IMPACT OF INTEGRATING DIGITALIZATION AND FINANCIALISATION IN AGRICULTURE AMONG SMALLHOLDER FARMERS IN NYANZA, KENYA

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List of Acronyms

AGRA	Alliance for Green Revolution in Africa
ASTGS	Agricultural Sector Transformation and Growth Strategy
CRB	Credit Reference Bureau
EAS	Extension and Advisory Services
FAO	Food Agriculture Organization of the United Nations
FINTECH	Financial Technology
GIS	Geographical Information System
GVC	Global Value Chain
GSMA	Global System for Mobile Communications
ICT	Information Communication Technology
M-PESA	Mobile Money
NALEP	National Agricultura Livestock Extension Program
NGO	Non-Governmental Organization
OAF	One Acre Fund
ROSCA	Rotating Savings and Credit Association
SMS	Short Message Service
UNDP	United Nations Development Programme
USSD	Unstructured Supplementary Service Data

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Abstract

The advent of digitalization in Kenya, promoted by the government, has led to significant advancement in Kenya's agricultural sector through the introduction of various digital technologies targeted at helping smallholder farmers. Among these innovations are the agricultural digital platforms built around network effect and consolidating various solutions into a single interface. These platforms utilize simple mobile phone technology that is easily accessible for smallholder farmers and are designed with a promise to make smallholder agriculture productive. The prevailing narrative suggests that smallholder farmers are poor and to alleviate them from poverty, it is essential to provide agricultural financial support for purchasing agricultural inputs necessary to improve their production. However, while these digital platforms have the potential to enhance productivity by providing financial assistance, they may also create dependencies and undermine the autonomy of smallholder farmers due to conditions often attached. For instance, the credit loans provided to the smallholder farmers being linked to the agricultural inputs at designated agro dealer shops limiting farmers choices. Moreover, they also have the potential of creating inequalities regarding who owns and benefits from the data generated by these digital platforms. It is therefore important not to idealize these digital platforms as purely positive developments without acknowledging the potential drawbacks. This paper explores the impact of integrating digitalization in agriculture and financialization amongst smallholder farmers using two case studies of One Acre Fund and Apollo agricultural digital platforms in Nyanza County, Kenya. By employing a political economy perspective grounded in critical agrarian studies, it examines how data is collected and utilized in these digital platforms while considering who stands to gain from it amidst various stakeholders involved, with a particular focus on smallholder farmers as the primary target in the ecosystem.

Relevance to Development Studies

The integration of digitalization and financialization in agriculture exemplified by digital platforms consolidating various digital solutions into one interface, hold the promise of economic growth among smallholder farmers. Proponents argue that these platforms foster collaboration among various stakeholders in the agricultural value chain, enhancing transparency and efficiency by creating a shared understanding of market dynamics. However, there is skepticism regarding strategies employed by these platforms. Critics argue that these platforms often prioritize potential profits rather than establishing a sustainable business model (Mann and Iazzolino, 2021). For instance, some farmers who register on these platforms may pay for insurance but find themselves without coverage when they need it the most.

Moreover, this paper contends that digitalization with the proliferation of digital platforms in Kenya is still at an early development stage thus raising important data protection concerns. Current legal frameworks regarding data protection are inadequate, and many smallholder farmers in the rural areas lack awareness about privacy issues related to data collection which increases the risk of data exploitation.

This research aims to inform policymakers, digital platform developers, agricultural organizations including NGOs, financial institutions, and investments such as banks, mobile network operators and smallholder farmers themselves about the significance of their data. It seeks to enhance their understanding of available technologies that can be utilized responsibly while maintaining control over their production processes. By targeting these diverse stakeholders, this research intends not only to contribute academically, but also foster practical applications leading toward improved outcomes across various sectors involved in Kenyan agriculture.

Keywords

Financial inclusion, smallholder farmer, public-private partnerships, mobile phones, agricultural inputs, digital platforms, digitalization and agriculture.

Chapter 1. Introduction

One evening during my regular visits to my elderly grandmother in the rural Ugenya, Kenya, a conversation arose as we were strolling in one of her small farms. She manages three separate farms for different crops claiming that if one underperforms the other could provide support. One acre has been allocated for maize which is a staple crop, two-acres for groundnuts- a drought resistant crop- and a three-acre dedicated for sorghum as a cash crop.

> "The world has gone digital! With just a click on my mobile phone, I can access credit loan to purchase fertilizers and seeds." She spoke. "Back then, we depended on either, ROSCAS, friends or banks which were quite a distant for financial support. However, with the introduction of mobile phones this has drastically changed". She explained having noticed that many farmers around her place are now using agricultural digital platforms. "At first, I did not understand what digital platforms were, but words spread like bushfire, and everyone seems to be joining in! I am registered with one of them (One Acre Fund), where I get frequent messages regarding loan eligibility, weather updates during plating season and confirmation messages to pick up my farm inputs at designated agro dealer shops, once my loan has been approved". Nevertheless, she expressed concern about potential poor yields due to last year's drought and locust invasion, and whether she'd had enough harvest to sell her surplus production to repay the loan. Failure to which the platform confiscates the available harvest or property pledged as a collateral for repayment. For example, she noted sadly, "My neighbor defaulted payment last year. Our group leader from the platform, serving as a debt collector came and took his goat as part of settling his debts."
>
> (Personal Conversation, 20-08- 2024).

Drawing from the conversation, I admired how she recognized both the potential benefits and risks associated with digitalization in agriculture. Recent developments in the agricultural practices within the Global South, have been actively exploring a wide range of digital solutions targeting smallholder farmers. Although, "digital agricultural technologies were initially developed for large scale agricultural producers and the Minority world, in recent years they have increasingly been adopted for small scale farmers in the Majority world" (Canfield and Ntambirweki, 2024, p. 2). The smallholder farmers are believed to need access to financial services to improve their productivity and alleviate themselves from poverty (Muriuki and Country, 2019). With the advent of digitalization and the widespread use of

mobile phones, agricultural services including access to information, agricultural input, and financial services has become much easier as compared to initial solutions that included the traditional banks that often-found smallholder agriculture unappealing.

The term digitalization in agriculture is used to mean the integration of digital technology and innovation in agriculture (Klerkx et al., 2019) using simple digital devices such as mobile phones and digital platforms to address productivity challenges in agriculture (Kieti et al., 2021). Digital transformation has been increasingly popular, penetrating rural areas with a notable increase of various private financial actors showing interest in agriculture-a trend that was previously rare. This raises questions on its potential impacts on the smallholder farmers and how they will be integrated in the global value chain.

The paper therefore aims to delve into how the agricultural digital platforms operates in conjunction with the digital financial services platforms. This is because both use mobile phone technology to offer services and obtain data impacting the smallholder farmers in Nyanza, Kenya.

The paper is structured as follows; The first chapter introduces what the study is about, giving the background information on agricultural policies and digitalization in Kenya. It outlines the research problem, question, objectives and the justification of the study while examining the drivers of digital technology. Chapter two conceptualizes digitalization of agriculture and financialization and establishes the theoretical framework. Moreover, it also addresses the downsides of digitalization of agriculture in relation to the thematic of financial inclusion. Chapter three talks about the methodology used in this research alongside consideration of positionality, ethical issues and challenges and limitations of the study. Chapter four explores the engagement of smallholder farmers with agricultural digital platforms and showcasing its complexities. Chapter five details the impact of platform dependency and limiting autonomy on farmers as chapter six addresses data ownership and control before concluding the paper.

1.1 Background information

Agriculture remains the backbone of the Kenyan economy. Kenya emphasizes the agricultural sector because it plays a crucial role in food security, employment creation and export earnings to its citizens. For instance, according to the economic survey of 2022, the agricultural sector contributed 22.4% of the Gross Domestic Product (GDP) supporting 80% of the population. Most of these populations come from the countryside characterized

by small-scale farming, deriving their livelihoods either directly or indirectly from agriculture. Hence due to the sector's high importance, its performance is reflected in the entire economy. Moreover, the development of the sector is also important for the alleviation of poverty levels since most of the marginalized like the smallholder farmers, and pastoralists depend on farming as their primary source of income (FAO, 2023). The efforts of the Kenyan government to incorporate the smallholder farmers and especially those in the countryside has been evident via the Kenya National Agricultural Livestock Extension Program. The government provides extension information to farmers in local dialects through audio formats. Local radio channels have enabled smallholder farmers, be empowered with knowledge and skills to improve agricultural productivity, access markets, and enhance their livelihoods (NALEP, 2005).

Agriculture in Kenya has evolved over time shaped by various historical, social, economic and political factors. Dating back to the colonial period, the dominant type of agriculture was subsistence farming with crops such as sorghum, yams and millet cultivated based on traditional farming methods (Ruthenberg, 2012).

In the colonial period, under the British rule, the Kenyan agricultural practices underwent a significant change due to introduction of cash crops such as coffee and tea in the Bimodal structure. The structure clearly distinguished the difference between the large-scale farmers and the smallholder farmers. Large scale farmers had power to shape agricultural policies to their advantage whereas smallholder farmers had limited political influence and economic leverage. The most fertile land in Kenya was reserved for European ownership used for commercial production. For instance, "the European farm averaging 800 hectares, sharply contrasting with the Kenyan smallholder farmer holding only 2 hectares of land" (Gow and Parton, 1995, p. 468). Consequently, smallholder farmers were excluded from the best farms and cultivation of the lucrative cash crops.

The colonial agricultural policy at that time, favored the European farmer expanding their plantations to export cash crops that were limited in their countries. This situation created dependency relationship between the colonizers (core) and their colonies (peripheries) in regions like Africa, Latin America and Asia. This exemplified capitalism by accumulation enabling exploitative practices that marginalized their colonies limiting their access to profitable opportunities (McMichael, 2009). Power differentials between the core and the peripheries was also a core issue. By power I mean who lose and win (Gaventa and Cornwall, 2015), affecting the equal distribution of wealth, which further exacerbated the inequalities based on race and class.

In the mid 1950's, there arose a political turmoil among the smallholder farmers in Kenya led by the Mau Mau rebellion (Maloba, 1994). The major aim being to change agricultural policy to reduce dependency on the European colony for economic opportunities. The smallholder farmer wanted to own land and cultivate the previously prohibited cash crop as well. Consequently, it influenced post-independence agricultural policy in Kenya with an objective of ensuring freedom from exploitation, reducing poverty levels and increasing per capita income distributed equitably. The question remains, has this objective been successfully achieved?

Spanning the period from 1960's to 1990's, the Green Revolution started in Kenya with its initiation being traced back to Mexico between the period of 1945 to 1960's when Mexico experienced a surge in its food production (Sonnenfeld, 1992). The kenyan government, with support from international organizations and agricultural institutions like Kenya Agricultural Research Institute, adopted this new agricultural policy-Green Revolution, aimed at eradicating poverty and enhancing food production. According to Alliance for Green Revolution in Africa (AGRA, 2014), the initiative sought to enhance agricultural productivity through four key strategies: utilizing hybrid and genetically modifying seeds, improving soil fertility with chemical fertilizers, liberalizing markets for better connections among producers and consumers and developing supportive agricultural policies. The Green Revolution policy emphasized collaboration between the public and private sector thus promoting public-private partnerships (PPP) as its central role to achieve its objectives effectively (Elhassnaoui et al., 2023). As part of this policy, Kenya initiated programs to improve food production through introduction of high yield varieties of crops such as beans, maize and rice. Farmers began adopting modern farming including chemical fertilizers, improved irrigation systems, and pest control methods which led to more efficient farming practices overall. However, there were some challenges like ensuring that the smallholder farmer who constitute a significant portion of the agricultural sector in Kenya, had access to and could afford the necessary inputs technologies (De Groote et al., 2005).

Today, in response to these issues aided by the advent of digitalization, the Kenyan government through its policies alongside ongoing public-private partnerships, is highly promoting digital transformation of the agricultural sector to ensure the smallholder farmer is included. According to FAO (2021), digital solutions play a crucial role in achieving the Food Security pillar of the country's Big Four Agenda. Majority of the agricultural policies revolve around, modernizing the agricultural sector through technology adoption and digital solutions, commercializing and intensifying production of smallholder farmers, increasing

productivity and promoting public-private partnerships in agriculture. As per the Kenya Ministry of Agriculture (2023), some of the policies addressing digitalization and promoting agriculture include the Agricultural Sector Transformation and Growth Strategy (ASTGS)- a ten-year plan from 2019 to 2029 with the goal of intensifying and advancing Kenya's agricultural sector. The ASTG aims to leverage digital technologies to enhance market access, and financial inclusion for smallholder farmers as well as to improve their productivity. The Information Communication Technology (ICT) policy framework promotes use of ICT in the rural areas to boost agricultural productivity and efficiency.

The Kenyan government is recognizing the importance of ICT including, the utilization of mobile phones and internet in agriculture as it aligns with Kenya vision 2030 launched in 2008. This vision emphasizes ICT integration to modernize its agri-food system towards achieving food security and poverty reduction by empowering smallholder farmers through the digital tools innovations across the value chain. Additionally, the vision aims to digitally transform the country into a newly industrialized middle-income country promoting inclusiveness through *Hustler Funds* and privatization of state-owned companies. Hustler funds, a financial initiative aims to provide funding and support for smallholder farmers and small businesses looking to start or grow their ventures. Furthermore, broadly speaking, Kenya's 2019, Digital Economy Blueprint policy, which promotes leveraging digital technologies to drive economic growth and innovation. Finally, the National Broadband Strategy of 2018 which aims to expand access to high internet connectivity across Kenya with smallholder farmers included.

Kenya is recognized in Africa as a digital successful story, due to its national supportive policies and regulatory system. It has a strong digital marketplace, supported by an innovative and entrepreneurial environment as well as high mobile subscriptions and reliable internet connectivity (Osiakwan, 2017) thus becoming the hub for "Digital for Agriculture" solutions in Africa (Krell at el., 2021). Consequently, public- private partnerships companies are emerging due to its friendly policies. For example, Dutch ICT-Agri companies like, *Agrivijana, Rabobank foundation* and *Agriwallet* in Kenya. They seek to enhance market access and integrate different Agricultural Technology and Financial Technology (Fin-Tech) services providing one service to clients (Akuku et al., 2019).) Mercy Corps together with Mastercard are enhancing financial inclusion for smallholder farmers using mobile technologies similar to Bills and Melinda Gates Foundation transforming the agricultural sector by ensuring financial inclusion of smallholder farmers in Kenya (FAO, 2021).

Nevertheless, some studies argue that with the digitalization of agriculture in Africa being championed by international organizations like the Bills and Melinda Gates Foundation, has shifted into a model that reflects neoliberal principles (Abdulai, 2022). In recent times, agricultural policies have been influenced by multinational corporations. Thus, shifting direct support from the government to farmers, towards promoting the public-private partnerships (Moseley et al., 2015). The Green Revolution which was initially intended to increase agricultural productivity and address hunger issues in developing countries through technological advancement, is now being used in the favor of public-private partnerships. Critics argue that this shift serves the interest of the powerful entities prioritizing profit over sustainability at the expense of the smallholder farmers and local communities. For example, data extracted from African organizations used for analysis in developed countries by multinational corporations which aim to control Africa emerging economies. This data can otherwise be used by African citizens as a valuable resource for power, revenue and knowledge (Mann, 2021). As per the CTA report (Tsan et al., 2019), the Kenyan government, through its friendly policies encouraging digitalization and public-private partnerships, should be cautious and consider formulating strong laws that govern data usage.

1.2 Research Problem

The proliferation of digitalization of Agriculture in Kenya due to the growing technology, dubbed as "Silicon Savannah" has made Kenya emerge as a hub of innovation and entrepreneurship in Africa. This is driven by private firms and large multinational corporations coupled with friendly government policies. The widespread digitalization of agriculture involves, mobile phone technology, internet connectivity, financial inclusion and platformization to transform agricultural farming. This can be exemplified through the access to information by the smallholder farmers such as weather forecasts, tailored agricultural trainings and agricultural pest management techniques through the agricultural websites or mobile apps. Thus, they can make informed decisions to improve their farm productivity (Hartmann, Nduru and Dannenberg, 2021).

"Nearly, 98% of Kenyans own mobile phone technology and over 80% have mobile subscriptions with 268% increased internet/data subscriptions experienced within the period of 2013 to 2018" (FAO, 2021, p. 6).

Furthermore, Kenya has introduced and expanded digital financial services such as Mpesa launched in 2007 by Safaricom, to promote financial inclusion by providing convenient banking solutions to the smallholder farmers (Jack and Suri, 2014).

Nonetheless, despite the potential benefits of digitalization and financialization of agriculture in the developing countries, Kenya included, digital agriculture is not devoid of critique. As such, the researcher situates the problem within the literature with two dominant narratives, illustrating the reasons for financial inclusion of the smallholder farmers within the realm of the digital agriculture.

The digitalization and financialization of agriculture hold the potential to provide smallholder farmers with greater financial inclusion, which is essential as argued by the proponents, to improve their productivity and alleviate them from poverty (Protopop and Shanoyan, 2016). To achieve this goal, the government through its friendly policies is promoting public-private partnerships to enhance access to resources, increase efficiency through technology and enhance financial accessibility (Yahaya and Ahmad, 2018). In contrast, critics contest that integrating smallholder farmers into formal financial systems through the fintech solutions, and micro financial institutions promoted by the public-private partnerships, may lead to increased indebtedness among smallholder farmers. This is due to the high-interest loans ultimately risking the overall wellbeing of the smallholder farmers, and potentially pushing them further into poverty (Akolgo, 2023). Consequently, this paper aims to explore how advancement in digitalization in agriculture coupled with financialization promoted by public-private partnerships, is fostering financial inclusion among smallholder farmers in Kenya and what this signifies to the smallholder farmers.

1.3 Research Question

How has the integration of digitalization and financialization of agriculture impacted the inclusion of smallholder farmers in Kenya?

1.3.1. Research Sub- Question

1. Which actors are involved in the promotion of digital solutions in agriculture among smallholder farmers in Kenya?

2. How does the relationship between access to agricultural digital platforms alongside data ownership and control affect smallholder farmers in Kenya?

3. What is the impact of digital technology on the intricate relationship between dependency and autonomy among farmers in Kenya?

1.4 Justification

The evolution of agriculture transitioning from labor intensive to mechanization and industrialization and now to technological transformation utilizing data from the digitized tools, highlights the increasing importance of research-intensive agricultural technologies. This evolution underscores the expanding role of "big data" in modern agriculture (Bronson and Knezevic, 2016).

Africa is emerging as a new market for the digitized tools promoted in agriculture. Kenya for instance, boasts of a significant number of agricultural digital platforms aimed at enhancing smallholder agriculture (Shakhovskoy et al., 2021). These platforms collect massive amounts of data from different smallholder farmers through farmers profiles provided during their registration. Consequently, the data collected is then analyzed through sophisticated algorithms to provide valuable information through the digital platforms. According to Visser, Sippel and Thiemann (2021), this big data needs a proper farmer interpretation as its accuracy is important hence, cautions against overreliance on this big data. While the big data might be beneficial, questions of concern regarding if ethical considerations are put in place while collecting the data from the farmers arises. Who controls and owns this valuable data at whose expense becomes very crucial as emphasized by Fraser (2019). Further, the platform nudges such as consolidating various digital solutions into a single interface like coupling the loans with the fertilizers and seeds at designated agro dealer shops, may potentially limit farmers choices thus increasing their dependency on these platforms. This can have adverse effects on the biodiversity of farming especially if the coupled branded fertilizers and seeds promoted through the platforms encourage monoculture practices among the smallholder farmers.

Policymakers, researchers, digital platform developers, and other stakeholders involved in the digitalization of agriculture should, therefore, carefully consider making policies related to economic, social, ethics and environmental impacts associated with this transformation in agriculture. By targeting these diverse stakeholders, the paper aims to contribute academically, but also foster practical applications that can lead to improved outcomes across various sectors engaged in Kenyan agricultural landscapes.

1.5 Drivers of digital agriculture

The dominant narrative is that smallholder farmers need digital solutions to address their agricultural challenges. Some of the challenges include, increasing their farm productivity,

being able to easily access credit agricultural inputs and obtaining different services in one platform. This suggests that the digital solutions adopted by the smallholder farmers are demand driven (Kiaka, 2024). Nevertheless, some studies in the developing countries show that it is not demand driven with an example from Kenya. Instead, it is driven by the need for expansion of the *private firms*, multinational corporations and international organizations (Mellor, 2017: Birner et al., 2021). Moreover, the Government, and the Banks also play a key role. In most cases, the operations of these entities and their roles are interconnected. For instance, the Government set policies and regulations to support digital initiatives enabling a conducive environment for innovations and public-private partnerships. Banks provide financial services in partnership with private firms for the farmers; international public organizations offer expertise and funding while private firms e.g. Big Tech companies in partnership with the local companies develop technological solutions tailored for agriculture. In the next subsequent paragraphs, I provide examples of the key actors in digital agriculture with specific instances.

Private Firms

The term Private Firms is used to mean the "Big-Tech" companies and the "Agribusiness" companies. Big Tech Companies are those corporations that focus on technological infrastructures, data processing capabilities and software solutions to enhance efficiency, sustainability, and productivity in farming. Big multinational software companies like Microsoft, Google and IBM have started investing in digital agriculture technology too. Gathering various agricultural data to experiment with modern technologies as they partner with local organizations to advance digitalization for agriculture as evidenced in Kenya (Kenney, Serhan and Trystram, 2020). IBM has partnered with Twiga foods (*a technology-driven food company*) to create a credit system utilizing blockchain technology and collaborated with Hello tractor (*a start-up company in Nigeria*) to capture an unchangeable record of all transactions from the first tractor request (Tsan et al., 2019). Similarly, Microsoft has teamed up with the Kenyan Ministry of Agriculture, Livestock and Fisheries (KMALF) to support Kenya's agricultural digital transformation strategy. Microsoft contends that, to allow digital transformation of the sector, large amounts of capital and data are essential. Data must be collected and properly utilized, arguing that the data will help inform decision making to the stakeholders, investors and especially smallholder farming to improve productivity, efficiency, and financial inclusion (KMALF, 2023).

Safaricom and Telkom companies in Kenya are known to be the biggest telecommunication operators providing connectivity and financial services through the

acclaimed M-Pesa. In Sub-Sahara Africa, M-Pesa has the most arguably successful story in digital innovations providing financial services to a wide range of users (Hartman, Nduru and Dannenberg, 2021). Smallholder farmers particularly benefit due to challenges of accessing the traditional banking services, enabling them to access loans and purchase inputs for their farms, and increased household welfare through the increased remittances (Jack and Suri, 2014; Iman, 2018; Senyo et al., 2022). These Fin-Tech solutions are more exemplified with TCASH in Indonesia and Telco in Ghana. According to (Tsan et al., 2019), MasterCard together with Mercy corps is funding the Agri-Fin Accelerate program to enhance financial inclusion for smallholder farmers using mobile technologies. Similarly, Safaricom collaborating with Mercy Corps is advocating for financial inclusion of smallholder farmers and linking them to input supplies through the Digifarm Platform (FAO, 2021).

Agribusiness companies with a deep understanding of the agricultural value chain also embrace various digital solutions and technologies to enhance their productivity, efficiency, and sustainability through data driven decision making. For example, Monsanto in the USA transitioned from chemical and seed company experts to data specialists and purchased Climate Corporations in 2013. Subsequently, Bayer acquired Monsanto in 2014 (Bronson and Sengers, 2022), exemplifying the essence of big data in modern agriculture.

Startup companies in Kenya in partnership with private firms are also leveraging data to improve their productivity and efficiency offering different services including financial services and market linkages. These two aspects in most cases are intertwined. For example, *Virtual city-a startup company* shares data with the banks under agreement with agribusiness to provide loans to farmers to purchase farm inputs (GSMA, 2024). In the snapshot table below, I will indicate the primary focus that each startup company is more inclined to although they typically cater to both market linkages and financial inclusion (*see table 1*).

International Public Organizations

International organizations like FAO, World bank and USAID assert that, with the growing global population, there is a need to enhance food production and resource management to address the challenges that might be brought by population increase. They advocate for the introduction of digital financial services to increase financial inclusion in agriculture through technology adoption (Worldbank, 2017). As a result, the World Bank has collaborated with KALRO to build a national agroclimatic data surveillance system called the Kenya Agricultural Observatory Platform (KOAP) with World Bank financing it. KOAP seeks to provide up to real time weather information to help farmers make informed decisions

(KOAP, 2019). On the other hand, USAID through its Feed the Future Initiative is collaborating with Safaricom and Telkom seeking to develop sustainable digital agriculture to enhance productivity (TechnoServe, 2019).

Banks

The growing importance of data to solve agricultural problems has enabled banks to leverage data analytics through digitized transactions. Banks are expanding their roles by incorporating innovative digital solutions to financially include the smallholder farmers too (GSMA, 2024). Government plays a dual role in advancing the financialization process within the economy. Firstly, through monetary and fiscal policy, and secondly, by acting as a stabilizer of the financial system using central bank mechanisms to ensure its smooth operation (Akolgo, 2023). For example, the Central Bank of Kenya, through regulation and supervision measures, has implemented a centralized Electronic Data Warehouse (EDW) to collect, store and analyze financial data from banks and various regulated financial institutions. By consolidating this information into one platform called the Application Program Interface (API), the Central bank can access supervisory data in near real time, enhancing surveillance systems and improving online banking inspections (IMF, 2022).

Digital financialization has led to partnerships between banks and telecommunication companies such as Safaricom as well as transnational actors such as Mastercard to create innovative platforms with the goal of financially including smallholder farmers (who might have been unbanked) by use of digital technological tools. The subsequent paragraphs will provide examples with three banks from Kenya in this context.

- **Kenya Commercial Bank (KCB)**

KCB, in partnership with MasterCard Foundation, developed a MobiGrow platform. MobiGrow is a mobile based account targeting smallholder farmers in Kenya and Rwanda when it comes to credit access and financial inclusion, leveraging technology and data analytics (National Media, 2020). Among the apps provided by KCB are KCB-mobile money loan, Kopa Float, KCB-M-pesa, Fuliza and Hustler Fund (KCB, 2022).

Safaricom, through its widely used mobile money, M-PESA, facilitates the seamless connection of smallholder farmers with MobiGrow accounts to their M-pesa wallets. This integration of Safaricom digital payment system with KCB banking services enhances accessibility and convenience to smallholder farmers who might not have easy access to traditional bank branches (GSMA, 2024).

The type of crops primarily focused are sorghum and soya beans under the Forum to Market Alliance Program in Nyanza and Western Kenya. Moreover, under the Mavuno Program in partnership with Sygenta and TechnoServe, tomato and potato crops are more targeted. The major objective being enabling smallholder farmers to access financial services for agricultural inputs, market linkage and agronomical support (Nation Media, 2020).

- **Equity Bank**

Equity bank is recognized to be among the best banks in Agriculture and Livestock financing as well as digital banking. The bank received prestigious awards based on these categories as argued by the Equity sustainability report of 2022. In partnership with Bill and Melinda Gates Foundation, Equity bank secured funds to create the Equifarm platform as outlined in their sustainability report. Equifarm's major objective is to provide innovative solutions to smallholder farmers through Smart farm technological solutions such as providing farm data on weather, crop monitoring, and market information. Moreover, it also provides financial inclusion services to the smallholder farmers through Farm finance solutions by digitizing credit processes such as digital credit scoring models and e-vouchers. Furthermore, the platform offers crop insurance and financial literacy training services through digital technology to smallholder farmers.

Apart from the partners previously mentioned, Equity bank has collaborated with various organizations including, European Union, NORAD, United Nations, Government of Kenya and IFAD which partnered to provide agricultural subsidies through the Kenya Cereals Enhancement Program.

Equity bank also offers a wide range of digital channels such as Equitel which is frequently used by smallholder farmers, Equity mobile app, Equity Online, Equity USSD, EazzyChama, Eazzy Biz and Pay with Equity.

The major crops that the bank has primary focus on are, coffee, grains and oil seed, tea and maize- a staple crop, with an aim to promote financial inclusion for marginalized and excluded groups such as young people, disadvantaged women and smallholder farmers (Equity, 2022).

- **Cooperative Bank**

Cooperative bank in partnership with Mastercard and RaboBank, created the Co-op Bank Soko platform in 2021. It is a platform providing online marketplace and access of financial services to smallholder farmers. While its primary emphasis is on potato crops with different tubers that could be used with outlets such as Kentucky Fried Chicken, it also focuses on coffee, tea and milk dairy (Nation Media, 2023).

Table 1: Snapshot of startup companies in Kenya

Platform	**Year Founded**	**Focus** Financial Inclusion *Through mobile based solutions that digitize transactions e.g. digital receipts and procurement payments*	**Focus** Market Linkage *Via online mobile based platform for buyers and sellers to connect*	**Some of the Investors**
Apollo Agriculture https://www.apolloagriculture.com/	2016	✓		Chan Zuckerberg & Rabobank
Digifarm https://digifarmkenya.com/	2016		✓	Bayer Foundation, Mercy corps, & Agri-fin Tech
Farmers market Kenya	2015		✓	Information not disclosed
M-Farm https://www.farm-d.org/organization/mfarm-ltd-kenya/	2009		✓	USAID
One Acre Fund	2006	✓		Bill and Melinda Gates Foundation
Shamba Pride https://shambapride.com/	2016	✓		Gray Matters & Seed Star Africa Ventures
Tulaa https://tracxn.com/d/companies/tulaa/__V6BUgL4-VbY6fpRdHWLMlMOf0GIHDjs2rm8KH-ymB38	2016	✓		USAID & CGAP
Twiga https://www.twiga.com/	2014	✓		CGIAR
Ujuzikilimo https://www.ujuzikilimo.com/	2016		✓	Google, World bank & Village Capital
Virtual City https://www.virtualcity.co.ke/	2000	✓		IBM & Commercial Bank of Kenya

Chapter 2. Digitalization in agriculture through financial inclusion

2.1 Conceptualizing digital agriculture

Digitalization in agriculture is the process of using digital technologies to "transform the agricultural production system, value chain and food system" (Klerkx et al., 2019, p. 1). In less developed countries, it encompasses the use of simple, low-cost digital technologies such as mobile application apps, high-speed internet, sensors, drones, blockchain, and digital platforms with an aim to enhance efficiency in farming operations (Tilson et al., 2010: Smith, 2018: Schoemaker et al., 2022). For example, in Kenya, various platforms offer digital agricultural solutions through mobile applications. Kenya Agricultural and Livestock Organization stands out as it has over thirty mobile applications to offer different services to the farmers (KALRO, 2023). These digital technologies focus on enhancing productivity but also raise concerns about equitable access among smallholder farmers.

2.2 Conceptualizing digital financialization

It is interesting how society has shifted and people viewing themselves through an economic lens. The idea of investment has become the central idea going beyond the financial aspects into other aspects such as cultural values and social relationships. This current trend in finance playing a powerful role in shaping economic and social roles, is what is commonly termed as financialization by analysts (Epstein, 2021, p. 271).

However, the term financialization has different definitions within different realms. Some perspectives explore it as a tool that advances capitalism as others view it as an evolution to capitalism alongside concepts like digitalization, globalization and neoliberalism. For example, Epstein defines the term broadly to capture different aspects. According to Epstein (2005), financialization is the "role of financial markets, motives and actors in the operation of the economy and its governing institutions" (Epstein and Jayadev, 2005, p. 30). Others have analyzed the term to highlight the relationship between neoliberalism and financialization emphasizing the role of neoliberal policies in the rise of financialization hence the term "neoliberal financialization" (Palley, 2013, p. 8).

Nevertheless, this paper delves more into digitalization of agriculture through financial inclusion lens hence interested more into digital financialization. The paper defines financial inclusion as the accessible, useful and affordable finance products and services to the

unbanked farmers using phone based digital transactions. Thus, digital financialization in agriculture broadly refers to the integration of digital technologies and the platforms into financial aspects of agricultural activities. By utilizing mobile money application services and the digital platforms, farmers particularly, smallholder farmers can now get credit facilities on the agricultural input, receive payments for their produce, and get insurance coverage on their crops ultimately improving their livelihoods (Suri, Bharadwaj and Jack, 2021). An example is Mpesa in Kenya which has the potential of transforming smallholder agriculture since they are important in promoting financial inclusion.

Conversely, some studies contend that digital financialization is a modern form of colonization, merging digital interactions and financial transactions into a new frontier underpinned by data harvesting by companies for monetization and government surveillance (Jain and Gabor, 2020). Relatedly, most of the innovations in agriculture are more data driven with examples of the proliferation of the digital platforms collecting vast amounts of data including farmer profiles, weather forecasts, crop yields and market prices. Derived valuable information from these analyzed data using advanced analytics, can thereafter be used to make informed decisions tailored towards farmers, such as their creditworthiness. Financial institutions on the other hand, which most are private, use these valuable insights to make strategic decisions regarding their investment priorities thus collecting and monetizing data for profit (Zuboff, 2019).

2.3 Theoretical framework

2.3.1 Critical agrarian studies

This research is deeply rooted in critical agrarian studies which explores the ongoing agrarian transition where traditional forms of farming are evolving towards more market-oriented practices with the introduction of digital technologies in agriculture. Furthermore, intersectoral flows such as integrating digitalization in agriculture and financialization raises agrarian questions about power dynamics involved when large tech companies such as IBM and Google or big corporations such as Bills and Melinda Gates Foundation enter rural spaces traditionally dominated by local actors. These large corporations dominate the market and fund most of the startups companies or digital platforms aimed at helping the smallholder farmers (Kenny, Serhan and Trystram, 2020).

The agrarian question in this context revolves around issues related to ownership and control over production means compared to dependence on these digital technologies.

Bernstein (2010) would argue that, while these digital tools, especially the digital platforms, offer opportunities for growth for the smallholder farmers, it is crucial to ensure equitable access so that benefits do not solely accrue to larger entities or corporations. A closer examination is required to analyze how different classes and stakeholders interact within these platforms in varying ways.

The paper investigates who benefits from the advancement in agricultural digitalization while considering issues like corporate control of seed varieties and access to control of big datasets in agriculture raising concerns about equity within the sector as highlighted by Canfield (2022). Furthermore, with digitalization in agriculture coupled with financial services, has led to worries over agricultural assets being viewed as investments opportunities rather than exclusive means for food production and livelihood sustenance. This shift raises questions about sustainability within the sector. Financial services such as insurance and microfinance products tailored for farmers become central to discussion around risk management and capital accumulation. Moreover, power dynamics in relation to the dependency and autonomy of the smallholder farmers from the digitized platforms also becomes crucial, requiring careful evaluation (Stock and Forney, 2014).

2.3.2 Political economy

Political economy to digitalization in agriculture, examines how the adoption and integration of digital technologies in agriculture impacts social relations, production dynamics, power structure and property ownership. It delves into who controls the agricultural Big Data (Bronson and Knezevic, 2016), how does technology shape power dynamics in the agricultural value chain such as governments, farmers and agribusinesses (Prause, Hackfort and Lindgren, 2021) and what are the rules and regulations in place including ethics surrounding farmers data privacy, rights and ownership (Canfield and Ntambirweki, 2024).

The shift of global corporations towards a financialized food regime (Burch and Lawrence, 2009) with an increased concentration of corporations in the agricultural sector has been drastic. Financial institutions are playing a more crucial role in the agricultural sector than before. For example, banks are expanding their roles investing in various aspects of the food system such as commodity trading, farmland, and production reshaping the global food system, contributing to a food regime driven by financial interests. However, in recent years, big technology companies utilizing big data in agriculture has become significant too. Thus, highlighting the connection between the increasing dominance of large corporations in agriculture, financialization of agricultural activities and now adoption of digital technologies

in agriculture as the driving force in digitalization of agriculture. This applied in broader terms looks at the role of data in capital accumulation and its impacts to the society (Srnicek, 2017).

The paper draws from Mann and Iazzolino (2021) on how digital platforms have transformed agricultural practices in Kenya through the narrative of incorporation of the marginalized. Digital platforms are performative infrastructures influencing human behaviors to align with specific models and theories (Mann and Iazzolino, 2021). Past developments strategies have influenced the current corporate dominance highlighting the shift from state led development in technological integration towards private sector engagement. This shift reflects evolving policy paradigms raising critical questions of who benefits from the data harvested in digital platforms. Brooks (2021), further emphasizes how the contemporary smallholder farmer is influenced through the digital platforms and reduced to human sensors to provide real time data to different stakeholders.

The paper is mindful of the comprehensive network to protect smallholder farmers' data rights, and data ownership. Increased corporate dominance with data control playing a significant role underscores the importance of farmers protecting their data. With agriculture becoming more intertwined with information capitalism (ETC group, 2024) through data capture by the private sector infrastructures, there is a potential of consolidation of power. This could have implications for farmers' livelihoods and exacerbate inequalities in the societies.

Farmers data protection is significant, although, promoting implementation of participatory data governance to tackle power imbalances in the decision-making process is even more crucial (Canfield and Ntambirweki, 2024). This is because individual data privacy inadequately addresses the collective risks as datafication empowers corporations and governments beyond the agricultural sector (Waldman, 2021).

2.3.3 Neo Marxist approach

Drawing from Neo-Marxists perspectives on new arenas of accumulation, focusing on how capitalism responds to crisis of overaccumulation, the paper situates the two concepts: digitalization in agriculture and digital financialization. The proliferation of digital platforms reflects this capitalist accumulation. The dominant narrative is that smallholder agriculture requires financial and asset assistance to eradicate poverty among the smallholder farmers, thus the demand for digital solutions raises concern (Akolgo, 2023). This emphasis of

poverty alleviation among smallholder farmers by prioritizing financial services such as credit agricultural input, via the digital platforms is aligned with capitalist agenda (Birner et al., 2021). Consequently, fostering financial dependency of the smallholder farmers on the digital platforms reinforcing power differentials within the agricultural system.

Most of these digital platforms are funded by the private entities which have an aim of expanding corporate capital rather than solely addressing smallholder farmers' fundamental issues. Harvey (2010) postulates that these large agribusiness corporations are increasingly turning to financial instruments for profit making rather than prioritizing sustainable farming practices essential for food security.

The adoption of digital technologies into agriculture allows capitalists' interests to extend their influence into previously untapped markets and resources (Arrighi, 1994). Through the collaboration of public-private partnerships, with an aim to make digital technological tools to provide digital solutions for smallholder farmers, highlights the intersection between economic interest and the technological interests under the capitalism approach. These technological tools leverage data driven insights which has the potential of revolutionizing smallholder agriculture although it is also subjective to heightened commodification like data monetization and subscription models.

Therefore, despite the advanced technologies and its potential benefits, social structures driving its development should be questioned. Modern economy that is profit driven and extractive in nature, has led to the justification of violence and inequality against both humans and nature (Gibson, 2015). This is because societal structures like capitalism tend to influence human interactions with either nature or humanity. What Moore (2016) refers to as binary divisions (*Humanity and Nature and Capitalism plus Nature*) contributing to the current environmental problems and societal issues such as inequality. Hence to analyze such issues, a more holistic approach should be examined looking at the underlying power structure ideologies guiding the interactions.

2.4 Downsides of digitalization in agriculture

There are mixed feelings regarding the supply of digital tools. While there are positive stories like those of Twiga Foods offering digital solutions to smallholder farmers (CGIAR, 2023), there are also the big tech companies such as IBM dominating the market with unclear motives in some instances. The sudden interest of big tech firms, especially with the big data analytics as characterized with the 3rd Food Regime, raises concern if data is the new kind of

asset that could lead to new colonial conquest and shift in global power relations (Mc Michael, 2016). Critics argue that digitalization across the entire food commodity chain is centralizing power in the retail sector enabling big tech companies to extract and use data. Consequently, paving the way for big tech companies to monopolize the market (Prause, Hackfort and Lindgren, 2021). Hence, the pivotal question of who owns the data generated and the four key questions of Bernstein on property ownership, division of labor, distribution of wealth and reproduction prove useful (Bernstein, 2010). There is a risk of data asymmetry especially when the corporations use the information asymmetrically from these digitized tools, against smallholder farmers during negotiations or decision making.

As aforementioned, the agricultural digitization is predominantly private led in Kenya reinforcing current development narratives like market integration, forming the underlying agricultural policies to enhance the digitalization in agriculture (Van der Ploeg et al., 2019). Nonetheless, it negates political economic issues that could potentially lead to neoliberal influence (Abdulai, 2022). By enabling smallholder farmers to access the market does not necessarily mean that their livelihood would be enhanced, and equality promoted. Whether smallholder farmers benefit from the market becomes the central question. Bernstein (2001) argues that market integration does not benefit the smallholder farmers because of their inability to profit from it and the very terms of the insertion in the markets. Corporations or large farms with more resources could leverage on digital technological tools limiting opportunities for smallholder farmers who struggle to compete on equal footing with Lami technologies -a digital insurance platform. The World Bank is supporting this initiative with a long-term plan of consolidating logistics in Africa (Wakarima, 2022).

Social media platforms, such as Facebook, enable farmers to access the market. However, according to Bronson (2022), Facebook also has other interested actors like traders, agricultural companies and agronomists who utilize the platform to exchange information regarding agriculture. Subsequently, Agri business companies use this data to their benefits. It is interesting how digitalization has been promoted as the way to reduce inequalities especially through market access and financial inclusion. However, in the real sense, the information shared and gathered is never equal. Thus, increasing patterns of inequalities (Hackfort, 2021) and digital divides between the industrialized and developed, rural and urban, big, and small firms, young and old, as well as the male and female populations (Aker et al., 2016).

Shifts in financialization through large investment entities, either by private equity funds or hedge funds may give more power to these entities depicting capitalism prevailing in the

agri food system (Burch and Lawrence, 2009). Mann and Iazzolino (2021) argue that this influence especially through financial inclusion in agriculture is intentional, seeking to change human behaviours and practices to align with economic theories and commercial models. Through the digital platforms, smallholder farmers' behaviours are influenced to align with market demands, potentially impacting traditional agricultural practices and social structures (Brooks, 2021). Moreover, if the financial inclusion services are tied to a proprietary system controlled by the private companies, it heightens the risk of creating dependency relationships of smallholder farmers on specific providers.

Banks on the other hand through their role of financial inclusion of smallholder farmers by providing financial services, facilitating digital payments, and offering credit facilities, in a way could contribute to the role of rural indebtedness in the evolution of capitalism in the rural areas (Gerber, 2017). When smallholder farmers are indebted due to debt accumulation, it might change ownership patterns like consolidation of land holding of the smallholder farmers. Additionally, due to increased reliance on the external source to get credit rather than community support system, it undermines traditional community bonds. The financial inclusion advocacy could therefore be business as usual prioritizing profits and not necessarily meaning financial inclusion for 'All'. Some individuals might be excluded based on social discrimination like class-based exclusion, ethnic bias, and geographical location among other factors (Johnson and Nino, 2011). Furthermore, there is a plausibility of exploitation of smallholder farmers with extreme examples of farmer suicide in North India due to indebtedness (Singh, 2019).

Lastly, autonomy remains the core value for farmers as it shapes their identity and their relationships within the context of economic environment (Stock and Forney, 2014). Every farmer wants to make their independent decision without undue influence. Nevertheless, with digitalization in agriculture and proliferation of agricultural digital platforms, autonomy of smallholder farmers might be weakened. Smallholder farmers' who are expected to be poor and require financial support for their farm inputs to improve their productivity, are increasingly depending on digital platforms for financial support. However, due to the platform's integrated nature providing multiple solutions, often comes with conditions attached such as packaged deals, coupling loans with fertilizers or seeds ((Mann and Iazzolino, 2021). This limits choices available for farmers. Moreover, these platforms use nudging effect (Brooks, 2021) such as frequent personalized automated messages sent to the farmers to encourage them make proactive decisions thus, affecting farmers' independent knowledge.

Digital platforms leverage data analytics, raising critical questions about the ownership and control of the data generated (Fraser, 2019). Who owns this information? Is it the farmer or digital platform providing the services? If these platforms retain the ownership over the critical operations insights generated through data analysis, like yield predictions, it could undermine farmer's power in making decision regarding how they practice their farming. For example, what type of seeds or fertilizers to use, or strict regulations to follow while planting. Moreover, this is emphasized by surveillance agriculture which also utilizes data analytics. Stone (2022) compares surveillance agriculture to surveillance capitalism claiming that both use big data to sell products and services to the farmers as well as influence their decision making in the process. Gradually, smallholder farmers get accustomed to the analyzed data from the technological tools making them rely more on technology driven solutions rather than the traditional knowledge experience.

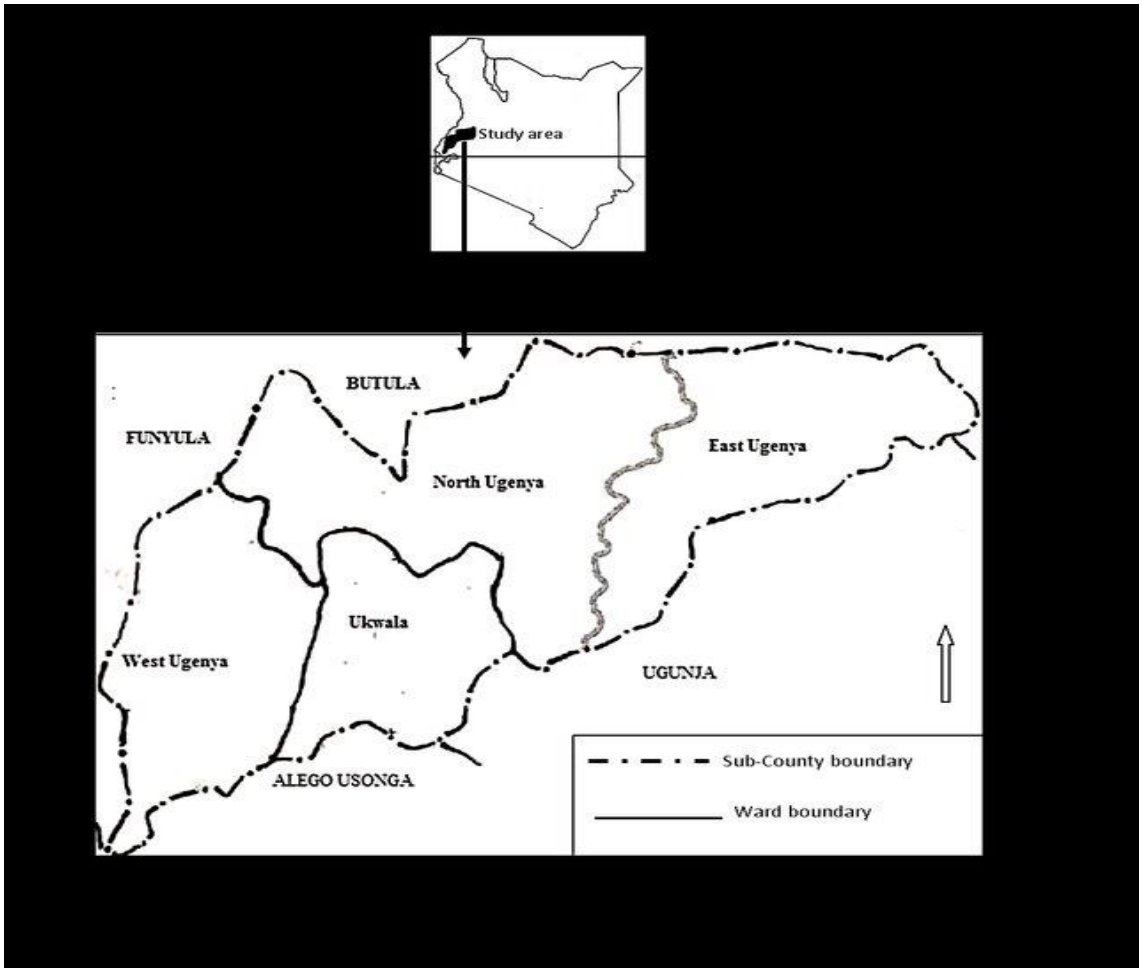
Chapter 3. Case study and methods

3.1 Study area and population

The research was conducted in Nyanza, Siaya County specifically focusing in Ugenya Sub-County, a countryside predominantly inhabited by smallholder farmers. It has four political electoral wards; Ukwala, West Ugenya, East Ugenya and North Ugenya (see *Figure* 2). The agroecological zone of Ugenya Sub County spans from ML1(Moisture level 1) to ML2. Located near Lake Victoria to the Southwest, the region experiences a tropical climate with distinct dry and wet seasons. The primary rainy season occurs from March to June while the short rains are experienced from September to December with annual precipitation ranging from 1200 to 2,200mm and thermal temperatures between 22.5°C and over 25°C (CGS, 2019). The soil is predominantly clayey or loamy types that vary across different areas and its fertility can be quite inconsistent. Some areas have rich alluvial soils due to sediment deposits from nearby rivers such as Nzoia River, while others may suffer from nutrient depletion due to continuous cropping without adequate replenishment (Oduor, Mutavi and Long'ora, 2022).

The location is home to approximately 134,354 people, with a total household of 62,624 in an area of 523sq.km (KNBS, 2019). Smallholder agriculture is prevalent with most of the farmers practicing subsistence agriculture of maize, millet, sorghum, groundnuts, beans and vegetables with farm size averaging 1 to 5 ha (CGS, 2019). Poverty, and low level of education are the main social characteristics and challenges in Ugenya-Sub County (Oduor, Mutavi and Long'ora, 2022).

Map with location and the study area



Source: Oduor, Mutavi and Long'ora, 2022.

3.2 Methodology

The research employed an exploratory design to gain in-depth understanding into the case of financial inclusion within agricultural digitalization using integrated platforms like One Acre Fund, Apollo Agriculture and M-Pesa. This approach aimed to explore challenges related to digitalization of agriculture through digital platforms and examine how these integrated platforms may impact relationships concerning inequality, autonomy and dependency among smallholder farmers.

Following the choice of the formulative research design, the study had to adopt a qualitative research approach to collect information utilizing both primary and secondary data sources (Yin, 2018). The population of interest comprised three main groups: banks that offer agricultural services to the smallholder farmers, digital platforms that provide integrated services like financial inclusion to the smallholder farmers and smallholder farmers who

utilize these digital platforms for agricultural purposes. As the first step, the researcher registered on the digital platform (Apollo Agriculture) to gain a firsthand experience and insights into how the platform functions in relation to services provided to smallholder farmers and how these services are accessed and utilized. The researcher was unable to register with OAF because of the mandatory group registration unlike Apollo which allowed individual registration.

The researcher then used purposive sampling from the three specific groups. The three selected banks were chosen because they are recognized for providing agricultural financial services to smallholder farmers and that they had branches in the nearby town center where the study area was located. While some other banks may also be providing agricultural services, they were excluded from this research due to their lack of branches in the rural areas making it less lucrative to the smallholder farmers. The OAF and Apollo digital platforms were chosen among many other digital platforms because they are widely used in the region, focusing exclusively on supporting smallholder farmers with the financial services and access to agricultural input bundles which the study had a particular interest in. Smallholder farmers included in the research had to be registered on either OAF or Apollo agricultural digital platforms, or both, and cultivating different types of crops. To identify registered smallholder farmers within the study area, the researcher collaborated with the farm leader who served as an Apollo agent and had contacts with Apollo digital platforms. Nonetheless, for identification of registered OAF smallholder farmers', the researcher collaborated with the farm leader to identify a contact person who could help identify these farmers.

The primary data collection methods involved key person and focus group interview sessions using semi structured guides with pre-scripted open-ended questions. The choice of semi structured instruments was appropriate because of its exploratory nature, flexibility in questioning, aiming for participant engagement, and comprehensive data collection allowing for nuanced insights and perspectives from the participants. Data collection included demographic information, insights on inequality, impact of digital platforms on farmers' dependency and autonomy, shared concerns about data usage and recommendations to improve the platform. Face to face interviews were conducted with 15 smallholder farmers, as well as representatives from three banks: Cooperative Bank, Kenya Commercial Bank and the Equity Bank. Moreover, an independent key informant interview was conducted with representatives from the One Acre Fund, and Apollo digital platform. Subsequently, a focus group interview was conducted with 10 smallholder farmers cultivating various crops to determine which crop types are given priority from the financial institution such as the bank

when it comes to financial inclusion. Whether they are staple crops, cash crops or any other type of crops and getting insights from a group perspective about the crops preferred by the digital platforms to access the credit agricultural loans.

The interviews with the smallholder farmers were conducted in the local language and translated into English by a professional translator. Conversely, the interviews with the other groups were carried out in English, recorded using digital audio recorders and supplemented with field notes taken during the interactions. The transcripts were then subjected to thematic analysis which involved, identifying and establishing associations, explanations and relationships to obtain meaning. After familiarization with the transcript content to understand the context of the data, codes were generated manually through open coding to highlight emerging insights. The emerging themes included financial inclusion in digital platforms, disparities in access to technology and adoption rates among smallholder farmers, dependency of smallholder farmers on external support systems and challenges regarding smallholder farmers decision making process and their interconnectedness. Subsequently, drawing from existing literature and multiple sources of data (Gerring, 2007), the researcher used an inductive approach for reflexive interpretation of the themes explanations which were then presented as part of the research findings.

3.3 Positionality and ethical considerations

I have worked as an assistant program officer with Malungu Community Based Organization for three years in rural Ugenya, with smallholder agriculture being the primary target. Having a rural background in the study area, familiarity with the local customs and language, it helped facilitate communications with the farmers' creating a rapport crucial for the engagement in the research activities. This experience influenced how I approached the research. As the researcher, I recognized the various power dynamics over the researched. For instance, having authority and control over the research process and how this power imbalance might affect both data collection process such as choosing who to include or exclude, and interpretations drawn from findings including how concepts and theories learnt in my master's studies influenced my conclusions.

I obtained informed consent by verbally explaining to the participants the aim of the study. I ensured that the farm leader who was facilitating my connection with the registered farmers on the platforms and served as a field agent for Apollo, did not attend the focus group discussion despite taking me to the location. This allowed for participants to participate freely without concerns of being judged. Moreover, I emphasized that participants

could withdraw at any time when they felt uncomfortable and maintained confidentiality regarding their information throughout all stages of the data collection.

3.4 Challenges and limitations

The research investigated the impacts of financial inclusion on digitized agriculture among smallholders within the Luo communities in Ugenya ward. To start with, one limitation of this study was its exclusive focus on only two digital platforms that is OAF and Apollo digital platform. There were several other digital platforms operating within this region that, if I could have embraced, could have enhanced my data. Kenya boasts of a diverse landscape with around 113 institutions supporting or providing digital solutions in Kenya's agricultural practices, including entities ranging from government bodies, corporations to various start-ups (Osiemo et al, 2021).

Secondly, getting access to the Safaricom tech company posed a challenge. Despite sending three emails to the company without getting a response, I attempted to leverage on an individual with the connections in the company, whose contacts I got from someone who had worked with the company before and left but was still denied the access. Later, I got an email from Safaricom indicating that they could not grant direct access to an individual but are open to talk with companies or platforms they work with directly like the digital platforms especially if it something related to data. On the same note, accessing the smallholder farmers from the OAF digital platform proved difficult initially however, after three persistent follow-ups with the farm leader, we got contact information that helped with the identification of the smallholder farmers enrolled in the OAF digital platform within the study area-Ugenya ward.

Finally, traveling between different regions presented difficulties. I required multiple sources of information (Gerring, 2007) to cross validate findings and enhance the research credibility targeting banks, Safaricom, the digital platforms and the smallholder farmers themselves.[1]

[1] Smallholder farmers were situated in Ugenya ward- a rural place while the nearest banks were found in Ugunja town center which is in a different ward. Furthermore, Safaricom headquarters was only accessible from the Nairobi headquarters. Safaricom branches located in different cities like in Kisumu that I visited, referred me to the headquarters. Moreover, at that time, there were nationwide protests regarding tax issues that made travelling arrangements complicated. Despite the protest challenge, I successfully navigated through it and prioritized my safety during this period of unrest.

Chapter 4. Smallholder farmers' engagement with digital technology

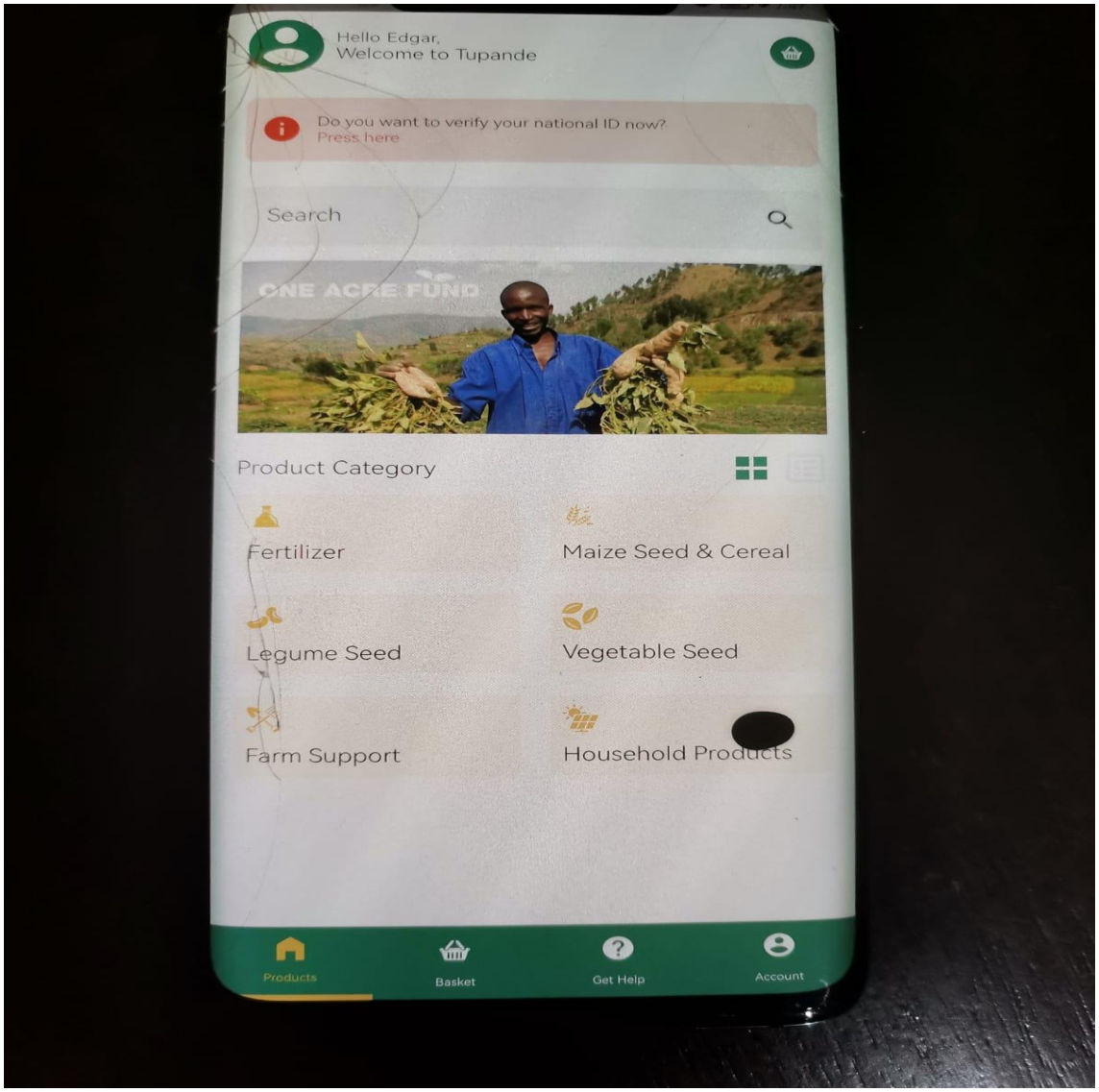
4.1 Digital platforms

The advancement of digital technology has enabled smallholder farmers to access a diverse range of resources, services, and information that can enhance their farming practices via mobile phone technology. Digital platforms are complex systems designed around network effects and come in various forms (Shakhovskoy et al., 2021). They leverage mobile apps, websites, and SMS services to connect farmers with essential tools and various stakeholders for more effective management of their agricultural activities. According to Babcock (2015), these platforms enhance efficiency and transparency throughout the agricultural value chain by fostering a shared understanding of market dynamics through collaboration among different stakeholders. For instance, in Africa, the increased adoption of mobile phones and mobile internet has opened new markets for digital platforms. Kenya boasts an impressive 98% mobile phone usage rate (Osiemo et al., 2021).

These platforms facilitate collection of data which can be potentially used by farmers to make informed decisions. The platforms not only provide technological infrastructures and services but also financial services opportunities through fintech operations, highlighting a complex relationship within these ecosystems. A notable trend in the recent years has been the shift by the digital developers from creating standalone apps to developing a centralized and integrated digital platform offering multiple services in one location (Mann and Iazzolino, 2021).

To provide further clarity on the preceding paragraph, the paper will illustrate with the two case studies of One Acre Fund (OAF) and Apollo agriculture, both of which are interconnected with Safaricom, a telecommunication company offering banking services through its mobile money M-Pesa. The discussion will explore how these platforms function and the range of services they offer to smallholder farmers within a centralized system.

Image 1: A cellphone screen with a picture example of platform website (OAF)



Source: Field data, 2024.

One Acre Fund Operation and Farm Services

One Acre Fund is one of the largest agricultural organizations operating in nine countries across East and Sub Shara Africa. Founded in 2006 in Kenya, and registered as an NGO in the USA, it has its headquarters in Kakamega Kenya. In 2012, OAF digital platform was established to include mobile money repayment for farming input credits and tablets used by OAF field staff to register farmers on the platform using farmers profiles. This saw an increase of clientele from 198, 000 to 4.8 million farmers registered on the platform between 2016 and 2023 (OAF, 2023).

However, the clientele is organized in groups of five to twenty-five members based on familiarity with one another. These groups can either be preexisting ones or newly created, provided the members are from the same stated location and know each other well. Group leaders facilitate these groups on a voluntary basis. The rationale for working with group structure being that it allows for concentration of training sessions offered by the OAF field officers (OAF, 2023).

Noteworthy donors supporting this platform include Mastercard Foundation, Bill and Melinda Gates Foundation, and tractor manufacturer John Deere Foundation (OAF, 2023). Moreover, it partners with Safaricom, through the Mpesa platform to facilitate seamless financial transactions among the farmers registered in its system.

In an informal conversation with the OAF officer, it was revealed that the platform's services for smallholder farmers can be organized into four different categories. At the beginning of the growing season, it offers loans on agricultural inputs such as seeds, and fertilizers based on local climate. During the growing season, farmers receive regular tailored training on effective farming practices like fertilizer microdosing, and pest and disease management. Ultimately after harvest, they are trained in proper storage techniques and market linkages while also being offered crop insurance. Moreover, OAF sells agricultural implements such as storage bags, storage water tanks and wheelbarrows alongside life improvement products like mobile phones, solar panels, and cook stoves. The officer highlighted that this approach capitalizes on a unique opportunity to provide essential lifestyle products that would be otherwise difficult for the smallholder farmer to access. One of the farmers who was among the first to join OAF when it was introduced in the region, confirmed some of the services provided during the agricultural season by sharing a detailed account of how the entire season unfolds.

> "I joined OAF in 2009, when it was introduced in our region. Normally, I receive weekly weather update messages for a month before the planting season to help me prepare my farm. I then either get seeds and fertilizers delivered promptly or visit a nearby OAF agro dealer shop before it is time to plant. During the planting season, I receive daily weather updates, along with weekly training sessions conducted by the OAF field officer in our various groups on how to plant, including instructions on fertilizer amounts and spacing between each hole. When it comes time for harvest, we are trained on how to arrange the harvested plants in bundles to dry out any remaining moisture from both the cobs and leaves. After that, we receive a one-time message on how to store the maize kernels in sealed sacks to prevent rodents and weevils from attacking the grains.

> Ultimately, we are encouraged to sell our maize when the market prices are high if we have that flexibility" (Sippy, 18-08-2024) Field Interview.

The platform claims to supply smallholder farmers with everything to grow out of poverty. The procurement of these products is facilitated through the credit model utilizing various channels such as retail shops, field officers and online apps such as USSD – a text messaging service available on basic mobile phones for last mile delivery to ensure accessibility (OAF, 2023).

Apollo Agriculture Operation and Farm Services

Apollo Agriculture is a Dutch startup company established in 2016 to offer digital agronomy services through mobile phone-based technology with its operation in Kenya and Zambia. The major objective of the platform is to "provide farmers with everything they need -from seed to sale-to become successful commercial farmers" (Apollo, 2023). With support from Rabobank and Mastercard foundation, the digital platform serves as an intermediary for finance options to the smallholder farmers. This service thus enables the smallholder farmers to invest in high quality products and transition from subsistence farming to commercial farming (Apollo, 2023). Registered farmers have the option to buy the agricultural inputs in either cash or credit, facilitated by machine learning credit models that access loan applications. Upon loan application by the farmer, the decision is made instantly regarding the credit approval using the platform interface. However, farmers' receiving agricultural inputs on credit receive insurance to safeguard their investment against unforeseen circumstances (Apollo, 2023). The platform operates with Field Agents who act as intermediaries between the Apollo platform and the smallholder farmers. Information regarding farmers profiles such as crop grown, size of land and the livestock kept is shared in the digital platform with the input suppliers who also share the information about the prices of products sold. Furthermore, it also uses Mpesa to facilitate its financial transactions as loan given to the farmers, is in form of a digital voucher to be redeemed in particular agro dealer shops (Knorringa et al., 2022).

Below is a matrix showing the comparison between the OAF and Apollo digital platforms and how they operate in relation to smallholder farmers.

Table 2: Comparison between OAF and Apollo digital platforms

Indicator	One Acre Fund Platform	Apollo Agriculture Platform
1.Model	NGO dedicated to providing comprehensive support to alleviate smallholder farmers out of poverty.	Business platform that brings commercial farming to smallholder farmers.
2.Land size requirement	1 acre & below	Unlimited hectares of land
3. Farmer services	-Inputs (seeds & fertilizers) -Financial service -Tailored training -Optional crop insurance -Cash crop purchase -Agricultural implements (e.g storage bags) -Market linkages	-Inputs (Seeds &fertilizers) -Financial service -Generic training -Bundled crop insurance (when purchase is made on credit)
4.Loan provision & repayment	Strictly on credit & repaid on mobile	Loan on credit & cash repayment allowed
5.Agro dealer shops	Only designated agro dealer shop	Any agro dealer shop
6.Operational structure	Group dynamics (8 -25 members)	Individual basis
7. Production	- Staple crop production & Livestock	Diverse crop production & livestock

Source: Field data, 2024; OAF, 2023 and Apollo 2023.

Overview of Payment (M-Pesa) Platform

The M-Pesa platform on the other hand, is a mobile financial service that has been widely scaled up in Kenya since 2007, operated by Safaricom, the country's leading mobile provider and part of the Vodafone Group. Its successful story (Jack and Suri, 2011) has led to many trading actors wanting to use it for their smooth financial operations. It has become an integral component of daily life for many people, empowers smallholder farmers by facilitating payments from buyers, money transfers to family members or suppliers and access credit facilities by use of SMS (GSMA, 2015). Smallholder farmers often require credits for essential items like food and seeds, as well as for life cycle events like sickness. They also use loans for productive investments such as paying hired farm labourers or

purchasing equipment such as tractors. With limited access to traditional banking services, smallholder farmers may increasingly rely on digital platforms for financial support and agricultural inputs. This reliance can result in them being bound by the requirements and regulations of these platforms leading to a sense of dependence on external entities for their farming needs.

4.2 Access to agricultural digital platforms

The research examined the demographics of the smallholder famers involved in the platform and within the study area, focusing on factors such as education level, age differentiation, gender and the farmland size.

Table 3: Demographics of the smallholder farmers

Education level	Age (Years)	Gender
Primary Level=16	19- 29=2	Female=19
Secondary Level =6	30-39 = 4	Male = 6
Tertiary Level = 3	40-59 =16	
University Level = 0	Above 60 =5	

Source: Field data, 2024.

4.3 The demographics and participation of the smallholder farmers in the digital platforms

The majority (nearly 64%) of the smallholder farmers registered on the platform had not completed the basic education which includes both primary and secondary levels as shown in *Table 2,* 1st column. This finding is supported by studies such as Morwani et al., (2017) which argue that a significant number of smallholder farmers in rural Kenya lack basic education thus limited digital literacy. During the interviews, most of the smallholder farmers, expressed their frustrations while trying to operate the mobile applications and even more on how to comprehend complex information sent to them from the digital platforms in English which they found difficult. A 57-year-old woman, managing 1.5 ha of land while taking care of her four school going grandkids, shared that,

> "I can barely understand English, therefore I rely on my school going grandchildren to help with the interpretation of the messages or wait for the group meetings where the

extension officer for the platform explains the content to us" (Margaret, 5-08- 2024) Field Interview.

The prevalent age group among smallholder farmers was between ages 40 and 59 years old with a percentage of 56% as shown in table 1, 2nd Colum. In an interview with Mercy, a 27-year-old, single mother of two, and a field agent representative of Apollo digital platform, it was noted that most of the smallholder farmers registered in the platform fall within this middle-aged category. This age group is considered more reliant in repayment of loans for agricultural input than the younger individuals (between 18 and 29 years old) who might be prone to migration. The researcher observed that most young individuals in the younger age group do not view agriculture as a viable option because of limited land ownership and control alongside lack of other resources. Thus, forcing most of them out of agriculture (Maina, W.N and Maina, 2012). Furthermore, it became evident that there were clear demographic disparities. Predominance of older users registered on these platforms creates an imbalance within the agricultural community registered online.

The gender disparity on the digital platform, with the female prevalence being 86% and men 14% is owed to men respondents' perspectives. One of the smallholder farmers, a middle-aged man of 54 years old, claimed that small scale farming alone cannot satisfy all their basic needs. He emphasized the necessity to supplement it with other income generating activities outside farming like motorcycle taxi services *(bodaboda),* an occupation common among men. These dynamics result in most of the farmwork being left to women. This imbalance thus contributes to gender disparities in agriculture as postulated by Huijsmans et al., (2021).

4.4 Farmer land size

The land size is a crucial matter for the digital platforms. For instance, OAF platform, derives its name from the requirement that farmers registering within the platform, are mandated to have a land size holding of one acre OR below. To an extent that if you have two or more acres of land, you must register them differently. The platform claims that targeting farmers with small land holdings, enables it to provide tailored assistance to help smallholder farmers out of poverty (OAF, 2023).

The term smallholder farmer is defined differently across regions and countries due to various factors such as land ownership, scale of production, access to resources and assets, living standards, and contribution of family labor (Maass, 2013). For example, a smallholder farmer in Australia has a land holding ranging from 0.5 ha to 500 ha. However, according to

FAO (2013), a land holding ranging below 10 ha is categorized as smallholder farmer. In this paper, land holdings below one acre are defined as smallholder farmers. It was evident from the interviews that most of these smallholder farmers are characterized by centrality of family labor, partially self-sufficient as they rely on external support for the inputs such as seeds and fertilizers and utilize low technological devices such as mobile phones for their farming operations.

4.5 Crops cultivated

Table 4: Type of crop cultivated and how it is practiced

Type of crop	Intercropping	Monocropping	Number of farmers	Total in percentage
Maize		✓	19	63.3%
Beans	✓		2	6.7%
Sorghum		✓	4	13.3%
Millet	✓		2	6.7%
Groundnuts	✓		3	10%
Total			30	100

Source: Field data, 2024.

The majority of the farmers (63.3%) as shown in Table 3 above are cultivating maize which is a staple crop essential for food security. Staple crops have established markets and value chains which make them highly attractive for digital platforms. For example, Apollo digital platform reported that during the Covid-19 pandemic, it almost tripled its customer base because maize as a staple crop, has a strong market presence even during challenging times (Apollo, 2023).

The smallholder farmers who are farming sorghum on monocropping basis are exclusively doing it for commercial purposes. These farmers in addition to one acre of land registered on the platform, also have other acres of land approximately three acres or less dedicated to sorghum farming. One of the banks representatives interviewed mentioned:

> "(…) the bank facilitates the connection between the smallholder farmers who are interested and have an account with us to the East African Breweries Limited for selling their sorghum produce. This is done through contract farming. Moreover, the company identifies the designated agrovet dealers for the specific inputs such as seeds and fertilizers and sometimes exercising control at the point of production. The bank acts as

> an intermediary leveraging its knowledge on the creditworthiness of the farmer. Subsequently, we provide credit vouchers via the M-Pesa app for the farmer to purchase the inputs at the designated agro dealers as per the company regulations and facilitate payment for the laborers hired by these smallholder farmers" (KCB representative, 15-08-2024) Interview.

Drawing from this interview, I observed the complexity of the system and how different actors are trying to collaborate with the smallholder farmers being the primary target. The narrative widely promoted to uplift these smallholder farmers who are perceived to be poor involves integrating them into the global value chain and enabling them to adopt modern technologies (FAO, 2023). However, does this truly help them out of poverty? Roseline, a 40-year-old middle-aged woman, participating in three different agricultural platforms, including OAF, Kuza, Apollo and has an account with the KCB bank practicing the contract farming stated:

> "East African Breweries Limited contractually specifies the market obligations by value, quality, volume and even sometimes, advanced price determination. If you do not meet these conditions after the harvest, you risk running at a loss as a farmer. Furthermore, I have noticed an increased interference with the soil fertility of this 3 ha of land that I practice sorghum cultivation. Initially, this soil of ours was fertile and one could do abundant planting and harvesting. However, the moment I started practicing monocropping and following the company's conditions to use the fertilizers, it has become impossible to plant without them" (Roseline, 12-08-2024) Field Interview.

This illustrates how stringent contractual agreements combined with unsustainable agricultural practices such as monocropping and decline in soil fertility, threaten smallholder farmers both economically- (potentially leading to financial loses) and ecologically, ultimately jeopardizing local food security.

Other crops such as beans, millet and groundnuts are intercropped to enhance soil fertility to maximize land use efficiency, reduce pest and disease pressure and diversify income for the smallholder farmers. When interviewed, Mercy a 36-year-old mentioned that,

> "Last year, we experienced a severe drought resulting in poor harvests. However, if you had intercropped with groundnuts, there was a potential for good harvest since groundnuts are drought resistant crops and thus can withstand harsh weather" (Mercy, 13-08-2024) Field Interview.

Chapter 5. Platform dependency and limiting autonomy on farmers

Smallholder farmers have been impacted in various ways by use of digital technological tools in their farming. As previously mentioned, benefits highlighted by digital platforms including OAF and Apollo include, increased financial inclusion through agricultural credit inputs, improved access to information such as weather forecast and enhanced market linkages. Proponents of digital agriculture contend that, when these technologies are integrated, they can enhance efficiency in agriculture by reducing financial and labor costs (Munthali et al., 2022) and providing valuable information for decision making processes which can help foster economic growth within the agricultural sector (Borrero and Mariscal, 2022). However, critics argue that increased reliance on the platform could potentially limit farmers' choices and skills. The section below will deal with several mechanisms that affect farmers' dependency and autonomy.

5.1 Platforms as a replacement for extension services

The actors involved in promotion of digital solutions among smallholder farmers as detailed in the background section are private firms such as big tech companies, international organizations, banks and government agencies. However, insights from the interlocutors revealed a predominance on digital platforms which most are private led as confirmed by Shakhovskoy et al., (2021). These platforms collaborate with various stakeholders such as the technology providers, financial institutions, extension service providers and insurers. Onyango, a 55-year-old villager, who has been practicing farming for over 30 years, noted:

> "Back in the days before mobile phones and digital platforms became common, agricultural state extension officers would frequently visit farmers door to door. However, these days, they are no longer present. Instead, we mostly receive visits from field agents if we are registered on the platform" (Onyango, 28-07-2024) Field interview.

Drawing from this interview, it remains unclear if the state extension officers are being privatized to the current field agents by the government to cut the costs or if the government is being overshadowed by these digital platforms. According to Mann and Iazzolino (2021) after the post-world war development paradigms, the state debt reduction policies changed resulting in state withdrawal from public investment in agricultural extension services. On the other hand, FAO (2021), argues that digital platforms bring new opportunities to

agricultural extension and advisory services (EAS) delivery, including financial inclusion to the smallholder farmers.

Some studies argue that there is a complex interplay between the financial capital *(provided by private actors*) and government policies in the advent of digitalization and financialization in the agricultural and food sector (Visser, Clapp and Isakson, 2015). This brings us to the dual contradictory role of the state (Fox, 1993). The state needs to promote capital accumulation to spur development while also seeking political legitimacy. Consequently, putting the state in a challenging situation between balancing development promotion and maintaining public support often leads to conflicting priorities and decisions. In this context, the role of the state becomes crucial in determining whether it becomes a tool in facilitating class dominance as argued by Marxist ideology. If so, then, it implies that the state is under capture by powerful groups or interests. Such capture could lead to misallocation of resources away from programs designed to support smallholder agriculture like extension services and towards increased reliance on commercial digital platforms for agricultural solutions. Furthermore, favorable policies by the government, shaped around proliferation of digital platforms, reduces competition among other services providers like community support systems such as ROSCAS or friends.

This shift from traditional services to reliance on technology driven solutions such as the platforms for information and resources, underscores potential limitations inherent within the platform-based model. For instance, in an engaging focus group discussion with eight farmers, four from OAF and four from Apollo, a concern regarding insurance was raised. Representatives from Apollo expressed that the area needing improvement in the platform is their insurance coverage. They mentioned that despite paying for insurance, they never got compensated when drought struck resulting in a significant financial loss. This discussion suggests lack of transparency from the insurers, limiting farmers ability to make informed choices. In contrast to this digital approach, the frequent door visits from the extension officers served as a direct link between farmers and the agricultural support they required. These interactions allowed for personalized communication and accountability. However, digital platforms like Apollo may prioritize efficiency over personal engagement leading to gaps in communication regarding the conditions of the services offered and limitations (Isakson, 2015).

5.2 Formal (platform based) credit

The research revealed that smallholder farmers became increasingly reliant on the digital platforms for financial services which are tied to credit agricultural inputs. In the interviews with the smallholder farmers***, all of them*** acknowledged heavy reliance on the digital platforms to access credit for the agricultural inputs. Only in certain circumstances when denied the loan did they opt for other sources of financial assistance. Obuya, a 43- year -old man, registered in Apollo highlighted this shift:

> "(…) before the proliferation of the digital platforms, I used to seek financial assistance from acquaintances, friends or ROSCAS, to buy agricultural inputs such as fertilizers. However, in the present day, a lot has changed. With the widespread use of digital technology, my friends and acquaintances may direct me to a digital platform or offer me a loan but, with interest rates applied- a practice which was not common initially" (Obuya, 23-08-2024) Field Interview.

With the heightened reliance on the digital platforms for quicker access to agricultural credit inputs, the social bonds that underpin informal arrangements like ROSCAS, might be weakened. The quote illustrates how social relationships are becoming commodified, exemplifying the transactional interactions focusing on individual gain rather than the community welfare. This shift towards individualism promoted by formalized credits at the expense of local cooperatives like ROSCAS, risks financial pressure on borrowers who may feel compelled to prioritize loan repayment over their communal obligations. Consequently, leading to ethical compromises that undermine moral economy (Gerber, 2017).

5.3 Behavioral nudges

Smallholder farmers are increasingly receiving reminders and personalized automated messages from the digital platforms once their financial eligibility is assessed, with content tailored to each farmer's profiles. Mercy, a young farmer mentioned:

> "I do receive frequent messages and constant reminders regarding loan eligibility making it increasingly difficult not to consider the digital platforms for credit agricultural inputs" (Mercy, 18-08-2024) Field Interview.

The timing of these financial messages is critical as they are sent at strategic moments such as before planting seasons when smallholder farmers most need credit inputs, typically associated with seeds or fertilizers. This implies that farmers may become dependent on

digital platforms for guidance and support due to the nudging effect, rather than developing independent knowledge, or utilizing informal methods towards their financial management.

Focus group discussion revealed that field officers consistently provide educational content during weekly group meetings. Field officers inform smallholder farmers about the availability of different types of seeds, their prices, and any new agricultural implements such as storage bags. Moreover, they often compare current prices with the previous prices during the last planting season, highlighting any price drops to encourage farmers to purchase credit inputs while supplies last. This situation aligns with Brooks (2021), argument of modern agriculture using behavioral insights to encourage proactive decision making among smallholder farmers. However, it also raises concern that such reliance might restrict farmer making decision capabilities over time. Through these platforms, smallholder farmers are being connected to the market by integrating them into the agricultural value chain and the financial services which may inadvertently increase their dependence on external sources of information.

5.4 Limited choices for inputs and dealers

The integration of digital solutions into agricultural settings is essential to examine how farmers' decisions may be restricted. This analysis becomes particularly significant when considering agricultural digital platforms that consolidate various digital solutions into one platform (*see an example of how Apollo digital platform operates in figure 1 below*). As these farmers increasingly rely on platforms like Apollo, OAF and Mpesa for financial services and agricultural inputs, their choices become limited in various ways.

The collaboration between OAF and Mpesa led to the development of a Single Application Program Interface (API) that streamlines various services provided to smallholder farmers, enhancing their access to financial resources and agricultural support. This integration allows for a unified access point for financial services allowing smallholder farmers to receive funds quickly and repay without needing separate banking processes. Moreover, the consolidation of other platform functions such as training programs and input supply further simplifies operations for the smallholder farmers. This consolidation was confirmed during interviews with the smallholder farmers, field officer and reflected on their webpage.

> "One Acre Fund, supplies smallholder farmers with everything they need to grow their way out of poverty" (OAF, 2023).

However, the regulatory constraints associated with credit for agricultural input may restrict farmers' options by funneling them towards specific products or services offered by the platform, rather than allowing them to explore alternatives that might better suit their local needs. For instance, OAF lends assets instead of cash claiming that smallholder farmers are less intimidated by taking a loan when they are receiving a comprehensive package of inputs that is profitable. (OAF, 2023). In cases such as Apollo's program, where vouchers must be redeemed via Mpesa at designated agro dealer shops, further constraints are placed on purchasing decisions. The requirement to couple loans with purchases of seeds from designated agro dealer shops significantly limits farmers choices considering they heavily depend on the digital platform for financial support. This confirms Mann and Iazzolino (2021) arguments about enclosed loop systems in which farmers are increasingly depending on the platform due to its integrated nature providing multiple solutions. In an interview with Atieno, a 29-year-old smallholder famer registered in OAF and a single mother of three, confirmed this packaged deal mentioning that,

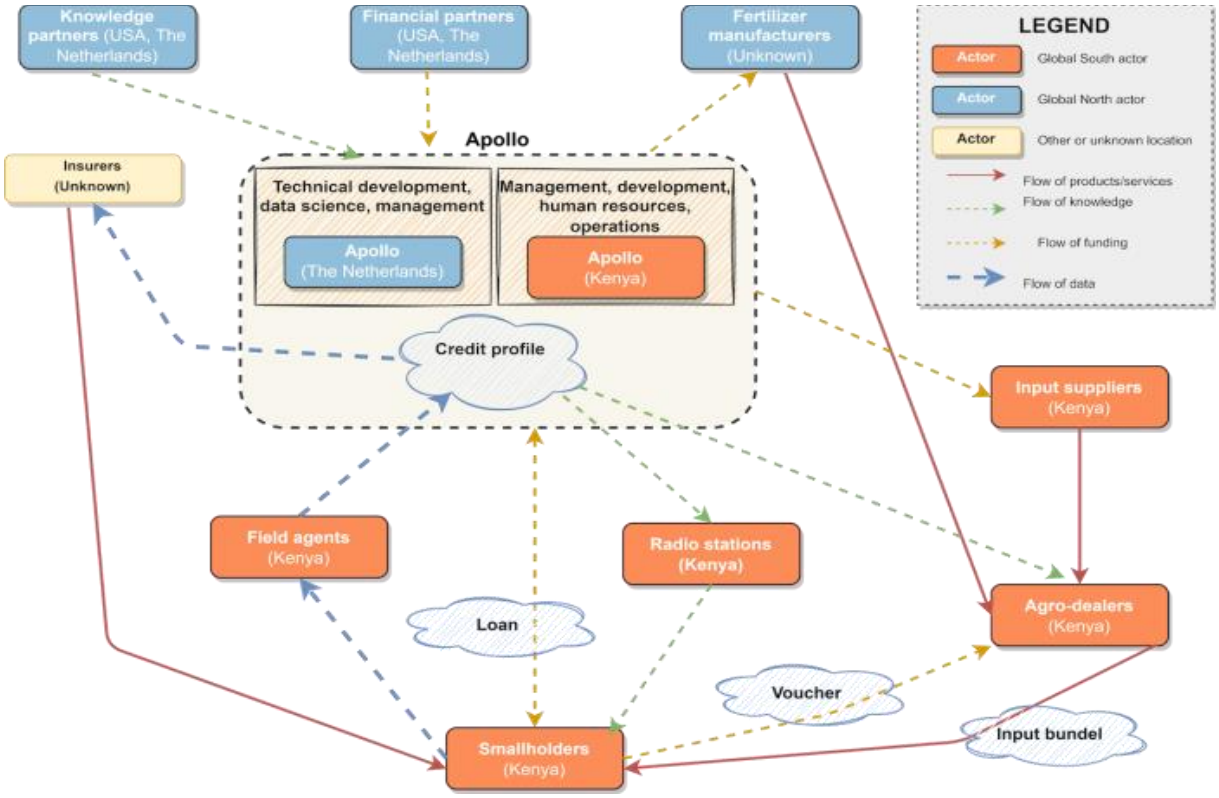
> "Loans are always linked to the purchase of seeds or fertilizers from a designated agro dealer shop. The maize seeds provided are always unique and hard to locate in other different agro dealer shops. Once you plant the seeds, you cannot replant them in the coming planting season and hence new seeds must be purchased in the next season. The fertilizers despite being of high quality, once used, it is challenging to plant without using them in the next season because it can lead to poor yields and disappointing harvest." (Jane, 5-08-2024) Field interview.

Furthermore, a focus group discussion with eight smallholder farmers revealed that, OAF provides specified tailored training to all the smallholder farmers using the same inputs. While this ensures consistency in farming methods aligned with organizations objectives, it might undermine individual farmers' autonomy in managing their farms independently (Stone, 2022). The concept of package deals of credit inputs is not entirely new, previous studies globally show how big food processors and traders already had such practices (Clapp and Isakson, 2018). However, with the rapid expansion of platforms these package deals have become more prevalent.

Image 2: Picture example of One Acre Fund agro dealer shop

Source: Field data, 2024.

Figure 1: Apollo Digital Platform Ecosystem



Source: Knorringa et al., (2022).

Explanation of the diagram

This is a *digital platform of Apollo Agriculture*. It features actors from the Global North represented by blue rectangles where knowledge partners, financial partners and manufacturers of fertilizers are located. The orange rectangles represent actors from the Global South involved in managerial roles and human resource development. The target of this ecosystem are the contractual smallholder farmers who are perceived to be poor and therefore require financial assistance to improve their productivity. To facilitate this support, smallholder farmers are registered on the platform with their agricultural data collected by the field agent who acts as the first contact between them and the platform. Based on this agricultural data, the smallholder farmers can access loans which are exclusively provided on credit basis. These credits are given as vouchers through the mobile networks that offer fintech services. The voucher is then redeemed at a designated agro dealer shop where the farmers obtain the input bundles intended to improve their productivity. Furthermore, there is an unknown actor in this platform who acts as an insurer and provides coverage to farmers in times of need by accessing their profiles in the platform. Therefore, this creates a complex interaction between smallholder farmers, fintech services, various stakeholders and the platform being at the center of this ecosystem as smallholder farmers being the primary target.

5.5 Surveillance via groups

There is another way in which farmers alignment with the platform's aim is enforced, potentially increasing their dependence on it. This is through the obligation to register as groups, which are collectively responsible for adhering to the platform's cultivation and guidelines.

OAF operates with groups of 8 to 25 members who are familiar with one another, each led by a group leader and weekly meetings with a facilitator from the OAF platform. The dynamics within these groups can be examined through two lenses: The micro credit system and the monitoring of farming practices. Both aspects have significant implications for farmers' dependency on the platform and consequently farmers' autonomy.

Micro credit systems

Micro credit systems particularly in the context of group dynamics rely heavily on the mechanism of social collateral (Postelnicu et al., 2014). This approach enforces collective responsibility among the group members on loan repayments and managing risk associated with lending.

Focus group discussion revealed that peer support and accountability foster a sense of togetherness among members, encouraging responsible behavior regarding loan repayments. This is because success is often closely linked to their collective effort. In the same discussion, Mwanjala, a middle-aged woman, who is a group leader corroborated this information.

> "(…) We need to support each other in repaying the loan on time, if we want to be ranked as the best group with the platform. That way, we can earn rewards from the platform such as the free t-shirts and a hoe for all of us meeting our individual credit deadlines within the stipulated loan repayment period" (Mwanjala, 13-08-2024) Field Interview.

However, Agness, 43 years old stated that,

> "As much as I appreciate receiving the loan, I am worried about how repayment is handled when you default. I once defaulted due to unavoidable circumstances, but the way they approached me for repayment was not ideal. I received daily calls and messages and eventually, because I still had not paid, our group facilitator came and collected my harvest as a repayment" (Agness, 19-08-2024) Field Interview.

This implies that not only do the group members monitor and apply social pressure to ensure adherence to repayment schedules, but they on the platform organization (OAF) also go as far as confiscating property such as farmers' harvests.

Surveillance of farming practices

OAF employs various methods to monitor farmer activities including input usage. Focus group discussion with eight smallholder farmers four from OAF and four from Apollo, an interesting conversation emerged. Most famers from the OAF platform expressed their concerns about the tailored training provided during planting season. They postulated that, if you do not strictly follow the rules of the planting as recommended by the field agent form the platform then, you risked being exiled from the group and ultimately from the platform itself. During the planting season, each farmer is supervised by some of the fellow group members to ensure adherence to the instructions given. Some of the instructions include, maintaining proper distances between the holes when digging - often measured with a rope that is marked with required measurements, and applying the recommended amounts of fertilizer.

Group dynamics with members monitoring each other's activities including loan repayments and adherence to agricultural practices, fosters accountability and shapes perceptions about acceptable behaviors. However, this can also create pressure to conform.

Consequently, farmers may strictly prioritize following guidelines or protocols set forth by the platform rather than experimenting with innovative techniques suited for their local context. Furthermore, standardizing agricultural practices limit diversity in agricultural practices and reduce adaptability to local conditions, essentially homogenizing approaches across different contexts as argued by Glover and Anderson (2016). This situation could lead to double surveillance of the farmers as users or products on digital platforms through indirect group methods, as well as surveillance of their financial behaviors as debtors (Zubboff, 2019 and Jain and Gabor, 2020).

5.6 Multiple platform registration by farmers

The number of digital platforms a farmer can get enrolled into, is unlimited. There are several reasons as to why smallholder farmers can get involved in various platforms. Some respondents indicated that they do this for comparative advantage, so that they could leverage on the strength of each digital platform. For instance, one middle aged man who is involved in five different platforms and cultivates various crops (maize, sorghum, beans and groundnuts) because each platform emphasizes on certain crops more than others, mentioned:

> "I am registered on both the OAF and the Apollo agriculture platform. I chose OAF because they promptly provide fertilizers and the seeds. Apollo on the other hand, offers a cash option in loan repayment as compared to OAF that strictly gives agricultural loans on credit and repaid using mobile payments. However, after some time I discontinued my membership with OAF because of the unfulfilled crop insurance promise. When drought struck resulting in poor yields, they failed to honor the insurance crop coverage making me run at a financial loss" (Mandago, 18-08-2024) Field interview.

This quote illustrates how farmers engage with diverse resources and information streams from multiple sources rather than being restricted to one platforms offerings or guidelines, farmers gain greater control over their decisions. Moreover, platforms do not restrict farmers to sell their surplus production to them. Farmers can sell their surplus produce to who they want. In that sphere there is no platform control allowing for greater choice among farmers. This diversity ultimately creates some limited power on farmers to counteract the various mechanisms that platforms use to create dependency among farmers as argued by Shakhovskoy et al., (2021).

Table 5: Comparison between OAF and Apollo repayment and monitoring

Indicator	One Acre Fund	Apollo Agriculture
Loan repayment	2 deadlines: 1st- Farmers prepay 10% of the loan before receiving services 2nd-Final loan repayment after harvest	3 deadlines: 1st-Initial payment of 10% of your loan size 2nd-Monthly fee of 2% of your loan 3rd- Final payment after harvest
Monitoring	High due to group surveillance on farming practices & credit	Operate on individual basis however, high due to detailed data collected from farmer
Limited choices	Strict planting guidelines	Flexible guidelines to follow

Source: Field data 2024, OAF, 2023 and Apollo 2023.

Chapter 6. Data ownership and control

Digital platforms have the potential of assisting smallholder farmers in addressing some of their challenges including improving their productivity, providing weather forecast information and reducing financial and labor cost (Munthali, 2022). This is achieved by aggregating, analyzing and utilizing large volumes of user data to improve the smallholder farmer productivity. However, despite these benefits, there are serious concerns associated with how much data is collected by these platforms often referred to as "big data". There are worries that certain groups may gain disproportionate control over these critical agricultural datasets collected during interactions between smallholder farmers and platform operators as data is increasingly being viewed as a new asset (McMichael, 2013).

During the interviews it was interesting to find that, as much as the smallholder farmers were enrolled in both the OAF and Apollo digital platforms, they do not have direct access to these platforms via their mobile phones. Instead of using the platform independently, there are *field agents* who serve as intermediaries between the smallholder farmers and the digital platforms in both cases. This situation contradicts the platform's communications, which often portray a seamless experience where users can easily engage with services on their own (Apollo, 2023). Moreover, this stands in contrast to OAF claim that "we work with smallholder farmers directly throughout the year" (OAF, 2023).

Field agents are the ones who visit the smallholder farmers on their farms and act as their first personal contacts. In the case of Apollo for example, these field agents conduct personalized training sessions to educate the smallholder farmer on how the bundled loan input works. What does this imply to the smallholder farmers? They lack direct access to the platform although they provide valuable data sets to the platform. This questions farmers direct agency to the platforms regarding its operations and services on the platforms. Moreover, concerns arise if this data is primarily controlled by the organizations and stakeholder involved without clear policies regarding who has access to what information and how it is used in making decisions, then it means certain groups could gain disproportionately.

Mark, a 30-year-old smallholder farmer on his inherited 2 ha of land from his late father, mentioned that,

> "(…) to be registered on the platform, data is collected and inserted by the field agents in their tablets. Data collected was through a survey that included questions such as my

> marital status, mobile phone numbers and household composition. Additionally, information regarding how my farm did in the last agricultural season and details about assets ownership including livestock was asked. Furthermore, the field agent took a photo of me alongside my farm using their tablets that looked quite complicated" (Mark, 29-07-2024) Field Interview.

This quote clearly indicates how detailed and personal information the digital platform takes from the smallholder farmer yet there is no transparency to them as they are represented by the field agents who are employed by the platform. Moreover, farmers might be unaware of which types of personal information that is stored or shared with the third parties without explicit consent. When this valuable data is transferred to a third party, the farmer risks losing the control of it as emphasized by Kiaka (2024). Who handles this data and how do they use it becomes a crucial question. According to the Kenya Data Protection Act (2019), this data should be protected, and every individual has the right to privacy as stated in Article 319(c) of the Kenyan constitution (Republic of Kenya, 2010).

The digital platform argues that the consolidation of the data including data on farm activities, together with the satellite data, plays a major role in creating credit profiles for smallholder farmers who have not had prior access to loans. These credit profiles are instrumental in assessing risk factors determining which farmers qualify for loans (Apollo, 2023). According to the OAF (2023), the risk assessment allows for a better understanding of each farmers' specific requirements. Consequently, tailoring training programs offered in groups and input provisions according to each individual farmer's needs.

However, some smallholder farmers argued that, despite giving detailed information they still do not end up getting the loan. In an interview with Adhiambo, a young smallholder farmer within the range of 20 to 30 years old and registered at the Apollo digital platform, argued that

> "I believed I had everything necessary to meet the requirements. I owned one acre of land, two cows, and three goats. I provided my personal details as requested in the survey. However, I was still denied the loan. Reason being my name was listed on Credit Reference Bureau (CRB) for a small loan of Ksh. 500, that I had taken from a different financial assistance app, and defaulted to pay" (Adhiambo, 16-08-2024) Field Interview.

As a researcher who registered on the platform, I noticed that the moment your national identification card number is taken during registration, it instantly enables the platform to easily see your financial standings, encompassing details from M- Pesa statement(s). While

these data help the digital platform to assess loan eligibility and highlight the complex interconnections of these digitized platforms, is it fair to take such detailed information about a smallholder farmer then deny them the loan on the basis of defaulting on another different platform altogether?

Consequently, in a focus group discussion with eight smallholder farmers of the whom majority did not complete college education as indicated by the research and supported by Morwani et al., (2017) studies, five respondents claimed that it is unclear to them what their data is used for apart from eligibility criteria for agricultural credit access. No one explained to them in detail what their data is used for, but because they urgently need the financial support, they would give the data as required. This questions whether the farmer gave meaningful consent. The remaining three respondents showed little concern about what happens with the data collected. They did not understand the value of their data thus how it was being used and by whom did not matter to them that much. According to Mann (2018), this lack of clarity regarding individuals' rights over their own data once it is collected by the platform raises critical concern of who truly owns the data generated through user interaction. For example, OAF was accused of making farmers become data laborers as argued by Mungai (2019).

Moreover, in the same focus group discussion, the smallholder farmers expressed their lack of digital operational skills stemming from limited exposure and training on innovative techniques. The FAO argues that this limitation restricts the innovative capabilities of smallholder farmers (FAO, 2023). However, it raises also a concern regarding what happens to the adaptability of the farmers' traditional methods or independent innovation if the farmers get overly dependent on the technology and innovation being promoted. Relatedly, there are even few professionals who fully understand how these platforms operate or are maintained. Often, most are being designed and maintained with the big multinational ICT and agri business companies at the source countries who influence agricultural practices through their expertise in handling large data sets (Kiaka, 2024).

Information asymmetry as data gathered from the API's may provide limited information to safeguard commercial interests (Burgess and Duguay, 2016) raising questions whether there are even equal exclusive rights of accessing the data driven from the digital platforms. Skills disparities giving an upper hand to the advantaged group in the digital system to exploit the less advantaged (Heeks, 2022). Such precise information can be used by the platform to assure investors of their return investments (Mann and Iazzolino, 2021). For example,

investors might be given preferential treatment as compared to smallholder farmers. Terms of engagement such as the agreements, conditions, and requirements before financial inclusion by the smallholder farmer, should therefore be critically looked at. Otherwise, profit motives without sufficient safeguard to ensure equitable distribution gains has the propensity of exacerbating social economic divide rather than fostering inclusive growth development across diverse farming communities.

In an interview with one of the smallholder farmers, a 36- years -old registered with the OAF platform mentioned that,

> "(…) besides the bundled offer on agricultural inputs provided on loan, we also receive vegetable seeds and tree seedlings free of charge" (Akinyi, 19-08-2024) Field Interview.

Major agribusiness companies like Monsanto (now part of Bayer), often employ various pricing strategies including, no cost programs, promotional discounts and bundled offers to promote their products. This strategy is also evident in the platforms through the extended packages of credit loans coupled with seeds or fertilizers and furthermore, provision of two other free items such as the vegetable seeds and tree seedlings. However, when platform services are offered at no cost or heavily discounted rates, it raises concern about the potential use of collected data in exchange for access to user generated content (Shakhovskoy et al., 2021). Moreover, when this data is monetized, the platforms do not compensate the original contributors raising ethical questions about fairness in profitability, a concern as highlighted by Fraser discussion on "data grab" (Fraser, 2019, p. 4).

As a result of these dynamics, an imbalance is created where flow of knowledge and essential agricultural technologies remain concentrated among those with resources (see *figure 1 for more illustration*). Furthermore, the concentration of big data ownership among powerful corporations may exacerbate existing inequalities by allowing these entities to leverage personal information for profit while leaving marginalized communities without agency over their own data (Fraser, 2019).

Chapter 7. Conclusions

This research paper has examined the intersection between digitalization and financialization focusing on how these trends are shaping agricultural practices today, exemplified by digital platforms. The research paper analyzed the proliferation of digital platforms that consolidate various digital solutions into a single interface and explored how these developments influence farmers' dependency and autonomy.

The research shows that, as expected, most smallholder farmers are poor and require financial support to buy commercial inputs (seeds and fertilizers). With the proliferation of digital platforms, access to credit input for smallholder farmers has been simplified. However, it has also increased the dependency of the smallholder farmers on the platform in various ways. First, it has led to replacement of state extension services (Mann and Iazzolino, 2021) increasing the dependence of the smallholder farmers on commercial digital platforms for agricultural solutions. The state has a dual contradictory role (Fox, 1993) however, it becomes a concern if state is used as a tool in influencing class dominance as argued by Marx ideology. This is more acute when the state lacks the adequate regulatory frameworks to govern the activities conducted by the digital platforms' corporations.

Second, proliferation of digital platforms has led to heightened dependence of farmers on formal platform-based credit weakening traditional social bonds such as ROSCAS. When farmers default on the payments, it could lead to confiscation of their property as a collateral for repayment which exacerbates their financial vulnerability. Moreover, this confiscation leads to wealth becoming increasingly concentrated among those who control these platforms. Consequently, contributing to rural indebtedness in the evolution of capitalism (Gerber, 2017).

Third, the digital platforms use nudges (Brooks, 2021) such as the SMS alerts for aggressive marketing of their farm inputs. This steers smallholder farmers to adopt behaviors necessary for market inclusion like establishing market linkages using promoted farm inputs, which enhances the legacy of the Green Revolution.

Fourth, provision of packaged deals that include credit coupled with fertilizers or seeds at designated agro dealer shops, creates a "closed loop system" (Mann and Iazzolino, 2021, p. 3). This approach limits farmers choices and further heightens their dependence on the platform. It has led to a transformation of agricultural assets from being merely tools for production and sustaining livelihoods, to being viewed as investments opportunities. This

has enabled the digital platform to further extract profit at the expense of smallholder farmers.

Fifth, the central role of group dynamics evident through group micro credit systems (social collateral) and peer surveillance of farming practices has increased farmers' dependence on the platform. This strategy allows the platform to shift down responsibility for mitigating risks onto group members who have to conduct peer support of monitoring each other in loan repayment as a cost-effective method for monitoring farming practices.

In contrast to the many mechanisms that enforce the heightened dependence, smallholder farmers can be registered in multiple platforms enabling them to draw comparative advantage leveraging on the strength of each platform. Conversely, it is nearly impossible to shift platform within an agricultural season of the year especially if they have not yet paid for credit inputs. If a farmer defaults in payment, their harvest might be seized as a collateral.

While previous studies have shown some mechanisms that create dependence of smallholder farmers on agricultural platforms in Africa, this study discovered new mechanisms that check dependence. Although nudging (Brooks, 2021) and packaged credit input deals (Mann and Iazzolino, 2021) have been identified in the literature, other mechanisms have remained under the radar of research to date. The group dynamics through which platforms enforce credit repayment as well as monitoring of field practices of farmers. This mechanism details traditional monitoring techniques from microcredit spheres with innovative methods of peer oversight induced by the platform. As often in other digital platforms, digital clients are typically monitored through various technological mechanisms that track their activities and behaviors. However, in this context, it is peers who primarily monitor the activities but mostly offline rather than online.

The data set collected from smallholder farmers is extensive and includes personal information that requires protection as indicated in the Kenyan law such as the Data Protection Act. It is important to examine in future studies whether these laws and policies can effectively protect data privacy, ownership and security while ensuring adherence to ethical consideration. For instance, some respondents claimed that they do not clearly understand what their data is used for beyond financial eligibility criteria suggesting that the principles of informed consent are not being fully upheld as argued by Klerkx (2019).

Future research is needed to delve deeper into the study of group dynamics. How farmers attempt to escape from platform and group surveillance as well as the extent to which using multiple platforms enhances farmers' agency.

APPENDICES

Appendix 1

Questionnaire for Smallholder Farmers

1.*What is your age?*

A) 18-28 B) 29-39 C) 40-59 D) Above 60

2.What is your gender?

A) Female B) Male C) Other

3. What is your education level?

A) Primary level B) Secondary level C) Tertiary level D) University level E) No education at all

4. a) What are your years of experience in farming?

b) What is the size of your farm? Which crops do you produce (or livestock products)?

5. a) Do you have access to a digital platform /app?

b) If yes which one (s)?

c) For how long have you been using the digital platform?

6. What do you use the digital platform for if you have access to one?

7. How frequent do you use the digital platform?

8. a) Are there also digital platforms /apps which you used in the past, but are not using anymore?

b) Please indicate if any, what kind of platform and why you stopped using it.

9.How has the use of digital platforms affected your farming practices (e.g. inputs used, crops cultivated, yields, sales etc)

10.a) Do you feel that using digital platforms has increased or decreased (or left unchanged) your independence in making farming decisions?

b) Has the type or number of suppliers of inputs changed due to advice/option given by the platform?

c) How much control do you have over the agricultural practices when utilizing the digital platform?

11.a) To what extent do you rely on digital platforms for essential farming resources (e.g. financial services, market linkage, weather forecasting, information access)?

b) Did the number of sources of credit you use (e.g. middlemen, ROSCAs, from acquaintances, banks) change over the past years? How?

c) Have there been instances where reliance on these platforms has affected your ability to farm independently, positively or negatively?

12. How reliable and precise is the advice from the digital platforms? Could you give an example of helpful advice? Could you give an example of not useful advice?

13. a) What sources of information do you use, in making decision regarding farming? (e.g. TV, radio, local farmers, agricultural platform app, other general apps (e.g. Facebook groups/ WhatsApp etc), state extension services)

b) Which one is most useful?

14. Has your use of other source of information changed since you use digital platform?

15. a) Do you believe that access to /technology affects smallholder famers differently (e.g. creates disparities)?

b) What type of data does the platform collect from you during the registration process?

c) Do the platform give you reason(s) why they collect your data and what it is used for?

d) Do you have concerns about the data of you and your farm being used by others?

16. What are some of the suggestions or improvements that you think could enhance the use of the platform?

Appendix 2

Questionnaire for Banks

1.What is your age?

A) 18-28 B) 29-39 C) 40-59 D) Above 60

2.What is your gender?

A) Female B) Male C) Others

3. Which sector do you work within the bank?

4. a) Does your bank deal with agricultural activities and smallholder farmers?

b) If yes, what services do you offer to the smallholder farmers?

A) Financial services B) Information Access. C) Market linkage D) Weather Forecasting

E) Agricultural inputs F) All of the above

c) If the answer to 4b includes other services other than the financial services, then why is your bank interested in offering non-financial services to the smallholder farmers?

5. In your opinion, what role does financialization play in shaping agricultural financing strategies today?

6. a) Does your bank work in collaboration with any telecommunication company such as Safaricom?

b) If yes, why do you work in collaboration with the telecommunication company?

c) Do you share data with each other for seamless transactions and effectiveness?

d) If yes, is the data sharing monetized?

7. a) How has the adoption of digital platforms influenced banking operations related to agricultural financing within your institution?

b) What challenges or opportunities have emerged from incorporating digitized process into agri-financing process?

8. What protocols does your bank follow to ensure data privacy and security concerns when handling financial transactions related to digitized agricultural activities?

9. How has the rise of digital agriculture and financial technologies impacted the relationship between banks and smallholder farmers in terms of accessing financing options?

Appendix 3

Questionnaire for the Digital Platform

1. What is your occupation?

2. How many years of experience do you have with the digital agriculture platforms?

3. a) What services do you offer to the smallholder farmers?

A) Financial services B) Information Access. C) Market linkage D) Weather Forecasting

E) Agricultural inputs F) All of the above

b) Which of these service(s) are most important?

4. a) How would you describe the impact of the digital platform on smallholder farmers' access to resources and information?

b) In what ways do you think digital platforms have transformed traditional farming practices?

5. a) Which specific services or tools provided by digital platforms have been most beneficial for smallholder farmers according to your observations?

b) Have there been any challenges faced by farmers when utilizing these platform services? If so, please elaborate.

6. How many of the subscribed farmers/smallholders are actively using the platform?

7. a) Does your platform work in collaboration with any telecommunication company such as Safaricom?

b) If yes, why do you work in collaboration with the telecommunication company?

8.a) Do you share data with each other for seamless transactions and effectiveness for smallholder farmers?

b) If yes, is the data sharing monetized?

c) What measures do you think are necessary to ensure data security and privacy for farmers engaged with these digitized agricultural solutions?

9. a) How many field agents does your firm/platform have?

b) How has the number of field agents changed in the last 4 years?

c) How important is it to have field agents next to the digital interface/ app?

10. How useful is personal or farm data of smallholders, for financial firms or other businesses?

11. a) Which measures are needed for a digital platform to become financially sustainable (without donor money)?

b) What extent (if at all) is integration of several services needed for that?

12. a) How important is inclusion of financial tools (e.g. money transfer, loans) for the functioning of digital platforms? Please given an example of the importance of the combination of farming and financial services within your platform.

b) How attractive is it for financial firms to work with agricultural platforms? What are the benefits form them?

13. How has the adoption of digitized farming practices through these platforms contributed to improving productivity or livelihoods among smallholder farmers?

14. What areas do you believe could be enhanced or innovated upon by the digital platforms to better support farmer needs in the future?

15. Any additional comments or suggestions for enhancing the effectiveness of digital platform services that were not covered in this interview?

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