CONNECTING COMMUNITIES OR CORPORATIONS?

Digital Agriculture, Data Harvests and Food Sovereignty in Kenya

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Connecting Communities or Corporations? Digital Agriculture, Data Harvests and Food Sovereignty in Kenya

Thika, Kenya

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Acknowledgments

This project was funded by the Dutch Research Council (NWO) SSH Open Competition XS Grant (No. 406.XS.01.138).

Special thanks to: Ashley Fent and Sabrina Masinjila for reviewing the text before publication.

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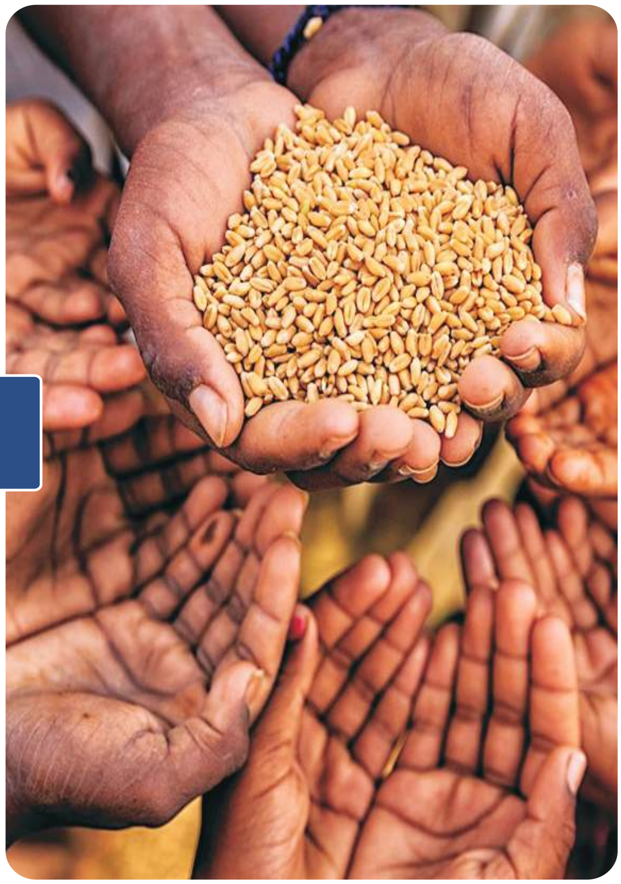

ABBREVIATIONS AND ACRONYMS

AFSA	Alliance for Food Sovereignty in Africa
AFRI-TAP	The African Technology Assessment Platform
AGRA	Alliance for Green Revolution in Africa
API	Application Programming Interface
ASTGS	Agricultural Sector Transformation and Growth Strategy
BGMF	Bill and Melinda Gates Foundation
CSO	Civil Society Organization
ISFAA	The Intersectoral Forum on Agrobiodiversity and Agroecology
KALRO	Kenya Agriculture and Livestock Research Organization
KAOP	Kenya Agricultural Observatory Platform
KCEP-CRAL	Kenya Cereal Enhancement Programme Climate Resilient Agriculture Livelihoods Window
KIAMIS	Kenya Integrated Agricultural Management Information System
MoALD	Ministry of Agriculture and Livestock Development
NGO	Non Governmental Organization
SAP	Structural Adjustment Programs
USSD	Unstructured Supplementary Service Data
USAID	United States Agency for International Development
VBA	Village Based Advisor

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Executive Summary

Digital technologies are rapidly being integrated into agriculture and food systems. In Kenya, and Africa more broadly, philanthropies, foreign aid donors and the private sector are promoting digital technologies as a key intervention for economic development, ecological sustainability and food security. However, despite the fervor surrounding these technologies, concrete evidence of their effectiveness remains sparse. Though digital technologies hold promise in extending communication and information-based services to rural populations, there are also risks that these technologies could exacerbate existing inequalities and disrupt social and ecological relationships. **Given the widespread consensus that small-scale food producers should be primary beneficiaries of this so-called "digital revolution," it is imperative that these technologies are assessed from their perspective.**

Kenya is currently a leading hub for digital agriculture on the African continent. The country boasts a dynamic ecosystem of start-ups, development organizations, consultancies, and foundations dedicated to the digitalization of agriculture. A core group of these actors are also part of the coalition supporting the Green Revolution—an approach to agricultural development that promotes the use of synthetic fertilizers, commercial seeds, and agrochemicals. Although the Green Revolution similarly claimed to deliver food security, previous research has found that it failed to do so. In light of these unmet promises, the involvement of the same organizations in digitalization raises crucial questions: Will this digital revolution merely reinforce the shortcomings of the Green Revolution, or can it effectively address Kenya's current challenges and move the country toward a more sustainable food systems and food security?

To evaluate the impacts of digital technologies, this report presents a qualitative case study of Makueni County, Kenya. Makueni has actively adopted digital solutions in its efforts to enhance farmer livelihoods and tackle climate change-related stresses. This report specifically assesses these technologies through the lens of agroecology —a food system transformation approach favored by farmers' organizations, social movements, and civil society in Kenya and across Africa. Agroecology emphasizes ecological sustainability and social equity, which can enable communities to have greater food sovereignty and control over food systems.

The findings reveal that **although digital agricultural technologies theoretically hold the potential to support agroecology by advancing elements such as diversity, knowledge co-creation, efficiency, recycling, and a circular economy, their current development is predominantly driven by private sector interests.** Private sector developers often focus on profitable business models that involve data extraction, commercial inputs, and financial services, with current reliance on donor funding. The research highlights significant risks for small-scale food producers, including threats to data privacy and security, unequal access to digital technologies, misalignment with farmers' needs, and potential erosion of farmer autonomy and food sovereignty.

This report emphasizes that to enable food sovereignty and agroecology, the impact of digital agricultural technologies must be evaluated based on the kinds of connections they foster, and their implications for farmer agency, ecological sustainability, and socio-economic equity. To ensure that digital technologies better align with the rights and needs of small-scale food producers, the report identifies multiple recommendations for civil society, the private sector, and the government.

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These recommendations were developed by Kenyan civil society organizations during a workshop organized in Nairobi in May 2024 by **BIBA Kenya**, in which the findings from this study were presented. These recommendations include:

Civil society organizations should:

- Raise awareness and educate farmers about data and digital technologies
- Enhance the knowledge and capacity of civil society and farmers on data privacy and protection
- Leverage appropriate technologies to encourage and support young people in adopting agroecological approaches
- Utilize digital technology to enable farmer-to-farmer learning and horizontal knowledge
- Develop inclusive technology assessment programs

Technology providers should:

- Co-create digital technologies with farmers that address their needs and livelihood constraints
- Enhance transparency on sponsored content and data sharing

Donors should:

- Incentivize technology developers and governments to advance digital technologies that promote agroecology
- Fund capacity building for civil society to engage in agricultural data governance

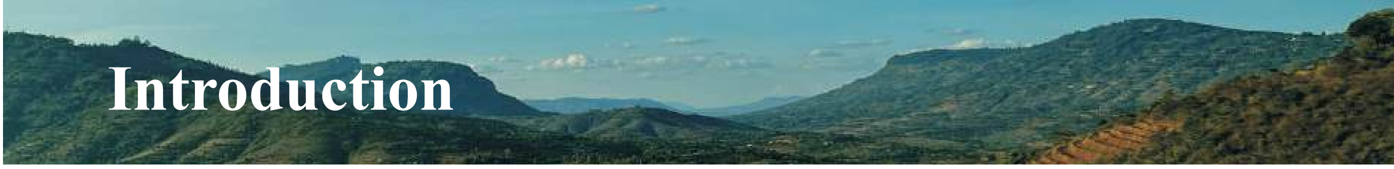
The Government of Kenya and County governments should:

- Strengthen data privacy protection for agricultural data
- Enhance transparency and privacy in private sector data collection
- Establish a framework to protect biodiversity and farmer-managed seed systems amid increasing digitalization of plant genetic resources
- Include agroecology practitioners as stakeholders in data governance policies
- Develop and enforce data governance regulations at the county level
- Ensure credibility and neutrality of content on digital apps
- Incorporate digital technologies into the National Agroecology Strategy
- Develop a transparent framework to identify agroecologically appropriate technology

All stakeholders should work together to:

- Refine the meaning and practice of informed consent
- Develop new models of human rights-based data governance that respect farmers' rights

chapter 1.



Introduction

Over the past decade, digital technologies have rapidly integrated into agricultural production and food systems. These technologies encompass a wide range of tools, including mobile phone applications, sensors and robots that collect vast amounts of data on food systems. This data is harvested for analysis using machine learning and artificial intelligence with the aim of providing decision-making support and predictive analytics. Together these technologies are described as the "Fourth Agricultural Revolution" due to the significant changes they herald.

Digital agriculture technologies are being presented worldwide as the solution to the pressing challenges facing agricultural and food systems, including high food insecurity, malnutrition, poverty and the impacts of climate change, all of which necessitate agricultural transformation.[1] In Africa, proponents of digitalization suggest that small-scale food producers experience immense benefits from digital technologies, including "access to real timely price, market and farming information and safe financial transactions, alternative value chain linkages, multifaceted knowledge, better earning and yield, reduced costs, social well-being and risk minimization, women empowerment benefits."[2] A wide range of actors are therefore now engaged in funding digital agriculture and advocating for digital transformation of food systems.

However, despite the hype and significant investment in digital agriculture, there is little evidence of its success. A recent survey of the scientific literature notes, "A distinct mismatch exists between how digitalization is promoted and what it has been proven to do."[3] Most research on digital agriculture is conducted by organizations with a vested interest in its promotion, raising concerns about the impartiality of the findings. While digital technologies may offer valuable tools for farmers and improve governmental planning, they also pose serious risks. The digitalization of agriculture and food systems will disrupt power structures, class dynamics and access to resources by creating new forms of connectivity and information flows. These technologies are predominantly driven by private sector actors, such as large agribusiness firms and tech companies who are reorganizing their operations around Big Data platforms and developing mobile applications to collect data from farmers for targeted marketing and service delivery.[4] As a result, digital agriculture is becoming a lucrative business, with major players vying for control over agricultural data. This underscores the urgent need for independent research to critically assess how digital technologies will impact the livelihoods of small-scale food producers and their communities.[5]

This report explores these impacts from the lens of food sovereignty and agroecology. Agroecology is a holistic and dynamic approach to food system transformation that is rooted around ecological practices and principles of social equity. It aims to promote healthy and biodiverse ecosystems, resilient communities and people's control over what they eat and how they produce it. The Alliance for Food Sovereignty in Africa (AFSA) has called for an agroecological food system transition to strengthen both African food systems and to adapt to and address climate

[1] Alana Lajoie-O'Malley et al., "The Future(s) of Digital Agriculture and Sustainable Food Systems: An Analysis of High-Level Policy Documents," Ecosystem Services 45 (October 1, 2020): 101183, https://doi.org/10.1016/j.ecoser.2020.101183; Montenegro de Wit, Maywa and Matthew Canfield. 2024" 'Feeding the World, Byte by Byte': Emergent Imaginaries of Data Productivism," The Journal of Peasant Studies 51 (2): 381–420. https://doi.org/10.1080/03066150.2023.2232997.

[2] Gezahagn Kudama et al., "Will Digital Solution Transform Sub-Sahara African Agriculture?," Artificial Intelligence in Agriculture 5 (January 1, 2021): 292–300, https://doi.org/10.1016/j.aiia.2021.12.001.

[3] Karen McGrath et al., "Investigating Narratives and Trends in Digital Agriculture: A Scoping Study of Social and Behavioural Science Studies," Agricultural Systems 207 (April 1, 2023): 103616, https://doi.org/10.1016/j.agsy.2023.103616.

[4] ETC Group, "Food Barons 2022: Crisis Profiteering, Digitalization and Shifting Power," 2022, https://www.etcgroup.org/content/food-barons-2022.

[5] Laurens Klerkx and David Rose, "Dealing with the Game-Changing Technologies of Agriculture 4.0: How Do We Manage Diversity and Responsibility in Food System Transition Pathways?," Global Food Security 24 (March 1, 2020): 100347, https://doi.org/10.1016/j.gfs.2019.100347.

change vulnerabilities. As Million Belay, the General Coordinator of AFSA writes; "When considering technology and the power relationship that lie behind said technologies."[6] Digital agricultural technologies must be evaluated based on the kinds of connections they foster and their implications for farmer agency, ecological sustainability and equitable access to resources and opportunities within food systems.

Social movements, civil society organizations and researchers are just beginning to consider how digital agricultural technologies can drive the transformation of agroecological food systems.[7] This report advances this evaluation by providing a qualitative analysis of agricultural digitalization in Kenya, a country at the forefront of agricultural digitalization. It draws interviews with key stakeholders and an in-depth case study of Makueni County, a leader in adopting digital technologies. Makueni County was chosen for its large population of small-scale food producers who highly vulnerable to climate change and for its proactive integration of digital solutions in local governance. The county has also sought to enhance residents' livelihoods through partnerships with diverse organizations, ranging from the Bill and Melinda Gates Foundations, which supports "Green Revolution" initiatives, to Biovision, which advocates for agroecological practices.

Interviews with farmers and other stakeholders involved in the digital agricultural transformation reveal that small-scale farmers are increasingly adopting digital technologies. While these tools can enhance connections between farmers, their communities, farmer organizations, government and extension services and other resources, they also pose important concerns. Because they are developed and promoted by the private sector, many digital technologies are designed to create dependencies on both technology developers and agribusiness. Most digital technologies are not only misaligned with the needs of small-scale farmers but they can also lead to the erosion of farmer autonomy and food sovereignty. Many of the digital solutions currently being developed do not support agroecology or food sovereignty approaches which prioritize the needs, agency and expertise of small-scale farmers but instead promote a "smart" vision aligned with large-scale commercial agriculture. Given the limited resources of farmers and civil society organizations in developing digital tools that support agroecology, there is a substantial risk that digital transformation in agriculture could exacerbate structural inequalities and increase dependence on multinational corporations.

The report begins with an overview of Kenya's agricultural sector and policy environment. It then explores the risks associated with digital technologies and highlights potential ways these technologies could support agroecological practices. The report concludes with targeted recommendations for various stakeholders involved in the digital transformation of agriculture. While it does not encompass all possible risks or benefits of digital technology in general, the report focuses on those linked to the current technologies in use. Ultimately, this report aims to contribute to the ongoing technology assessment process led by food sovereignty movements, fostering a broader and more informed evaluation of digital tools in agriculture.

[6] Million Belay, "Africa's Agricultural Future Lies in Agroecology," June 17, 2024, https://www.rosalux.de/en/news/id/52216/africas-agricultural-future-lies-in-agroecology.

[7] Nyéléni Newsletter, no. 37 (March 2019): "Digitalization and the Future of Food Sovereignty," https://nyeleni.org/DOWNLOADS/newsletters/Nyeleni_Newsletter_Num_37_EN.pdf; FIAN International, "Digital Agriculture: A New Frontier for Data Rights," FIAN International, August 29, 2023, https://www.fian.org/en/news/article/digital-agriculture-a-new-frontier-for-data-rights-3185; Committee on World Food Security Civil Society and Indigenous Peoples' Mechanism. Vision Statement on Data for Food Security and Nutrition. Accessed September 22, 2024. https://www.csm4cfs.org/csipm-vision-statement-on-data-for-food-security-and-nutrition/.

Agriculture and Food Systems In Kenya

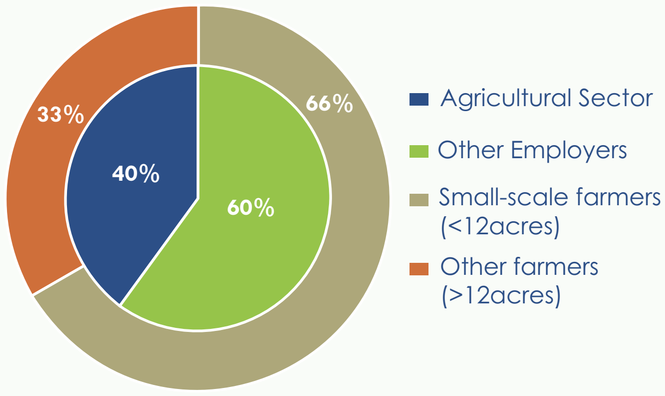
2.1 Kenyan agricultural economy

Agriculture is a backbone of the Kenyan economy. Together, agriculture and related food system activities make up a combined one-third of the country's gross domestic product.[8] The agricultural sector employs over 40% of people in Kenya. Many of those working on farms are small-scale farmers over two-thirds of farmers cultivate plots smaller than 12 acres.[9] These farmers produce 63% of Kenya's food, mainly through rainfed agriculture.[10]

While agriculture is central to the livelihoods of rural people in Kenya, food security remains a significant challenge in the country. In the 23 counties designated as rural arid and semi-arid lands, which encompass most of Kenya, around 1.5 million people were estimated to experience severe acute food insecurity from October 2023 to January 2024. While this represents an improvement from the previous year, thanks to better weather and the end of a prolonged drought[11] –the increased rainfall also brought challenges. In 2024, El Nino flooding inundated more than 41,000 acres of land, displacing over 280,000 people and resulting in significant livestock losses.[12]

The volatility of climatic conditions, primarily driven by climate change, poses the most significant and ongoing threat to food security in Kenya. Currently 15 million rural Kenyans are affected by climate change yearly. Recent modeling has suggested that over the next twenty-five years, over 40 million ha of land[13] will be exposed to climate hazards, posing major risks to the food security of millions of people.[14] Some estimates suggest that for each degree rise in temperature above the optimal range, cereal yields could decrease by about 200kg per hectare.[15]

Figure 1: Kenya's employment rate and food producers



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15M
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[8] Food and Agriculture Organization of the United Nations. "Kenya at a Glance." https://www.fao.org/kenya/fao-in-kenya/kenya-at-a-glance/en/

[9] Breisinger Clemens et al., Food Systems Transformation in Kenya: Lessons from the Past and Policy Options for the Future Loading... Files Full Book (7.78 MB, Pdf) Chapters List (73 KB, Pdf) Authors Breisinger, Clemens Keenan, Michael Mbuthia, Juneweenex Njuki, Jemimah Date Issued 2023-12-20 Language En Type Book Review Status Peer Review Access Rights Open Access Open Access Usage Rights CC-BY-4.0 Metadata Sha (Intl Food Policy Res Inst, 2024).

[10] https://openknowledge.fao.org/server/api/core/bitstreams/32709b4d-ed41-4b1e-9d37-91786824cb9e/content

[11] Food and Agriculture Organization of the United Nations. 2024. Kenya: Food Security Update - October 2023 to January 2024. Rome: Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/server/api/core/bitstreams/9256a602-dcee-4af5-8740-302f6f903f7f/content.

[12] Action Against Hunger, Flooding Displaces More than 200,000 in Kenya, Fueling Hunger, May 16, 2024, https://www.actionagainsthunger.org/story/flooding-displaces-more-than-200000-in-kenya-fueling-hunger/.

13 AGRA Watch, "Corporate-Led Climate Change Adaptation: How the Gates Foundation, Microsoft, and AGRA Are Enabling the Digital Capture of African Food Systems" (Seattle, WA, 2023).

14 Wietske Kropff et al., "Mainstreaming Digital Approaches for Adaptation in Agriculture in Kenya," December 1, 2023, https://hdl.handle.net/10568/138918.

[15] Benjamin Kipkemboi Kogo, Lalit Kumar, and Richard Koech, "Climate Change and Variability in Kenya: A Review of Impacts on Agriculture and Food Security," Environment, Development and Sustainability 23, no. 1 (January 1, 2021): 23–43, https://doi.org/10.1007/s10668-020-00589-1.

While climate volatility in Kenya's predominantly rainfed agricultural sector is a significant factor driving food insecurity, it is not the sole cause. Small-scale food producers grapple with a range of structural challenges, including limited access to land, land degradation, declining public support for agricultural extension services, and insufficient infrastructure, markets and credit.[16] Additionally, they face production hurdles, particularly from pest pressures like desert locusts and fall armyworms, which exacerbate food insecurity. However, those seeking to promote the Green Revolution often emphasize specific production challenges such as limited access to technologies or pesticides over other structural issues such as access to land, water and markets. This focus reflects how debates over food system transformation are often shaped by differing interests and priorities.

2.2 Contested approaches to food system transformation development

Despite its ambitious goals and the importance of agriculture for Kenya's social and economic well-being, the Government has been severely constrained in its allocation of resources to agriculture. Today, the government invests under 3% of its national budget to agriculture.[17] This under-investment cannot simply be understood as a lack of prioritization, but rather the reality of the global political and economic structures in which Kenya's food system is embedded.

Under investment in African agriculture is historically rooted in the infamous structural adjustment programs (SAPs) which had negative effects on small scale production of food crops for domestic consumption. SAPs undermined the capacity of many African countries, including Kenya, to ensure sufficient sources of revenue to support agriculture sectors among other critical sectors. Many African countries, including Kenya, have failed to recover.

The ongoing under-funding of Kenya's agriculture is further perpetuated by the neoliberal policies and by the subordinate position of Kenya within the unequal international financial system, which has resulted in Kenya's ongoing debt burden and loan relief conditions mandating cuts in state spending.[18] As a consequence of these economic dynamics, the Kenyan government has been forced to reduce spending on agricultural extension services, leaving only one extension officer for every 1800 farmers.[19] This under-resourcing further hampers the ability of small-scale farmers to adapt to the increasing challenges they face, undermining the country's efforts to achieve food security and agricultural resilience.

These international economic dynamics are especially troubling because while farmers in Kenya are experiencing the impacts of climate change, their contribution to this global problem has been minimal. In contrast, industrialized food systems, predominantly in the Global North, are responsible for about one-third of all greenhouse gas emissions. As a result, Kenyan farmers are now suffering the consequences of a crisis they did not create.

[16] Foresight4Food, "Final Kenya Food Security Map," accessed September 18, 2024, https://foresight4food.net/wp content/uploads/2024/05/Final-Kenya-FS-map-for-lay-out_V2.pdf.

[17] In the 2024-2025 budget, the Kenyan Government allocated approximately 2.1% to the agricultural sector. See: Ngotho, Agatha. 2024. "2024/25 Budget: Agriculture Sector Gets Sh84.9 Billion." The Star, June 14, 2024. https://www.the-star.co.ke/news/star-farmer/2024-06-14-202425-budget-agriculture-sector-gets-sh849-billion/.

[18] Fibian Lukalo, "Putting Agriculture Ahead? Some Reflections About the Early Years of Neoliberalism in Kenya," in Capital Penetration and the Peasantry in Southern and Eastern Africa: Neoliberal Restructuring, ed. Freedom Mazwi, George Tonderai Mudimu, and Kirk Helliker (Cham: Springer International Publishing, 2022), 163–77, https://doi.org/10.1007/978-3-030-89824-3_8.

[19] https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/JEQ9BO

As Kenya seeks to address these crisis, it has largely been dependent on bilateral and multilateral aid. Kenya is one of the largest recipient of agricultural aid in sub-Saharan Africa.[20] As a result, much of its research and policy agenda has been driven by donors who have promoted the commercialization of agriculture, the use of external inputs and support for export-oriented value chains. A key actor in this aid ecosystem is the Bill & Melinda gates Foundation (BGMF) and its grantee, the Alliance for a Green Revolution in Africa (AGRA), which has its continental headquarters in Kenya. As a result of its influence, a Green Revolution narrative dominates Kenya, leading to an emphasis on efficiency and markets rather than ecological sustainability, equity and well-being.[21]

The influence of AGRA on Kenya's agricultural policy and research is concerning due to its failure to deliver on its promises. AGRA claimed it would "double yields and incomes for 30 million farming households by 2020."[22] But in Kenya, one of AGRA's key target countries, maize yields declined, and food insecurity rose during the period of AGRA funding from 2006 to 2018.[23] Despite these failures, BGMF and AGRA continue to promote a technologically driven and market oriented approach in Kenya and across the continent. Though it has at points claimed that it supports other approaches, like agroecology, only 3% of BMGF's total funding has agro-ecological components.[24]

Since at least 2020, AGRA has collaborated with Microsoft, the company founded by its key benefactor, Bill Gates to drive digital transformation in agriculture as part of AGRA's Green Revolution initiative. AGRA has also been working with the Kenyan government to support digitization through Kenya's Agricultural Sector Transformation and Growth Strategy.[25] This included the use of AGRA's "Agribot" as a possible e-extension system.[26] AGRA's support for digitalization illustrates how digital technologies can enable further expansion of the Green Revolution's goals to modernize and commercialize traditional agriculture. Researchers have already raised concerns that digital technologies may entrench the values of the Green Revolution by not only promoting external inputs like hybrid seeds and synthetic fertilizers at the population level, but also using new technologies to "nudge" individuals' behaviors to suit the goals of technology developers.[27] AGRA's promotion of digital agriculture necessitates a critical assessment of the claims made by advocates of the digital food systems revolution, especially given its failure to improve the livelihoods of small-scale food producers over the past two decades of its interventions into African agricultural systems.

Yet despite the influence of powerful donors, both the national and county governments have increasingly supported agroecology as an alternative model for ecological and economic sustainability. As a "science, practice and social movement," agroecology has been promoted by many farmer organizations and networks in Kenya who have advocated for a participatory approach to research and policy-making.[28] In 2020, the government established the Intersectoral Forum on Agrobiodiversity and Agroecology (ISFAA), a multistakeholder platform that brings together government entities, farmer organizations, civil society organizations (CSOs), private sector representatives, researchers, academia and donors.

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[20] IPES Food, "Money Flows: What Is Holding Back Investment in Agroecological Research for Africa?" (Biovision Foundation for Ecological Development & International Panel of Experts on Sustainable Food Systems, 2020), http://www.ipes-food.org/_img/upload/files/Money%20Flows_Full%20report.pdf.

[21] IPES Food, 13

[22] AGRA has since removed this goal from their website. See endnote 8 of Abdallah Ramadhani Mkindi et al., "False Promises: The Alliance for a Green Revolution in Africa (AGRA)" (Rosa Luxemburg Stiftung, July 2020), https://www.rosalux.de/en/publication/id/42635/false-promises-the-alliance-for-a-green-revolution-in-africa-agra.

[23] Ibid.

[24] IPES Food, "Money Flows: What Is Holding Back Investment in Agroecological Research for Africa?"a

[25] https://news.microsoft.com/en-xm/2020/09/22/microsoft-reaffirms-its-commitment-to-the-alliance-for-a-green-revolution-in-africa-to-support-digital-transformation-in-agriculture/

[26] https://kihingu.com/agra-final/news/agra-and-microsoft-extend-their-partnership-to-support-digital-agricultural-trans formation/

[27] Abdul-Rahim Abdulai, "A New Green Revolution (GR) or Neoliberal Entrenchment in Agri-Food Systems? Exploring Narratives Around Digital Agriculture (DA), Food Systems, and Development in Sub-Sahara Africa," The Journal of Development Studies 58, no. 8 (August 3, 2022): 1588–1604, https://doi.org/10.1080/00220388.2022.2032673.

[28] A. Wezel et al., "Agroecology as a Science, a Movement and a Practice. A Review," Agronomy for Sustainable Development 29, no. 4 (2009): 503–15, https://doi.org/Doi 10.1051/Agro/2009004.

The national multistakeholder platforms' goal is to scale up agroecology and integrate it into national agricultural policy. Reflecting this shift, MoALD launched the National Agroecology Strategy in November 2024.

Additionally, several county governments are creating their own agroecology policies. Murang'a County was the first to establish such a policy in 2022, with similar initiatives underway in Makueni County, West Pokot and other regions. These county-level agroecology plans are particularly significant, given that agricultural policy has been devolved to the county level since the implementation of the 2010 Constitution.

Agroecology and Digital Agriculture

Researchers and social movements have begun to critically explore the implications of digital technologies for smallholder farmers and agroecological systems by employing participatory methodologies that co-develop values, identify risks and document experiences with digital tools, rather than seeking to establish definitive criteria. In Tanzania, Hilbeck et al. developed a participatory methodology for monitoring and assessing digital technologies in agroecology using an application called "Ugunduzi", co-created by farmers and researchers. This tool facilitates data collection from on-farm experiments and enables information sharing with researchers and peers. The co-production process was intentionally designed to empower farmers, fostering a sense of ownership over the research and the application. the study concluded that "record-keeping and data-gathering using mobile phone-based applications is highly advantageous."[29] Similarly, Wittman, James and Mehrabi propose a framework for farmer-driven 'digital agroecology,' demonstrated through their testing of LiteFarm, a digital platform for a participatory guarantee system in Latin America. They argue that " for digitalization to be farmer-driven, it "must also acknowledge and appreciate all dimensions and outcomes, including the delights, well-being and power that working in food systems can provide to participants. This entails ensuring that farmers are at the forefront of designing digital tools that work for them and that respect local cultural contexts and conditions."[30] Overall, emerging research on 'digital agroecology' suggests that realizing the potential of digital technologies to support agroecology requires co-developing these technologies with farmers. This approach leverages their knowledge and expertise to identify challenges and co-create solutions that are appropriate, affordable and adaptable to diverse agricultural context.[31]

[29] Angelika Hilbeck et al., "ICT4Agroecology: A Participatory Research Methodology for Agroecological Field Research in Tanzania," Agroecology and Sustainable Food Systems 48, no. 4 (April 20, 2024): 465–500, https://doi.org/10.1080/21683565.2023.2259828.
[30] Hannah Wittman, Dana James, and Zia Mehrabi, "Advancing Food Sovereignty through Farmer-Driven Digital Agroecology," Ciencia e Investigación Agraria: Revista Latinoamericana de Ciencias de La Agricultura 47, no. 3 (2020): 235–48.
[31] Agroecological Intelligence: The Challenges and Opportunities of Digital Agriculture, A Bigger Conversation, May 2024, https://abiggerconversation.org/wp-content/uploads/2024/05/ABC_Agroecological-Intelligence-Report_Final_280524.pdf.

Kenya's Digital Agricultural Ecosystem

Kenya has been enormously successful in fostering an environment to enable this transformation. Today, the country is home to a growing ecosystem of start-ups, development organization, consultancies and foundations that support the digitalization of agriculture. Nairobi is a hub for growing investment in digital agriculture. Globally, the market for digital agriculture is over $20billion and is projected to double by 2030.[33]

3.1 Kenya's digital infrastructure and innovation ecosystem

Kenya has made an ambitious plan to achieve 100% food and nutrition security by 2029 through its Big Four Agenda. As part of this, Kenya has sought to transform its agricultural sector through the Agricultural Sector Transformation and Growth Strategy (ASTGS), which spans from 2019-2029. The strategy is driven by three main outcomes: increasing small-scale farmer incomes, increasing agricultural output and value addition and boosting household resilience. Digital technologies are seen by the Government as a major enabler in meeting these goals. In its National Position Paper to the 2021 UN food Systems Summit, the Kenyan Government made clear that "Our agricultural transformation will be based on digitization. We will foster an environment that allows our innovators to thrive and contribute to this agricultural transformation."[32]

In Africa, 119 digital agriculture companies raised $636million USD in 2022.[34] Kenya is the top destination for this investment[35] and it accounts for nearly 25% of start-ups in Africa.[36]

Kenya's emergence at the forefront of digital agriculture is a product of extensive mobile connectivity and a vibrant innovation ecosystem. 98% of the country is covered by 4G networks, while the Government and the private sector have rolled out fiber optic cables.[37] As of 2023, there were approximately 66 million cellular mobile connections (of a population of approximately 56 million people).[38]

The widespread use of mobile phones led to the success of the digital payment platform M-PESA, which was rolled out by the telecommunications company, Safaricom in 2017. M-PESA is used by more than half of

[32] https://www.unfoodsystemshub.org/docs/unfoodsystemslibraries/national-pathways/kenya/2021-09-27-en-kenya-fss -dialogue-series-national-position-paper.pdf?sfvrsn=7a668679_1

[33] Precedence Research. Smart Agriculture Market. Accessed September 15, 2024. https://www.precedenceresearch.com/smart-agriculture-market.

[34] AgFunderNews. The Largest Funding Rounds of the Decade for Africa AgriFoodTech. Accessed September 15, 2024. https://agfundernews.com/the-largest-funding-rounds-of-the-decade-for-africa-agrifoodtech.

[35] Kenya Investment Authority. Kenya: Top Destination for Digital Agriculture Investments in Africa. April 7, 2022. Accessed September 15, 2024. https://www.invest.go.ke/2022/04/07/kenya-top-destination-digital-agriculture-investments-africa/.

[36] ISF Advisors. Agricultural Platforms Report. March 2021. Accessed September 15, 2024. https://isfadvisors.org/wp-content/uploads/2021/03/ISF_RAFLL_Agricultural_Platforms_Report.pdf.

[37] https://www.mobileconnectivityindex.com/index.html#year=2023&zoneIsocode=KEN&analysisView=KEN

[38] Communications Authority of Kenya. Mobile Subscriptions Hit 66M in March 2023. Accessed September 15, 2024. https://www.ca.go.ke/mobile-subscriptions-hit-66m-march-2023.

Kenya's population to send and receive payments and is one of Africa's most successful fintechs. The digital payment system has been celebrated by some researchers for lifting poor households, particularly women-headed households, out of poverty by incorporating them into formal financial systems.[39] Other researchers, however, have disputed this claim, arguing that the expansion of fintech has not necessarily led to poverty alleviation, but rather indebtedness and growing corporate control.[40] As a result, some have argued that the celebration of formal financial inclusion through M-PESA overlooks the structural causes of gendered financial exclusion.[41] Such analyses are important in assessing digital agriculture, and many mobile advisory services for digital agriculture incorporate financial technologies in order to extend loans and credit to small-scale farmers.

Among mobile phone-based digital agricultural technologies, advisory services are the most common offerings provided to farmers in Kenya and across East Africa, as multiple studies have consistently shown. Other agricultural mobile applications include financial services, which are the second most common, and applications facilitating market linkages.[42] Importantly most of these technologies are currently being bundled. As described below, the private sector bundles educational information with input sales and financial services in an attempt to develop a profitable business model.

While mobile phone applications are the most widely adopted digital agricultural technology in Kenya, the field of digital agriculture includes a diverse range of tools, such as SMS-based services, sensors, drones, satellites and remote sensing technologies **(see Table 1).**

Notably, many mobile phone applications do not require smart phones; they can be accessed via Unstructured Supplementary Service Data (USSD), enabling interactive services on basic feature phones.

[39] Tavneet Suri and William Jack, "The Long-Run Poverty and Gender Impacts of Mobile Money," Science 354, no. 6317 (December 9, 2016): 1288–92, https://doi.org/10.1126/science.aah5309.

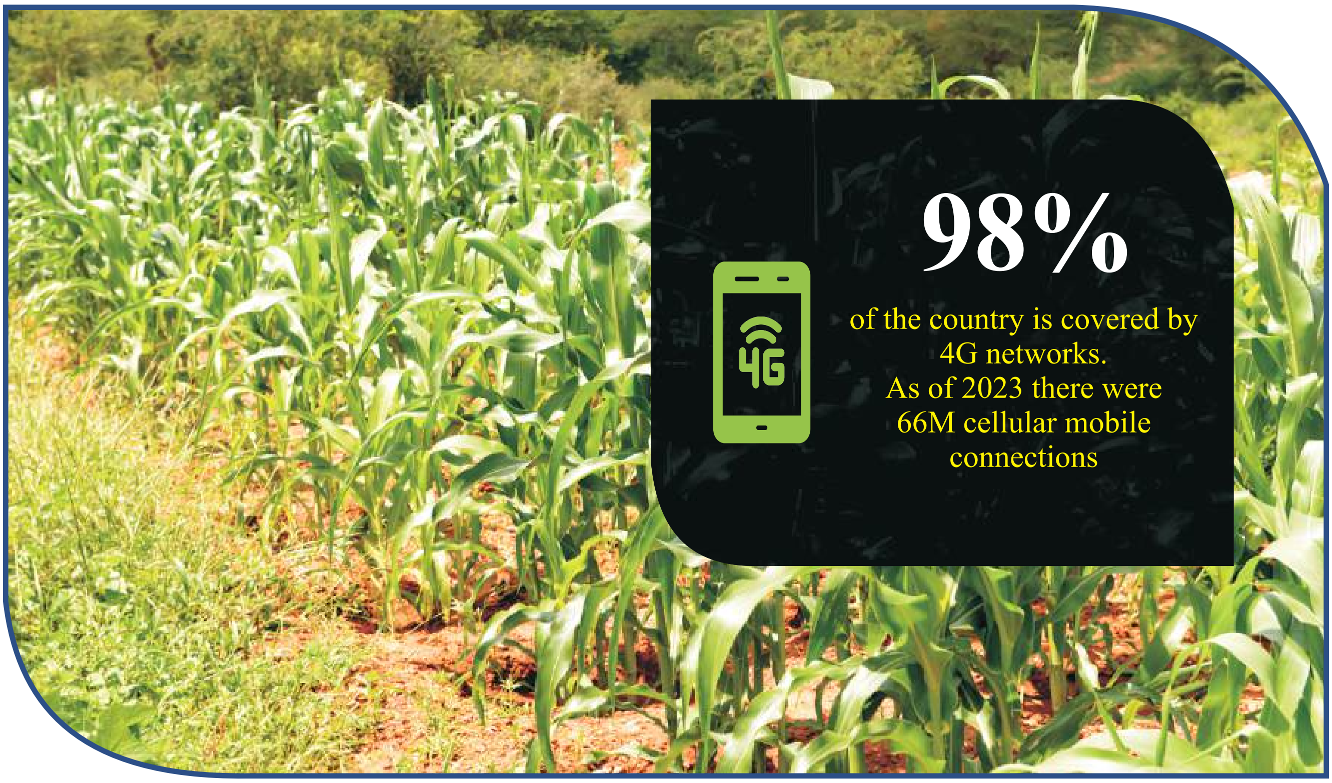
[40] Milford Bateman, Maren Duvendack, and Nicholas Loubere, "Is Fin-Tech the New Panacea for Poverty Alleviation and Local Development? Contesting Suri and Jack's M-Pesa Findings Published in Science," Review of African Political Economy 46, no. 161 (July 3, 2019): 480–95, https://doi.org/10.1080/03056244.2019.1614552.

[41] Serena Natile, "Digital Finance Inclusion and the Mobile Money 'Social' Enterprise: A Socio-Legal Critique of M-Pesa in Kenya," Historical Social Research / Historische Sozialforschung 45, no. 3 (2020): 74–94.

[42] FAO, CIAT and World Bank, "Digital Agriculture Profile Kenya" (Rome, Italy, 2021), https://openknowledge.fao.org/items/fab01c51-9c1e-4497-8d4b-6f8477a177c2; GATSBY Africa, "Digitally Enabled Agriculture: A Landscape Study of Digital Advisory Models for Smallholder Farmers in East Africa."

Table 1. Types of digital agricultural technologies offered in Kenya

Type of technology	Services offered	Sample of actors in Kenya
SMS-messaging services	Market prices, weather updates, agronomy advice, alerts	iCow, iShamba
Mobile phone and web-based applications	Advisory services, farm management tools, market access, crop disease identification	Plantix, Biovision Infonet, Kenya Agriculture Observatory Platform,
Soil sensors and connected devices	Real-time soil monitoring, automated irrigation	UjuziKilimo, SunCulture
Drones	Aerial crop monitoring, pesticide spraying, land mapping	Kenya Flying Labs, Astral Aerial
Satellites and remote sensing	Crop health monitoring, land-use planning, climate adaptation	Agr-vision, SayariLabs
Artificial intelligence	Pest and disease detection, yield prediction, decision support	PlantVillage, AgriPredict
Blockchain	Transparent supply chains, food traceability, smart contracts	Twiga Foods, Farmshine



3.2 Key actors and investors in Kenya's digital agriculture economy

With the support of foundations, development agencies and the private sector, the Ministry of Agriculture and Livestock Development (MoALD) and Kenya Agriculture and Livestock Research Organization (KALRO) have made extensive investments in digitalization and sought out partnerships to further enable the digitalization of the agriculture sector.

Today, most investments in digital agriculture in Kenya come from international donor funding. Foreign donors and international organizations have played a pivotal role in building and sustaining digital agriculture. For example, the World Bank's One Million Farmer Initiative, which was piloted in Kenya, provides financing and incubation support for various digital agriculture start-ups, with the aim of developing a comprehensive digital agricultural ecosystem. The initiative also established a database of farmer profiles that it sought to share among its partners. The World Bank plans to expand this project to eight additional countries across Africa.[43]

Foreign development aid has also been instrumental in shaping Kenya's technical and legal landscape to support digital agriculture. For instance, substantial funding from Germany was pivotal in establishing Kenya's agricultural data governance framework, which plays a crucial role in ensuring that public data sharing with the private sector aligns with national data protection laws. Similarly, the Swedish government contributed significantly to the development of the Kenya Integrated Agricultural Management Information System (KIAMIS) by financing the collection of farmer data, resulting in a database of over six million digital farmer profiles. According to USAID, such digital farmer profiles are the foundation for enabling digital service provision from both the public and private sector.[44]

Private foundations are also pivotal in establishing the infrastructure for digital agriculture, often driven by industries poised to benefit from its expansion. For example, the Mastercard Foundation, Bill and Melinda Gates Foundation and Bayer Foundation, each rooted in the financial services, technology and agribusiness industries respectively, have emerged as significant funders of MercyCorps AgriFin. This non-profit organization was established in 2012 as a spin-off of the US-based humanitarian and development organization, MercyCorps. It has become a crucial player in advancing the digitalization of agriculture, leveraging the resources of the aforementioned foundations to drive growth and scalability in the sector.

Overall, donor funding not only exceeds private investment in digital agriculture but also accounts for more than half of the sector's revenue.[45] This highlights a significant issue: few digital agricultural models have developed a profitable approach, especially those engaging directly with farmers. The digital agricultural landscape is populated by numerous competing firms, including many local start-ups, yet few services boast an active user base exceeding 50,000 farmers. One key reason firms struggle to be profitable is that farmers are often reluctant to pay for digital advisory services, prompting companies to seek alternative revenue models. Consequently, many companies rely on monetizing data or earning commissions on agricultural inputs and credit. **In essence, the sector's primary business model depends on increasing the sale of external inputs and enhancing farmers' visibility to the private sector.**

Understanding the revenue models driving digital agriculture is crucial to evaluating the validity of its 'win-win' claims, particularly regarding the implications for food sovereignty.

[43] Pauline Kairu, "World Bank Eyes a Million Farmers with 'Disruptive' Digital Platform," Business Daily, December 19, 2020, https://www.businessdailyafrica.com/bd/corporate/technology/world-bank-eyes-a-million-farmers-with-disruptive-di gital-platform-2245876

[44] USAID, "Digital Farmer Profiles: Reimagining Smallholder Agriculture," 2018, https://www.usaid.gov/sites/default/files/2022-05/Data_Driven_Agriculture_Farmer_Profile.pdf.

[45] GATSBY Africa, "Digitally Enabled Agriculture: A Landscape Study of Digital Advisory Models for Smallholder Farmers in East Africa," April 2022, https://www.gatsbyafrica.org.uk/app/uploads/2023/01/gatsbyafrica-digitally-enabled-agriculture-april-2022-003.pdf.

Industry experts suggest that profitability in this sector often requires market consolidation and fewer pilot projects, raising a critical question: Will domestic firms be able to truly benefit from this emerging market? Equally important is identifying the key donors backing the digitalization push, as this reveals the broader dynamics of the digital agriculture ecosystem. For example, as previously mentioned, MercyCorps AgriFin has received substantial funding from the philanthropic arms of corporations positioned to profit from digital input sales and financial services.

AGRA's involvement is particularly noteworthy, as it brokers partnerships between entities like Microsoft and the Kenyan Government. AGRA's primary donor, the Bill and Melinda Gates Foundation, raises significant concerns about potential conflicts of interest, an issue that civil society has already highlighted.[46]

[46] AGRA Watch, "Corporate-Led Climate Change Adaptation: How the Gates Foundation, Microsoft, and AGRA Are Enabling the Digital Capture of African Food Systems" (Seattle, WA, 2023).

Goverment Support for Digitalization

4.1 National digitalization initiatives

For governments, the digitalization of agricultural and food systems enables the collection of unprecedented amounts of data on food production and consumption, which can inform policy development and food system management. During the COVID-19 pandemic, Kenya formed the "Food Security War Room" and emerged as important leader in demonstrating the power of data. In partnership with the US-based company Esri, Kenya coordinated and deployed the use of a nation-wide survey on food stocks and availability which enabled it to build a real-time dashboard of food supplies in the country.[47] Since then, with the support of foreign donors, the government has worked to create an extensive infrastructure for data collection, analysis and sharing in order to address food insecurity, as well as to roll out agricultural development programs like the National Agricultural Value Chain Development Project.

The Kenyan Government has sought to support the digitalization of the agricultural sector through its ASTGS. The Strategy aims to increase incomes of small-scale farmers, pastoralists and fishers; increase agricultural output and value add; and boost household food resilience. Digitalization is a key mechanism through which the government seeks to achieve these aims. MoALD has developed seven priority "use cases" applications for digitalization to reach the ASTGS outcomes. These include:

1. Develop an e-incentive system through a farmer registration process.
2. Improve farmer practices through e-extension.
3. Monitor emergence food reserve stocks through a national Food Balance Sheet.
4. Develop an Early Warning System to support trade and price stability decisions.
5. Improve value chain selection through an agricultural land optimization model.
6. Establish standards and protocols for a national agriculture data platform.
7. Support monitoring and evaluation with a dashboard that streamlines data collection, verification and visualization.

The government has advanced quickly on the first use case through its farmer registration process that took place in 2023. Supported by over US$5 million in aid from the Swedish Government, the Kenyan Government collected over four million farmer profiles throughout the country in 2023 and integrated them into the KIAMIS.[48] With these farmer profiles, the Kenyan government plans to develop a system aims primarily to deliver fertilizer subsidies with transparency, traceability and timeliness.

In addition, KALRO has developed several innovative e-extension platforms. Among these are 65 mobile phone applications, most of which are dedicated to specific value chains. Some apps offer more comprehensive support, such as the KALRO KAOP App, which provides weather information and the KALRO Selector, which helps farmers identify suitable crops for their sub-wards along with relevant production information. The Kenya Agricultural Observatory Platform also sends short-form SMS messages to farmers with weather and agronomic advisories. Additionally, KALRO collects and shares market data through various apps and websites, including the Kenya Digital Agriculture Platform.

[47] Data for Sustainable Development Goals (Data4SDGs). Real-Time Agriculture: Kenya COVID-19. Accessed September 15, 2024. https://www.data4sdgs.org/sites/default/files/file_uploads/Real-time%20Ag%20Kenya%20COVID-19_0.pdf.
[48] Mumbi, Lucy. 2023. "Kenya Receives Funds to Establish National Central Farmers' Database." The Star, February 27, 2023. https://www.the-star.co.ke/news/realtime/2023-02-27-kenya-receives-funds-to-establish-national-central-farmers-dat abase/.

4.2 Kenya agricultural data governance

All data in Kenya is regulated under the Kenyan Data Protection Act (DPA), which was enacted in 2019 to provide a comprehensive legal framework for data privacy and protection. The DPA is designed to align with and uphold Article 31 of Kenya's Constitution, which enshrines the right to privacy, including the protection of personal data. This legislation outlines clear obligations for data controllers and processors, ensuring that the collection, storage and use of personal data are conducted lawfully.

The DPA defines the rights of individuals whose data is being processed, including the right to be informed about the collection and use of their data, the right to access their data and the right to request its correction or deletion. It mandates that data processing must adhere to key principles such as lawfulness, fairness, transparency, purpose limitation, data minimisation, accuracy, storage limitation and integrity and confidentiality. Moreover, the DPA establishes the Office of the Data Protection Commissioner, which is tasked with overseeing compliance, handling complaints and taking enforcement actions against violations. This regulatory framework is critical in safeguarding personal data in an increasingly digital society and ensuring that the rights of individuals are protected against unauthorized use and breaches of data.

In addition to the DPA, Kenya has become one of the pioneering countries to develop a governance framework tailored specifically to agricultural data. The Kenyan Agricultural Data Governance Framework, published in 2022, operationalizes the 2019 DPA, with funding and support from the German Development Corporation (GIZ). This Framework while an important step forward, specifically targets farmers registration data, aligning with Use Case 1, which focuses on farmer registration and e-incentives, rather than comprehensively covering all data collected by the MoALD.

The Framework establishes a set of rules and processes for data sharing and seeks to clarify the distinction between personal and non-personal data in the agricultural sector. However, its scope is limited in several key ways: First, it does not address the vast amounts of data collected by the private sector, which currently remains under the purview of the DPA and private contract law. Second, while the framework attempts to distinguish between personal and non-personal data, it acknowledges that the sharing of agricultural data is highly contextual, often depending on combination of different types of data. Consequently, the government's approach to data sharing is increasingly mediated through technical protocols such as application programming interfaces (APIs).These APIs, while serving as implicit governance mechanisms, pose challenges in transparency, making it difficult to understand the criteria and processes behind data-sharing decisions.

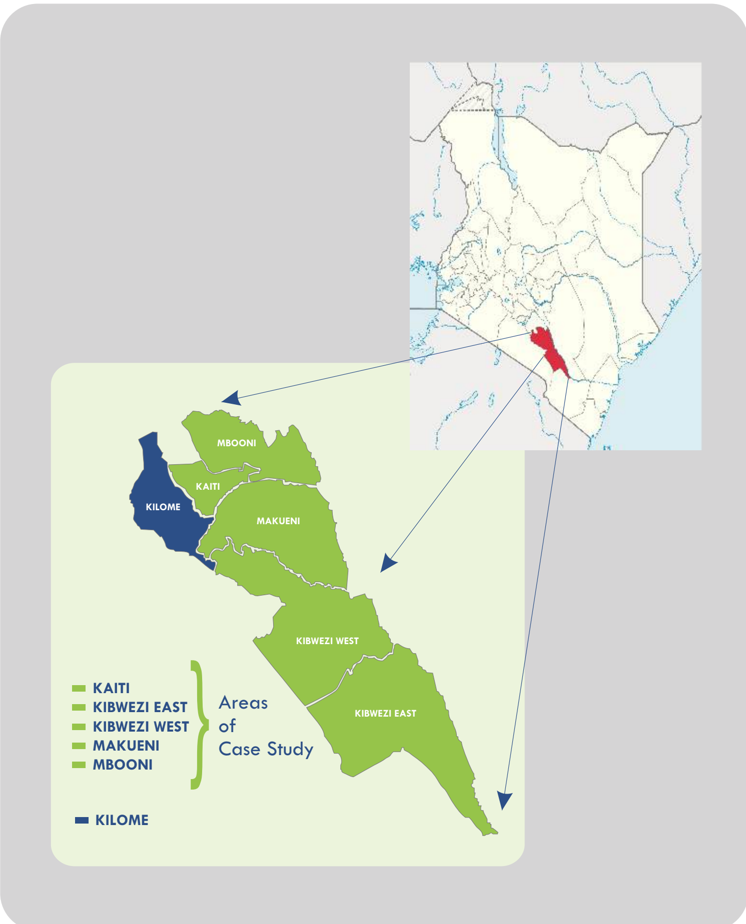
As of this writing, MoALD employs various platforms for sharing farmer data, with much of it fragmented across different sites. This highlights the need for continued development and refinement of data governance mechanisms to ensure that they are not only comprehensive but also effectively implemented.

chapter 5.

Case Study: Makueni County

This report is based on a case study of Makueni County. Makueni County was chosen for this study because it has been an early adopter of digital technologies. It is also largely dependent on agriculture. 78% of people in Makueni County work in agriculture, the vast majority of whom are small-scale farmers who farm primarily for subsistence. The average small-scale farm in the county is 3.44ha. Makueni County, like much of Kenya, is also highly vulnerable to climate change and has already seen agricultural production suffer because of drought. Makueni County also stands out because of the active role of the County government in pursuing partnerships to improve the livelihoods of its small farmers. The county became on of the first to partner with Safaricom's Digifarm to roll out its service. The county also partnered with AGRA through the Cereal Growers Association (CGA), resulting in multiple visits by Bill Gates to the County in 2022 and 2023. Makueni is also the only county in Kenya with a County Climate Change Fund that requires 1% of the county budget to be allocated to climate change issues.[49] The County's agricultural profile, coupled with its efforts to facilitate partnerships aimed at improving the livelihoods of small-scale farmers, made it an ideal location to capture the impacts of digitalization.

Figure 2: Makueni county and its sub-counties



5.1 Methodology

This is an exploratory, qualitative case study that drew on interviews and observations with farmers, community-based organizations, organizations, policy makers and agricultural extension officers. It examined how farmers are using digital technologies, as well as the benefits and concerns identified by a wide range of stakeholders. The eight-month long study (October 2023-May 2024) consisted of four one week visits to Makueni County in five of six sub counties: Makueni, Mbooni, Kaiti, Kibwezi East, Kibwezi West. The project team interviewed over 67 people in Makueni, including 30 farmers. Farmers were identified primarily by contacting community-based civil society organizations. Of those interviewed in Makueni County, 39 people were male and 29 were female. Nearly all the farmers interviewed were small holders, typically farming 3 hecaters or less. Only two farmers we spoke with managed approximately 20 hectares. The project team also conducted background interviews with an additional 15 people outside of Makueni for context on digital agriculture. Interviews lasted between one and three hours. After completing the fieldwork, the project team held a workshop with thirteen civil society organizations from Makueni and other regions of Kenya to verify and collectively analyze the findings (see Section 6).

[49] The Kenya Ministry of Agriculture, Livestock and Fisheries (MoALF), "Climate Risk Profile for Makueni County. Kenya County Climate Risk Profile Series" (Nairobi, Kenya, January 1, 2016), https://ccafs.cgiar.org/resources/publications/climate-risk-profile-makueni-county-kenya-county-climate-risk-profile

5.2 Use of digital applications

Farmers described downloading and trying multiple apps, sometimes as a result of interactions with civil society organizations or private extensions agents. Social media applications (including WhatsApp and Facebook) were by far the most widely used digital technologies. Farmers are often in several different WhatsApp groups, including neighborhood farming groups through which they exchange information on pests, practices, markets and services. Public and private extension officers also identified WhatsApp as one of their main tools for communicating with farmers, and they create groups to more efficiently communicate with communities. Farmers also often use Facebook to seek out information, as well as to find markets for their agricultural produce.

Beyond Facebook and WhatsApp, the farmers we interviewed identified over twenty different applications specifically designed for agriculture which they were either currently using or had used at one point. All of the applications listed in order of usage. What is important to note is that no single application was dominant nor widely used.

However, not one single farmer described consistently using a digital service beyond WhatsApp and Facebook. Surprisingly, though Safaricom's Digifarm application was once one of the most widely touted applications in Kenya and was introduced into Makueni as early as 2018, no farmer reported actively using Digifarm during the study period (see pg.27 on Digifarm).

The table below lists applications used by farmers, including those utilized by 'lead farmers' or Village-Based Advisors' (VBAs). The VBA model, initially introduced by Farm Input Promotions Africa Limited and later adopted by the CGA and promoted by AGRA represents a unique form of community-based extension service. Unlike traditional extension workers, VBAs are not government employees but are instead local farmers who offer peer-to-peer support. Given their dual role as both advisors and active farmers, we have included VBAs in our analysis of the digital services employed by farmers. The broader implications of the VBA model are discussed in detail below.

Table 2. Applications used by farmers

Name of application	Service provided	Type of user	Application owner	Number of users
Whatsapp	Social media	Farmers, extension agents, and service providers	Meta	28
KALRO Apps	Variety of apps, many of which are value-chain specific	Farmers	Kenyan government	12
Facebook	Social media	Farmers, extension agents, and service providers	Meta	8
Biovision Infonet	Advisory services via website	Farmers and service providers	Biovision (NGO)	5

CABI Bio Protection and fertilizer optimization apps	Advisory services	Farmers	CABI International (NGO)	4 (VBAs)
Agri-bot by AGRA	Advisory services	Farmers and Extension officers	AGRA	4 (VBAs)
Bayer (multiple apps)	Advisory services	Famers, VBAs, and ag input suppliers	Bayer	2
Plantix	Advisory services	Farmers	Plantix (Indian-based start-up)	2
M-Shamba	Advisory services	Farmers and Agricultural experts	Kenyan-based start-up	2
Twiga DMS App	Data management	Twiga staff and partners.	Twiga Foods (Kenyan-based corporation)	1
I-Cow	Advisory services	Farmers and experts in dairy and beef farming	I COW Global	1
Mazao Hub	Data management and advisory services	Farmers, experts and extension officers	Ujuzinet Edtech Ltd	1
Mbegu Choice	Advisory services	Farmers	Mbegu Choice	1
NetBeat	Precision irrigation	Farmers and extension service providers.	Neta Fim	1
ODOO	Data management	Farmers and agricultural experts/consultants.	ODOO	1

Of the apps listed, **two-thirds were developed by the private sector and facilitated access to external inputs such as seeds, fertilizers and agro-chemicals.** The remaining third were applications developed by the KALRO to offer weather information, applications developed by the CAB International on input optimization and Biovision's Infonet, which provides information on organic agriculture. Half of the applications listed were also too complicated for many elderly farmers to use, as most farmers could not get past the long registration processes (particularly some of the Bayer applications). Some apps such as NetBeat and ODOO were mostly used by highly educated and financially stable farmers because they are very technical and expensive to install and use.

Farmers' interests in digital applications varied significantly depending on their age and the size of their farms. **Older farmers in particular showed limited enthusiasm for digital tools beyond social media and were generally skeptical of their utility. These farmers were primarily concerned with structural issues such as water access, the lack of agri-processing facilities for value addition and limited market opportunities.** In Makueni county, these concerns were particularly pronounced around mango farming, a major cash crop and a key focus for value chain development. The region had previously faced a devastating export ban due to fruit fly infestation, which severely impacted mango farmers by cutting off access to international markets and causing significant financial losses. This history has made farmers wary of new risks leading them to prioritize tangible, structural improvements over digital services like loans and input purchases. The disinterest may also reflect local knowledge and generational wisdom, emphasizing caution in adopting untested innovations.

In contrast, younger farmers were more likely to engage with a broader range of digital technologies, though few used dedicated farming applications consistently. These younger farmers often faced limited access to land and were not typically the primary decision-makers within their households. As a result, they found the greatest value in educational resources related to farming. Those with limited access to land or resources particularly benefitted from agroecological information, which enabled them to farm effectively with minimal resources and greater independence.

The small number of **farmers we spoke to who had larger land holdings showed a greater interest in digital applications, particularly for record keeping and market access.** These farmers who primarily farmed as a business and had significant surpluses, sought to leverage technology to enhance their operations. One middle-aged farmer, for instance, received assistance from his son, a recent university graduate, in using mobile applications to optimize his farming practices.

Despite the growing availability of digital applications, farmers and other stakeholders in Makueni County face significant challenges in accessing and utilizing these services. **Many older farmers do not own smart phones, which limits their access to some of the more advanced and user-friendly technologies currently being developed.** Although someone in the household might have access to a smart phone, the high cost of data—averaging $2.25 USD per gigabyte in Kenya—remains a prohibitive factor for small-scale farmers.[50] Additionally, for those in remote areas, **the lack of reliable access to electricity makes charging phones another substantial hurdle.** While these practical challenges are important, farmers are also reluctant to adopt digital technologies due to perceived risks. These risks are described in detail in section 6.1. Ultimately, despite the variety of apps, almost all farmers still primarily preferred and depended on face-to-face meetings with extension officers

> "Many farmers from my group don't use digital platforms because most of them are old and don't have smart phones. It's our children who use smart phones and they are not farmers."
> **- Kibwezi farmer**

5.3 Data collection and use

A key finding of the study in Makueni County is that extensive data is collected by a diverse array of stakeholders, extending beyond just digital applications. National and county governments collect data to enhance service delivery, manage food security and deploy resources more efficiently. Private companies collect data for marketing products, including seeds, fertilizers and agro-chemicals. Civil society organizations gather data to enhance their services and demonstrate their involvement. Researchers collect data for academic and scientific purposes. Additionally, farmers organizations and Savings and Credit Cooperative organizations (SACCOs) collect information to support a variety of initiatives and operations. Most recently, a new group of private sector and non-profit actors have begun collecting data on farmer production for emerging carbon credit schemes.

[50] Global Center on Adaptation. Kenya Mainstreaming Digital Approaches for Adaptation. Accessed September 15, 2024. https://adaptationportal.gca.org/files/kenya-mainstreaming-digital-approches-for-adaptation.pdf.

Figure 3: Services offered by digital applications

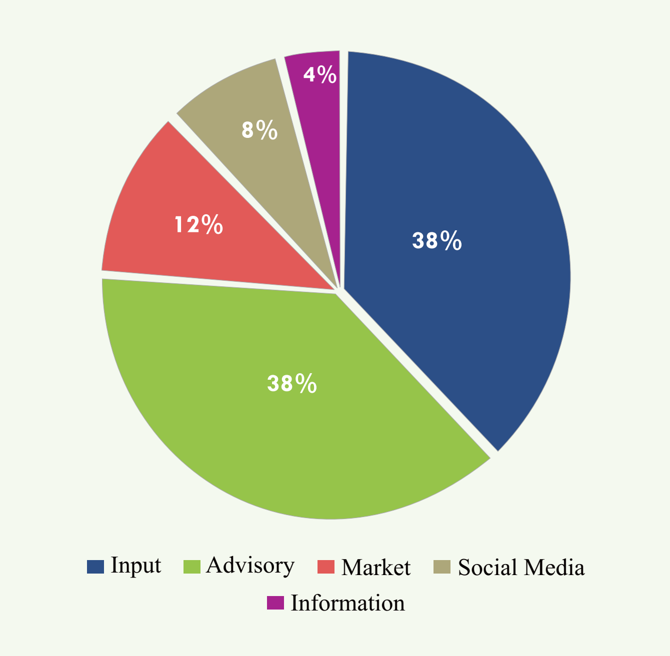
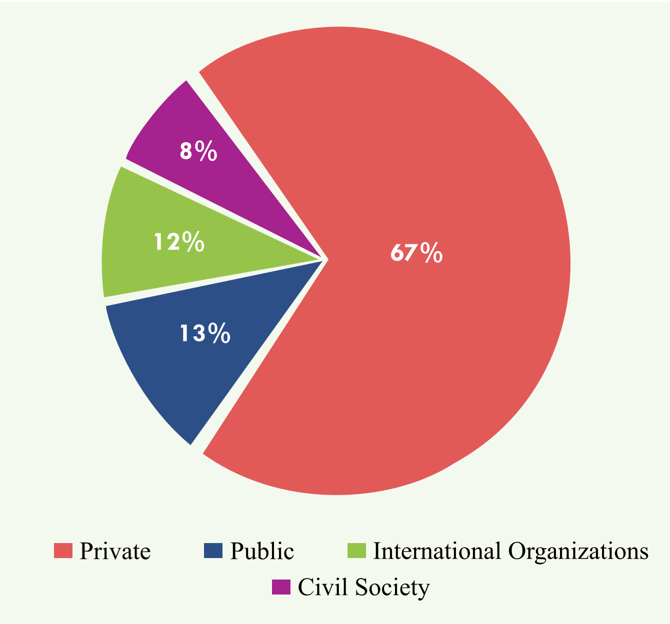


Figure 4: Applications by provider



The scope of data collection varies significantly among stakeholders. Civil society organizations often limit their data collection to basic contact information. In contrast, the national government and private sector gather more comprehensive data, including location details, land title information, extensive production information and information about access to inputs, credits and advisory services. Such data is important not only for planning and service provision, but also for enabling the growth of a digital agricultural economy.

As data collection grows more comprehensive, **farmers have grown increasingly concerned about how this data is being used and who will benefit from it.** For example, one farmer expressed concern that "farmer information could be used by organizations to mobilize resources without the farmers knowing or getting any benefits." Similarly, another farmer said that they were concerned that the farmer data "might be used to benefit the private sector and not the small-scale farmer."

The extensive data collection by numerous actors has several significant implications. First, **it challenges the prevalent narrative in development discourse—particularly concerning digital agriculture—that the primary obstacle is a lack of data. In reality, there is an overabundance of data that is often inadequately secured or inefficiently shared among stakeholders.** This is especially evident in the private sector, which amasses substantial data on farmers but frequently withholds it due to its perceived economic value. Second, **the pervasive data collection has heightened farmers' concerns about potential misuse and exploitation.** As farmers become increasingly aware of the value of their data, it is crucial for all parties involved in data collection not only to handle this information responsibly in compliance with the Kenya Data Protection Act, but also to engage the communities whoa re producing data. The associated risks and challenges related to data protection are discussed further in section 6.1.

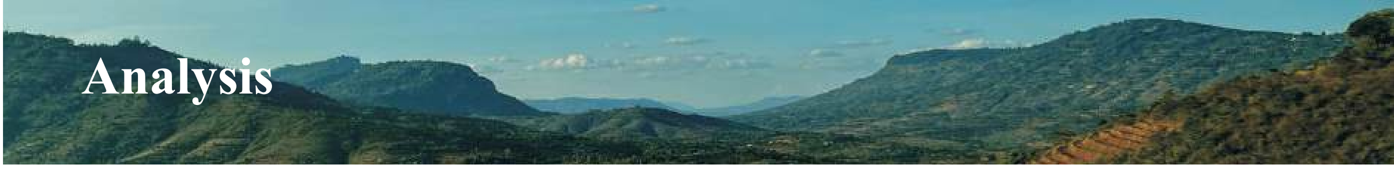
Farmers concerns on data collection and use

> My main concern is that farmer information could be used by organizations to mobilize resources without the farmers knowing or getting any benefits.
>
> **- Wote Farmer**

> I am concerned that in case of a farmer's death their information could be used to steal their property.
>
> **– Nguumo Ward Farmer**

> I am afraid that farmer data might be used to benefit the private sector and not the small-scale farmer.
>
> **- Wote Farmer**

chapter 6.



Analysis

All the stakeholders that we interviewed agreed that digital technologies hold the potential to enhance farmers access to information and foster community connections. However, many farmers and civil society organizations also identified significant problems and risks with digital technologies in the current form.[51] Broadly, these included concerns about data privacy and security, the uneven distribution of access and benefits, the impact of digital services on farmer autonomy, the prioritization of private sector needs over those of farmers. The following analysis of the benefits and risks is based on data collected from our case study in Makueni County, which was collaboratively analyzed by civil society organizations in Kenya dedicated to food sovereignty and agroecology during a two-day workshop in Nairobi in May 2024. Additional analysis was informed by interviews with stakeholders, donors and policy officials in the Makueni county and national government.

6.1 Risks and problems of digitalization for small-scale farmers

The following risks were identified both by farmers in Makueni County and by civil society organizations during the evaluation of digital technologies.

A. Data privacy and security:

Data collection and processing are crucial for developing digital agricultural services. However, **farmers expressed significant mistrust regarding the use and sharing of their data.** There is widespread concern that the data collected by many applications could be misused or lead to negative consequences. This mistrust is exacerbated by current fears of tax hikes, with farmers worried that data collected through this applications and registration processes could be used to increase their tax liabilities.

- **Opaque data sharing practices:**
  Farmers often lack transparency regarding how their data is shared by technology developers. Data sharing extends beyond the private sector to civil society organizations, which sometimes engage in similarly opaque practices. In Makueni County, for example, VBAs share farmer data with public and private partners through digital platforms introduced by organizations like AGRA. Many farmers are unaware of the full extent of this data sharing. Additionally, government-collected data could be shared with private entities without farmers' knowledge. During the KIAMIS digital farmer profile project, farmers were led to believe their dat would be used solely for government agricultural support, without disclosure of potential sharing with private companies. **Some farmers, for instance, were particularly concerned about GPS data on their land being collected without their knowledge, highlighting significant gaps in transparency and informed consent.**

- **Data-driven land grabbing:**
  Farmers are especially wary of land-related data collection, particularly sensitive information such as land titles and geolocation. Some fear this data could be exploited to claim their property after death. While digitizing land records in Makueni County is planned, it has not begun yet. **Although digital land records could increase title security, they also risk dispossession, particularly in areas with complex intergenerational and informal tenure systems.**[52]

- **Expropriation of traditional knowledge and resources:**
  Civil society organizations raised concerns that **digitalization of traditional knowledge, such as indigenous seed varieties, could be exploited by more powerful actors without**

[51] A growing literature elaborates these risks. See, for example: Hackfort, Sarah. "Patterns of Inequalities in Digital Agriculture: A Systematic Literature Review." Sustainability 13, no. 22 (January 2021): 12345. https://doi.org/10.3390/su132212345; Seufert, Philip. "How Digital Technologies Affect the Human Rights of Peasants and Small-Scale Food Producers." FIAN International, June 2023. https://www.fian.org/files/is/htdocs/wp11102127_GNIAANVR7U/www/files/policy%20paper%20digitalization_rev.pdf

[52] FIAN International, "Disruption or Déjà Vu? Digitalization, Land and Human Rights," January 27, 2021, https://www.fian.org/files/files/FIAN_Research_Paper_Digitalization_and_Land_Governance_final.pdf; Izabela Bludnik, "Digitalisation as a Driving Force for Land Grabbing in the Global South," Procedia Computer Science, Knowledge-Based and Intelligent Information & Engineering Systems: Proceedings of the 26th International Conference KES2022, 207 (January 1, 2022): 265–71, https://doi.org/10.1016/j.procs.2022.09.059; GRAIN, "The Digitalisation of Land: More Data, Less Land," April 15, 2022, https://grain.org/en/article/6832-the-digitalisation-of-land-more-data-less-land.

fair benefit-sharing. Civil society organizations dedicated to protecting indigenous seed varieties have increasingly turned to digitaltools to create databases and libraries of locally developed seed. **While these digital resources can aid communities in organizing and potentially sharing their agricultural assets, they also raise concerns about biopiracy in the absence of legal protections.** organizations have already reported instances where seeds developed by local communities were hybridized and commercialized by government entities without any benefits being shared with the original seed developers. The risk is amplified with new genomic technologies such as digital sequencing, that enabled digitalization of seeds.

B. Unequal access:

Much research on the risks to farmers emphasizes their potential exclusion from the digital revolution and the problem of the "digital divide."[53] Important issues include lack of connectivity, access to smart phones and other technologies and uneven levels of technological proficiency. In addition, a key challenge to the adoption of digital services in Kenya is the cost of data, which remains high in the country.[54] Though smart phone usage is on the rise in Kenya, many farmers—especially older ones—face barriers not only in accessing these devices but also in feeling comfortable using digital technologies. In regions like Makueni County, where the farming population is predominantly older, this issue is particularly pronounced. Even when a household possesses a smart phone, it is often not used regularly for farming activities. While some research has shown that there is a gap between men's and women's access to smart phones, this was not found by the project team. In fact in 2024, the GSMA found that for the first time in Kenya, access to mobile internet demonstrated gender parity.[55] **Despite equal access by men and women, the digital divide across the country raises concerns about the uneven distribution of the benefits of digital agriculture, potentially exacerbating existing inequalities and leaving some farmers behind.**

C. Misalignment of technology with farmers' contexts and needs:

Since digital technologies are primarily developed by the private sector, they often prioritize profitability over farmers' actual needs. Indeed, digital agriculture is often framed within the narrative of "smart agriculture," which emphasizes risk-taking and a commercial mindset reliant on external inputs. This perspective can be at odds with the realities and constraints faced by small-scale food producers. It has also fueled concerns and mistrust among farmers and it has also limited the relevance and effectiveness of some technologies.

Unrealistic expectations about livelihood constraints:

Some farmers pointed out that **digital technologies make unrealistic assumptions about their capacity to commercialize.** The Kenya Cereal Enhancement Program Climate Resilient Agricultural Livelihood (KCEP-CRAL) —a program that was conceived as a use-case for digital technologies through its data collection and "e-incentive" system- serves as a pertinent example. KCEP-CRAL was designed to provide farmers with debit cards to enable them access subsidized inputs. The program offered seeds, fertilizers, pesticides and even crop insurance. During the first year, farmers were asked to pay 10% of the total costs. The program's design included a phased reduction in subsidies over three years, expecting farmers to gradually shoulder more of the financial burden. However, many of the farmers we spoke to found it increasingly difficult to continue purchasing inputs as their financial obligations grew. Indeed, social research on similar development programs that offer loans for agricultural inputs has illustrated that small-scale farmers suffering from climate vulnerabilities and food insecurity are likely unable to commercialize through individual loans due to structural issues, including the lack of markets as well as other expenses for basic subsistence and school fees.[56] This example highlights a broader issue: **these**

[53] See, for example: John Kieti et al., "What Really Impedes the Scaling out of Digital Services for Agriculture? A Kenyan Users' Perspective," Smart Agricultural Technology 2 (December 1, 2022): 100034, https://doi.org/10.1016/j.atech.2022.100034.
[54] Digital Frontiers and USAID, "Kenya Digital Ecosystem Country Assessment," 2020, https://www.digitalfrontiersdai.com/resources/kenya-digital-ecosystem-country-assessment/.
[55] GSMA. The Mobile Gender Gap Report 2024. May 2024. Accessed September 15, 2024. https://www.gsma.com/r/wpcontent/uploads/2024/05/The-Mobile-Gender-Gap-Report 2024.pdf?utm_source=website&utm_medium= button&utm_campaign=gender-gap-2024.
[56] Miriam Waltz, "Visions of Growth: Agricultural NGOs, Loans, and Indebtedness in Western Kenya," *Etnofoor* 35, no. 1 (2023): 51–66.

programs often operate on a commercialization model that fails to account for the diverse livelihood strategies and resource constraints of small-scale farmers. By discounting these constraints, such programs risk alienating the very people they aim to assist.

- **Short-term benefits over long term-term sustainability:**
Many farmers expressed concern that the "benefits" offered by digital technologies are often short-term fixes rather than sustainable solutions. Agroecological farmers emphasized the detrimental long-term impact of synthetic fertilizers on soil health, advocating instead for practices like the use of locally sourced manure. Despite this, **most digital applications tend to recommend products that appear to favor corporate interests over the well-being of farming communities.** These recommendations often prioritize immediate gains such as increased yields without considering the long-term consequences for soil fertility, environmental sustainability, or the resilience of farming systems. **This focus on short-term benefits can undermine the ecological and economic sustainability of small-scale farming, leaving farmers dependent on external inputs and vulnerable to the shifting demands of the market.**

- **Neglecting structural challenges:**
Many of the critical challenges farmers face are structural in nature and cannot be addressed by digital solutions alone. For example, increasingly erratic rainfall due to climate change has made water scarcity for irrigation a top concern. Other significant structural barriers include limited access to land, particularly for women and youth, as well as difficulties in obtaining quality seeds and reaching markets. **Without addressing these underlying structural challenges, digital agriculture risks offering superficial solutions at best and at worst, lead farmers into debt and encourage the adoption of unsustainable practices.**

- **Unfulfilled expectations, business failures and problematic roll-outs:**
Many of the applications introduced in Makueni over the past six years have either gone out of business or stopped being updated. Farmers are skeptical about the promises of digital technologies and wary of registering

Case in point: Safaricom's DigiFarm service

DigiFarm, launched in 2017 by telecommunications giant Safaricom, was designed as a 'one-stop shop' for farmers. It is available both on feature phones via USSD (Unstructured Supplementary Service Data) and as a smart phone application. Building on the success of Safaricom's M-PESA, DigiFarm claimed to revolutionize farming by easily integrating with Safaricom's services. The platform offers access to third-party services such as inputs, financial and advisory services, crop insurance and an agricultural market place.

In 2018, Safaricom introduced DigiFarm Village, aiming to expand the service through field experts across the country, with Makueni County being one of the target areas. However, challenges soon emerged. One farmer in Kibwezi reported registering on DigiFarm but receiving no follow-up support. She also noted that non-farmers were registering to receive inputs, which they then sold instead of using them for farming. Despite these issues, DigiFarm claimed to have registered over 150,000 farmers in Makueni county at one point. Today DigiFarm is no longer operating in Makueni County and it remains unclear how this data is being stored and with whom it's being shared.

While DigiFarm continues to operate in Kenya, it has not lived up to the high expectations set for it. This is because DigiFarm misunderstood farmers' needs and financial constraints. It has failed to generate a profitable business model even with the backing of one of the largest telecom providers in the country. DigiFarm thus raises important questions about the promises of market-driven digital agricultural technologies.

with services that lack a proven track record. The example of DigiFarm, described below, highlights broader concerns about the reliability of digital applications.

- **Privatization of public infrastructures:** Agricultural extension officers in Makueni County acknowledged the potential of digital technologies to deliver information to farmers dispersed across vast geographic areas. However, they expressed concern that **the expansion of digital services might accelerate the decline in funding for extension services.** These officers stressed the importance of their role in providing rigorously vetted and unbiased information, something that private digital advisory services often lack. As public extension services have weakened, philanthropies and civil society organizations have introduced new models of extension work over the past decade, such as the VBA. This community-based model fills some gaps left by traditional public services but because VBAs are unpaid volunteers, they are encouraged to pursue business ventures such as opening Agrovets to sell agricultural inputs or collaborating with the private sector to share farmers' data. **This shift towards digital advisory services combined with the VBA model, underscores a growing concern; agricultural advisory services are increasingly becoming privatized. This trend risks promoting agricultural practices that foster dependancy on agribusiness and big tech companies.**

D. Undermining farmer autonomy and food sovereignty:

Farmers and civil society organizations have voiced concerns that **digital technologies developed by private sector actors may increase dependancy among farmers by emphasizing the use of external inputs while marginalizing local, indigenous and agroecological practices in advisory services.** Furthermore, the continuous collection of data on farming practices enables heightened surveillance by both the private sector and government, which threatens the privacy and autonomy of small-scale food producers. In Kenya where advisory services form bulk of the digital offerings, these concerns about autonomy and food sovereignty are particularly pronounced. They center on whose interests shape the information provided, the types of practices endorsed and the overall credibility and accuracy of the advice disseminated.

- **Biased and/or inaccurate information:** Traditionally, farmers navigate conflicting advice from neighbors, agrovets, extension officers or NGOs by assessing the credibility of these sources based on their personal knowledge and the context in which the advice is given. In contrast, the digitally delivered information lacks this transparency, making it much harder for farmers to discern potential biases or inaccuracies. For instance, while it may be evident that applications developed by agribusiness giants like Bayer might prioritize solutions involving their own products, the biases of other digital tools are often far less clear. This lack of transparency complicates farmers' ability to make informed decisions. Extension officers in Makueni county have also expressed concerns, pointing out that farmers are increasingly receiving information that is not only poorly vetted but also potentially inaccurate. Unlike digital tools, these officers have a deep understanding of the resource constraints faced by small-scale farmers and are more likely to recommend practices that are both realistic and contextually appropriate. **Although digital agriculture is often heralded for its potential to enable more precise and informed decision-making on farms, a significant and growing concern among farmers is the unreliability of information provided by digital agricultural tools.** For instance, during the study period, digital weather forecasts inaccurately predicted rain weeks before they occurred. **Such inaccuracies not only erode trust in digital agriculture but also cast doubt on the broader claim that these technologies can constantly deliver precise and actionable insights.** This has led some researchers to dub digital agriculture "imprecision farming."[57]

[57] Oane Visser, Sarah Ruth Sippel, and Louis Thiemann, "Imprecision Farming? Examining the (in)Accuracy and Risks of Digital Agriculture," Journal of Rural Studies 86 (August 1, 2021): 623–32, https://doi.org/10.1016/j.jrurstud.2021.07.024.

Inaccuracies may also stem from flawed underlying data. Farmers wary of privacy and security risks, may deliberately provide false information to digital platforms as a protective measure. This is particularly likely when there is a lack of informed consent and transparency about how their data will be used. As a result, the very foundation of the digital information provided may lead to further inaccuracies. Thus, **issues of data protection and transparency are critical to addressing the broader problem of inaccurate information in digital agriculture.**

- **Insufficient agroecological information:** Most mobile phone applications that offer advisory services promote the use of external inputs such as commercial seeds, synthetic fertilizers and agro-chemicals, including pesticides and herbicides. **Few applications provide information on locally available agroecological inputs and soil amendments.** Additionally, the limited digital resources on agroecology often lack the user-friendliness and accessibility of those developed by the private sector. **As a result, farmers are receiving heavily biased advice that pushes them to become reliant on costly external inputs and excludes sustainable, locally adapted farming practices.**

- **Digital surveillance:** Digital technologies in agriculture collect extensive data on farmers, which may be shared with private sector companies, governments and development organizations. Some of this data can be useful for informed governance, strategic planning and improving agricultural practices. For example, accurate information on food stocks can help governments ensure food security. However, **data sharing also raises concerns about surveillance and control.**[58] Farmers in Kenya are being asked to provide increasing information about their land and practices to the government and the private sector. This allows institutions to monitor what farmers are doing. Monitoring is built into the e-incentive system that the government is developing. Through e-incentive system, KALRO aims to collect geo-located yield data that will enable them to do performance monitoring and update e-incentive criteria. The system thus enables the government to monitor not just the delivery of e-incentives, but also the performance of farmers. This information can be used to adjust eligibility, so that farmers who do not perform as well are no longer eligible for subsidies. However this can also have additional consequences. The government could increase the tax on farmers, penalize those that do not use the practices prescribed or even prosecute farmers for seed sharing (which is currently prohibited under Kenya's Seeds and Plant Varieties Act).[59]

- **Nudging farmers towards monocropping:** Most advisory services developed by the private sector tend to focus on commercial crops, which make them incompatible with growing interest in cultivating and preserving indigenous vegetables, especially after the pandemic. **Information on planting, pests and disease are also typically oriented around single crops, rather than the polycultures that are more common and sustainable.** This implicit proportion of monocropping can increase pest and disease pressures, reduce biodiversity and decrease the overall resilience of farming systems.

- **Diminishing collective power:** Digital agricultural tools aim to provide financial and market opportunities for farmers, but this trend risks undermining the power of collective organizations and institutions developed by farmers. For instance, many farmer organizations have established table banking projects to offer small loans for purchasing tools and inputs, with the risks collectively guaranteed. If farmers cannot repay these loans, the loss to the organization is minimal. However, many financial institutions have begun offering micro-credit to farmers. While these loans may be more "efficient," they pose significant risks. In case of harvest failure, farmers face serious losses and some institutions have sought compensation for unpaid loans by seizing farmers' limited resources, including the roofs from their houses.

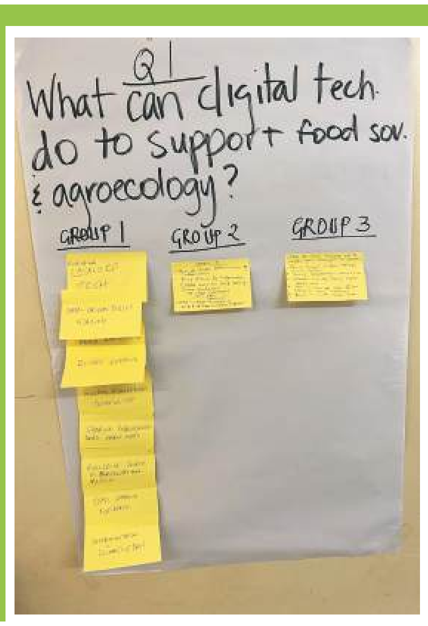
[58] Glenn Davis Stone, "Surveillance Agriculture and Peasant Autonomy," Journal of Agrarian Change 22, no. 3 (2022): 608–31, https://doi.org/10.1111/joac.12470.

[59] Kenya's 2012 Seeds and Plant Varieties Act currently prohibits and even criminalizes the sale and exchange of peasant seeds, making it illegal to sell uncertified seeds. This law has sparked significant concern among farmers and their advocates, who argue that it undermines traditional, farmer-managed seed systems. In response, farmer organizations are actively pushing for a review of the Act to protect and promote these farmer-managed seed systems. See: https://defendingpeasantsrights.org/en/kenyan-farmers-challenge-the-constitutionality-of-seed-law/

Additionally, **digital tools risk diminishing the collective bargaining power of farmers.** Numerous organizations have highlighted the crucial role of cooperatives in pooling resources, offering loans and providing market access. However, several people in Makueni County noted the challenges of maintaining good governance and trust in cooperatives, citing past issues with coffee cooperatives in the area. Despite these challenges, many **digital technologies developed by the private sector target individual farmers rather than facilitating collective organization and bargaining, further eroding the strength of farmer cooperatives.**

> "Digifarm failed in my area because I feel Safaricom did not do proper vetting, many people who registered to the program were not farmers, so they would take the inputs and then sell them."
> **-Kibwezi farmer**

Data analysis workshop, Nairobi, May 2024



- **Financialization of land and resources:** **The collection of data on land ownership and tenure, farmer production practices and other resources is empowering public and private actors to create a new class of assets.** These assets are gaining value in the context of climate change, as carbon markets enable corporations and other entities to claim decarbonization by investing in conservation and ecosystem services. Kenya is positioning itself as a leader in carbon credits issued in Africa.[60] Moreover, while companies offer payments to small-scale farmers for ecosystem services that sequester carbon—such as agroforestry and no-till agriculture—experiences in other countries suggest these farmers may not reap the benefits of their changing practices.[61] They might also be pressured to adopt practices or plant crops that are not advantageous to them. For instance, farmers in Makueni are being encouraged to plant mango and avocado trees to gain carbon credits through agroforestry. However, without established markets for these crops, the income from carbon credits alone may not ultimately provide adequate benefits.

[60] Kenza Bryan, "The Looming Land Grab in Africa for Carbon Credits," December 6, 2023, https://www.ft.com/content/f9bead69-7401-44fe-8db9-1c4063ae958c.

[61] Melissa Gómez Gil and Philip Seufert, "Coffee and Carbon in Colombia: Human Rights Concerns at the Intersection of Food Systems,

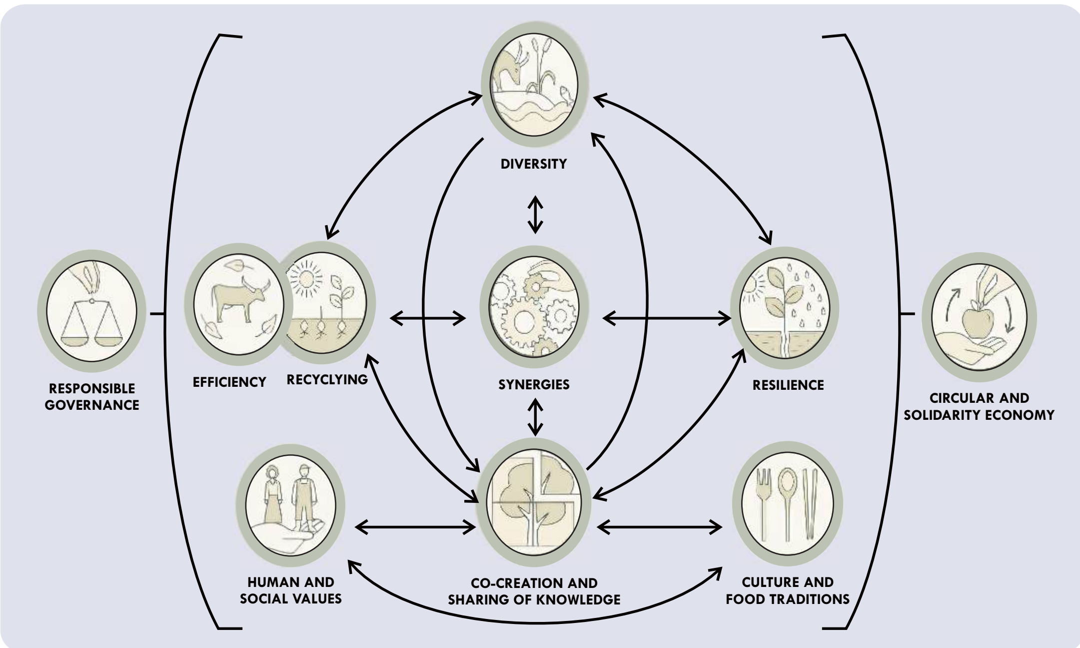
6.2 Benefits of digital technologies for agroecology and food sovereignty: Fostering connections between humans and nature

Technologies that promote food sovereignty and agroecology foster the exchange of local knowledge, collective care, resources and sustainable practices. By doing so, they reinforce community resilience, resource independence and ecological balance. Social movements and civil society organizations advocating for food sovereignty are increasingly establishing criteria for appropriate technology, alongside fair protections for small-scale food producers.[62] However, to genuinely advance agroecology, these technologies must adhere to ten elements of agroecology agreed to by the Food and Agriculture Organization:

1. Diversity
2. Co-creation and sharing knowledge
3. Synergies
4. Efficiency
5. Recycling
6. Resilience
7. Human and social values
8. Culture and food traditions
9. Responsible governance
10. Circular and solidarity economy

Digital agriculture, in its current form, is often at odds with these principles. Dominated by the private sector interests, it tends to promote external inputs that reduce biodiversity and cause long-term harm to soils, while top-down information flows prioritize private sector and government value chains. As a result, the connections facilitated by digital agricultural technologies predominantly link farmers to corporations rather than fostering community-driven innovation. Nevertheless, **digital technologies can significantly contribute to agroecological transformation when they are farmer-led.**[63] Below are some of the ways that digital technologies may strengthen community food sovereignty and the transition to agroecological food systems.

Figure 5: The 10 elements of agroecology



https://openknowledge.fao.org/server/api/core/bitsreams/99ed290e-1c80-4687-ba83-3ab58ef19b24/content

[62] Ayms Mason et al., "Agroecological Intelligence: Establishing Criteria for Agroecologically Appropriate Technology" (A Bigger Conversation, 2024), https://abiggerconversation.org/wp-content/uploads/2024/05/ABC_Agroecological-Intelligence-Report_Final_280524.pdf.

[63] Hannah Wittman, Dana James, and Zia Mehrabi, "Advancing Food Sovereignty through Farmer-Driven Digital Agroecology," Ciencia e Investigación Agraria: Revista Latinoamericana de Ciencias de La Agricultura 47, no. 3 (2020): 235–48.

A. Enhancing diversity:

Digital platforms have the potential to greatly enhance agrobiodiversity by facilitating the sharing of seeds and agroecological inputs. In Kenya, civil society organizations are already creating online catalogs, libraries and platforms to support biodiversity and farmer-managed seed systems. For instance, the Seed Savers Network in Kenya collaborates with farmers to develop and preserve local seed varieties, establish seed banks and expand sharing networks. Digital platforms can scale up these initiatives by connecting more farmers and communities. However restrictive seed laws in Kenya present a significant barrier. To fully harness the potential of these technologies, Kenya must establish a supportive legal and governance framework that prioritizes farmers' rights to save, share and exchange seeds.

B. Facilitating co-creation and sharing of knowledge:

Even though most digital technologies are often developed by technology companies, civil society organizations identified a number of ways in which digital technologies can enable co-creation of specific knowledge and innovations.

Facilitating information sharing:

WhatsApp groups have become an indispensable tool for farmers, civil society organizations and extension agents in Makueni County. Nearly every farmer we met with who had access to a smart phone was actively involved inn WhatsApp groups with other farmers in their area. These groups facilitate the exchange of crucial information and the organization of small collective infrastructure projects. In the context of reduced public extension services, these groups also enable extension officers to efficiently communicate with farmers groups about pests, diseases and other production challenges.

Enabling connections between agroecological farmers and movements:

Civil society organizations are leveraging digital tools-such as email, text messaging and social media-to forge connections between individuals and link local activists with global movements. These technologies enable local farmers' organizations to engage with regional, national and international networks advocating for policies that uplift small-scale food producers. This digital interconnectedness amplifies the collective voice and influence of agroecological communities.

Fostering farmer-to-farmer learning:

While in-person farmer-to-farmer learning remains invaluable, civil society organizations are increasingly harnessing digital technologies to create new avenues for farmer education. For instance, Biovision's Infonet, a web-based platform and database, provides farmers and other stakeholders with access to research and insights on sustainable agricultural practices. This resource is actively utilized by field officers and farmers in Makueni to address practical agricultural challenges. Similarly, the Grow Biointensive Agricultural Center of Kenya (G-BIACK) has produced YouTube videos on sustainable pest control methods, such as those for the Black Soldier Fly, as well as music videos on climate change to raise awareness. During our visit to Makueni, we met a farmer and community leader who was participating in an online course on soil biology via Zoom. **Farmers are increasingly embracing these diverse technologies apart is their ability to facilitate direct connections between farmers and farmer organizations.** Although they may operate on corporate platforms that collect data and make algorithmic suggestions (such as YouTube), the primary intelligence driving these initiatives comes from farmers and researchers, not artificial intelligence.

Documenting and sharing local innovations:

In Kenya, numerous organizations are actively engaged in supporting and highlighting farmer-led innovations across diverse agricultural practices. These initiatives often involve in-person events where farmers can directly interact, exchange ideas and learn from one another's experiences. However, the advent of digital technologies present new opportunities to broaden these exchanges. **By leveraging digital platforms, farmers can document and disseminate their innovations remotely, overcoming geographical barriers and facilitate a wider reach.**

- **Monitoring and evaluation of agroecological projects:**

A key principle of agroecology is farmer-centered knowledge generation, where researchers and scientists collaborate closely with farmers to identify priorities and co-develop and test local innovations that address shared challenges. Researchers and scientists often work with farmers to define priorities and to develop and test local innovations that enable farmers to address shared challenges. **Digital communication tools, such as SMS and WhatsApp, have the potential to significantly enhance this collaboration by facilitating real-time, two-way communication between farmers and researchers, thereby generating greater support and evidence for agroecology.**

C. Promoting efficiency:

From an agroecological lens, efficiency refers to the enhancement of production by using fewer external resources. From this perspective, digital technologies can enable farmers to be more efficient in several ways.

- **Providing timely information:**

Many farmers that we met appreciated receiving up-to-date information on weather and market prices through SMS and mobile phone-based applications. KALRO has developed several online platforms and Makueni County government also sends out text messages on weather. This information can be helpful for farmers in deciding when to plant, harvest and sell their crops. In addition, KALRO's data on market pries is also being used by some cooperatives that collectively market cereals to make decisions on whether to sell their produce. Some large-scale farmers, particularly those with over 10 Hectares in production, reported consulting market price dat provided by KALRO.

- **Assisting with record keeping:**

Digital technologies can also provide farmers with tools for basic record keeping, including planting and harvesting schedules as well as budgets. In Makueni, we met a young farmer who had developed a digital farm record-keeping tool specifically for his community, demonstrating the practical benefits of such innovations. However, while these tools may be useful, they also raise important concerns about data privacy and security. Farmers must carefully evaluate these tools to ensure that their data is protected and that there is transparency in how their information is collected, used and shared.

- **Access to credit:**

Some farmers utilizing digital service to access credit and insurance. However, few small-scale farmers we interviewed have the capacity to take on substantial credit beyond small loans from table banking. Most small-scale farmers rely minimally on external inputs and seek advice from friends, service providers, the government and agricultural input suppliers before making purchases.

- **Soil and water management:**

Digital tools can play a role in addressing challenges related to water and soil management. For instance, soil sensors provide valuable data on moisture levels, pH and micronutrient content, helping farmers gain a deeper understanding of their soil health. However, soil health extends beyond just chemical metrics; biological factors like microbial activity and organic matter are also vital. While digital tools offer precise and actionable insights, they capture only a segment of the soil's complex ecological profile. Thus, **while these technologies are instrumental in enhancing soil management, they should be seen as complementary to a more holistic approach that integrates both digital data and traditional knowledge to achieve comprehensive soil health and sustainability.**

D. Recycling:

Digital technologies can contribute to the nutrient recycling principles of agroecology by facilitating the sharing of agroecological inputs and practices among farmers. These technologies enable the efficient exchange of resources such as compost, organic fertilizers and pest management solutions, which help in reducing waste and promoting sustainable use of materials.

E. Circular and solidarity economy:

Digital technologies can foster shorter and more resilient supply chains. Some farmers in Makueni are leveraging digital applications to market their products. Currently, many rely on platforms like Facebook and WhatsApp groups to sell surplus crops, such as mangoes within their communities and nearby urban centers, including Nairobi. These digital tools are playing a crucial role in bridging the gap between rural and urban areas fostering stronger connections between producers and consumers. We also encountered entrepreneurs collaborating with farmer cooperatives in Makueni to develop digital platforms specifically designed to enable farmers to market agroecological and organic produce directly to consumers. **These direct connections have the potential to secure better prices for farmers while providing consumers with access to fresh healthy food.** However, it is essential to critically evaluate organizations, companies and entrepreneurs that are developing farmer-to-consumer platforms. There is a risk that these platforms could evolve into a new form of "middlemen," imposing high fees on farmers and undermining the very benefits they promise to deliver.

Positive feedback from farmers

"Digital Agriculture is the future and more farmers need to embrace digital technologies in Agriculture.

-Kibwezi East Farmer

I expect that once I register to a digital platform, I will have access inputs, information, and marketing for my products.

- Kibwezi farmers."

chapter 7.

Conclusions and Recommendations

The digital agricultural revolution is currently being heralded as a transformative force in food systems. However, historical precedents show that previous "revolutions" have frequently facilitated the outflow of resources and capital from the African continent, leaving small-scale farmers with little improvement in their circumstances.[64] Given that this revolution is predominantly driven by private sector entities and philanthropies linked to the "Green Revolution," there is substantial reason for skepticism regarding the genuine benefits of digital technologies. Moreover, the computational processes behind these technologies often remain "black boxed", creating challenges for civil society and researchers in evaluating their true impact.[65]

The findings of this report reveal that digital technologies alone will not advance food sovereignty or enhance agroecological practices when their primary purpose is to connect farmers with agribusiness and financial institutions. Many digital tools developed by the private sector tend to increase farmer dependency, shift the burden of risk onto individual farmers and foster indebtedness. In these scenarios, it is the private sector that benefits, not the farmers. In Kenya, where agribusiness is already "ascending," digital technologies are likely to reinforce and widen structural inequalities, with large firms capturing the benefits over small businesses and farmers.[66]

The dominance of the private sector in digital agriculture may have significant ecological consequences. Although digital technologies are frequently promoted as part of "climate-smart agriculture," they are often designed to support Green Revolution practices, such as the use of synthetic fertilizers, agrochemicals and commercial seeds. Over time, these practices can degrade soil health and reduce agrobiodiversity, ultimately weakening the resilience needed to address climate change. For Kenya, which is already grappling with heightened climate vulnerability, the current trajectory of digital agriculture may inadvertently exacerbate these challenges. However, digital technologies can potentially support agroecological practices. As described above, **farmers are leveraging social media applications to build connections with each other, farmer groups, government officials, consumers and civil society organizations. These networks enhance farmers' access to information, resources and support thereby strengthening their rights and autonomy.** Importantly though, disparities in resources between farmers' organizations, civil society, governments and the private sector- such as differences in usability design, AI computational power and software updates- can exacerbate existing inequalities. This imbalance risks reinforcing prevailing power dynamics and deepening reliance on multinational corporations.

To ensure that digital technologies do not exploit farmer data, land and livelihoods, it is crucial for all stakeholders to play a proactive role. The following recommendations were collaboratively developed by civil society organizations during a workshop where the findings of this case study were presented.

Civil society organizations should:

- **Raise awareness and educate farmers about data and digital technologies:**
While farmers are increasingly encouraged to adopt a variety of digital technologies, they often lack critical information about how their data is used, the origins of the information provide to them and the long-term consequences of engaging with specific technology providers. To bridge this gap, **civil society organizations must take a proactive role in educating farmers and their organizations about data privacy laws and boarder implications of digital technology use in agriculture.** This includes providing accessible training that equips farmers with the knowledge to make informed decisions about their digital interactions.

[64] William Moseley, Matthew Schnurr, and Rachel Bezner Kerr, "Interrogating the Technocratic (Neoliberal) Agenda for Agricultural Development and Hunger Alleviation in Africa," African Geographical Review 34, no. 1 (January 2, 2015): 1–7, https://doi.org/10.1080/19376812.2014.1003308.

[65] Thomas, Jim. Black Box Biotech: AI and Synthetic Biology. Accessed September 15, 2024. https://acbio.org.za/wp-content/uploads/2024/09/Black-Box-Biotech-AI-Synth-bio-paper_fin.pdf.

[66] M. V. de Jong et al., "An Overview of the Kenyan Food System: Outcomes, Drivers and Activities," May 2024, https://doi.org/10.18174/658586.

- **Enhance knowledge and capacity on data privacy and protection:**
  It is essential for civil society to deepen its understanding of both the technical and legal dimensions of data governance. This will enable more effective participation in participatory governance and the active monitoring of digital agricultural technologies for potential data breaches. The enforcement of the Kenya Data Protection Act heavily relies on civil society and other actors reporting breaches to the Office of the Data Protection Commissioner. Therefore, civil society organizations working with farmers should build their capacity to monitor data protection issues and report breaches to the appropriate authorities.

- **Leverage appropriate technologies to encourage and support young people in adopting agroecological approaches:**
  Farmers' organizations are increasingly leveraging digital technologies to build knowledge and support for agroecology. For instance, G-BIACK is creating music videos on YouTube to raise awareness about various agricultural issues. Given that young people are the primary users of digital platforms, **civil society organizations should harness these technologies to engage youth and showcase stories of young individuals integrating digital tools into their agroecological practices.** This approach not only empowers the next generation but also provides valuable opportunities for ongoing technology assessment.

- **Utilize digital technology to enable farmer to-farmer learning and horizontal knowledge:**
  Farmers are increasingly using social media platforms like WhatsApp and Facebook as well as tools like Zoom, to exchange information and access courses on agroecological practices. **CSOs should explore innovative ways to enhance these digital channels, facilitating direct sharing of best practices, innovations and experiences among farmers.** This approach can significantly bolster farmer autonomy and collective learning. Additionally, CSOs should collaborate with telecommunications providers to subsidize data costs, ensuring that farmers can access and benefit from these digital resources effectively.

- **Develop inclusive technology assessment programs:**
  Farmers' movements and civil society are actively evaluating which technologies best support agroecology and food sovereignty. Institutions like the African Technology Assessment Platform (Afri-TAP) provide an important model, empowering these groups to collaboratively and continuously assess technological impacts. These models can be locally and regionally adapted, facilitating the sharing insights and fostering more informed, context-specific decisions.

Technology providers should:

- **Co-create digital technologies with farmers that address their needs and livelihood constraints:**
  Effective digital solutions for small scale farmers require close collaboration between farmers and researchers. **Engaging farmers in the development process ensures that technologies are tailored to address their specific challenges and opportunities.** This approach should include designing digital tools that are accessible in local languages, reflecting the local context, culture and practices. By co-creating technologies with input from farmers, technology providers can create solutions that are more relevant and impactful.

- **Enhance transparency on sponsored content and data sharing:**
  To foster trust and ensure the ethical use of digital agricultural technologies, **it is crucial to improve transparency regarding sponsored content and data sharing practices.** Technology providers should clearly disclose any sponsored content on their platforms, allowing farmers to easily identify when content or recommendations serve third-party interests. Additionally, companies must offer clear and accessible information about how farmers' data is collected used and shared. This includes detailing the purposes of dat collection, the types of data collected and any third parties with whom the data is shared, ensuring that farmers are fully informed about the handling of their information.

Donors should:

- **Incentivize technology developers and governments to advance digital technologies that promote agroecology:**
This research underscores the potential of digital technologies to enhance small-scale farmers' agroecological practices. Given that donors provide a significant portion of the funding for digital services, they hold a crucial role in shaping the digital agricultural landscape. **Donors should prioritize investments in non commercial digital technologies, particularly those developed by research institutions like KALRO, civil society, farmers' organizations and other researchers to create a strong, agroecology-focused digital infrastructure.** Additionally, donors can fund initiatives that involve co-creation of technologies with framers, ensuring that digital innovations are tailored to the needs of agroecology. By doing so, they can promote equitable distribution of the benefits of digital agriculture, while supporting sustainability and biodiversity.

- **Fund capacity building for civil society to engage in agricultural data governance:**
Effective data governance requires active participation from farmers' organizations and civil society. However, these groups often lack the expertise needed to navigate data protection and the complexities of datafication. Without targeted capacity-building efforts, the private sector may dominate data governance discussions. **Donor can bridge this gap by funding civil society organizations to enhance their knowledge and skills, fostering more inclusive and effective agricultural data governance.**

The Government of Kenya and county governments should:

- **Strengthen data privacy protection for agricultural data:**
Kenya has already exhibited leadership in developing agricultural data governance. However, current protection of farmers' data is inadequate. A key challenge is the distinction between personal and non-personal data in agriculture. Most agricultural data isn't classified as "personal data." According to the DPA, personal data is any information related to an identifiable natural person. By contrast, non-personal data includes weather, machine dat and agronomic data such as yield, nutrient and soil information, which are not protected under the DPA. However when combined (e.g yield data with location dat), agricultural data can reveal personal information, blurring the distinction between 'personal' and 'non-personal' data. Critical questions persist regarding which types of data should be classified as personal and therefore protected under the DPA. **As the current framework primarily addresses the farmer profile system, it must clearly define what data will be shared, with whom and under what circumstances.**

- **Enhance transparency and privacy in private sector data collection:**
While private sector data collection must comply with the DPA, small-scale farmers often lack negotiating power in contract and licensing agreements, which are typically mistrusted due to complex terms MoALD can play a vital role in strengthening data governance across the digital agriculture system by ensuring that private sector data practices are transparent and ethical. Through Memorandums of Understanding, data sharing agreements and other partnerships. MoALD should provide clear, actionable guidelines on informed consent. This includes defining what constitutes informed consent and mandating transparency and data ownership protocols for technology providers.

- **Establish a framework to protect biodiversity and farmer-managed seed systems amid increasing digitalization of plant genetic resources:**
  Local and indigenous seeds represent a critical form of "data" that currently lacks adequate protections. To prevent biopiracy and appropriation and to promote biodiversity, **the government should establish a robust regulatory framework that supports and safeguards farmer-managed seed systems**. Additionally, **the government should create a framework to ensure equitable benefit-sharing in instances where "digital information sequencing" of Kenya's plant genomic resources is involved**. Such measures are essential to preserve the integrity of indigenous knowledge and to ensure that the benefits derived from these resources are fairly distributed.

- **Include agroecology practitioners as stakeholders in data governance policies:**
  The Data Governance Framework includes a mechanism for farmer participation through the Data Governance Council. This Council, as described in the Framework, includes senior management from MoALD and various stakeholders. However, the Council lacks representation from agroecology practitioners and farmers' organizations. ISFAA provides a model for a multi-stakeholder and multisectoral platform that can address the needs of small-scale food producers. Including these groups in the Council will ensure that the voices and interests of agroecology practitioners are considered in policymaking.

- **Develop and enforce data governance regulations at the county level:**
  While the national government should strengthen data governance policies, **county governments should also develop data governance framework to govern their own practices of data collection and sharing.**

- **Ensure credibility and neutrality of content on digital apps:**
  Efforts are needed to ensure that the information provided to small-scale farmers through digital applications is reliable and unbiased. Digital advisory services should offer information on a range of practices, allowing farmers to choose freely based on the best possible information suited to their needs. **The government can play a role in certifying the validity of information provided through digital applications, while civil society organizations can monitor these applications to maintain impartiality.**

- **Incorporate digital technologies into the National Agroecology Strategy implementation framework:**
  Digital technologies should be integrated into the National Agroecology Strategy implementation framework. Applications and digital technologies produced and managed by KALRO and MoALD should include information and support for agroecology. This integration ensures that digital tools are aligned with the goals of promoting sustainable agricultural practices and supporting small-scale farmers.

- **Develop a transparent framework to identify agroecologically appropriate technology:**
  The government and interested stakeholders, including civil society, should develop a framework to ensure that technology is developed and deployed in an equitable and responsive manner for farmers and other stakeholders. Critical questions that might be considered include:

(1) Who is responsible for ensuring new technology is deployed and developed?
(2) How will the risks and benefits be distributed and measured?
(3) How can we ensure that technology developments employ appropriate safeguards for farmers?
(4) What is the intention behind the development of these technologies?

These questions ensure that technology developed is equitable and responsive to the needs of farmers and all stakeholders more generally. These kinds of questions should form the basis of any policy framework on adoption of any technology.

All stakeholders should work together to:

- **Refine the meaning and practice of informed consent:**
The DPA underscores the importance of "informed consent," requiring that individuals, including farmers, be given clear and comprehensive information about how their data will be used, the purposes for its collection and any third parties with whom it may be shared. However, the concept of "informed" consent remains ambiguous. A key issue is the widespread lack of transparency, which undermines farmers' understanding of how their data will be used, shared and stored. Privacy statements associated with digital applications are often long, vague or convoluted making it difficult for farmers to fully understand the implications of their consent. This lack of clarity hampers their ability to make truly informed decisions about participating in digital platforms and services, posing significant challenges to protecting their privacy and the security of agricultural data. Moreover, there are broader issues with informed consent. First, consent is typically obtained once but data may be shared indefinitely. Second, even if farmers understand the risks of data sharing, they have limited bargaining power compared to technology developers, who unilaterally set the terms of data use. **All stakeholders should work together to develop informed consent practices that empowers farmers, inform them of their rights and establish an ongoing ability to retract consent.**

- **Develop new models of human-rights based data governance that respect farmers' rights:**
Farmers must have meaningful control over data collected about themselves, their communities and their lands. Policies should guarantee their rights to access, correct, erase and transfer data while recognizing the collective dimensions of data governance. Farmer organizations should play a central role in shaping rights-based approaches that cover the entire data lifecycle, including models of collective stewardship such as farm/data cooperatives or democratically managed data commons. Such approaches can strengthen collective bargaining power and food sovereignty. To achieve this, researchers, governments and the private sector must collaborate with farmer organizations to co-create human rights-based frameworks for data governance. These frameworks should draw on principles from the African Charter on Human and Peoples' Rights and the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas to establish equitable models of data governance that empower farmers in the digital age.

CONNECTING COMMUNITIES OR CORPORATIONS?

Digital Agriculture, Data Harvests and Food Sovereignty in Kenya

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Biodiversity and Biosafety Association Kenya

Universiteit Leiden
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