas poses significant challenges to developing effective digital advisory services and tools that cater to farmers' needs.

The Data Protection Act of 2019<sup>43</sup> highlights Kenya's initial steps towards safeguarding personal information. Yet, interviews reveal limited effectiveness on the ground, particularly at the SHF level. At the heart of the data governance issue lies a lack of enforcement mechanisms, which discourages farmers from sharing their data. This tension is stressed:

*At the farmers' level:*

- **Data privacy:** From a farmer's perspective, data privacy concerns and information overload due to frequent data collection are becoming major issues, according to researchers and organizations.
- **Monetization of farmers' data:** Based on the insights of several KIs including farmers associations and focus groups, there is a fatigue among SHFs over the use of their data —some mentioning unsolicited calls or farm visits of structures collecting their data. This mirrors an awareness that their data possesses intrinsic value for marketing purposes by third parties and that they might expect some compensation

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<sup>42</sup> KALRO's mission is to conduct research in agriculture and livestock production to boost productivity and ensure food security in Kenya. It operates under the Ministry of Agriculture and Livestock Development, is a public sector effort to bridge the data gap. KALRO serves as a hub for generating innovative and technology-driven solutions for farmers. To date, it has developed over six digital apps (around advisory, weather alert, marketplace) tailored for farmers in Kenya.

<sup>43</sup> Kenya's Data Protection Act of 2019 is a legal framework that governs the processing of personal data, ensuring privacy and protection for individuals.

for it.

- **Transparency in data-use and informed consent:** Related to privacy and monetization, clarity and openness about how data is used have been mentioned by many stakeholders as an important step for maintaining trust between farmers and D4AG providers. Yet, some digital providers and researchers expressed concern over the ability of SHFs to provide genuine informed consent given the complexity of data concepts.

*At the ecosystem level:*

- **Institutional capacity and regulatory framework:** To regulate and protect the sensitive digital agricultural data effectively, there is a need to strengthen the effectiveness of the Data Protection Act amongst all stakeholders in the ecosystem. As mentioned above, the emergence of frontier technologies and AI creates a challenging new context for data protection. Current frameworks focus mostly on Personally Identifiable Information, but AI presents new challenges.
- **Data silos hinder collaboration:** While data protection is crucial, data governance presents an additional challenge: data sharing. Numerous agricultural entities, like KALRO which actively collects data, are reluctant to openly share it. This fragmented approach creates data silos, hindering collaboration and innovation in the sector. This hesitancy largely stems from concerns about data ownership, security, and the *"belief that their particular data set is the most accurate or valuable"* (Local researcher), leading to a competitive rather than a collaborative environment, which in turn limits the sector's ability to innovate and grow. Various researchers from institutions worldwide have pointed out the need for better mechanisms that allow for sharing and collaboration on data without ignoring the issues of ownership and protection.

## **B. Impact Measurement**

In Kenya, several critical evidence areas related to impact assessment have emerged. While many impact reports are being generated, there is a need to advance methodologies that can track the long-term interplay of multiple interventions amidst various external factors affecting agricultural outcomes. The underlying task in these discussions is twofold: developing methodologies to disentangle the variables affecting agricultural output, and fostering strategic collaborations to enhance empirical long-term studies on the effectiveness of D4AG tools.

The sector lacks a standardized framework for impact assessment, especially among digital innovators who may lack the necessary expertise or motivation. Furthermore, there are no established mechanisms for evaluating the long-term effectiveness of digital tools beyond the duration of specific project interventions. Finally, there is a need to understand the dynamics of digital tool usability and develop frameworks that



measure their effective use and influence on farming practices.

In the context of Kenya, four major gaps emerge that call for an approach to understanding and assessing the effectiveness and long-term impact of D4AG tools:

- **Long-term impact of interventions:** There is a consistent call amongst KII surveyed during the deep-dive for long-term, robust methodologies capable of tracking the impact of interventions over extended periods. These methodologies should consider external factors and varying farm conditions.

One D4AG provider operating in Kenya shared examples of a specific challenge in the long-term evaluation of yield impact. Given that farmer output is significantly affected by uncontrollable external factors like weather, it is challenging to isolate and measure the effects of specific interventions. Variability in farming practices and land conditions further complicates this assessment.
- **Lifecycle of donor-funded digital projects:** Similarly, a notable trend has emerged where digital solutions are rarely evaluated beyond the initial phase of donor support. This trend contributes to the scarcity of data regarding their prolonged effectiveness and sustainability. A leading farmers organization in Kenya notes that digital solutions tied to project lifecycles rarely see continuity beyond donor funding, resulting in a lack of long-term impact data.<sup>44</sup>
- **Lack of robust methodology for impact evaluation:** According to several key informants (researchers, D4AG support organizations), most current studies lack experimental rigor and are not comprehensive. According to an international research organization, existing evaluations amongst ag-tech in Kenya fail to meet the rigorous standards required for conclusive results. Interviews indicate that a capacity issue among D4AG innovators is one of the root causes of this shortfall. Those are often pushed by donors to conduct evaluations, suggesting a need for capacity building or collaboration with entities that can provide such methodologies.
- **Assessing the usability of digital advisory tools:** While digital advisory is developed in Kenya, the sector is missing effective monitoring systems that can consistently measure actual usage and how such access translates to behavioral change and direct use, as well as improved practices. A research institute identifies a gap between access and utilization, lacking substantial metrics or frameworks to gauge the influence of digital information on farmer behavior. Although projects like Advanced Investment Climate for Climate-Relevant Agriculture (AICCRA) Kenya<sup>45</sup> have rightly focused on usability, a concrete methodology to quantify actual tool usage remains limited.

<sup>44</sup> This finding was mentioned in the context of projects implemented by donor-funded organizations, rather than private initiatives.

<sup>45</sup> AICCRA Kenya is a ILRI-led project that provides targeted digital advisory that support climate risk reduction. According to a deep-dive interview, ILRI is investigating the usability of information among SHF, although no publicly available data exists.

### C. Specific Impact Assessment of Bundled Digital Services

The number of D4AG solutions employing bundled approaches in Kenya is substantial. Preliminary evidence indicates that bundles combining output market access with advisory services may be more effective. However, definitive conclusions are still lacking. This applies to both physical and digital forms of bundled services. Importantly, the effectiveness of these bundles seems to depend not only on the appropriate combination of inputs but also on a thorough understanding of the incentives of all parties involved in the transaction.

Although there is no specific data on the market share of bundled services versus single services solutions in Kenya, the popularity of such bundled offerings is evident with examples like Apollo Agriculture's combined packages of inputs, financing, and insurance, or Grow Agric's platform that combines access to markets, finance, and good agricultural practices amongst others.<sup>46</sup> Bundled services come in both digital and non-digital forms. A systematic review<sup>47</sup> found that only 30 of 315 studies on digital agricultural services examined bundled services, indicating a need for more evidence on their effectiveness compared to individual services.

The following bundles were discussed in the context of Kenya:

- **Insurance as a value-added service:** One D4AG organization offering a bundle that includes inputs, financing, and insurance has highlighted significant challenges, particularly within the insurance aspect. Disparities in farm sizes and crop yields make it difficult for farmers to appreciate the value of insurance, as the payouts do not reflect their circumstances. The model which relies on zone averages often fails to address the specific needs of individual farmers. This leads to dissatisfaction and challenges in demonstrating the value of bundled insurance schemes.
- **Advisory services:** One farmer association notes that evidence is thin on the ground regarding which specific bundles yield the most benefit. Additionally, there is an observed reluctance among farmers to pay for advisory services, questioning the perceived value of bundles offering primarily advisory.
- Early analysis from a research institute suggests that bundled services that include **market access for outputs alongside advisory services are more effective.** These

<sup>46</sup> Additional examples of bundled services in Kenya include Green Edge, which provides tailored agricultural advice and inputs, iProcure's supply chain solutions, Digital Green's educational video resources, and the mobile platforms iCow and WeFarm, which offer information networks and community engagement for farmers.

<sup>47</sup> *Agriculture in the Digital Age*. This BMGF-USAID. (2021) funded document forms a review of literature of D4AG services scoping more than 7,000 studies.



bundles align the incentives of service providers, such as aggregators, with farmer outputs. It was observed that the service providers who were able to sustainably offer advisory services to farmers were those with a vested interest in the quality of the output. For example, an aggregator collecting potatoes for processing has a direct incentive to ensure farmers produce high-quality potatoes, in line with the processor's requirements. As a result, the aggregator is motivated to provide consistent training and advisory services to farmers to achieve this quality. The incentive alignment ensures that farmers receive the right inputs and advice, ultimately benefiting both the farmers and the aggregators, who make their margins from aggregating the produce.

- Contrarily, preliminary studies from that research institute<sup>48</sup> indicate that **bundles mixing input sales with advisory services are less effective**. The incentive for input sellers is often skewed towards maximizing sales rather than focusing on the actual outcomes for the farms. For instance, input sellers are motivated to sell as much fertilizer as possible without necessarily ensuring that its use is optimized for productivity and sustainability. This misalignment of incentives does not lead to the same level of effective and sustainable support for the farmers.
- **Sustainability of bundled packages:** Another aspect examined by the research institute, is the sustainability of providing these bundles. Short-term interventions by NGOs may offer bundled services such as inputs and credit, but if these services are not financially viable for the providers, they are unlikely to be sustained beyond initial project durations. Evaluating bundles should therefore not only focus on farmer outcomes but also on the long-term viability of service providers.

### 3.1.3. Farmer-Centric Research

Despite Kenya being one of the most developed D4AG ecosystems within Sub-Saharan Africa, the deep-dive scoping confirmed the local validity of a disconnect between farmers' needs and the digital tools available in-country. This gap is primarily attributed to the lack of localized, relevant or timely information, inadequate user guidance, and limited institutional support. Many digital tools fail to consider the specific contexts and challenges faced by farmers, such as the need for hyper-local weather forecasts and practical, actionable advice. Additionally, with a cluttered landscape of multiple platforms, farmers experience confusion and diminished trust in these digital solutions. Strengthening the connection between D4AG tools and local institutions, incorporating farmer feedback in tool development, and ensuring the solutions are intuitive were best practices or areas of future improvements raised by stakeholders during the scoping.

Despite Kenya's position as a leader in digital agriculture within Sub-Saharan Africa,

<sup>48</sup> Those studies have not been published to date.

interviews and focus groups revealed a concerning disconnect between farmers' needs and the available tools. This finding highlights the gap in farmer-centric research. The collected data supports this conclusion, indicating a need for more tailored and relevant solutions for farmers. Factors contributing to this mismatch include:

- **Insufficient research into farmer needs:** There is a consensus among stakeholders, from local associations to researchers, that human-centered design is often sidelined in D4AG development. Farmer associations voiced during the interviews that *“the adoption of digital tools is low because solutions aren’t designed with enough farmer input”*, stating a mismatch between digital tools and on-the-ground needs, resulting from inadequate farmer input during the design phases.

One research institute points out that D4AG solutions often prioritize designing products that ensure market fit and adoption, but not necessarily where the need is greatest. Specifically, in challenging environments like dryland areas, the context for D4AG operations is particularly difficult due to factors such as nomadic populations, sporadic conflicts, prolonged droughts, and high costs due to remoteness. Consequently, D4AG innovators frequently avoid these high-need areas, opting instead for 'low hanging fruit' markets where the risk of failure is lower and success easier to achieve. This focus leaves behind consumers in more challenging environments who could benefit significantly from these solutions, resulting in a tendency for everyone to target the same value propositions. For instance, some informants mention KALRO's apps<sup>49</sup> as an example of disconnect. Despite being a flagship initiative supported by the government and designed to address specific barriers with customized solutions, the users perceive that it has not effectively tackled these challenges.

- **Limited information relevance and lack of farmer-centricity:** Insights from the deep-dive reveal that many tools do not meet farmers' needs. For instance, the KALRO Crop Selector app requires significant agronomic knowledge, making it less accessible to farmers. Additionally, many advisory tools provide generic advice without considering local soil conditions, crop varieties, or weather patterns, thus offering limited value. Weather advisories also lose their effectiveness if they are not hyper-local or timely, as highlighted by feedback from focus group discussions: *“If you tell me it is going to rain today, it is not going to help. If there were projections that were accurate, it could help me plan better.”* This underscores the need for timely/predictive and localized weather information to make the alerts more actionable and beneficial for farmers.
- **Farmers confusion and mistrust :** The D4AG landscape is cluttered with multiple platforms (government-run, marketer drive, or donor-funded) leading to confusion and undermining trust in relying on a particular platform. Farmers associations mentioned the promotion of agricultural practices with occasionally untested

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<sup>49</sup> KALRO has developed several in-house apps to address specific challenges faced by the agricultural sector. These include a weather advisory app in partnership with KAOP, a crop selection app for 65 value chains through KALRO Selector, and a market price information app, the KALRO Market Information System, to solve market challenges.

information, which challenges the decision-making process for SHFs.

- **Ineffectiveness of price advisory services in D4AG tools:** Assessment of price advisory confirmed our initial high-level findings. The market control exerted by a handful of entities dilutes the relevance of these apps, as the insights they provide often do not translate into actionable information for the farmers. Concretely, the apps may show a price for local markets, but this does not necessarily mean that farmers can find a buyer willing to pay that price. This discrepancy further undermines the practical utility of the price advisory services.

#### **Which digital tools are relevant for farmers? Insights from the focus group discussions**

The FGDs revealed that while there are numerous digital agricultural services available to farmers in Kenya, their actual use is minimal. Farmers frequently turn to more traditional media including social media (WhatsApp, Youtube) for their information needs. Government-provided services were commonly received but seldom used, with farmers highlighting the need for more timely and localized information.

Farmers consistently reported that digital tools must be more intuitive and tailored to their needs to be truly useful. One specific story from the FGD highlighted these points. Farmer #10<sup>50</sup> who grows vegetables shared his experiences with various digital tools:

- John, a farmer with 1.5 hectares of land, focuses on vegetables. John has found that platforms including KENAFF's<sup>51</sup> online field library, WhatsApp, and YouTube are very useful.
- He appreciates KENAFF for its updates on weather and market prices. WhatsApp serves as a quick and effective means of sharing knowledge. For practical advice on growing his vegetables, John prefers short video clips, on tailored Youtube channels.
- John tried using the KALRO apps, but found it somewhat disconnected from his needs. Upon registering, he noticed the app asked detailed questions about his farming practices, including value chains, soil testing, and GPS coordinates. While the tailored information had the potential to be highly useful, John found the general information to be irrelevant, likening it to spam.
- John also noted that many apps lack proper guidance for farmers on how to interact with the digital tools, he suggests additional farmer input during the development phase.

- **Low engagement of local institutional support:** According to KIIs, the network of extension workers providing support to SHF is under-resourced. One researcher emphasized that *"the effectiveness of digital innovation is interdependent with the strength of institutional support"*. During the interviews, several KIIs advocated for a

<sup>50</sup> To ensure the anonymity of the participants, we anonymized the data.

<sup>51</sup> KENAFF is developing an online library called [Farmers' Organization Video Library](#) with videos on agricultural practices transformed into text summaries and audio files, allowing farmers to access information quickly and affordably.

stronger connection between D4AG tools and local institutions to enhance training and adoption. Influential entities for technology uptake include self-help groups and cooperatives. To that, farmer associations confirmed that farmers respond better to extension workers or local institutions using digital tools, compared to tools being in their hands.

### 3.1.4. Funding Mechanisms and Scalability of Business Models

While Kenya presents a promising D4AG landscape with successful ventures and investment opportunities, the overall narrative is nuanced. There exists a gap in long-term funding (scale-up funding) mechanisms essential for sustained growth and scalability. Comprehensive, evidence-based research is imperative to fully grasp the extent, trends, and constraints of financial support available to D4AG startups, facilitating more tailored interventions and support structures for this burgeoning sector.

As of 2024, Kenya stands out as the region's top destination for agri-tech funding, attracting over \$800 million in the past decade. This represents 60% of all publicly known agritech funding in Africa.<sup>52</sup> Key players like the World Bank, the Gates Foundation, USAID, and the European Union drive the funding landscape, while other contributors like Mercy Corps Agrifin, Foreign, Commonwealth & Development Office (FCDO), and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) play smaller but still essential roles.

#### A. Funding Mechanisms

Despite perceptions of the ease of availability of funding within the local ecosystem, data gathered in the deep-dive points out that the narrative of Kenyan success in funding has been driven by the experience of a select few startups—such as Pula, Apollo Agriculture, and Sunculture—rather than a widespread phenomenon.

A local consultant mentioned that *"there are 300 startups, but only a few receive a lot of support."* This observation aligns with Briter Bridges's insights,<sup>53</sup> which highlight the disparity in funding distribution among startups:

- **Risk perception and early-stage funding:** When it comes to risk perception and early-stage funding, some interviews confirmed a tendency of investors to view D4AG solutions as risky investments, with a predominant focus on seed funding (early-stage funding). This leaves mature D4AG initiatives challenged when scaling up.
- **A balanced investment ecosystem:** One distinguishing factor of Kenya's investment

<sup>52</sup> Retrieved from Briter Bridges's presentation at the AgriTech4Kenya conference. Topic: *Empowering Emerging Markets: Leveraging Long-term, Inclusive, and Localized Collaboration for AgriTech Innovations*

<sup>53</sup> *ibid*

landscape is the balance between private and public funding. A research institute pointed out that, *“unlike other African countries, which lean more heavily on government and donor funding, Kenya benefits from a relatively developed investment ecosystem”*. Notably, the government's involvement through KALRO has been pivotal, although its reliance on funding entities<sup>54</sup> raises questions about sustainable, profitable business models.

- **Alignment with donors' agenda:** A number of informants point out misalignment with the needs of D4AG initiatives. One consultant raised concerns that the narrow focus of criteria set by funders (e.g., gender, youth, regenerative agriculture etc) might not align with the broader needs or support required by ag-techs and farmers.
- **Competition for funding:** At the AgriTech4Kenya conference, the strain between donor expectations and D4AG objectives was further emphasized. Panelists noted that as ag-tech companies compete for the same funding and technical assistance opportunities, collaboration is inhibited. Many companies tailor their applications to meet specific program criteria, which often leads to heightened competition due to a lack of differentiation, as well as reduced incentives to innovate. According to some, competition has adverse effects, impeding the potential for data sharing, partnerships that could significantly benefit the ecosystem, and replication of value propositions.

### ***B. Business Models for Farmer-Facing Technology***

In essence, a gap remains in deepening the understanding of farmers' financial behaviors and preferences to develop relevant D4AG tools.

The USAID study with KALRO<sup>55</sup> reveals that only half of farmers are willing to pay for D4AG services, with costs being a known barrier to adoption. The conclusion from the study suggests the need for more research to understand farmers' willingness to pay. Indeed, the disparity from the perspective of the providers could imply several things:

- (i) The perceived value of digital tools by the farmers differs from that predicted by the providers, which could mean that the tools' benefits are being overestimated by those who offer them;
- (ii) There could be an issue of trust; and/or
- (iii) It might also suggest that there is a question of affordability or accessibility, leading to a consideration that some digital tools might need to be offered for free or at a reduced cost to align with what farmers are willing or able to pay.

It is important to recognize that not all D4AG services hold the same value, with advisory services often viewed by farmers as a public good that should not incur costs. However, farmers are generally willing to pay for high-value propositions, emphasizing the need to understand what drives their willingness to pay. Further research would aim to guide more effective pricing and development strategies for digital agricultural tools.

<sup>54</sup> World Bank in Kenya supported the government to implement digital technology innovations to improve agricultural productivity through KALRO one-million farmer platform and apps developed under KALRO. The World Bank also provided Technical Assistance to develop a data-driven digital ecosystem in Kenya.

<sup>55</sup> Kamau et al. (2024).

Discussion during the deep-dive scoping asserted the need for further research into how farmers engage with these models, particularly concerning their willingness and ability to pay.<sup>56</sup>

- **Farmers' willingness to pay:** A USAID study investigating KALRO's weather-advisory services<sup>57</sup> and farmers' perspectives, found that just half of the farmers were willing to pay for weather-advisory services at the surveyed prices.
- **Farmers' ability to pay:** Compounding the issue is the question of affordability, the same study reported that farmers were generally willing to spend \$0.58 for these services. A research institute revealed a long-term view, suggesting that *"it could take up to 20 years before farmers in Sub-Saharan Africa, including the Sahel region, are prepared to invest in information services"*.

Various business models, such as "freemium", pay-per-use, and service bundles, have been introduced by organizations, yet the efficacy and farmer acceptance of these models are inconsistent. In Kenya, our scoping study highlights a gap in understanding the underlying factors that influence farmers' willingness to pay for digital services.

- **Farmer trust and value proposition:** Several KII point out that farmers often hesitate to pay upfront without clear value delivery, they must experience tangible benefits first. The challenge for digital agriculture providers lies in showcasing and delivering this critical value proposition. Even with a clear value proposition, trust issues tied to upfront payment models persist.
- **Perceived value for digital services:** KII pointed out a gap in understanding how farmers perceive the value of digital agricultural tools, with many considering them public goods that should be freely available. This perception impacts their willingness to pay, particularly for advisory services. One research institution suggested that *"Digital information is monetizable only if it is farm-specific,"* suggesting a need for personalized digital advisory.
- **Tailoring to farmers' profile on payment model:** A few KIIs including researchers and D4AG innovators highlight a disconnect in the understanding of farmers' actual willingness and capacity to pay for digital services. There is a necessity to tailor business models to accommodate diverse socioeconomic and farming landscapes.

### 3.1.5. Technology Utilization

#### A. Frontier Technologies

In Kenya, there is a growing effort to harness frontier technologies in agriculture. However,

<sup>56</sup> Depending on whether they are private, donor-funded, or public initiatives, some D4AG tools are offered at no charge. However, there is no specific information available regarding the exact distribution or split of these tools among the different funding sources.

<sup>57</sup> Kamau et al. (2024).



interviews reveal a debate regarding whether AI should enhance the accuracy of existing digital tools or develop entirely new products. Key areas of research include evaluating the potential and constraints of frontier technologies in Kenya's agricultural advisory, taking into account language and literacy barriers. Comparisons with India, where AI chatbots are showing greater promise, offer particularly valuable insights.

Kenyan agriculture sees a growing presence of advanced technologies being used in the context of agriculture,<sup>58</sup> but the conversion of these technologies into day-to-day farming solutions for smallholder farmers is still nascent. Through the deep-dive scoping, limitations and gaps around the use of frontier technologies emerge:

- **Cost challenges:** Most respondents knowledgeable on the issue agreed that costs remain a significant barrier for frontier technologies.
- **Language barriers:** Language barriers represent another challenge, with many new technologies like AI-powered chatbots operating primarily in English, which puts non-English-speaking smallholder farmers at a disadvantage. According to a center focused on in-country AI projects, efforts are underway to adapt complex Large Language Models (LLMs) into local languages, yet there is a challenge to cater to each of Kenya's ethnic groups. One digital innovator compared the effectiveness of a chatbot offering Good Agricultural Practices (GAP) operating in India and Kenya, mentioning that it was more effective in India because the language was better understood by the machines.
- **Lack of user-centric design:** According to one digital tool provider using AI as part of its core product, *"chatbots may not be the best user interface for rural contexts where farmers have varying literacy levels."* With chatbots and AI being tailored for smartphone interfaces, there is a gap in adapting these technologies for farmers with different literacy levels or those who do not have access to smartphones.
- **Challenges of scaling AI systems:** One key informant focusing on piloting early-warning systems using AI models shared his perspective stating that those demonstrated accurate predictions for maize and beans. However, current systems are designed to support single agricultural value chains individually, which presents a scaling issue. The goal to evolve into a tool that can simultaneously cater to multiple value chains and be directly employed by farmers in their decision-making processes is not achieved yet.
- Deep-dive stakeholders also note no evidence of the impact assessment of frontier technologies publicly available at this stage.

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<sup>58</sup> Examples include Apollo Agriculture's predictive analytics, Gro Intelligence's data platforms, and GIZ's Digital Transformation Center's initiatives, such as KALRO's use of satellite and weather data for crop modeling.

### 3.1.6. Cross-cutting Themes: Gender Dynamics & Climate Resilience

#### A. Gender and Social Norms

**Social norms and gender bias create a significant barrier for Kenyan women to access and benefit from D4AG services.** Limited access to finance, often controlled by men, restricts their ability to afford phones or data plans. Additionally, tools focused on crops traditionally grown by men or lacking information relevant to women's crops further marginalize them. To address these issues, the sector necessitates gender-specific training programs, inclusive tool development, and participatory design. This approach will ensure that D4AG services meet women's unique needs and unlock their full potential in agriculture.

The intersection of D4AG services and prevailing social norms represents a critical evidence gap in the high-level scoping phase of the study. This gap is particularly noticeable in Kenya. The depth and nuance of their influence on technology acceptance and use amongst women smallholder farmers remain areas of research. In the context of Kenya, deep-dive stakeholders shared similar findings as our high-level scoping:

- **Social and gender norms hinders access to digital devices:** Predominantly male-dominated control over financial matters, including phone ownership, often restricts women's ability to access and benefit from D4AG services. These barriers are reinforced by social norms dictating agricultural roles which, in turn, may hinder the adoption of technologies that could alter traditional gender dynamics in agriculture. Women are also challenged by domestic responsibilities, digital literacy gaps due to limited education opportunities, and social stigma associated with technology use. Several KIIs have pointed to the discrepancy in smartphone ownership between genders and its influence on D4AG adoption rates.
- **D4AG tools bias:** As pointed out in the high-level scoping early findings, in Kenya, many D4AG tools exhibit a bias towards crops traditionally managed by men, which are often designated as 'cash crops'. This bias overlooks normative gender roles and fails to accommodate the requirements and constraints unique to women in agriculture. Women specifically face challenges in accessing technology that is not designed with their needs in mind. A persistent issue is that many digital tools do not account for the financial restrictions women may experience, such as the consistent limited ability to pay for services, which are often designed for, and marketed to men.
- **Women-centered training programs:** To address gender disparities, respondents in Kenya suggested crafting training programs and tools with an understanding of the specific needs and challenges women face. This can involve providing cost-effective devices directly to women, utilizing existing social networks, and highlighting female agricultural role models. One KII representing a farmers association underscored the



significance of gender-specific training, while a D4AG innovator highlighted the positive impact of trainings delivered by female trainers. GROOTS Kenya, a *grassroots women's movement organization that works to empower women through leadership and economic development*, calls for a participatory design in developing technologies for women, encouraging investment in inclusive tool development.

### **Bridging the digital gender gap: The Role of GROOTS Kenya in empowering women Farmers through technology**

In Kenya, GROOTS operate through over 5,000 local women champions. Economic empowerment is central to their mission, facilitated through land ownership, technology access, and nurturing financial independence

GROOTS is helping bridge the digital gender gap, distributing educational videos on farming practices via mobile phones, in local languages, providing technical assistance and empowering women with the skills to gather and utilize digital data effectively.

According to GROOTS team, the effort to close the digital gender gap uncovers challenges such as the male-dominance in phone usage and a general hesitancy among women to adopt new technologies. In response, GROOTS has implemented support systems that involve financial assistance for acquiring phones, and education initiatives that boost technological confidence among women.

GROOTS mentioned some gaps in the use of digital by women in Kenya:

- **Tailored digital tools:** There is a need for designing and utilizing digital tools that cater to the unique needs of women farmers.
- **Inclusive frameworks:** Involving women in the creation of these tools ensures their voices are heard and their needs are addressed in the digital agriculture landscape.
- **Leveraging grassroots structures:** According to GROOTS, there is a gap in investments for lower-level technology development with a bottom-up approach essential for creating systems that truly serve community needs. Utilizing networks like GROOTS can aid in designing digital tools that work for broader demographics, addressing social norms in Kenya, and influencing D4AG adoption.

## **B. Climate Resilience and D4AG Tools**

According to the scoping review, digital tools for climate resilience in Kenya provide weather and climate information, but their effectiveness in farmers' decision-making remains questionable. Interviews indicate that climate-smart GAP (Good Agricultural Practices) and weather alerts are overly general, lacking actionable details for smallholder farmers. To enhance the utility of these tools, future iterations should prioritize tailoring advisories to specific agricultural value chains and delivering localized,

practical weather forecasts..

To address these gaps targeted research efforts are recommended to define how digital tools should be developing increasingly precise and customized agricultural advisories, ultimately leading to more resilient agricultural practices.

Most digital tools designed for climate resilience in Kenya focus on providing farmers with weather and climate information. However, there is a notable gap in assessing whether these tools help farmers understand and utilize this information for better decision-making on their farms. Concerns also exist regarding the accuracy and relevance of the information provided by these tools, particularly in areas such as crop cultivation methods and weather advisories.

- **Relevance of climate-smart GAP advisory:** Farmers' associations and individuals in focus group discussions have raised concerns about the relevance of GAP around climate-smart practices recommended by digital tools. They note an absence of information on indigenous climate-smart practices, which suggests that D4AG tools have not thoroughly captured or integrated this local knowledge for climate change adaptation. The incorporation of such traditional practices into D4AG tools is a critical component that remains under-explored and insufficiently documented by digital innovators themselves.
- **Accuracy of weather advisory:** Some digital tools in Kenya are using real-time data to share weather alerts either as daily forecasts, radar, or early warnings. Those have been acknowledged for their potential to foster climate resilience for farmers. Kenyan farmers typically plan their activities around seasonal weather patterns, and the lack of accurate weather information has historically resulted in significant losses. The direct application of D4AG tools offers the benefit of greater climate adaptability through timely and informed advisory services. Yet, the specificity and personalization of these advisories are wanting. Key organizations during the deep-dive and Kenyan farmers during focus groups have pointed out that existing tools, such as KALRO's weather data system, often fail to deliver accurate, hyper-local, and timely information, which undermines their effectiveness in aiding farmers' decisions.
- **Effectiveness, through personalized and actionable climate-smart advisories:** Many interviews with key informants and feedback from farmers during focus group discussions have revealed a shared shortfall in climate-smart GAP and weather alert tools. They often fail to convert information into practical actions for smallholder farmers. Advisories tend to be too general and lack the detail necessary for application to individual farms or value chains. Weather alert systems do not always deliver nuanced information crucial for farmers' decision-making processes. To enhance the utility of these tools:
  - Climate-smart GAP advisories need to be tailored to specific agricultural value chains, and distinct farmers' profiles; and

- Weather alerts should provide localized forecasts with clear, actionable steps for farmers to follow.
- **Lack of evidence of the impact of existing solutions:** According to a local researcher, despite the innovations brought forth by large ag-tech like Sun Culture and Pula, there is a distinct need for building conclusive evidence around these digital tools and their impact on climate resilience.

## 3.2. Senegal

### 3.2.1. Sector Overview

**Table 5:** Senegal country facts

Indicators		Value
Country facts	Total population (M) <sup>59</sup>	17.3
	Rural population (%) <sup>60</sup>	51
	GDP (current millions of USD) <sup>61</sup>	27.7
Digital infrastructure	Number of headquartered D4AG solutions <sup>62</sup>	11 (headquartered); 43 (with a presence)
	Mobile (device) ownership (% of population) <sup>63</sup>	57.6
Gender gap	Gender gap in mobile ownership (%) <sup>64</sup>	13
Governance	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan) <sup>65</sup>	3.7
	Role of government	The government has not developed any strong D4AG policy or programs.

#### A. Agricultural Ecosystem in Senegal

Almost 40% of Senegal's population resides in rural areas. Although the agriculture and livestock sector employs a significant portion of the workforce, it contributes less than one-fifth of the nation's GDP. Despite various strategies aimed at boosting agricultural productivity, the sector remains largely at a subsistence level.<sup>66</sup> Only 65% of the country's arable land is cultivated, with less than 5% benefiting from irrigation. Senegal's agricultural landscape is dominated by smallholder farmers who primarily grow staple crops such as millet, sorghum, maize, and rice for local consumption.<sup>67</sup> Besides, Senegal is categorized into six agroecological zones, which dictate cultivation patterns and necessitate zone-specific

<sup>59</sup> World Bank. (2022).

<sup>60</sup> *ibid*

<sup>61</sup> *ibid*

<sup>62</sup> Briter Bridges. (2023).; CTA, Dalberg Advisors. (2019).

<sup>63</sup> ITU. (2022).

<sup>64</sup> GSMA. (2010).

<sup>65</sup> World Economic Forum. (2014).

<sup>66</sup> IFAD. (2024a)

<sup>67</sup> World Bank. (2015).

agricultural programs.

Discussions during the deep-dive scoping highlighted several challenges and risks to smallholder farmers in Senegal:

- **Weather vulnerability:** Senegalese agriculture is mainly rainfed farming.<sup>68</sup> Hence, agriculture heavily depends on weather conditions that pose risks such as excessive rainfall, drought, or rain delays.
- **Market risks:** Farmers operate within underdeveloped market systems both domestically and internationally. When selling their harvest, they frequently face volatile prices, posing significant concerns for both small-scale subsistence farms and larger commercial operations.<sup>69</sup> This price volatility results in unstable value chains, which adversely affects the economic stability of the broader agricultural sector.
- **Land tenure:** 95% of Senegal's farms are smallholdings, with farm sizes ranging from 1.5 to 5 hectares. The remaining 5% of holdings are larger farms. The primary means by which people access land in Senegal is through inheritance, leasing, borrowing, land purchase, and allocations from rural councils. Inheritance rights in most communities are governed by customary and religious laws, which often create gendered imbalances in access to land penalizing women farmers.<sup>70</sup>
- **Access to information:** Important updates on market rates, weather forecasts, and farming best practices are vital yet often out of reach for SHFs due to literacy and skill gaps.

## **B. Digital Ecosystem in Senegal**

Senegal started a national journey of digital transformation with the strategic initiative "*Sénégal Numérique 2025*" (SN2025),<sup>71</sup> conceived in 2016 as a key component of the Plan Sénégal Émergent (PSE).<sup>72</sup> The objective of SN2025 is to serve as a catalyst for economic modernization and to boost competitiveness. Embracing the motto "*digital technology for everyone, for every use by 2025,*" the strategy aimed for an innovative and competitive private sector thriving within an effective digital ecosystem.

We encountered a lack of publicly available assessments of the SN2025, latest publicly available resources in partnership with the United Nations Development Program (UNDP)<sup>73</sup> revealed some challenges in the implementation of the plan, including funding shortfalls and

<sup>68</sup> UN-Water. (n.d).

<sup>69</sup> World Bank. (2019).

<sup>70</sup> USAID. (2016. a).

<sup>71</sup> SN2025's operational plan supported by the Ministère de l'Économie Numérique et des Télécommunications involves the implementation of 28 sector reforms and 69 projects, requiring an investment of 1.362 trillion CFA francs.

<sup>72</sup> The 'Plan Sénégal Émergent' (PSE) is a national strategy aimed at achieving an emerging Senegal by 2035 with three strategic pillars: (i) structural economic transformation and growth, (ii) human capital, social protection, and sustainable development, and (iii) governance, institutions, peace, and security.

<sup>73</sup> Gouvernement du Sénégal. (n.d. a).

delays in establishing the reforms with fewer than 20% being completed by the time of that report.

SN2025 recognizes the importance of agriculture, admitting that the uptake of ICT in agricultural practices remains limited. One axis of the SN2025 is related to digitalization projects within agriculture, with three projects designed through public-private partnerships (PPPs).<sup>74</sup> Information on current progress on these digital agriculture initiatives is not publicly available, with efforts focusing narrowly on crop identification rather than offering comprehensive services.

### **Digital infrastructure disparities**

As of early 2023, Senegal had 10.2 million internet users, corresponding to a 58.1%<sup>75</sup> penetration rate. Yet, with over 18 million inhabitants, almost half of the population is without internet access, primarily in rural areas which are home to over 50% of the Senegalese population.<sup>76</sup> The lack of internet connectivity is further exacerbated by disparities in infrastructure and affordability, despite a youthful median age of 18.5 years that indicates a high potential for digital adoption.<sup>77</sup>

### **Digital support**

Through the "Digital Senegal 2025" strategy, the Senegalese government hopes to develop the country's digital innovation ecosystem through support to over 15 incubators, accelerators, and coworking spaces having supported over 2,500 startups and entrepreneurs.<sup>78</sup> This includes entities like the Center for Technology, Innovation, and Competition (CTIC), Jokkolabs Dakar, and Yeesal AgriHub which is the main Senegalese-based structure dedicated to agri-tech.<sup>79</sup> However, it is worth noting that the level of maturity, proficiency, and specialization among these structures shows variability. Despite progress in the sector, stakeholders from recent in-depth discussions echo the situation depicted in the CTA, Dalberg report (2019). They point to continuing issues like a shortage of early-stage investors and mentors, as well as a lack of seed funding, which are crucial for supporting start-ups in their nascent stages.

### **Digital for Agriculture Programs in Senegal**

In Senegal's digital agriculture landscape, Briter Intelligence cites around 10 active AgTech companies, including:

- **Afrikamart** (Access to market) Offers a tech-enabled marketplace to link smallholder farmers with retailers, streamlining the supply chain;
- **Soreetul** (Access to market): Provides a digital platform aimed at opening market access for women's cooperatives;

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<sup>74</sup> UNDP. (2021).

<sup>75</sup> Data Reportal. (2024).

<sup>76</sup> World Bank. (2022).

<sup>77</sup> *ibid*

<sup>78</sup> BMZ. (n.d).

<sup>79</sup> Created in 2017, Yeesal Agrihub is the first structure in West Africa specialized in supporting start-ups in agribusiness through incubators and dedicated programs.

- **mLouma** (Access to markets, access to information): Acts as a virtual agricultural hub, delivering real-time product availability, prices, and vital information like weather and market trends; and
- **Jokolante** (Access to information): Collaborates with NGOs to furnish smallholder farmers with localized climate and market data, along with tailored agricultural advisory services.

On the public front, several government and donor-funded initiatives aim to bridge the digital divide in rural areas or include a digital component into agriculture programs. A number of these were mentioned during the deep-dive phase further details coming from publicly available information, including:

- **Food and Agriculture Organization (FAO) - 1,000 Digital Villages Initiatives (DVI):**<sup>80</sup> This initiative, in collaboration with the national advisory agency (ANCAR), is digitizing farming by providing 120,000 farmers in Senegal with resources like climate-smart advice through mobile access. It is coupled with the *Senlouma* e-commerce platform, which connects farmers with a network of traders and financial services. According to our interviews, the platform is still in the pilot phase but with potential for scaling up the initiative within Senegal and into neighboring regions.
- **UN Capital Development Fund (UNCDF) - Inclusive digital economy program in partnership with mLouma:**<sup>81</sup> This supports the digital inclusion of 45,000 rice producers in the Senegal River Valley. Partnerships with local AgTech players, including mLouma, deliver essential market data and facilitate access to farming-smart tools and financial products.
- **USAID/Feed the Future - Nataal Mbay:**<sup>82</sup> The project is focused on equipping farmer organizations within the cereal value chains with digital tools. CommAgri assisted cooperatives in managing farm inputs, loans, and agricultural data for 68,000 registered farmers. Post-project evaluations<sup>83</sup> reveal challenges in maintaining the momentum of digital systems due to high costs, highlighting the need for continued support and cost-effective planning in digital agriculture initiatives.

### 3.2.2. Data Gap and Impact Measurement

#### A. Assessing the Data Need

Overall, the pattern across key informants indicates that stakeholders acknowledge the value of agricultural data. However, the primary challenges lie in establishing trust and implementing effective data-sharing practices, beyond simply data collection. To address

<sup>80</sup> DVI is a program by the FAO aimed at digitizing rural localities globally, with pilot operations across several countries, including Senegal.

<sup>81</sup> UNCDF. (2021).

<sup>82</sup> The project started in 2019 as assessed in the report FEED THE FUTURE SÉNÉGAL. (2019).

<sup>83</sup> MarketShare Associates. (2023).



these issues, some organizations, particularly local research agencies, are developing targeted solutions and capacity-building programs, often in collaboration with farmer networks. Nevertheless, the overarching challenge remains the establishment of a national, trusted data system.

Our deep-dive into the need for data in Senegal finds that the main challenge lies in trust and access to information. A majority of the stakeholders we interviewed, including local researchers, cite the following themes:

- **Fragmented data collection methods from private actors:** One digital hub supporting innovators across a variety of agri-tech projects in-country pointed out that those often face data collection challenges, with rural data and data stemming from farmers directly being difficult to acquire due to logistical challenges. The key informants interviewed did not identify any specific trust-worthy open-source socio-economic data sources that could fill this gap.
- **Private sector dynamics:** Similarly to Kenya, the insights from digital innovators note a reticence among private companies when it comes to sharing data, often reserved due to competition, whereas government data, although available, is hard to access and use effectively potentially because of bureaucratic gatekeeping.
- **Trust in public data:** There is skepticism towards state-collected data, with local innovators and researchers questioning its accuracy. A digital tool hub team member mentioned that *"the primary challenge with data published in Senegal, is not necessarily quantitative or qualitative but psychological,"* due to concerns with the accuracy of the public actors responsible for the collection and dissemination of national data. This emphasizes skepticism over the data's representation of ground realities; stakeholders are fearful of sensitive information misuse, implying a challenge beyond mere data collection —there is a strong call for trust-building.

## ***B. Impact Measurement & specific Impact Assessment of Bundled Digital Services***

Senegal's digital agriculture local ecosystem is still in an entrepreneurial and early stage. While some ground-breaking tools developed locally are linking farmers to markets through digital platforms, many of these still lack concrete indicators to show their effect on income or farmers' livelihoods. Interviews suggest a willingness to undertake impact assessments, often driven by the requirements of funders or investors, which necessitates methodological investments and resources for innovators to conduct these evaluations independently.

The sharing of data, particularly from donor-funded programs, remains limited. Such information tends to stay within the realms of the programs themselves, leading to siloed knowledge that could otherwise inform and improve the wider landscape of digital

agriculture.

As mentioned in the previous section, Senegal's D4AG ecosystem remains entrepreneurial and nascent with less than 20 local active D4AG initiatives to date<sup>84</sup> and lacking strong governmental backing or policies aimed explicitly at driving digital farming policies forward. As a result, the local culture of evidence and impact measurement for digital tools is less developed. Discussions have highlighted various themes concerning gaps in impact evidence, particularly regarding methodologies.

- **Limited impact assessment resources:** Some local actors interviewed pointed out that no specific impact measurement of Senegal's D4AG services was known to their knowledge. One researcher underscored the point, noting a *"lack of resources for impact assessment and very few available studies on the ground. Most barriers come from the lack of knowledge on these technologies."*
- **D4AG initiatives M&E activities:** Two Senegal-based D4AG innovators were interviewed —both focusing on market linkages. They keep track of their activities but have not yet tied them to impact numbers on income or farmers' livelihoods. Despite this, both innovators mention actively looking to build stronger impact indicators, especially with the push from impact investors looking for tangible metrics..
- **M&E activities of donor-funded program:** Senegal is home to several major initiatives backed by international donors, all with a stake in digital agriculture. A relevant digital hub noted that *"while M&E is a routine for donor-funded programs, these are often kept internal."* This culture of keeping insights close to the vest means missed opportunities for learning and making all digital farming efforts better.
- **Impact of bundled services:** Amongst the two D4AG innovators interviewed during the deep-dive, both provide single access to market services, and did not have extensive knowledge on bundled services. More broadly, some donor-funded programs such as FAO Digital Villages and UNCDF offer bundled services alongside more established solutions like myAgro. Additionally, platforms like mLouma are also moving towards this approach, giving farmers a one-stop shop for pricing information, market access via e-commerce, and meteorological services. Despite these offerings, there is still a gap –the scoping study did not find the data to indicate whether farmers prefer these bundled services over single solution offerings.

Despite the limited sample, it is interesting to note from focus group discussions with Senegalese farmers, that some are indeed utilizing a variety of digital tools to gather different types of information, from agricultural best practices and weather advisories to locating buyers, often relying on social media and generic weather apps. This could indicate a grassroots demand for a unified platform that could streamline these services under one comprehensive app. The convenience and efficiency of such a bundled service could

<sup>84</sup> Briter Intelligence. (2023).

potentially resonate with the needs and preferences of farmers looking to simplify their decision-making processes and optimize their farm operations.

### 3.2.3. Farmer-Centric Research

Senegal's digital agriculture ecosystem features a smaller number of initiatives, which according to discussions in the deep-dive scoping, do not always align with the realities of smallholder farmers in Senegal to be effectively used. Research frequently does not match the on-the-ground needs of Senegalese farmers, who face numerous socioeconomic and structural barriers, including internet and data cost issues. Key challenges include the necessity for co-design and co-learning to align digital solutions with SHFs. And while donor-funded projects tend to adopt a structured approach including established digital development principles, private solutions sometimes lack this rigor, impacting their efficacy.

Strengthening the value chain with private and public investment is also seen as critical to enhancing the effectiveness of D4AG services.

In contrast to Kenya, Senegal's D4AG ecosystem is characterized by a relatively limited number of initiatives, whether they are privately led or designed through development programs.<sup>85</sup>

Several interviewees during the deep-dive, including support organizations that incubate a number of D4AG solutions, admit occasionally seeing a gap between the digital tools solutions available and the needs of SHFs in Senegal, with *"solutions being designed in silos."* Findings, besides those mentioned in the high-level scoping, include:

- **Reliance on donors requirements:** One researcher notes that *"numerous studies are driven by the requirements of donors rather than by the needs identified by entrepreneurs themselves."* Such studies do not always reflect the ground realities faced by farmers in Senegal, or give innovators the information they need to create more effective digital tools.
- **Specific D4AG tools are hampered due to structural challenges:** Discussions with Klls noted two types of inefficiencies:
  - The value chain in Senegal is extremely fragmented, whilst digital tools aim to facilitate access to inputs, markets, and services to bridge those gaps. Panel discussions amongst D4AG stakeholders recognized that value chains need to be strengthened at the same time for the services to be effective with the private and public investment playing a catalyzing role in supporting inefficiencies in the agriculture sector.
  - Farmers in Senegal face similar barriers that were raised in the high-scoping

<sup>85</sup> A number of development organizations (FAO, UNCDF, USAID) have directly integrated digital tools in their programs either through partnerships with tools providers or by developing their own tools.

findings both socio-economic (low level of education, literacy, low purchasing power) and structural (access to reliable internet connection). During focus group discussions with farmers in Senegal, a key constraint to regularly accessing the digital tools they were using was *“consistent internet connections and the cost of data.”*

The intersectional issue of educating farmers on available tools has come to the forefront in high-level investigations, revealing some key points:

- **Absence of co-learning:** Although there is an adequate supply of and demand for digital solutions according to one researcher, the absence of a co-design approach and preliminary evaluations tailored to SHF signifies the need for a more robust ecosystem.
- **Design principles for D4AG:** Furthermore, in terms of training, best practices identified during the high-level scoping —like *phy-gital* solutions<sup>86</sup>, offline access, local language usage, and simple design— are widely acknowledged. It is noteworthy that a stakeholder from a donor-funded project highlighted a disconnect: projects adhering to “principles of digital development” tend to have a more structured approach, and those are donor-funded projects whereas private initiatives often lack comprehensive toolkits and familiarity with these principles, potentially hindering their effectiveness.

### 3.2.4. Funding Mechanisms and Scalability of Business Models

Scaling business models within Senegal's agri-tech and D4AG sectors face significant hurdles. A pronounced lack of infrastructure to support innovators after the initial stages is problematic, especially with insufficient government engagement and a critical need for scaling capital. This creates a less appealing investment landscape for impact investors due to the limited financial turnaround from smallholder farmers who often rely on NGO partnerships.

Various business models are in play —from consumer premiums in market linkages to layaway payment schemes and harvest-based credit systems, with subsidies showing variable effectiveness across different contexts. There is no clear evidence as to which model is most effective, adding to the complexity of the ecosystem.

The fragmentation of Senegal's agricultural value chain only amplifies these issues. A number of stakeholders noted that tackling the value chain barriers is important for the

<sup>86</sup> This term refers to a hybrid approach that combines digital tools with offline, on-the-ground support such as with field staff. By integrating physical components like field visits, training sessions, and direct farmer engagement, the *phy-gital* approach aims to provide comprehensive support to farmers and ensure the successful adoption and practical application of digital tools in agriculture.

success and adoption of solutions. Nevertheless, the perceived absence of government backing makes strengthening this chain an even more challenging task.

### A. Funding Mechanisms

- Funding challenges post-early stages:** Key informants, notably from agri-tech platforms, highlighted the uncertainty of post-early-stage funding noting that *"there is been some interest in funding ag-tech but not as big as we would have expected."* (digital innovator). Yeestal Agrihub, an incubator fostering local agri-tech innovations, stands out in the ecosystem. Yet, there is a noticeable void when it comes to structures that offer both funding and technical assistance for solutions that are past the early-stage stage and ready to grow. The ongoing challenge is further exemplified by ANCAR's work with the SenLouma platform.<sup>87</sup> Despite such backing, the platform is still in the pilot stage, with our interviews indicating a lack of the follow-up funding necessary for scaling.
- Lack of national ecosystem supporting digital innovators:** Several interviewees highlighted the presence of foreign investors as present in Senegal's ag-tech ecosystem, with organizations like the Catalyst Fund, Mercy Corps Ventures, and GIZ SAIS program. Despite this, a statement from a local innovator stands out: *"Our own institutions do not know us,"* pointing to the fact that there is a significant gap in local funding relationships and mechanisms. It suggests that for the ag-tech sector in Senegal to truly flourish, there must be better alignment and collaboration between local institutions and the innovators within the country. This sentiment is captured in the words of a research institute operating in West Africa which shared that *"the challenge in terms of access to funding is exacerbated by a lack of information regarding available funding."* This illustrates the difficulty connecting with specific networks as a newcomer in the ecosystem.

### B. Business model from farmers-facing technology

Discussions concerning business models for farmer-facing technologies revealed a dearth of contextual knowledge. However, interviews yielded several specific examples of such models. Notably, a distinction emerged between product innovation, which is often conceptualized through value propositions, and business model innovation, which focuses on value capture mechanisms.

- Farmers' preference regarding the timing of payment:** One researcher shared hesitancy among farmers when it comes to perceiving the value of, and willingness to pay for, advanced services despite the availability of subsidies. This lack of

<sup>87</sup> The Senlouma is a market linkage platform developed by ANCAR with the support of the FAO through the DVI initiative (see 3.2.1 section)

comprehensive understanding impedes the development of effective business models that are truly responsive to farmers' needs and capabilities. One promising avenue for business model evolution lies in innovative value capture schemes. Initiatives like the Manobi AgCelerant program exemplify this approach, where producers can leverage a **pay-as-you-go** model by contributing a portion of their harvest as payment. This disrupts traditional upfront cost barriers, enabling wider access to ag-tech for resource-constrained farmers. By deferring payment until after experiencing the benefits in their harvest, the model directly links value creation with value capture, fostering trust and long-term engagement with the technology.

- **D4AG provider's revenue model:** Two D4AG innovators interviewed shared that their platforms operate free of charge for farmers, earning revenue instead through a percentage of the sales price. This model places the cost burden on the consumer rather than the farmer, aligning with the innovators' focus on added value higher up the value chain, where the digital agriculture tools could command a premium and generate significant returns. Indeed from panel discussions,<sup>88</sup> profitability for SHF is identified as predominantly occurring post-transformation, suggesting a target area for ag-tech positioning.
- **Farmers' challenges across the value chain:** Despite understanding where to position their value propositions effectively, the fragmented nature of Senegal's value chain presents challenges. To be successful, there needs to be a holistic enhancement across the value chain. For instance, improving farmers' access to credit requires increasing their revenue. At the same time, the potential for impact exists at the SHF level, higher up in the value chain.
- **Farmer-facing business models:** As D4AG players pivot towards a B2B approach, experts from organizations like RTI International and FAO called for exploration into this shift. How do these models intersect with the day-to-day realities of farmers? Are these solutions in line with what farmers are willing and able to pay for? The dynamics of these interactions remain critically understudied. Quotes from sector professionals suggest this gap is not merely a question of economics but of understanding cultural and practical attitudes towards agri-tech. "*Establishing a business relationship that is not solely dependent on external financing*" (ICT4Ag specialist) is necessary for the longevity of these services.
- **Sustainability in funding:** To ensure the long-term sustainability of ag-tech services, a local ICT4Ag specialist emphasized the need to establish business relationships "*not overly reliant on external funding*". This approach becomes even more pertinent in light of the impact investor's observations made during the panel discussion. The investor highlighted a cycle where SHFs, lacking significant revenue, pushed D4AG innovators to rely on partnerships with NGOs. This dependency creates a less attractive scenario for impact investors, as it presents a weaker business case, leading to challenges in scaling agri-tech solutions and questioning the real impact at

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<sup>88</sup> Retrieved from the panel discussion *Connect needs and capabilities of users* at the Development Gateway conference (Dakar, January 2024).



a low scale. However, the landscape is not static. Innovative models like Tolbi's<sup>89</sup> are setting new trends. According to secondary data collected in panel discussions,<sup>90</sup> Tolbi collects data from SHFs and shares it with off-takers, effectively turning data into a monetizable asset. This creates a new opportunity for SHFs to generate additional revenue streams while raising questions on data governance.

### 3.2.5. Technology Utilization

#### A. Frontier Technology

AI is expanding in Senegal's agricultural sector, fueled by a national strategy intending on making the country a West African data science leader.

Despite this, AI in agriculture largely remains at the ideation stage, with cost and lack of solid business models challenging progress beyond pilots. Progress hinges on overcoming financial and structural barriers and fostering a government that is as invested in technology as it is establishing as a regional leader in AI.

Based on in-depth in-country interviews, insights into the use of AI and other frontier technologies in agriculture primarily originated from a single actor, complemented by publicly available data.

- **National AI strategy:** The national AI strategy rolled out less than a year ago in November 2023.<sup>91</sup> Despite its recency, Senegal harbors ambitious goals for AI adoption. It aspires to be a regional leader by training 90,000 individuals in data science by 2028 and by establishing a West African center of excellence in data science and AI.. A local think tank specialized in AI notes 350+ applications of local solutions to the *Africa IoT and AI Challenge*<sup>92</sup> in 2023.
- **Use of AI in agriculture:** During interviews, a local think tank highlighted their collaboration with the Ministry of Telecommunications and the Digital Economy to develop a national strategy for embedding AI in agricultural practices. From a 2023 benchmarking study they conducted, it emerged that 15% of AI applications in Senegal are intended for the agricultural sector, with a significant portion developed by local talents.

<sup>89</sup> Tolbi leverages drones, satellite imagery, and IoT with sensors to provide farmers with real-time data for optimizing irrigation via a simple SIM-enabled phone using voice commands in Wolof.

<sup>90</sup> Retrieved from the panel discussion *Funding models - Creative approaches to financially sustainable tech* at the Development Gateway conference (Dakar, January 2024).

<sup>91</sup> Note that fewer than 10 african nationals have established national AI strategies or policies

<sup>92</sup> *Africa IoT and AI Challenge* is a regional challenge for entrepreneurs with innovative ideas in the areas of the Internet of Things (IoT), Artificial Intelligence (AI), and related fields.



### Examples of use cases of frontier technologies in Senegal<sup>93</sup>

- **Lifantou**<sup>94</sup> leverages geospatial AI to connect Senegalese smallholder farmers directly with school canteens. Their GIS-based platform streamlines the supply chain, boosting access to school meals with local produce while opening new markets for farmers. Using *Radiant Earth's* tools, Lifantou maps resources and needs, supporting enhanced agricultural decision-making. This system promises improved nutrition for students and sustainable market opportunities for smallholder farmers —despite the absence of data on its current scale publicly available.
- **Smart Granary** offers an AI-powered solution designed to help farmers safely store their crops longer. The system's automated ventilation responds to temperature changes, reducing post-harvest loss. However, at a cost of 2 to 3 million CFA francs, the device is currently beyond the financial reach of many SHFs and remains in pilot stages, largely distributed through NGO partnerships, as confirmed by the founder. Despite its potential, the high cost poses a significant barrier to wide-scale adoption.
- **Tolbi** harnesses satellite imagery and machine learning to monitor crop health and delivers tailored recommendations to farmers through automated calls in various local languages. Tolbi's innovative approach extends to its business model. Instead of selling directly to farmers, they partner with agribusinesses connected to smallholders, ensuring widespread adoption of their data-driven recommendations through a B2B framework, effectively reaching farmers who may otherwise be excluded due to cost barriers.

- **Challenges to scale:** The highlighted use cases, while illustrating the innovative potential of AI in Senegal agriculture, face significant scaling challenges. Among the three use cases, Tolbi is the only solution that has achieved notable scale managing over 50,000 hectares by 2023 and operating in several countries.<sup>95</sup> However, as one researcher emphasized during the deep-dive phase, *“the high costs of AI solutions and a general tendency for such projects to remain at the pilot stage”* are major barriers to widespread implementation. This is exacerbated by a lack of governmental support, as seen in Tolbi's need to revise its strategy notably due to insufficient backing from ministries (not just in Senegal).

### B. Data Governance

The exploration of data governance in Senegal is drawn upon insights from deep-dive interviews and two key workshops involving agricultural stakeholders —one in March

<sup>93</sup> The box showcases a sample list of agri-tech initiatives using AI in Senegal's agriculture, based on public data and Key Informant Interviews. This list is certainly not comprehensive.

<sup>94</sup> Radiant Earth Foundation. (2021).

<sup>95</sup> Catalyst Fund. (2023).

2022 focusing on data sharing and a more recent one in January 2024. The consensus from these discussions is that, while there are frameworks in place, they require reinforcement to adequately address current challenges. Data quality and the public's trust in governmental data continue to be major concerns. Stakeholders are calling for improved interoperability, as multiple initiatives in the country often proceed in parallel without collaboration, leading to unnecessary replication and a fractured information landscape.

Data Governance in Senegal resonates with the theme around *Assessing the data needs* discussed earlier in this report. As Senegal embraces rapid digital transformation, data regulation has been part of the national agenda since the Loi d'orientation sur la Société de l'Information (LOSI) was established over a decade ago.<sup>96</sup> Regarding agriculture specifically, the insights from the deep-dive interviews have been complemented by publicly available takeaways of a multi-stakeholder workshop in 2022 focused on *Data Sharing Policies in the Agricultural and Financial Services Sector*:<sup>97</sup>

- Awareness and accessibility of agricultural data:** Multi-stakeholder, during the workshop, pointed out that despite regulatory progress, two persistent challenges remain: (i) awareness and (ii) accessibility of agricultural data. There is a disconnect between data producers, such as government agencies and institutions, and data consumers, including farmer organizations and the broader agricultural value chain. The lack of a centralized, accessible database hampers the effectiveness of digital strategies in agriculture. Deep-dive interviewees voiced a common concern: *"it is not the quantity but the accessibility of data that's the challenge."* (Local researcher). For example, the ANSD (National Agency of Statistics and Demography) is the central leader for data in Senegal, but actors mention not managing to access disaggregated or socioeconomic data from the governing body. Compounding the challenge of accessibility is the question of data quality. Public skepticism about the reliability of government-shared data underpins a trust deficit according to the insights shared in the first section.
- Infrastructural challenges:** One local researcher supported those arguments with additional insights regarding the underlying challenges of data storage. Sufficient data storage emerges as a technical dilemma. Current systems for archiving and retrieving data fall short of the growing needs, raising concerns about sustainable data management practices.

**Institut Sénégalais de Recherches Agricoles (ISRA) data governance efforts**<sup>98</sup>

<sup>96</sup> République du Sénégal. (2008).

<sup>97</sup> Bakhoum et al. (2024).

<sup>98</sup> Retrieved from the take-away report Bakhoum et al., (2014) from the multi-stakeholder workshop *Shaping Data Sharing Policies in the Agricultural and the Financial Services Sector* (Dakar, March 2022).

Reflective of these wider challenges is the case of ISRA. Engaged in multiple projects requiring personal and non-personal data collection, ISRA faces the dilemma of how best to share and govern this data. Its 'Yield Gap' project illustrates the challenges and potential of agricultural data use —data on factors like irrigation and soil health can significantly reduce the difference between potential and actual crop yields. ISRA gathers its own weather data and also pools from national sources like the National Agency of Civil Aviation and Meteorology (ANACIM), but the issue lies in the integration and sharing of this data.

Without a national framework, ISRA designs its own sharing protocols, offering some data openly while restricting other parts. This approach, while practical, highlights the gap regarding a nationwide governance framework.

- **Interoperability of solutions:** During the Development Gateway workshop,<sup>99</sup> a strong emphasis was placed on the need to foster connections and synergies among agriculture data-driven projects, aiming to elevate data quality. A recurring issue identified was the redundancy of efforts, with many ag-tech projects being duplicated. This reflects a need for interoperability to streamline operations, maximize data usage.

### 3.2.6. Cross-cutting Themes: Gender Dynamics & Climate Resilience

#### A. Gender and Social Norms

In summary, the barriers for women in Senegal to access agricultural and D4AG services, such as constraints on land ownership, literacy, education, social norms, and the gender gap in mobile ownership, align with the findings of our high-level scoping.

A convergence of evidence from interviews and scholarly works reveals significant gaps in the operational design and implementation of gender targets within D4AG initiatives. While stakeholders establish targets at a high level, these often lack concrete implementation details and robust follow-through mechanisms. The true impact of these barriers on women's participation in D4AG services remains underexplored and presents a crucial avenue for further investigation.

In the literature, while a number of papers focus on the role of women in Senegalese agriculture,<sup>100</sup> there is a lack of detailed information regarding gender and youth access to D4AG services. The 2023 Winrock International report addresses this information gap by

<sup>99</sup> Development Gateway "From Product to Market: Lessons Learned in the Digital Transformation of Agriculture" (Dakar, January 2024).

<sup>100</sup> Examples include Nation. (2010)., USAID. (2016. b)., Rubin. (2010).

focusing on specific barriers faced by providing *A Gender and Social Inclusion Analysis of Access to Agricultural Services in Senegal*.<sup>101</sup> Our findings from the deep dive have been triangulated with this report.

- **Women access barriers to D4AG services:** Aggregated findings from the discussions pinpointed four primary barriers for women from fully benefiting from D4AG services in Senegal. Those are in line with the high-level scoping findings:
  - Social norms limit access to resources like land directly impacting their ability to participate fully in agriculture and thus use digital tools. In Senegal between 30% and 65% of women do not have access to land.<sup>102</sup> This is highlighted to “contribute to discriminatory practices that affect their access to agricultural services.”
  - Women and youth often find themselves underrepresented in formal agricultural groups such as farmers organizations, which are the primary avenues for a host of agricultural services, including digital ones.
  - Lower levels of education and literacy among women restrict their abilities to leverage various services and technologies. As of 2020, the literacy rate among Senegalese women is only 40% compared to 52% among the total population.<sup>103</sup>
  - While various factors like religious norms and domestic responsibilities have been noted, they compound the specific gender disparity in mobile access in Senegal, where women are 13% less likely to own a mobile phone than men.<sup>104</sup>

While the analysis shows that stakeholders have been aware of the barriers facing women to accessing D4AG services, very little has been done to research on how best to address these topics and evidence remains limited. From the deep-dive, stakeholder recollections point to only a handful of D4AG tools with a pronounced gender focus, such as Jokolante and Soreetul. Findings from the interviews and literature highlight the following:

- **Lack of depth of gender-focused policies:** While several organizations recognize the need for gender-targeted services, their actions are often superficial. This is highlighted in the Winrock study for digital extension services. According to the analysis, institutions like ANCAR maintain gender policies for field staff promoting digital services and set participant targets but frequently fall short in implementing strategies that address the specific needs and barriers faced by women. A governing body mentioned that “*women often comes third (in prioritization of D4AG programs)*” since the take-up of the tools are low. There is a discrepancy between acknowledging the need for gender inclusivity in agricultural services and understanding how to effectuate such inclusion.
- **D4AG field operations to limit access to the tools:** In a context where social and religious norms significantly influence gender dynamics, whether the field agent is a

<sup>101</sup> Winrock International. (2023).

<sup>102</sup> Access to land varies according to eco-geographical zones based on ict4d.(2010).

<sup>103</sup> GSMA. (2024)

<sup>104</sup> *ibid.*

man or a woman can profoundly affect the adoption of digital extension services. Women in Senegal may feel more at ease and speak more freely among female agents but currently constitute a minority (11%) of field staff.<sup>105</sup> This impacts D4AG tools awareness, access, and benefits. The D4AG innovators surveyed during the dee-dive did not have readily available details on their field staff gender ratio.

- **Information gap:** Based on the limited sample of informants with in-depth knowledge of gender-specific policies in-country, there remains a lack of information on specific gender approaches being implemented by D4AG innovators in Senegal. The Winrock study note a number of gaps that remain in-country, including limited data quantifying the impacts and outcomes of the gender barriers in access to advisory services in Senegal, notably digital services. Broader than advisory services, data remains limited for services including access to credit, market information, and climate-related information.

This gap in data underscores the urgent need for comprehensive research and targeted data collection efforts to inform policies and programs that effectively bridge gender and youth inclusivity in Senegal's D4AG landscape.

### **B. Climate Resilience and D4AG Tools**

Senegal's reliance on rain-fed agriculture amidst changing climate dynamics intensifies the need for climate data for informing planting and harvesting.

Although ANACIM and various initiatives work to distribute this data, barriers in access, dissemination speed, and clarity persist, affecting farmers' ability to react proactively. Innovators like Tolbi are stepping in with proprietary satellite data to fill these gaps, yet their reach and effectiveness are yet to be proven at scale, signaling ongoing challenges within the sector and potential for further research.

Senegal's agricultural sector remains predominantly rain-fed, with 5% of agricultural land benefiting from irrigation.<sup>106</sup> This vulnerability is heightened by an increasing variability in rainfall patterns alongside a substantial rise in mean temperatures.<sup>107</sup> To that end, information on the timing of rain start, the duration of the rainy season, and the right seeds to plant based on rainfall is particularly important.

In Senegal, the Senegalese National Meteorological Agency (ANACIM) is the provider of climate data, which is then distributed through a variety of channels. This includes advisories from public sector agencies like the National Agricultural Insurance Company of Senegal (CNAAS)<sup>108</sup> and ANCAR, private D4AG providers such as Mlouma and Jokolanté, and donor-funded initiatives like the USAID's Feed the Future Nataal Mbay and the FAO's Agricultural Services and Digital Inclusion SAIDA Project.

Some evidence has been published on the impact of climate information dissemination to

<sup>105</sup> Franzel et al. (2018).

<sup>106</sup> World Bank. (2019).

<sup>107</sup> *ibid.*

<sup>108</sup> CNAAS. (2021).

farmers in Senegal. For instance, Chiputwa et al. (2020) observed a positive correlation between obtaining climate information and the adoption of farming practices that enhance adaptation to climate change in Senegal.<sup>109</sup> Yet, interviews note a number of barriers to dissemination of information.

- **Climate-information accessibility:** A significant highlight by various interviewees including research and D4G support hubs is the accessibility of climate data in Senegal. The reach of information provided by ANACIM is not instantaneous, pointing to a pressing need for improved access mechanisms tailored for D4AG providers. Although the study lacks evidence from D4AG providers providing climate information through ANACIM, this delay raises issues regarding the timeliness of the data for the ultimate end-users, the SHFs, who require timely information to make informed decisions.
- **Climate information clarity:** Insights from the FGD reveal a need for clarity in disseminating climate information to farmers. Participants SHFs expressed that forecasts are sometimes misinterpreted due to the language used not being clear. In one focus group, farmers were calling for explicit guidance on the broader implications of weather events on agriculture. One farmer uses the examples of tide forecasts used by fishermen to request specialized, detailed, and ongoing climate information. Additionally, there were mentions of incidents where weather predictions, like dust accompanied by wind or rainfall, were inaccurate. While these mispredictions are not necessarily leading to a loss of trust, they underscore the importance of timely and precise forecasts for agricultural planning.

Two actors interviewed have noted that Tolbi aims to bridge the existing climate information gap by collecting its own satellite data. Despite this promising initiative, there is an anticipation to see how effectively it can scale. Besides Advancing Climate Change Resilience in Agriculture (AICCRA) and a few donor-funded projects (e.g. ISRA), few impact assessments or evidence of solutions were found.

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<sup>109</sup> Chiputwa et al. (2020).

## 3.3. Morocco

### 3.3.1. Sector Overview

**Table 6:** Morocco country facts

Indicators		Value
Country facts	Total population (M) <sup>110</sup>	37.4
	Rural population (%) <sup>111</sup>	35
	GDP (current millions of USD) <sup>112</sup>	130.9
Digital infrastructure	Number of D4AG solutions <sup>113</sup>	9
	Mobile (device) ownership (% of population) <sup>114</sup>	96
Governance	Importance of ICTs to government's vision (index ranking 1–7: no plan/ there is a clear plan) <sup>115</sup>	0.25
	Role of government	Recent and highly coordinated with a dedicated structure promoting D4AG initiatives.

#### A. Agricultural Ecosystem in Morocco

Agriculture in Morocco, contributes around 15% to the nation's GDP and employs 45% of the workforce.<sup>116</sup> The sector is characterized by a structure with large, modern export-focused farms, reservoir-irrigated enterprises catering to local markets, and traditional rain-fed farms varying in productivity and resources. As of 2014, 70% of farmers worked on farms of less than 5 Ha.<sup>117</sup> Traditional rain-fed farms often face volatility due to dependency on rain and the use of traditional methods which are accentuated by issues such as fragmented landholdings and soaring land prices.

Two challenges were identified through based on the in-country discussions:

- **Access to real-time, actionable information:** This lack of timely data can hinder a

<sup>110</sup> World Bank. (2022).

<sup>111</sup> ibid

<sup>112</sup> ibid

<sup>113</sup> Briter Bridges. (2023).

<sup>114</sup> ITU. (2021)

<sup>115</sup> World Economic Forum. (2014). The figure cited is from 2014 and does not reflect the developments under Morocco's current Generation Green plan, which includes ICT as a pillar.

<sup>116</sup> IFAD (2024b)

<sup>117</sup> FAO. (2014).



farmer's ability to make informed decisions, ultimately affecting crop yield and market value.

- **Access to markets:** Intermediaries dominate the landscape, and their presence can create barriers for SHFs, impacting the visibility and profitability of their goods.

In Morocco, agricultural governance involves collaboration between key institutions, coordinating efforts to enhance sector policies and initiatives. The Ministry of Agriculture, Fisheries, Rural Development, Water and Forests (MAPMDREF) stands at the forefront, creating policies and aligning strategies. It works closely with agencies such as:

- The National Office of Agricultural Counseling (ONCA), which offers essential advisory services to Moroccan farmers and is a potential partner in digitization efforts to modernize agricultural support;
- The Moroccan Confederation of Agriculture and Rural Development (COMADER), which advocates for farmers and contributes to rural development; and
- The Agricultural Development Agency (ADA), tasked with implementing agricultural strategy and encouraging investment.

Morocco's agricultural value chains stand out as being systematically organized into *Filière interprofessionnelles*. These sectoral clusters benefit from a high degree of coordination and support from the COMADER<sup>118</sup> which plays a crucial role in driving agricultural development and representing the interests of farmers and rural communities.

## **B. Digital Ecosystem in Morocco**

### *Generation Green 2020-2030 and Digital Transformation*

Underpinning Morocco's agriculture is the *Generation Green 2020-2030* strategy, a sequel to the *Plan Maroc Vert*. The plan sets out an agricultural development strategy through 2030 by (i) "developing a new agricultural middle class representing between 350,000 and 400,000 households by supporting young entrepreneurs through the mobilization of one million hectares of collective lands and the creation of 350,000 jobs with a focus on high-value agriculture," and (ii) "promoting human and social development."

At the heart of plan is the goal to create a new generation of extension services by "*connecting over 2 million farmers to digital platforms by 2030,*"<sup>119</sup> transforming how agriculture is practiced in Morocco and enabling farmers to make more informed decisions that can boost productivity and sustainability. This digital push is part of the broader aim to modernize the agricultural sector through enhanced access to information, better market reach, and more efficient farming practices.

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<sup>118</sup> COMADER is a professional agricultural organization established representing national and regional associations across the production, processing, and marketing spectrums of various value chains. COMADER currently includes 19 agricultural inter-professional member groups, uniting a total of 356 national and regional/provincial agricultural professional organizations.

<sup>119</sup> Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts. (n.d. a).

### *Coordination through the Pôle Digital*

The Generation Green strategy expands on the digital ecosystem, most notably through the creation of the *Pôle Digital* (or “Digital Hub”) in 2022. The Pôle Digital represents a shift from previously disjointed, project-based initiatives to a more cohesive national strategy for digital transformation within Moroccan agriculture.<sup>120</sup> Its core mission is to streamline the country's digital agriculture initiatives for better strategic focus and resource use. It strives to nurture a knowledge-based, innovative ecosystem that addresses real needs, engaging with agritech startups to foster innovation and direct on-the-ground tech application.

A key part of its efforts is the development of the *Réseau de Fermes Digitales* (“Connected Farms networks”), which serves as a real-world lab where new technologies can be tested and showcased in practical scenarios.

This structure was formed through a convention with Crédit Agricole du Maroc (CAM), FIMASUCRE, Technopark, and ENA Meknès.<sup>121</sup> In terms of roles, CAM backs the Digital Factory<sup>122</sup> to finance and nurture start-ups; FIMASUCRE contributes to digitizing the sugar industry; Technopark offers technical assistance; and ENA Meknès provides research assistance, with Pôle Digital harmonizing these efforts. This multi-sectoral involvement underscores the strong governance to integrate digital technologies into agriculture as part of the nationwide *Generation Green 2020-2030* plan.

### *Research institutions*

Besides the Pôle Digital, various research institutions and universities in Morocco are deeply engaged in digitizing agriculture. Notably, universities like Institut Agronomique et Vétérinaire Hassan II (IAV II), ENA Meknès, and Institut National de la Recherche Agronomique (INRA) among the founding members of Pôle Digital, actively participate in the “Connected Farms network” initiative, using it as laboratory to test new innovations and develop agricultural technology products –mostly on the high-tech side.

Additionally, the Mohammed VI Polytechnic University (UM6P) has a dedicated agriculture lab that works closely with Pôle Digital and government entities. As confirmed by one of the interviewed researchers, the College of Agriculture and Environmental Sciences in Ben Guerir recently received funding for digitalization studies with UM6P focusing on the technical and agronomic aspects. This showcases the commitment of Morocco's leading research and public institutions directly aligning with the government's national agricultural plan.

### *Digital programs*

Pôle Digital's survey of in-country tech solutions revealed that most of the digital services existing in Morocco are not tailored to smallholder farmers.<sup>123</sup> Of these solutions, 59% are

<sup>120</sup> The Pôle operates as an independent entity, despite being administered by the MAPMDREF, and works closely with public and private institutions.

<sup>121</sup> Pôle Digital Maroc. (n.d).

<sup>122</sup> Digital Factory is an open innovation platform promoted by Credit Agricole. It aims to support startups with innovative solutions in AI, banking, mobility, digitalization, and sustainability, aligning with the needs of Credit Agricole.

<sup>123</sup> Based on a mapping of 92 in-country solutions. Not all of these solutions are affiliated with *Pôle Digital*, and vary in terms of their degree of activity, which does not necessarily correlate with being operational.

start-ups with a substantial focus on advanced technologies: 38% in Enterprise Resource Planning (ERP) systems, 34% in drone tech, and 21% involving IoT. These figures suggest a landscape skewed towards larger farms, where such technologies are more applicable.

However, a handful of enterprises do offer digital solutions suitable for smallholder farmers:

- Companies like SoWIT, PCS Agri, and Fila7a have managed to scale up offerings benefiting to SHFs.<sup>124</sup>
- Another incubator of solutions which includes some related to smaller-scale farmers, is AI Moutmir.<sup>125</sup> AI Moutmir, launched by leading fertilizer company Office Chérifien des Phosphates (OCP) in partnership with UM6P in 2018, has developed some services in-house, as well as collaborated with digital solutions providers in Morocco to integrate their solutions on the AI Moutmir platform. Notable solutions tailored to SHF include @tmar, an advisory app, and T@swiq, a market connectivity platform. The @tmar app particularly stands out, aiming to democratize access to scientific information and facilitate agricultural decision-making with services like weather updates, funding requests, market price information, and plant disease identification.

### 3.3.2. Data Gap and Impact Measurement

#### A. Assessing the Data Need

In Morocco, agricultural data management requires enhanced coordination and accessibility, with the need for frameworks that allow broader use and interoperability. According to the deep-dive discussions, data systems like the National Agricultural Registry (RNA) are pivotal yet underused by private actors due to challenges in open-source viability and the absence of clear government guidelines for private sector engagement.

In Morocco, the strategic coordination of agricultural data is largely managed by key public bodies such as MAPMDREF's Directorate of Information Systems (DSI), ONCA, and Pôle Digital. The DSI not only enhances synergy among different governmental entities through efficient data collection but also plays a pivotal role in monitoring and evaluating local development initiatives.

In the context of Morocco's agricultural sector, the National Agricultural Registry (Registre National Agricole - RNA) serves as an important pillar of the country's data strategy, aligning

<sup>124</sup> Morocco-based D4AG tools. SoWIT offers precision agriculture tools, optimizing irrigation, fertilization, and crop health, along with providing weather information and alerts to support farmers' decision-making. PCS Agri develops AI-based digital solutions for Moroccan and export markets, focusing on monitoring germination, aiding small farmers with harvest quantities, and improving price negotiations. Fila7 is an access to market platform for Moroccan farmers, including SHF.

<sup>125</sup> AI Moutmir. (n.d.).

with the Generation Green initiative under the MAPMDREF.<sup>126</sup> The RNA comprises two databases: one mapping agricultural holdings to support strategic and agricultural planning, and one farmers database for personalized services. This system aims to optimize subsidy distribution and advisory services, intending to create a data-informed, efficient agricultural sector even though challenges remain.

- **Accessibility and framing of open-source data:** The availability and usability of RNA data for D4AG actors are limited. While RNA is rich in data, there is a need for clear frameworks to enable its broader use and ensure data can be shared across platforms. A private sector D4AG innovator points out the dilemma of incurring costs to gather farmer-level data while facing the risk that open-source sharing could benefit competitors, saying that investing in *"open-source data is not viable if competitors take it."* The government's push for open-source data access for private entities lacks clear guidelines, hindering its effectiveness. Clear frameworks for data use and interoperability are crucial to unlock the value of these datasets for innovation and economic growth.

Making sense of the vast volumes of data, managing them effectively, and ensuring data governance aligned with Morocco's National Commission for the Control of Personal Data Protection (CNDP), remain challenges in the context of Morocco.

The spectrum of data being collected is broad, especially by governing bodies including MAPMDREF's directorates and ONCA. However, while innovators acknowledge that *"information is here,"* there is a noted absence of a centralized repository for this data, and *"accessing information is difficult."*

As Morocco progresses with its digital efforts in agriculture, there are growing questions on how to effectively organize this data into a user-friendly, centralized hub, usable for all stakeholders.

## **B. Impact Measurement**

Morocco's digital agriculture initiatives are faced with early-stage challenges that hinder comprehensive long-term impact assessments. The current emphasis on commercial viability and functionality often overshadows evaluations of broader social impacts. Additionally, the absence of baseline data and clarity in metrics complicates measuring the true effects on small-scale farmers. Therefore, there is an urgent necessity for sustained, in-depth research to thoroughly understand the impact of digital tools on Moroccan agriculture. Given the large scope of digital tools available in Morocco, this includes metrics from immediate efficiency gains in agriculture to sustainable benefits for the lives of smallholder farmers.

While Pôle Digital's ongoing partnerships with research institutions mark an initial step towards gathering evidence before scaling up digital tools, there should be a more

<sup>126</sup> Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts. (n.d. b).

focused effort to include an evaluation of their impacts in the long run. Research institutions could integrate this aspect into their scope of work to ensure thorough and meaningful analysis.

- **Market-driven digital agriculture:** According to one D4AG innovator, the focus of many digital solutions appears to be commercial, with an emphasis on market-driven outcomes rather than the social impact that might be characteristic of donor-funded projects. Consequently, there is a noted deficiency in rigorous, long-term evaluations particularly with respect to social impact for end users post-project implementation.
- **Limited scale of solutions to be evaluated:** Morocco's agricultural strategy, including the introduction of digital innovation under the Generation Green plan, is relatively new, and the sector is in its early stages of development. Comments by a research institute supports this view by stating that technology must be widely available before its impact can be effectively measured. This indicates that the sector is still organizing and rolling out initial deployments rather than evaluating their effects. This is compounded by a lack of baseline assessments for understanding digital tools' catalytic impact. Besides, since many pilots have not achieved a scale at which impact could be visible across a certain population or in certain areas, their external validity—whether the results are applicable to other settings—is still uncertain.
- **Emerging research collaborations in a pre-defined setting:** The *Réseau de Fermes Digitales* focuses on thoroughly refining and testing each innovation prior to widespread adoption. These initiatives are rooted in public-private partnerships with a strong research focus.<sup>127</sup> These efforts are akin to impact assessments, though it remains to be clarified what specific aspects are being measured and evaluated.

### Réseau de Fermes Digitales - Pôle Digital

The *Réseau de Fermes Digitales* managed by the Pôle Digital establishes "Connected Farms networks" as innovative testing grounds for ag-tech solutions. At these sites, farmers, innovators, researchers, and other stakeholders collaborate to refine and advance new agri-tech tools. These farms offer a real-world setting for the trial of technologies, allowing for their validation and enhancement ahead of broader distribution.

The emphasis on collaboration and partnerships is crucial within these digital farms, reflecting an ecosystem approach. They feature a broad geographical reach and adaptability to various agricultural products, ensuring that the benefits of innovation are widespread and relevant to diverse farming needs.

By 2023, three digital farms are operational, with plans to increase this number to 13 by 2026, illustrating a commitment to expanding this promising model. These digital farms ensure

<sup>127</sup>Involves a close collaboration with academic institutions such as UM6P, INRA, ENA-Meknès, and IAV Hassan II.

innovations are thoroughly tested before large-scale implementation. However, there is a need to consider the controlled nature of these environments and whether the insights gained can be effectively translated to the wider, more variable real-world agricultural settings in Morocco.

- Lack of impact metrics:** Despite a rise in the number of agri-tech solutions developed by government entities and the effort to boost their practicality, there is a lack of solid evidence regarding their direct effect on farming methods and the eventual results for farmers to date. During the interviews, respondents commonly referenced metrics like farm productivity, including factors such as reduction in water use and yield increases. However, it was also noted that there is no clear evidence demonstrating how these improvements in productivity translate to tangible impacts on the livelihoods and overall well-being of farmers.

### C. *Specific Impact Assessment of Bundled Digital Services*

The analysis reveals that the majority of digital agriculture services offered in Morocco to dates are single services. We still note different strategies amongst stakeholders on the need for 'super apps' rather than developing singles tools. Additional research on preferences of smallholder farmers, and implication on the supply of agricultural services could shed light on this area.

Key stakeholders in Morocco during the deep-dive show mixed opinions on how to present digital tools to farmers: should they be offered separately or as part of an all-in-one 'super app'?

CAM is currently developing a 'super app' aiming to house multiple services in one platform, while Pôle Digital advocates for a suite of 16 individual services tailored to meet distinct needs, suggesting a focus on ease of use for smaller farmers. According to a mapping of digital solutions conducted by Pôle Digital, 80% of those are a single service.<sup>128</sup>

Currently, attention is on perfecting these services rather than examining the precise impact of each within a bundled package. It could be anticipated that an in-depth assessment of each service's effect will come later, once a stronger culture of impact measurement is established.

## 3.3.3. Farmer-Centric Research

### A. *Smallholder Farmers' Focus*

Morocco's digital agriculture landscape presents a unique case study. Tailored solutions are emerging from both public initiatives (such as COMADER, ONCA, and Pôle Digital)

<sup>128</sup> Pôle Digital. (2024b).



and private programs, with a strong focus on inclusivity and meeting the needs of SHFs. Unlike smaller D4AG tools in Kenya and Senegal, which often prioritize rapid scaling, Moroccan solutions benefit from the backing of larger entities. This support enables intensive ground-level testing and a more measured, resource-intensive approach to scaling. Integration within specific agricultural value chains further enhances the adoption of these digital solutions by ensuring they are tailored to the practices of farming activities, and the specific needs of smallholder farmers effectively.

- **Bottom-up approach to D4AG design:** Morocco's digital agriculture landscape is evolving to become more inclusive, with a growing focus on meeting the needs of smallholder farmers. Strategic planning under the Generation Green initiative views digital technology as a critical, integrative facilitator within agriculture, aiming to embed this mindset across all departments involved in agricultural governance. Examples of this inclusive approach include Pôle Digital's mission to reach all farmers through a *"bottom-up methodology and agile processes, ensuring solutions align with farmers' needs"*, and OCP's AI Moutmir program,<sup>129</sup> which emphasizes ground-level testing and feedback before scaling solutions.

A noticeable shift is occurring in the technologies and actors involved in Morocco's agricultural sector. Traditionally, private companies have concentrated on advanced technology solutions like ERP systems, drones, and IoT, whereas public initiatives by bodies such as ONCA focus more on advisory services. Recently, there's a pivot observed towards 'low-tech' solutions by private initiatives, aiming to be more accessible to a broader base of farmers, including smallholders, as highlighted by key informants.

- **Integration of digital solutions in value chains through customized solutions:** In Morocco, the agricultural sector is distinctly organized around specialized agricultural value chains, supported by COMADER. This interconnectedness fosters a collaborative environment conducive to the tailored development and application of digital agricultural tools. For smallholder farmers, this integration within value chains offers bespoke solutions that cater to diverse needs across different crops and farming activities. Tailored tools designed for specific digital requirements of various crops—such as wheat, livestock, and olive act as catalysts for adoption. Pôle Digital and ONCA enhance the uptake of these digital tools by offering customized advisory services and deploying a mix of USSD, SMS, and voice services that connect with farmers regardless of internet access, directly in their language. Their strategy of rolling out digital tools methodically by value chain acknowledges the diverse on-the-ground realities of Moroccan farmers, ensuring inclusivity and relevance across different value chains.

<sup>129</sup> OCP, Morocco's largest fertilizer company, launched 'AI Moutmir' to empower farmers with digital tools created in-house like the @tmar advisory app, Agripedia share GAP, and T@swiq market platform. Retrieved from the 2023 impact report.



In the sugarcane industry, COSUMAR and its subsidiary FIMASUCRE exemplify the effective adoption of digital technologies at the value chain level.

**COSUMAR/FIMASUCRE showcases a model for successfully integrating digital technology within a specific agricultural value chain in Morocco**

COSUMAR, a player in Morocco's sugar industry, controls the entire process from growing sugar beets and cane to processing and selling sugar. FIMASUCRE, part of the COSUMAR group, shares in these operations. Since embracing digital transformation in 2016, COSUMAR has developed a digital ecosystem that addresses the sugarcane industry's needs. Their recent partnership with Pôle Digital to implement advanced e-services stands as a case study step towards a more ag-tech including farmers needs.

An example is the onboarding of over 80,000 users, many of whom are small-scale farmers, into a digital network that enhances farm management and planning through precise geolocation. The initiative underscores two key benefits:

- In-house development of digital tools ensured they are matched to the demands of the sugarcane value chain, enhancing the likelihood of adoption by farmers; and
- Developed tools could focus on user accessibility and catered to farmers with varied digital skills. This entailed employing voice messaging to relay critical information in local languages, providing climate updates, and putting forth practice advisories —made even more robust with support from a dedicated team of advisors.

COSUMAR illustrates the potential for comprehensive digital initiatives to transform agriculture when there is a centralized structure, as is the case with FIMASUCRE being the primary buyer in the sector. This centralization mitigates the frequent issue of inconsistently applied digital tools and underscores the importance of having digital solutions that are carefully adapted to meet the specific needs of farmers, including smallholders.

**B. Best practices on D4AG Tools Training for SHF**

Pôle Digital and ONCA are pioneering inclusive training strategies for digital tools among smallholder farmers, yet the full impact and scalability of their efforts remain uncertain. While Pôle Digital's *Réseaux de fermes digitales* offer innovative on-site training, reaching the broad farming population effectively as digital adoption grows is not fully assured. ONCA's approach, which includes field staff support with an acknowledgment of the cultural shift needed to embrace digital tools, faces challenges with staff limitations and farmers' skepticism despite the technology being provided at no cost.

These initiatives highlight a broader need for research on the scalability of digital tool education, the cultural adoption of technology in agriculture, and identifying the main barriers to digital tool adoption among various farmer demographics. There is also a need to explore how cooperatives can amplify the effectiveness of digital solution

dissemination among smallholder farmers.

- Inclusive approach to training:** Amongst the key informants in Morocco, Pôle Digital and ONCA are leading advocates for an inclusive approach to educating smallholder farmers on the use of digital tools. However, a gap remains in understanding the effectiveness of scaling up educational efforts and ensuring farmers grasp the benefits of these digital tools. The training initiatives conducted through the "Réseau des fermes connectées" seem to function but it is not clear if this approach can reach all farmers effectively as digital tech becomes more common. On the other hand, ONCA recognizes the significant challenge of *"shifting mindsets and fostering a culture that believes in and leverages digital tools"* and offers field staff support to help bridge the generational divide between tech-savvy youth and more traditional older farmers. Even so, their limited staff numbers may not be enough for this ambitious goal. Additionally, ONCA mentions that barriers like the costs of adopting recommended practices and skepticism about new tools can discourage some farmers, despite the training and technology being free.

### 3.3.4. Funding Mechanisms and Scalability of Business Models

#### A. Funding Mechanisms

In essence, while initiatives exist to support D4AG, a critical question remains regarding the effectiveness of current funding models in fostering scalable, sustainable business solutions that truly address the needs of Moroccan SHFs. A thorough understanding of this gap is essential to pave the way for a robust and SHF-centric D4AG ecosystem in Morocco.

- Private and public funding:** In examining the D4AG funding models in Morocco, distinct contrasts emerge between private and public sector involvement and between the requirements of high-tech agri-tech ventures *versus* interventions tailored for smallholder farmers. High-tech solutions, including drones and AI, find traction with larger operations that can afford such investments. However, these solutions' applicability to SHFs is constrained by cost and complexity. Interventions tailored to smaller farmers are mostly coordinated by governing bodies and are intended to be more accessible.
- Donor involvement in Morocco:** The landscape of donor involvement in Morocco is less prominent than what is observed in West and East Africa, with government bodies taking the lead on the incubation of SHF-oriented solutions. According to a

digital tool provider, *“in Morocco, public sector takes the lead in terms of supporting digital innovation through the Pôle Digital or the Agro IT Days, [while] private investment is less at the forefront besides Credit Agricole and OCP interventions.”*

- **Funding model effectiveness:** There is a gap in understanding the effectiveness of the public-led support structures in fostering a dynamic environment for D4AG solutions that cater to SHF needs. Pôle Digital acknowledges the fundraising challenges for ag-tech startups, with a reported *“3% success rate”* in Morocco.<sup>130</sup> This suggests a lack of understanding on how incubators and consortia such as the one between Pôle Digital, Crédit Agricole du Maroc (CAM), and Technopark can grow D4AG innovations. Crédit Agricole du Maroc combines empowerment via financial backing for agri-tech startups, while strategically buying some of these solutions to incorporate these in its own mobile banking. Nonetheless, the extent and reach of CAM’s impact on agri-tech development remain to be measured;

On the other side, Technopark provides incubation services and, through the consortium, aims to bolster the D4AG domain. How this translates into scalable and economically viable agri-tech businesses is another gap in our current understanding.

In both cases, the question is not just about the initial support but the actual capacity to sustainably scale up agri-tech solutions that are tailored to smallholder farmers as well. Success stories like SoWIT and PCS AGRI do exist, yet they tend to pivot to government contracts or foreign associations for viability, highlighting obstacles in scaling tailor-made solutions for SHFs within the Moroccan market.

### **B. Business Models for Farmer-Facing Technology**

The provision of free advisory services by ONCA, while beneficial for farmer accessibility, brings into question the long-term viability of such models. Pôle Digital’s need for additional donor funding highlights potential hurdles in scaling agri-tech support as the Moroccan ecosystem matures and more startups emerge. Notably, the financial sustainability concerns in Morocco differ from countries with a private, venture-driven landscape. Here, most initiatives are public and primarily focus on advisory services. Thus, the lack of understanding around value delivery of information for SHFs described above could further hinder the development of sustainable financing models for these technologies. Consequently, the ability and willingness of SHFs to pay for digital tools remains underexplored.

A second evidence gap centers on smallholder farmers’ financial capacity to pay for digital agricultural tools.

- **Sustainability of advisory services provided by governing bodies:** ONCA offers SMS advisory services free of charge, which is ideal for farmer access yet raises questions about maintaining such a model long-term. This is one of the very few

<sup>130</sup> The figure comes from a statement by Pôle Digital during KII but could not be verified.

digital tools provided at no cost.

Pôle Digital, through its SWOT analysis,<sup>131</sup> acknowledges the search for additional donor funding. This suggests that while Pôle Digital can support the current scope of agri-tech startups, scalability might become an issue if there is a significant increase in the number of startups creating new solutions.

### 3.3.5. Technology Utilization

#### A. Frontier Technologies

Morocco stands out in the continent with its advanced integration of frontier technologies like AI in agriculture, surpassing developments seen in Sub-Saharan Africa and other case study countries. Such technologies are being adopted at the smallholder farmer level, yet there remains a significant challenge in making these tools accessible and affordable for the entire spectrum for smallholders farmers.

In Morocco, the adoption and integration of frontier technologies such as drones, artificial intelligence, and satellite imagery into agriculture is pretty advanced compared to the other two case study countries.

Morocco's agricultural ecosystem is characterized by large, export-oriented commercial farms driven to adopt advanced technologies, such as drones, AI, and satellite imagery, side by side with smaller local farms. This duality creates different accessibility for the adoption of frontier technologies.

- Initiatives using frontier technologies:** In Morocco's agricultural sector, initiatives like Agro IT Days and Pôle Digital play an important role in promoting frontier technologies.<sup>132</sup> They work together with government efforts to bring advanced tools such as artificial intelligence and satellite imagery to the forefront of agricultural practices. Highly integrated value chains, as seen with COSUMAR, are also driving this tech integration.

#### Use cases of frontier technologies in Morocco with Pôle digital<sup>133</sup>

Pôle Digital's non-exhaustive mapping into frontier technologies reveals that a sizable 38% portion of initiatives are implementing ERP systems, while a close 34% involve drones. About

<sup>131</sup> Pôle Digital. (2023).

<sup>132</sup> The Agro IT Days, an initiative by Morocco's Ministry of Agriculture (under the Directorate of Information Systems) focused this year on promoting "Artificial Intelligence for Sustainable and Resilient Agriculture" through hackathons and showcases of the prominent start-ups in the space which underscores Morocco's ambition to become an innovation hub for Agriculture 4.0 through significant investments in research and development.

<sup>133</sup> Pôle Digital. (2024b). Non exhaustive mapping out of a sample of 93 solutions.

21% are focusing on IoT, weather stations, and sensors.

For instance, COSUMAR/FIMASUCRE solutions include an AI innovation that customizes fertilizer blends to specific soil conditions, potentially reducing fertilizer costs by as much as 30%. Such cost-cutting could significantly benefit farmers economically and also contribute positively to environmental conservation.

Drones are in use for precision agriculture. They survey crop conditions and direct treatment to where it is needed most. Other advancements include intelligent irrigation systems that synchronize weather data with plant growth patterns to optimize water usage. These technologies not only aim to enhance efficiency but also to minimize resource wastage, marking a step forward in sustainable farming practices.

While there has been a push towards high-tech solutions in Morocco's digital agriculture landscape, some researchers during the deep-dive phase are recognizing the need to pivot towards more accessible low-tech options. It requires an approach that distills high-tech advancements into forms that are accessible through more basic means, such as voice notes, straightforward advice, or the direct intervention of agents in the field.

Despite the shift toward low-tech interfacing for smallholder farmers, it still necessitates sophisticated high-tech backend technologies, representing an additional layer of innovation for developers to ensure compatibility and effectiveness.

Nevertheless, the cost remains a barrier. The concept of 'smart farming' is still generally out of reach for smallholders, and even organized value chains face challenges when attempting to implement technology at scale. Conversations with stakeholders like COMADER underscore the need for cost-effective solutions. This relates to the evidence gap in understanding the best models for financing and scaling these technologies so they are attainably priced for smallholder farmers.

### 3.3.6. Cross-Cutting Themes: Gender Dynamics & Climate Resilience

#### A. Gender and Social Norms

In Morocco, initiatives like the Agency for Agricultural Development's use of cooperatives and ONCA's GAP programs are making strides in gender inclusivity in digital agriculture, with efforts like the Centre d'Inclusion des Femmes au Foncier (CIFF) under Pôle Digital addressing women's land rights. However, the explicit impact of these initiatives on women's access to digital tools has been less clear in our scoping through interviews.

Further in-depth assessment is required to understand how gender-specific issues are being addressed directly within digital tools development and deployment, particularly by the private sector.

In 2022, the GSMA estimated that women in the Middle East and North Africa (MENA) region

were 9% less likely to own a mobile phone and 16% less likely to have access to the internet than men.<sup>134</sup> Although national-level figures for Morocco are unavailable, it is important to recognize that this gap likely reflects broader regional trends where women are not specifically targeted for client enrollment or distribution. This context is important to consider for D4AG initiatives in Morocco as it underscores the need to address gender disparities in digital access to ensure equitable benefit distribution.

To address the evidence gap around gender and social norms in the context of digital agriculture in Morocco, the initiatives mentioned during the deep-dive scoping phase should be noted:

- The Agency for Agricultural Development effectively utilizes cooperatives, a common structure for women farmers, as a way for disseminating digital tools and training. Similarly, the ONCA is proactive in incorporating a gender-focused lens within its digital GAP initiatives. Notably, ONCA has established targets for female representation within their field teams, aiming for 30-40% women inclusion.
- Pôle Digital also has a strategic program related to gender, the Centre d'Inclusion des Femmes au Foncier (CIFF), which is pivotal in promoting women's land rights and governance. A critical part of this initiative is the gendered land data observatory tasked with managing gender-disaggregated data, a resource essential for understanding and addressing disparities in land ownership and use. Yet, despite the clear strategic positioning of CIFF within the digital arena and its collaboration with the Millennium Challenge Corporation under Compact Morocco II, details on specific policies or projects that could enhance women farmers' access to digital tools has not been clear during the deep-dive scoping.

While these initiatives showcase progressive steps towards gender inclusivity, the private sector's role in this domain is not well documented, representing a gap in the comprehension of how gender perspectives are being integrated into D4AG by private entities.

## **B. Climate Resilience and D4AG tools**

In Morocco, D4AG is increasingly adopting a climate resilience angle, aligning with the Generation Green initiative. Both the public sector, with initiatives like Pôle Digital's Drought Observatory and ONCA's climate-adaptive advisories, and the private sector's technological solutions, like precision irrigation, are contributing to this aim. However, the real-world efficacy of these innovations, especially for smallholder farmers' resilience, has not been conclusively determined.

Potential themes to explore include the effectiveness of public and private digital tools in bolstering climate resilience and their accessibility to smallholder farmers in the face of

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<sup>134</sup> GSMA. (2023).

growing climate variability.

In Morocco, digital agriculture tools are increasingly focused toward enhancing climate resilience, a pressing concern given the country's vulnerability to climate variability. This topic is particularly pertinent as it aligns with the national Generation Green agenda, which strives to promote sustainable and climate-resilient agricultural practices.<sup>135</sup> Within the nation's digital agriculture ecosystem, both the public and private sectors are active in this area, but the efficacy of these tools, notably for smaller, remains to be thoroughly evaluated.

**Public sector initiatives include:**<sup>136</sup>

- Pôle Digital's Drought Observatory: Pôle Digital has initiated projects that leverage digital advisories for climate resilience through the *Observatoire de la Sécheresse* (Drought Observatory). It collects and provides data for monitoring and managing drought risks. The tools are intended to foster climate adaptation and resilience among farmers;
- ONCA's Initiatives: As the national agricultural advisory organization, ONCA has adapted the information disseminated to include best practices related to climate adaptation and resilience such as weather forecast stations and agricultural apps that offer recommendations for irrigation based on soil data analysis.

**Private Sector contributions:** Technological advancements like drones and smart irrigation systems developed by the private sector are aimed at making farmers more resilient by providing precision agriculture tools that can optimize inputs and reduce resource wastage. While there are some studies on how these technologies benefit farmers—for example, Pôle Digital's studies suggest that certain irrigation systems can reduce water usage by 30%—rigorous assessments of how these tools improve farmers' overall climate resilience are lacking.

According to several researchers during the deep-dive scoping, both private and public sectors in Morocco are discussing digital innovations for climate-smart farming, due to the significant threat that climate change poses to all scales of agriculture in the country. Yet, it is unclear if these tools are genuinely helping smallholder farmers become more resilient in practice.

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<sup>135</sup>The strategy aims at accelerating the transition towards a more climate resilient agriculture initiated under the Generation Green 2020-2030 strategy.

<sup>136</sup> Non-exhaustive lists based on the insights collected during the deep-dive scoping



## 4. Recommendations for IDRC research agenda in Kenya, Senegal, and Morocco

The research agenda outlined below reflects IDinsight's recommendations and is derived from the analysis of the gaps within each country's context from the previous "case study and evidence gaps" section. The suggested research questions aim to address the most significant gaps identified in each respective country's digital agriculture ecosystem while considering IDRC's strategic priorities on climate-resilient food systems.

This agenda prioritizes:

- Addressing knowledge and empirical gaps, which our analysis showed to recur across and within the three focus countries; and
- Evaluating the feasibility of research questions for each gap, with less tangible or actionable gaps being strategically deprioritized in favor of those that can be answered through clear research methods.

For each gap, we suggest a general approach that outlines potential research questions, partners, and subjects. These are intended to be high-level, and should be refined as IDRC formally adopts research questions, and generates requests for proposals.

### 4.1. Kenya - Research agenda

Kenya stands out as one of the most dynamic environments for digital innovation in agriculture within the continent. With a robust mobile money infrastructure, a high-level of mobile penetration, and high digital literacy Kenya possesses the foundational elements necessary for a thriving D4AG ecosystem. This is evident in the number of D4AG solutions being present in-country and relatively high levels of funding. However, despite this maturity, the transformative potential of D4AG remains only partially realized, largely due to unmet needs pointed out by our country's deep-dive, in particular:

#### **1. *Building a D4AG value proposition adapted to farmers' specific needs, and grounded realities***

The emergence of D4AG tools in Kenya, particularly from the private sector, presents a paradox: despite high technology penetration, there is a disconnection between tool offerings and smallholder farmer uptake that was consistently pointed out in the key informant interviews and focus groups. The root cause seems to lie in the misalignment between products that often have a broader, more general value proposition and SHFs' specific needs.

While D4AG providers generally agree on the necessity for tailored solutions —advisories adapted to specific value chains, available in local languages, and appropriate for local contexts— the pathway to achieving this remains unclear.

Tailored solutions require creating technologies that are specifically designed to address the unique challenges faced by specific groups, or even individual smallholder farmers. Such solutions can encompass:

- *Tailored advisory*: These provide actionable recommendations that are relevant to specific crops, local weather patterns, and even individual farm plots;
- *Adaptations to local value chains*: Understanding the idiosyncrasies of local markets and crop value chains can help in crafting tools that assist farmers not just in cultivation, but also in storage, processing, and selling; and
- *Local language support*: Tools should offer interfaces and support in languages and dialects that farmers are comfortable with, improving accessibility.

However, developing hyper-localized advisories is technically challenging and costly. High resolution of data, both geographically and temporally, is necessary, which can be expensive to gather and maintain.

**An effective research agenda would help generate knowledge aimed at navigating and potentially relaxing the barriers around such personalization.** While the level of specificity requested may initially seem impractical, the long-term goal would be to explore innovative methodologies and partnerships, and to create an enabling environment where tailored advisories are feasible and cost-effective at scale.

Proposed high-level approach for this gap	
Potential research questions <i>(non-exhaustive)</i>	<ul style="list-style-type: none"> <li>- To what extent do current data collection methods like bottom-up approaches address the need for tailored advisory information?</li> <li>- What specific methods can effectively capture the local dynamics (e.g., agronomic, climatic) of the Kenyan ecosystem?</li> <li>- What specific types of granular, farmer-level data are most essential for creating tailored D4AG solutions?</li> <li>- How farmer-led innovation can be improved to ensure farmer views are present in the design and trajectory of digitalisation?</li> </ul>
Type of Partners & subject of research	<p><b>Type of partner:</b> Partnership with D4AG providers offering advisory services.</p> <p><b>Subject of research:</b> SHF from different agroecological zones to provide insights into specific local conditions and validate the appropriateness of the advice.</p>

Secondly, Kenyan stakeholders have consistently emphasized the importance of a 'phy-gital'

approach —combining digital technologies with offline support— as a means to scale D4AG solutions effectively. Key informants have highlighted that on-the-ground resources are vital for gathering the crucial farmer feedback required to ensure solutions are robustly grounded in local contexts. Towards this end, the prevailing opinion is that existing community institutions (cooperatives, extension agents) should be leveraged to play a role in delivering context-specific, practical, and actionable information.

**Given such a bottom-up approach, it becomes important to ascertain how partnerships with local institutions such as networks or cooperatives can be more effectively mobilized as key partners and inputters to D4AG innovation.**

Proposed high-level approach for this gap	
Potential research questions <i>(non-exhaustive)</i>	<ul style="list-style-type: none"> <li>- What roles do local institutions, as extension agents play in the adoption and practical use of digital tools by farmers, and how can institutional support structures be enhanced to support a 'phy-gital' mix of interventions for scaled impact?</li> <li>- What approaches can ensure the long-term sustainability of phy-gital D4AG services through partnerships with local institutions? (e.g., cost-sharing models, capacity building for local ownership)</li> </ul>
Type of Partners & subject of research	<p><b>Type of partners:</b> Farmer cooperatives and associations working as partner feedback and ensuring practical adoption of digital tools. Engaging cooperatives offers direct access to farmer networks and leverages established trust and community ties.<sup>137</sup></p> <p><b>Subject of research:</b> Extension services directly linked to the Ministry of Agriculture which can bridge the gap between digital solutions and practical farm applications.</p>

## **2. Building a supporting ecosystem for private-sector digital tools**

Stakeholders mention several challenges including data held in silo by private actors due to fear of competition, whilst a large-scale open-source database from KALRO remains largely inaccessible, leading to inefficiencies. Fostering a more collaborative environment, for example via incentives for open data practices, could accelerate innovation growth of digital services by providing D4AG product designers and engineers with the inputs required to meet pressing needs, including granular, farmer level data necessary to create the tailored solutions described above.

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<sup>137</sup> KENAFF for instance could be a relevant research partner, as the national association of Kenya was met during the KII phase. Its large network and strategic alignment with the Ministry of Agriculture position it as a potential collaborator.

Proposed high-level approach for this gap	
Potential research questions <i>(non-exhaustive)</i>	<ul style="list-style-type: none"> <li>- What factors contribute to the underutilization of open-source databases, especially KALRO, and how can these barriers be effectively mitigated?</li> <li>- What incentive structures could encourage private actors to share their agricultural data, balancing competition with collaboration for sector-wide benefit?</li> <li>- Which models and platforms (e.g data brokers) for data sharing have been successful internationally, and how can these be adapted to fit the Kenyan context to enhance efficiency and innovation in ag-tech services?</li> <li>- What is the potential economic and social impact of improved data accessibility and collaboration on agricultural innovation?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> To promote a supportive environment for private sector D4AG tools, we suggest looking at these questions at the D4AG ecosystem level. This would include D4AG private actors operating in Kenya, as well as KALRO, focusing on qualitative research to pinpoint facilitators and barriers to data sharing.</p> <p><b>Subject of research:</b> The study could look into experiences from other countries where open-source platforms have proven beneficial.</p>

### 3. Further exploring gender gaps in the adoption of D4AG technologies

In Kenya, women in agriculture confront significant barriers that align with the high-level scoping findings. Lower literacy rates and social norms seem to constrain adoption of digital tools, and limited mobile access.

Despite ongoing research, gaps in access to D4AG tools remain, as seen with GROOTS, where D4AG tools may unintentionally perpetuate these inequities. A deeper dive is needed to understand the exact nature of the barriers to use of digital tools faced by women farmers in Kenya, and to identify potential strategies to overcome them.

Such a research agenda might consider the following approaches:

- *Investigate the nuanced barriers faced by women in accessing D4AG tools:* This could include socio-cultural constraints, financial control dynamics, or technology literacy.
- *A women-centered approach for evaluating D4AG tools:* Assessing existing D4AG tools with a gender lens could pinpoint design and operations that overlook the needs of women users. Based on this research, one could develop interventions that directly tackle these barriers. This could lead to gender-specific training programs, inclusive and participative tool development, and policies that ensure equitable access to and

control of D4AG resources. If existing interventions are underway, a research agenda might include impact evaluations.

Proposed high-level approach for this gap	
Potential research questions <i>(non-exhaustive)</i>	<ul style="list-style-type: none"> <li>- How do existing D4AG tools unintentionally perpetuate inequities for women in agriculture, and what modifications are necessary to make these tools more inclusive?</li> <li>- How can participatory design processes be structured to include women farmers effectively and ensure that emerging digital tools are responsive to their needs?</li> <li>- What is the impact of current interventions aimed at bridging the digital gender gap among women farmers in Kenya, and how can these interventions be optimized?</li> <li>- How does the adoption of agroecological business models empower women in agriculture, particularly in accessing resources, enhancing entrepreneurial capacity, and improving organic agriculture production and market outcomes?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> A collaboration with local organizations such as GROOTS Kenya could be an approach due to their track-record of research partnerships,<sup>138</sup> their focus on the use of digital as a strategic pillar to bridge the digital gender gap amongst women in Kenya, and the number of their projects targeting rural women through digital tools. This collaboration is also in line with GROOTS Kenya's strategic objectives, leveraging research findings to enhance their initiatives focused on women in digital agriculture.</p> <p><b>Subject of research:</b> A partnership with a local entity like GROOTS Kenya could serve a dual purpose: securing a research partner knowledgeable in the nuances of gender and agriculture, as well as gaining access to a network of women farmers who are both users and non-users of digital tools.</p>

#### 4. Deeper research on D4AG business models and ability to pay

Taking into account the recommendations from the CTA and Dalberg (2019),<sup>139</sup> the collaborative report by USAID and KALRO (2023),<sup>140</sup> and insights from in-depth interviews, we acknowledge the need to enhance the understanding of farmers' willingness to pay for advisory services. Specifically, there is a requirement to quantify the value that farmers assign

<sup>138</sup> According to information gathered from our interviews, GROOTS has previously collaborated with the Gates Foundation on a study focusing on digital inclusion, highlighting their active role and existing research efforts in the realm of digital technology within grassroots communities.

<sup>139</sup>CTA and Dalberg. (2019).

<sup>140</sup>Kamau et al. (2024).

to digital services, which can guide decisions regarding the development of appropriate tools and strategies for their funding. Willingness to pay is related to the perceived value of the digital tools, trust, affordability and accessibility.

Proposed high-level approach for this gap	
Potential research questions <i>(non-exhaustive)</i>	<ul style="list-style-type: none"> <li>- How do farmers perceive the value of different D4AG services, in particular advisory services, and how does this perception influence their willingness to pay?</li> <li>- To what extent does trust play a role in farmers' willingness to pay for digital agriculture services, and how can D4AG providers build and maintain this trust?</li> <li>- To what extent does the personalization of digital advisory services impact the willingness to pay among farmers, and how can such customization be scaled?</li> <li>- What non-financial barriers prevent the adoption of D4AG services even when farmers recognize their potential value?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> Partnering with D4AG service providers will enable to gather data on the variety and adoption of digital services. While the USAID study provided insights on KALRO weather advisory digital services,<sup>141</sup> the goal would be to expand across advisory services and to other verticals such as market access digital tools, informing how to tailor these tools to enhance perceived value.</p> <p><b>Subject of research:</b> (i) Farmers using D4AG services to quantify the value they place on these services and identify factors affecting their payment decisions; (ii) Farmers unfamiliar with D4AG services to assess baseline willingness to pay and barriers outside the digital scope; or (iii) D4AG service providers (including advisory services) to understand how they are building trust and personalizing services, influencing farmers' perceptions of value.</p>

## 4.2. Senegal - Research agenda

Senegal's D4AG ecosystem remains nascent and entrepreneurial, mostly made up of private companies. While there is a clear recognition of the value of digital tools for agriculture, stakeholders are hoping to bridge the constraints that limit the development of that

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<sup>141</sup> *ibid*

ecosystem, specifically:

- *Limited support from the government:* Currently, the Senegalese government's direct support for D4AG initiatives is limited in terms of funding, data sharing and technical assistance to private initiatives leaving a void that could limit the growth of the D4AG ecosystem;
- *Lack of trust in publicly available data:* There is a sense of skepticism in data among various agricultural stakeholders, partly due to alleged mistrust towards government-collected data and a lack of transparent practices; and
- *Disorganized value chains:* The agricultural value chain in Senegal is highly fragmented, which creates barriers for D4AG services to effectively integrate and deliver solutions that can operate at scale. Addressing these foundational issues is crucial for creating a conducive environment where D4AG can flourish.

We suggest focusing on the following three key areas that call for further exploration and developing research questions that could be addressed by IDRC.

### 1. Investigating data sharing in the D4AG ecosystem.

The trust in data sharing encompasses challenges that, while not confined to the D4AG ecosystem, significantly affect its functioning in the way D4AG actors engage with and utilize agricultural data.

Stakeholders, through interviews, have suggested that willingness to share and use data could help enhance the efficacy and impact of D4AG services. **There is a need to investigate the drivers of the lack of data sharing practices in Senegal.** However, tackling this issue may involve navigating through governance decisions, which necessitates a nuanced approach, with an understanding that changes may be slow and require coordination across all sectors involved. Potential research questions include:

Proposed high-level approach for this gap	
Potential research questions ( <i>non-exhaustive</i> )	<ul style="list-style-type: none"> <li>- What are the key challenges and opportunities for stakeholders in overcoming issues around the trust in data sharing within the Senegalese D4AG ecosystem?</li> <li>- What drives the mistrust in government-collected data, and how can these low levels of trust be understood and mitigated? If data reliability is one of the issues, what can be done to enhance reliability and increase public confidence?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> (i) Partnering with D4AG services providers in Senegal (private organizations), and (ii) engaging with agencies responsible for data collection (e.g. ANACIM, ANSD) to provide insights into the current state of data governance and potential areas for enhancing reliability and trust.</p> <p><b>Subjects of research:</b> The reliability gap should be approached</p>



	<p>considering whether the answers will be actionable and capable of implementation on a reasonable timeframe, and within stakeholders' capacity to adapt to proposed trust-building measures. Also, it is worth evaluating how similar challenges have been approached in different contexts and whether effective solutions have been operationalized elsewhere.</p>
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**2. Value chain fragmentation and its impact on the effectiveness of D4AG tools in-country**

The fragmentation of the agricultural value chain in Senegal poses a question of how to effectively integrate D4AG services in a way that can support the entire chain. The effectiveness of D4AG tools is contingent upon addressing interconnected issues across the entire value chain. To truly transform agriculture, digital interventions must be holistically designed, tackling barriers end-to-end, financial or otherwise. A coherent research agenda in Senegal should look at key points of fragmentation and how to overcome those.

Potential research questions to guide research include:

Proposed high-level approach for this gap	
Potential research questions ( <i>non-exhaustive</i> )	<ul style="list-style-type: none"> <li>- What are the key points of fragmentation within Senegal's agricultural value chain, and how can D4AG solutions be tailored to overcome these barriers to both ends of the value chain?</li> <li>- How can insights from successful integrations of D4AG in other regions with fragmented value chains inform the development of such services in Senegal?</li> <li>- How can D4AG services be designed to address the interconnected issues across Senegal's agricultural value chain, from production to distribution and consumption?</li> <li>- What would be the impact of value-chain integrated D4AG solutions on Senegalese smallholder farmers to accelerate co-learning in sustainable food systems?</li> </ul>
Type of partners & subject of research	<p><b>Type of partners:</b> Digital solutions that facilitate access to markets for inputs, or output markets (e.g. Afrikamart or mLouma) are potential relevant partners of research as their services are solving one or more value chain barriers in the context of SHF.</p> <p><b>Subjects of research:</b> Actionable research should examine case studies highlighting both successes and failures in similar contexts, focusing on the role digital tools have played in promoting better integration. The emphasis would be on strategic, digital interventions that enhance connectivity and efficiency within the current value</p>

chains.

### 3. Understanding gender dynamics in D4AG access

This gap emphasize **significant disparities in how women access and benefit from D4AG services in Senegal**,<sup>142</sup> including (i) broader barriers and challenges that limit women in accessing D4AG services, (ii) shortfalls in addressing gender inclusivity by D4AG actors, and (iii) limited data quantifying the impacts gender gaps, including case studies on gender programs being implemented by D4AG providers.

The proposed research gap aims to build on existing research.

Proposed high-level approach for this gap	
Potential research questions (non-exhaustive)	<ul style="list-style-type: none"> <li>- What specific gender-approaches are being implemented by D4AG innovators and public institutions in Senegal, and how effective are they in addressing gender inequalities?</li> <li>- What are the specific barriers limiting women's participation in D4AG services in Senegal, and what targeted interventions have been most effective in overcoming these challenges?</li> <li>- How does the gender of field agents affect the uptake of D4AG services by women, and what (other) approaches can increase female representation and effectiveness in these roles?</li> </ul>
Type of partners & subject of research	<p><b>Type of partners:</b> Conduct in-depth case studies on providers like Jokolante and Soreetul, which have a focused gender component, along with ANCAR projects that integrate elements of D4AG, to uncover best practices and areas for improvement.</p> <p><b>Subjects of research:</b> Employ a mixed-methods approach, blending quantitative data analysis with qualitative insights from stakeholder interviews and focus groups, to develop a nuanced understanding of gender dynamics in D4AG service usage.</p>

## 4.3. Morocco - Research agenda

Morocco's trajectory in integrating D4AG is characterized by a strong governmental commitment to engaging all farmers in digital agriculture. This is encapsulated in the Generation Green 2020-2030 initiative, which targets the integration of over 2 million farmers into digital platforms by the close of the decade. The establishment of Pôle Digital in 2022

<sup>142</sup> Winrock International. (2023).

symbolizes the government's strategic efforts to coordinate D4AG initiatives, ensuring a cohesive development within this sector. The success of these initiatives may be facilitated by the country's well-structured agricultural value chains, which are conducive to the integration and emergence of D4AG solutions adapted to farmers needs.

Additionally, key research institutions like UM6P, INRA, and ENA-Meknès, are developing work in the D4AG field in partnership with governing bodies including Pôle Digital. They possess extensive knowledge of the ecosystem and its challenges and could be relevant organizations as study partners.

### 1. *Developing impact assessments of the existing tools promoted by the Pôle Digital and government actors.*

**There is a scarcity of robust methodologies for evaluating the impact of D4AG initiatives.** Efforts to initiate such assessments are underway, especially in partnership with entities like Pôle Digital. The scoping review identified a key limitation within the D4AG ecosystem: the absence of standardized methodologies for measuring impact. This finding is particularly relevant considering the nascent stage of D4AG implementation. Currently, tools are primarily evaluated based on their commercial effectiveness, and, while research institutes possess knowledge of impact methodologies, these have not yet been implemented in the context of D4AG.

Proposed high-level approach for this gap	
Potential research questions (non-exhaustive)	<ul style="list-style-type: none"> <li>- What best practices from other sectors can be adapted to create effective short-term and long-term measurement methodologies for D4AG initiatives in Morocco?</li> <li>- What has been the measured impact of specific D4AG tools or programs implemented by Pôle Digital (e.g., <i>Réseau de Fermes Digitales</i>) on farmer outcomes, and how can these measurements inform future scaling?</li> <li>- What role do various stakeholders (e.g., farmers, technology providers, policymakers) play in the development and adoption of standardized impact measurement methodologies for D4AG?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> This effectiveness gap could be assessed through a partnership with Pôle Digital, leveraging their <i>Réseau de Fermes Digitales</i>, to improve the understanding of the impact at the farmer-level of the D4AG services being piloted under this program.</p> <p><b>Subjects of research:</b> According to the insights from the deep-dive, while the D4AG tools are currently tested to ensure they meet farmer needs, no standardized impact metrics are being used. Introducing impact assessment methodologies could support in evaluating the true benefits and areas for improvement of the D4AG initiatives.</p>

## 2. Assessing the inclusivity of Morocco D4AG initiatives

There is a critical knowledge gap regarding the comparative inclusivity and effectiveness of high-tech advanced technologies (e.g., drones, AI) versus low-tech digital services for Moroccan farmers. While initiatives like ONCA, AI Moutmir, and Pôle Digital aim for inclusivity through D4AG growth programs, their focus on promoting advanced technologies (drones, AI) raises questions about accessibility for small-scale farmers.

Proposed high-level approach for this gap	
Potential research questions (non-exhaustive)	<ul style="list-style-type: none"> <li>- How do high-tech advanced technologies (e.g., drones, AI) compare to low-tech digital services in terms of inclusivity and accessibility for small-scale Moroccan farmers?</li> <li>- What are the factors influencing the appropriation of such technologies (e.g. self reported benefits)?</li> <li>- Among the mission of reaching "2 million farmers to digital platforms by 2030," how inclusive is the Pôle digital project in reaching smallholder farmers?</li> <li>- What are the social and economic impacts of promoting high-tech advanced technologies over low-tech digital services on small-scale farming communities in Morocco?</li> <li>- What actions need to be taken to ensure that digital divides do not deepen, avoiding a scenario where some farmers are 'left behind' (i.e., digital exclusion)?</li> </ul>
Type of partners & subjects of research	<p><b>Type of partners:</b> Given their focus on developing cost-effective technologies with efficient transfer methods for SHFs, ENA-Agri Tech emerges as a potentially valuable partner for investigating the effectiveness of D4AG programs for this population group in Morocco. Their research experience in this specific domain suggests they possess relevant expertise and potentially hold crucial data on technology adoption among SHFs.</p> <p><b>Subjects of research:</b> The study population should include a representative sample of farmers across different regions and scales of operations (small, medium, and large). This sample could be used in a mixed-methods descriptive evaluation that includes a sample survey, KIs and focus groups. This will ensure that the findings are comprehensive and reflect the diversity of the farming community in Morocco.</p>

## 3. Understanding gender disparities in D4AG adoption in Morocco

According to the scoping review in Morocco, initiatives aimed at integrating female SHFs into D4AG programs remain ill-defined. **Specific barriers hindering technology adoption by**

**women are not well documented, reflecting a broader gender gap in agricultural research within the country.** This ambiguity calls for a detailed investigation into how existing programs, like those with gender KPIs set by ONCA, translate into real-world digital practice adoption among female farmers.

Proposed high-level approach for this gap	
Potential research questions ( <i>non-exhaustive</i> )	<ul style="list-style-type: none"> <li>- What are the specific barriers hindering the adoption of D4AG technologies by female SHFs in Morocco compared to other SSA countries?</li> <li>- How effective are existing D4AG programs in Morocco at promoting digital technology adoption among female SHFs?</li> <li>- How do digital literacy and access to resources affect the participation of female SHFs in D4AG programs in Morocco?</li> </ul>
Type of Partners & subject of research	<p><b>Potential study partners:</b> ONCA has programs directly integrating gender KPIs focused on advisory services, making it a potential partner for understanding and enhancing female SHF participation in D4AG programs.</p> <p><b>Subject of research:</b> Female smallholder farmers are the primary group under investigation.</p>

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# Appendix

## Appendix A - List of Abbreviations and Acronyms

- **ADA** (Agence pour le Développement Agricole) - Agricultural Development Agency
- **AI** - Artificial Intelligence
- **AICCRA** - Advancing Climate Change Resilience in Agriculture
- **ANCAR** (Agence Nationale de Conseil Agricole et Rural) - National Agency for Agricultural and Rural Advising
- **ANACIM** (Agence Nationale de l'Aviation Civile et de la Météorologie) - National Agency of Civil Aviation and Meteorology
- **ANSD** (Agence Nationale de la Statistique et de la Démographie) - National Agency of Statistics and Demography
- **ASTGS** - Agricultural Sector Transformation and Growth Strategy
- **B2B** - Business-to-Business
- **B2C** - Business-to-Consumer
- **CAM** - Crédit Agricole du Maroc
- **CIFF** (Centre d'Inclusion des Femmes au Foncier) - Center for Women's Land Inclusion
- **CNAAS** (Compagnie Nationale d'Assurance Agricole du Sénégal) - National Agricultural Insurance Company of Senegal
- **CNDP** (Commission Nationale de Contrôle de la Protection des Données à Caractère Personnel) - National Commission for Data Protection
- **COMADER** (Confédération Marocaine de l'Agriculture et du Développement Rural) - Moroccan Confederation of Agriculture and Rural Development
- **CGIAR** - Consultative Group on International Agricultural Research
- **D4AG** - Digital for Agriculture
- **DSS** (Direction de la Stratégie et des Statistiques) - Directorate of Strategy and Statistics
- **DSI** (Direction des Systèmes d'Information) - Directorate of Information Systems
- **DVI** - Digital Village Initiative
- **ERP** - Enterprise Resource Planning
- **FAO** - Food and Agriculture Organization
- **FCDO** - Foreign, Commonwealth & Development Office (FCDO),
- **FGD** - Focus Group Discussion
- **GAP** - Good Agricultural Practices
- **GIZ** - Deutsche Gesellschaft für Internationale Zusammenarbeit
- **IFAD** - International Fund for Agricultural Development
- **IAV II** (Institut Agronomique et Vétérinaire Hassan II) - Agronomic and Veterinary Institute Hassan II
- **ILRI** - International Livestock Research Institute
- **INRA** (Institut National de la Recherche Agronomique) - National Institute of Agronomic Research
- **KADP** - Kenya Agricultural Development Program
- **KAOP** - Kenya Agricultural Outreach Program
- **KALRO** - Kenya Agricultural and Livestock Research Organization

- **KCSAS** - Kenya Climate Smart Agriculture Strategy
- **KENAFF** - Kenya National Farmers' Federation
- **KII** - Key Informant Interview
- **KYC** - Know Your Customer
- **LLM** - Large language model
- **MAPMDREF** (Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts) - Ministry of Agriculture, Maritime Fisheries, Rural Development, Water and Forests
- **MENA** - Middle East North Africa
- **NA** - North Africa
- **OCP** - Office Chérifien des Phosphates
- **ONCA** (Office National du Conseil Agricole) - National Office for Agricultural Counseling
- **PSE** (Plan Sénégal Émergent) - Emerging Senegal Plan
- **SHF** - Smallholder Farmer
- **SN2025** (Stratégie Sénégal Numérique 2025) - Digital Strategy for Senegal 205
- **SSA** - Sub-Saharan Africa
- **UNCDF** (Fonds des Nations Unies pour le Capital-Développement) - United Nations Capital Development Fund
- **UNDP** (Programme des Nations Unies pour le Développement) - United Nations Development Programme
- **UM6P** (Université Mohammed VI Polytechnique) - Mohammed VI Polytechnic University
- **VSLA** - Village Savings and Loan Association

## Appendix B - List of Interviews conducted

List of organizations with whom we conducted sessions during the high-level scoping and the deep-dive scoping in-country.

### A. High-level scoping interviews

*The Key Informant Interviews conducted as part of this study were scoped to have a continental reach, thereby not focusing on individual country-specific details, to ensure a wide-ranging understanding of the region as a whole.*

Actor type	Name of the organization
<p style="text-align: center;"><b>UN Development agencies and government bodies</b></p>	<ul style="list-style-type: none"> <li>• <b>GIZ, SAIS</b> (Deutsche Gesellschaft für Internationale Zusammenarbeit, Scaling digital Agriculture Innovations through Start-ups)</li> <li>• <b>IFAD</b> (International Fund for Agricultural Development)</li> <li>• <b>Pôle digital - Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts du Maroc</b> (Digital Hub - Ministry of Agriculture, Maritime Fisheries, Rural</li> </ul>

	<p>Development, and Water and Forests Morocco)</p> <ul style="list-style-type: none"> <li>● <b>UNCDF</b> (United Nations Capital Development Fund)</li> </ul>
<b>Investors and incubators</b>	<ul style="list-style-type: none"> <li>● <b>Catalyst Fund</b></li> <li>● <b>Digital Africa</b></li> <li>● <b>Katapult</b></li> <li>● <b>Startupbootcamp</b></li> </ul>
<b>Digital Agriculture researchers and strategic advisors</b>	<ul style="list-style-type: none"> <li>● <b>CGAP</b> (Consultative Group to Assist the Poor)</li> <li>● <b>Development Gateway</b></li> <li>● <b>GSMA Agri-Tech</b></li> <li>● <b>IDH</b> (Initiative for Sustainable Trade)</li> <li>● <b>ISF Advisors</b></li> <li>● <b>Jengalab</b></li> <li>● <b>60 Decibels</b></li> </ul>
<b>Digital services providers</b>	<ul style="list-style-type: none"> <li>● <b>AgUnity</b></li> <li>● <b>agrocenta</b></li> <li>● <b>CoAmana</b></li> <li>● <b>Crop2cash</b></li> <li>● <b>Farmerline</b></li> <li>● <b>Farmz2U</b></li> <li>● <b>HelloTractor</b></li> <li>● <b>Jangolo</b></li> <li>● <b>Moome</b></li> <li>● <b>OKO</b></li> <li>● <b>wiAgri</b></li> </ul>

## B. Deep-dive scoping interviews

<b>KENYA</b>	
<b>Actor type</b>	<b>Name of the organization</b>
<b>Governing bodies</b>	<ul style="list-style-type: none"> <li>● <b>KALRO</b> - Kenya Agricultural and Livestock Research Organization</li> <li>● <b>KeFAAS</b> - Kenya Forum for Agricultural Advisory Services</li> </ul>
<b>D4AG/D4AG support organizations</b>	<ul style="list-style-type: none"> <li>● <b>Apollo Agriculture</b></li> <li>● <b>CARE Kenya</b></li> <li>● <b>GIZ Digital Transformation Center Kenya</b></li> <li>● <b>World Bank</b></li> <li>● <b>Mercy Corps AgriFin</b></li> <li>● <b>GROOTS Kenya</b></li> </ul>

<b>Research organizations</b>	<ul style="list-style-type: none"> <li>● <b>ILRI/CGIAR</b> - International Livestock Research Institute / Consultative Group on International Agricultural Research</li> <li>● <b>IFPRI/CGIAR</b> - International Food Policy Research Institute / Consultative Group on International Agricultural Research</li> <li>● <b>JKUAT</b> - Jomo Kenyatta University of Agriculture and Technology</li> <li>● <b>Kenyatta University</b></li> <li>● <b>PxD</b> - Precision for Development</li> </ul>
<b>Farmer Associations</b>	<ul style="list-style-type: none"> <li>● <b>KENAFF</b> - Kenya National Farmers' Federation</li> <li>● <b>Women's Farmers Association of Kenya</b></li> </ul>

<b>SENEGAL</b>	
<b>Actor type</b>	<b>Name of the organization</b>
<b>Governing bodies</b>	<ul style="list-style-type: none"> <li>● <b>ANCAR</b> - Agence Nationale de Conseil Agricole et Rural (National Agency for Agricultural and Rural Advisory Services)</li> </ul>
<b>D4AG/D4AG support organizations</b>	<ul style="list-style-type: none"> <li>● <b>Afrikamart</b></li> <li>● <b>Soreetul</b></li> <li>● <b>Yeesal AgriHub</b></li> </ul>
<b>Research organizations</b>	<ul style="list-style-type: none"> <li>● <b>CORAF</b> - Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricole (West and Central African Council for Agricultural Research and Development)</li> <li>● <b>IPAR</b> - Initiative Prospective Agricole et Rurale (Agricultural and Rural Foresight Initiative)</li> <li>● <b>ISRA</b> - Institut Sénégalais de Recherches Agricoles (Senegalese Institute of Agricultural Research)</li> <li>● <b>UCAD - CEA Agrisan</b> - Université Cheikh Anta Diop - Centre d'Excellence Africain en Agriculture pour la Sécurité Alimentaire et Nutritionnelle (Cheikh Anta Diop University - African Center of Excellence in Agriculture for Food Security and Nutrition)</li> <li>● <b>RTI International Senegal</b></li> </ul>
<b>Farmer Associations</b>	<ul style="list-style-type: none"> <li>● <b>COLIER</b> (Producer organization)</li> </ul>

<b>MOROCCO</b>	
<b>Actor type</b>	<b>Name of the organization</b>

<p><b>Governing bodies</b></p>	<ul style="list-style-type: none"> <li>● <b>COMADER</b> - Confédération Marocaine de l'Agriculture et du Développement Rural (Moroccan Confederation of Agriculture and Rural Development)</li> <li>● <b>Direction des systèmes d'information, Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts</b> - Directorate of Information Systems - Ministry of Agriculture</li> <li>● <b>Direction des Statistiques et de la Stratégie, Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts</b> - Directorate of Information Systems - Ministry of Agriculture</li> <li>● <b>ONCA</b> - Office National du Conseil Agricole (National Office for Agricultural Advisory)</li> <li>● <b>Pole Digital - Ministère de l'Agriculture</b> - Digital Hub - Ministry of Agriculture (Morocco)</li> </ul>
<p><b>D4AG/D4AG support organizations</b></p>	<ul style="list-style-type: none"> <li>● <b>Crédit Agricole Maroc</b></li> <li>● <b>PCS Agri</b></li> <li>● <b>SoWIT</b></li> </ul>
<p><b>Research organizations</b></p>	<ul style="list-style-type: none"> <li>● <b>ENA Meknès (ENA-Ag-tech)</b> - École Nationale d'Agriculture de Meknès (National School of Agriculture in Meknès - Agriculture Technology)</li> <li>● <b>INRA Meknès</b> - Institut National de la Recherche Agronomique de Meknès (National Institute of Agronomic Research in Meknès)</li> <li>● <b>UM6P</b> - Université Mohammed VI Polytechnique (Mohammed VI Polytechnic University)</li> </ul>
<p><b>Farmer Associations</b></p>	<ul style="list-style-type: none"> <li>● <b>FIMASUCRE</b> - Fédération Interprofessionnelle Marocaine du Sucre (Moroccan Interprofessional Sugar Federation)</li> </ul>

## Appendix C - Interview guide for focus group discussions

*Note: Interview guide used for focus group discussions across the three case study countries (Senegal, Kenya, Morocco) with smallholder farmer groups during the deep-dive phase. Questions within this guide were adapted to accommodate each context or profile of the participating farmers.*

*Focus group discussions had the following guidelines*

- *Two groups of 5-10 SHF aiming for a representation of both male and female farmers, with groups disaggregated by gender.*



- *A moderator/translator will be there to support the IDinsight lead. The moderator received training beforehand to get context.*

**Objective of the focus group discussions:** The focus group discussion aims to identify key characteristics of farmers' attitudes toward digital technologies.

## **I. Introduction**

- *Introduce the team, the IDRC study, and the purpose of the FGD.*
- *Explain the importance of farmers' input and how the data will be used for the study*
- *Set rules of discussion*
- *Ask for authorization to record the discussion*
- *Define what is understood by digital tool*

## **II. Discussion on digital tools**

### **Introduction**

- 1) To enhance our understanding, we would appreciate learning a bit more about your personal farming context along with the digital aspect. When it is your turn, please tell us:
  - a) The type of crops you are growing,
  - b) Which crop do you grow to feed your family and which crop do you grow to sell?
  - c) Is farming your main way of making money?
  - d) Do you own the land you farm on, or is it rented?
  - e) Approximately, how large is the area of land that you farm?

### **Theme #1: Digital Tool Usage**

#### ***For farmers using a digital tool***

- 2) Do you use any kind of digital tools to help with your farming, like mobile apps for weather or farming advice, SMS services, or records management?
  - a) If yes, how long you've been using these digital tools?
  - b) Have you used any other tool before?
- 3) Let's talk about the specific digital tools or services you use in your farming. What are they, and what features do you find most helpful?
- 4) I'm curious, how did you first learn about these digital tools?

***For farmers not using formal digital tools:*** Note some farmers are not using proper digital apps, the guide was adapted with additional questions.

- For those who haven't adopted formal digital tools for farming assistance, what are the main reasons for this choice?

- What methods do you rely on to gain farming knowledge and stay updated with agricultural practices?
- Have you encountered any barriers to accessing digital tools, such as smartphones, internet connectivity, or user-friendly apps?

### **Theme #2: D4AG Impact, Adoption, and Effectiveness**

- 5) Think back to when you first decided to try out digital tools for your farm:
  - a) What were the benefits (such as easier access to market prices, better farming tips, etc.) that made you interested in these tools?
  - b) On the other hand, were there any specific difficulties or needs in your farming practice that made the use of digital tools feel essential or urgent?
  - c) Were there any initial doubts or hesitations you had to overcome?
- 6) I would like to understand better the main challenges you face in your farming activities today.
  - a) Do you think the digital tools you're using are effective in helping you improve your farming?
  - b) In what ways have they been beneficial or not?
  - c) Do you feel digital tools are addressing your exact needs? What could they do/change to meet your needs?
- 7) Does anyone have a specific story or example of how a digital tool directly benefited your farming activities?
- 8) Can you tell us about how often and in what situations you use these digital tools? Have they become a regular part of your farming routine?

### **Theme #3: Challenges, accessibility and Training**

#### ***Challenges and barriers in accessing digital tools***

- 9) Let's talk about getting to these digital tools.
  - a) Are you able to access them easily, and is your internet and power supply dependable enough for their use?
  - b) Could you tell us what challenges you face or reasons you might hesitate to use more?
- 10) How easy do you find these digital tools to use? What, specifically, could be done to make them simpler for you?

#### ***Training and learning***

- 11) Reflect on when you first learned to use these digital tools.
  - a) What kind of training did you receive?
  - b) What parts of the process were easy or hard?
  - c) What could have been done better?
- 12) Do you need additional training and support?
  - a) If so, what kind of training or support?
- 13) When you run into issues with these tools in terms of understanding the information on the app, how do you overcome them?

- a) Do you get help from your community, family, or the tool providers?

#### **Theme #4: Specific D4AG benefits**

##### ***Climate change***

- 14) Climate change:** Has any digital tool helped you respond to weather changes or manage climate issues on your farm? If so, how do these tools help you plan better for such events?

***Effectiveness of Digital Advisory Services:*** Only if the digital tool used include digital advisory (weather alert, weather advisory, good agricultural practices advisory)

- 15) When you receive advice from digital tools, how often do you find yourself following it as given, and how often do you not follow it?
- 16) Do you believe all of the information is relevant for the type of crops you grow?
- a) Do you wish the information was more specific?
- b) Is the information sometimes false or misleading?

##### ***Need assessment***

- 17) Are there specific features of digital tools or types of information that you find lacking or would like to have?
- 18) Are there other digital tools or services you've heard about that you're interested in? What have you heard from others that might be useful for your farm?

## **Appendix D - High-level scoping report**

*For additional context and detailed findings on the high-level scoping phase, please refer to the high-level scoping report provided in the appendix below.*

High-level scoping findings [\[External\]](#)