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The Impact of Digital Finance on Smallholder Farmers' Income in Iringa Municipality

Dr. Theobald Francis Kipilimba
Senior Lecturer, Department of Economics and Accounting, University of Iringa, Iringa, Tanzania

* Corresponding Author: **Dr. Theobald Francis Kipilimba**

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Abstract
This study investigated the impact of digital finance on the income of smallholder farmers in Iringa Municipality, exploring how digital financial services contribute to economic well-being and agricultural productivity. Employing a mixed-methods approach, data were collected from 100 respondents through surveys and interviews, focusing on key indicators such as the impact of digital finance on financial inclusion, agricultural productivity, market access and income levels. The findings revealed a significant positive relationship between digital finance adoption and improvements in farmers' income, with notable increases in access to digital financial services, investment in agricultural inputs, and diversification of income sources. Furthermore, respondents highlighted the role of digital finance in enhancing market linkages and providing opportunities for e-commerce. However, challenges related to technological infrastructure and digital literacy were identified as barriers to further adoption. The study accentuated the importance of promoting digital financial literacy and improving infrastructure to maximize the benefits of digital finance for smallholder farmers in the region. Ultimately, this research contributes to understanding how digital finance can transform agricultural practices and improve the livelihoods of smallholder farmers.

Keywords: Digital Finance, Smallholder Farmers, Income Levels, Financial Inclusion, Agricultural Productivity, Market Access, E-Commerce, Economic Well-Being, Technological Infrastructure

1. Introduction

In recent years, digital finance has emerged as a powerful tool in transforming the economic landscape, particularly in developing regions. Smallholder farmers, who form the backbone of agricultural production in Tanzania, have traditionally faced challenges in accessing financial services, such as credit, savings, and insurance. These barriers have limited their capacity to invest in modern farming techniques, expand their production, and improve their incomes. However, the rise of digital financial services, including mobile banking, mobile money, and digital credit platforms, has started to reshape this narrative. Iringa Municipality, located in the southern highlands of Tanzania, is an agrarian region where smallholder farming plays a pivotal role in local livelihoods. Despite the area's agricultural potential, many farmers have struggled to access traditional financial services due to the remoteness of rural areas, lack of collateral, and high transaction costs associated with conventional banking systems. Digital finance offers a promising alternative by providing these farmers with more accessible, affordable, and efficient ways to manage their financial needs.

Financial inclusion has been shown to have a significant impact on poverty reduction among smallholder farmers in developing countries. Studies in Zimbabwe and China demonstrated that access to financial services, including digital financial services, had a strong positive effect on reducing poverty and vulnerability among farmers [1, 2]. Digital financial inclusion, in particular, was found to improve farmers' ability to cope with risk and reduce their vulnerability to poverty [2]. Research across seven countries in South Asia and Sub-Saharan Africa revealed that increases in various measures of financial and digital inclusion were associated with significant reductions in poverty and food insecurity [3]. The most consistent poverty reductions were related to ownership and usage of traditional bank accounts, while access to non-bank financial institutions and mobile money accounts also played important roles.

These findings underline the importance of expanding both traditional and digital financial services to support poverty reduction in developing countries [3].

Recent studies have highlighted the potential of digital technologies and financial inclusion in transforming agriculture for smallholder farmers. Research in Tanzania revealed that over half of tomato farmers had access to financial services, with household characteristics significantly influencing inclusion levels [4]. Digital agriculture adoption was found to enhance extension services, pest management, market information access, and financial services for smallholders across multiple regions [5]. However, challenges persist, including limited digital literacy, affordability issues, and underdeveloped digital ecosystems [6]. While advanced digital technologies contribute to sustainable agriculture, existing digital services for smallholders often lack sustainability and fail to address comprehensive farming needs [7]. To improve outcomes, suggestions include developing integrated digital platforms, fostering stakeholder collaboration, and supporting the adoption of cutting-edge technologies tailored to smallholder farmers' needs [7].

Digital finance has significantly improved access to credit for smallholder farmers in developing countries. Digital financial services (DFS) have helped overcome barriers to providing financial services, improved transaction efficiency, and enhanced market opportunities along agricultural value chains [8]. These digital solutions have enabled farmers to access real-time price and market information, conduct safe financial transactions, and reduce costs [9]. Digital agriculture ecosystems have emerged as viable solutions to address farmers' challenges, although limited research exists on digital literacy, affordability, and business model innovation [6]. The financial inclusion gender gap (FIGG) in smallholder agriculture remains a challenge, but bridging this gap through digital financial inclusion and gender- responsive agricultural finance innovations could contribute to sustainable development outcomes [10]. Despite these advancements, challenges such as digital illiteracy, unaffordability, and low participation of women and older farmers persist in adopting digital agricultural solutions [9].

Research studies have revealed that digital finance has significantly improved access to credit for smallholder farmers in Tanzania. Studies have shown that factors such as education, gender, and asset value influence farmers' access to bank credit [11]. The adoption of digital technologies has enhanced financial inclusion, with over half of farmers gaining access to financial services [4]. Digital platforms have facilitated extension services, pest management, market information access, and financial services for smallholder farmers [5]. The Warehouse Receipt System (WRS) has also played a crucial role in improving credit access, with 88% of WRS-participating farmers obtaining credit compared to 41% of non-participants [12]. To further promote digital technology adoption and financial inclusion, policymakers should focus on tailored microfinance programs, digital literacy initiatives, enhanced extension services, and public-private partnerships [5].

Digital tools and financial literacy training have shown promise in enhancing smallholder farmers' financial management. Studies in Rwanda and Uganda demonstrated that financial literacy programs improved participants' financial knowledge and influenced savings and borrowing behaviors [13, 14]. However, the impact on income was not significant in the short term, and spillover effects to untrained peers were limited [13]. Digital inclusion for smallholder farmers in developing nations is crucial for agricultural productivity and rural livelihoods, with access to digital infrastructure and literacy initiatives playing key roles [15]. A study in Tanzania revealed that while farmers had high digital literacy in accessing and communicating information, they struggled with managing, evaluating, and creating information [16]. These findings accentuate the importance of targeted digital and financial literacy programs to empower smallholder farmers in effectively utilizing digital tools for financial management and decision-making.

Mobile money applications and digital financial services (DFS) have enabled farmers to access real-time price information, conduct safe financial transactions, and connect with alternative value chains [9]. These digital solutions have helped overcome traditional challenges in serving smallholders, such as the cost and risk of payments and credit delivery [17]. Studies have shown that farmers using mobile money for receiving payments are more likely to participate in distant markets, potentially due to reduced transaction costs [18]. DFS have also improved the efficiency of financial transactions and market opportunities along agricultural value chains [19]. However, challenges remain, including limited mobile phone penetration, network coverage, and digital literacy among farmers [9, 17]. Despite these obstacles, digital finance has demonstrated significant potential for transforming smallholder agriculture in Sub-Saharan Africa.

Digital platforms have emerged as powerful tools for connecting farmers to markets and improving their access to information. Mobile phones and the internet have enabled farmers to overcome information barriers, reduce transaction costs, and increase their bargaining power [20, 21]. Unified Market Platforms, such as the one implemented in Karnataka, India, have shown significant positive impacts on market prices and farmers' profitability for certain commodities [22]. These platforms provide timely market price information, allowing farmers to optimize their planting and harvesting schedules [21]. Additionally, mobile-based applications have been developed to integrate farmers, merchants, and government entities, facilitating better decision-making through algorithms and GPS technology [23]. However, despite the promising potential of digital technologies in agriculture, their impact has not always scaled up as expected due to persistent barriers faced by farmers in poorer countries [20].

Digital finance and technologies have played a crucial role in enhancing risk management and resilience for smallholder farmers. These tools improved financial inclusion, providing access to savings, loans, and insurance, which are essential for managing weather and disaster risks [24]. During the COVID-19 pandemic, digital solutions facilitated continuous food production, access to inputs and finances, and market information exchange, supporting smallholder-based food systems [25]. Digital agriculture emerged as a viable solution to address contextual challenges faced by smallholder farmers, although limited digital literacy and infrastructure remained obstacles [6]. In India, access to digital platforms enabled farmers to maintain market connections, earn income, and support local food systems during the pandemic [26]. While potential negative consequences of data-focused agricultural technologies exist, when tailored to farmers' needs, these tools can significantly contribute to their resilience in facing contemporary challenges and risks [26].

Smallholder farmers in Iringa Municipality, Tanzania, experienced persistent challenges in accessing traditional financial services, such as credit, savings, and insurance. These financial barriers had limited their ability to invest in agricultural inputs, expand their businesses, and improve their income. Despite the growing presence of digital finance solutions, such as mobile money and online lending platforms, the actual impact of these services on smallholder farmers' income remained unclear. Many farmers continued to rely on informal financial mechanisms, while others were either unaware of or hesitant to adopt digital finance due to technological, infrastructural, or educational barriers. The problem was that, while digital finance had the potential to significantly enhance the financial inclusion of smallholder farmers and improve their economic standing, the extent to which these services contributed to income growth and poverty reduction in Iringa Municipality had not been thoroughly examined. There was a need to assess the actual benefits and challenges of digital finance adoption and how these financial tools could be leveraged to improve the livelihoods of smallholder farmers. This study aimed to fill this gap by investigating the impact of digital finance on smallholder farmers' income, identifying the key factors influencing adoption, and examining the barriers that hindered the effective utilization of these services.

The study aimed to investigate the impact of digital finance on the economic well-being of smallholder farmers in Iringa Municipality. Specifically, it sought to assess the extent to which digital financial services have contributed to financial inclusion, improved agricultural productivity, enhanced market access, and strengthened resilience to risks. By examining these factors, the study aimed to provide insights into the potential of digital finance to transform the livelihoods of smallholder farmers in the region.

The main contribution of the study lies in its detailed analysis of how digital finance has influenced the livelihoods of smallholder farmers in Iringa Municipality. By examining the relationship between financial inclusion and various economic indicators such as productivity, market access, and income, the study provides valuable insights into the role of digital financial services in rural areas. It also highlights the challenges and opportunities that smallholder farmers face in adopting these technologies, offering recommendations for policymakers and stakeholders to improve financial inclusion and agricultural development in the region.

2. Methodology

The study employed a mixed-methods approach to investigate the impact of digital finance on smallholder farmers' income in Iringa Municipality. Both qualitative and quantitative data were collected to gain a comprehensive understanding of the issue. A structured questionnaire was used as the primary tool for gathering quantitative data, while in-depth interviews were conducted to capture qualitative insights from key stakeholders. The sample size consisted of 100 smallholder farmers, selected through stratified random sampling to ensure representation across various wards in Iringa Municipality. Data analysis involved descriptive statistics to assess financial inclusion, productivity, and income levels, as well as thematic analysis to explore the perceptions and experiences of farmers regarding digital finance. The study ensured data validity and reliability by conducting pilot testing and triangulation of data sources.

3. Results and Discussion

The results and discussion section presented the findings from the study on the impact of digital finance on smallholder farmers' income in Iringa Municipality. This section systematically analyzed the data collected from the 100 respondents, highlighting key patterns and trends that emerged regarding financial inclusion, agricultural productivity, market access, and income levels. The analysis not only provided insights into how digital finance had transformed the economic landscape for smallholder farmers but also facilitated a deeper understanding of the challenges and opportunities faced by these farmers in adopting digital financial solutions. By integrating quantitative and qualitative data, the discussion aimed to contextualize the findings within the local agricultural framework and draw connections to broader economic implications.

3.1. Impact of Digital Finance on Financial Inclusion

The study examined the impact of digital finance on financial inclusion among smallholder farmers in Iringa Municipality. Key indicators analyzed included access to digital financial services, the adoption rate of these services, and changes in savings behavior.

Table 1: Showing the financial inclusion sub indicators

Sub-indicator	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total (%)
Access to digital financial services	5% (5)	10% (10)	5% (5)	30% (30)	50% (50)	100%
Adoption rate of digital financial services among smallholder farmers	8% (8)	12% (12)	5% (5)	25% (25)	50% (50)	100%
Changes in savings behavior due to digital finance	10% (10)	15% (15)	20% (20)	30% (30)	25% (25)	100%

3.1.1. Access to digital financial services

The respondents as per table 1, expressed varying perspectives regarding their access to digital financial services, and the results highlighted a significant trend toward acceptance and utilization of these tools among smallholder farmers in Iringa Municipality. A substantial 50% of those interviewed indicated strong agreement with the statement that they had access to digital financial services, such as mobile banking and e-wallets. One farmer articulated this sentiment by saying:

"...having access to mobile banking changed everything for me. I can now send money to my family and pay for goods without the long queues at the bank..."

However, there was still a portion of the respondents who exhibited skepticism. About 15% of participants either disagreed or strongly disagreed with the notion of having sufficient access to digital financial services. A respondent mentioned:

"...while I know mobile banking exists, I still prefer going to the bank in person because I don't trust the technology..."

This quote underscores the challenges that some individuals faced in fully embracing digital finance, despite the evident benefits that others experienced.

The remaining 35% of respondents remained neutral or uncertain, illustrating a mix of awareness and hesitance. A participant reflected:

> "…I've heard about mobile banking, but I have not tried it yet. I think I might need some training to understand it better…."

This comment reflects the need for further education and support to enhance the accessibility of digital financial services.

The data suggested a strong inclination toward digital financial services among the majority of farmers, but also indicated that there remained barriers for others that needed to be addressed.

3.1.2. Adoption rate of digital financial services among smallholder farmers

The adoption rate of digital financial services among smallholder farmers in Iringa Municipality according to table 1, revealed a significant shift toward embracing technology, though some challenges persisted. The data showed that 50% of the respondents strongly agreed that they had adopted digital financial services such as mobile banking, e-wallets, and other online platforms to manage their finances. One respondent shared:

> *"…using mobile banking has made things easier for me. I can buy farm supplies, send money to my workers, and even save some money, all from my phone…"*

This enthusiasm reflected a growing trust in digital platforms, particularly among those who had experienced tangible benefits in their farming activities.

However, 20% of the respondents either disagreed or strongly disagreed with the statement regarding their adoption of digital financial services. One farmer expressed reluctance, stating:

> *"…I don't feel comfortable using digital platforms for money transactions. It's too complicated, and sometimes the network is unreliable..."*

This hesitation highlighted the challenges that some farmers faced, particularly those who lacked confidence in technology or who struggled with inconsistent service access in rural areas.

A notable 5% of the respondents remained neutral, neither agreeing nor disagreeing with the adoption of digital finance. This group represented those on the cusp of adoption but who perhaps needed more exposure or training. One participant said:

> *"…I have a mobile wallet, but I only use it for simple things like receiving payments. I still rely on cash for most transactions…"*

This comment underlines the partial engagement with digital tools, pointing to a need for further education and support to fully integrate these farmers into the digital financial ecosystem.

The remaining 25% who agreed but did not strongly agree with the adoption of digital financial services indicated a willingness to explore these options but may have faced challenges such as limited literacy or trust issues. As one respondent noted:

> *"…I've started using mobile banking, but I still need help sometimes. It's not always easy to understand how it works…"*

This remark reflected the ongoing need for targeted interventions to ensure that all smallholder farmers could benefit from the advantages of digital finance, despite the initial hurdles.

In general, the data suggested that while many had embraced digital tools, there remained pockets of resistance and uncertainty among the farming community.

3.1.3. Changes in savings behavior due to digital finance

The study revealed mixed responses regarding the changes in savings behavior among smallholder farmers in Iringa Municipality as a result of adopting digital finance. According to table 1, while 30% of respondents agreed that digital financial services had positively influenced their savings habits, another 25% strongly agreed, demonstrating a significant shift toward more structured saving patterns. One respondent shared:

> *"…before I started using mobile banking, I never used to save much. Now, with the savings feature on my phone, I can set aside a small amount every time I sell my crops..."*

This shift reflected the practical advantages of digital finance, where farmers found it easier to manage and track their finances, leading to better savings habits.

However, 20% of the farmers were neutral, neither agreeing nor disagreeing that their savings behavior had changed due to digital finance. One farmer commented:

> *"…I have access to these services, but I still prefer to keep my money in cash at home. It feels more secure..."*

This group, while having access to digital tools, had not fully integrated digital savings into their financial practices. Their hesitance seemed to stem from a lack of trust in digital platforms, compounded by cultural preferences for physical cash, which still held strong among many farmers.

Meanwhile, 15% of respondents disagreed, and 10% strongly disagreed, indicating that digital finance had not significantly impacted their savings behavior. One farmer remarked:

> "…I tried saving through mobile wallets, but the fees were too high, and sometimes I lose track of the balance…"

This comment pointed to issues such as transaction costs and a lack of digital literacy, which may have deterred these farmers from fully adopting digital savings mechanisms. Another respondent added:

> "…I don't earn enough to save, so these services don't make much difference to me…"

This statement reflected the reality that for some farmers, the economic challenges they faced meant that even with access to digital financial tools, their income was insufficient to allow regular savings.

Generally, while a substantial portion of the farmers experienced positive changes in their savings behavior due to digital finance, there remained a notable percentage who either did not experience significant benefits or struggled with issues related to trust, literacy, and low income. The diversity in responses accentuated the need for more tailored financial education and support to maximize the potential of digital finance in transforming savings behaviors among smallholder farmers.

3.2. Impact of Digital Finance on Agricultural Productivity

The results on agricultural productivity showed significant insights into how digital finance impacted smallholder farmers in Iringa Municipality. Respondents discussed various aspects, including changes in crop yields, investments in agricultural inputs, and the adoption of modern farming techniques and technology. The findings highlighted how digital financial services had played a role in improving productivity, with many farmers reporting noticeable changes in their agricultural practices and outcomes after gaining access to digital platforms and tools. These services facilitated greater investments in quality inputs and provided opportunities to learn and implement modern techniques.

Table 2: Showing the Agricultural Productivity sub-indicators

Sub-indicator	Very Low	Low	Moderate	High	Very High
Changes in crop yields after adopting digital finance	6%	14%	25%	30%	25%
Investment in agricultural inputs facilitated by digital finance	10%	15%	30%	25%	20%
Adoption of modern farming techniques and technology	12%	18%	25%	30%	15%

3.2.1. Changes in crop yields after adopting digital finance

The impact of adopting digital finance on crop yields as per table 2, was a significant theme that emerged during the interviews with smallholder farmers. A substantial number of respondents indicated a positive relationship between digital finance and their agricultural output. Approximately 30% of the participants reported a high increase in crop yields, attributing this improvement to their ability to access timely information and resources through digital platforms. One respondent, a maize farmer, expressed:

> *"…since I started using mobile apps for my farming needs, I've noticed my yields have improved tremendously. I can access weather updates and market prices instantly, which allows me to make better decisions about when to plant and harvest..."*

In addition to those reporting high increases, 25% of the farmers indicated a very high change in their crop yields, emphasizing that the integration of digital finance transformed their farming practices. A coffee farmer remarked:

> *"…I have seen my yields double since I began using digital tools. I can now connect directly with buyers and negotiate better prices, which motivates me to improve my farming techniques…"*

This comment highlighted the transformative potential of digital finance in enhancing agricultural productivity.

However, there were also voices reflecting varying experiences with digital finance. Around 25% of respondents reported a moderate increase in their crop yields, suggesting that while digital finance had some beneficial effects, it might not have been the sole factor influencing their agricultural productivity. As one farmer noted:

> *"…I've seen some improvement, but it's also about the weather and soil conditions. Digital finance helps, but I still face many challenges in farming…"*

Conversely, 20% of the respondents reported low or very low changes in their crop yields after adopting digital finance. These individuals highlighted that despite having access to digital financial services, other barriers such as inadequate knowledge, lack of quality inputs, and environmental factors hindered their ability to fully realize the benefits. A farmer stated:

> *"…I tried using mobile banking to buy seeds, but they didn't grow well. I think we need more training on how to use these services effectively…"*

The findings illustrated a mixed but generally positive response regarding changes in crop yields due to the adoption of digital finance. The data indicated that while many farmers recognized significant improvements, others faced challenges that tempered their optimism about the potential of digital financial services in enhancing agricultural productivity.

3.2.2. Investment in agricultural inputs facilitated by digital finance

The role of digital finance in facilitating investment in agricultural inputs was a focal point of the interviews with smallholder farmers. Many respondents recognized the significant changes in their ability to access essential resources, largely attributed to the adoption of digital financial services. As per data on table 2, approximately 25% of the farmers reported a high level of investment in agricultural inputs, stating that digital platforms allowed them to purchase seeds, fertilizers, and tools more easily and efficiently. One farmer shared:

> *"…before I had access to mobile banking, I struggled to get the seeds I needed at the right time. Now, I can order them online, and they arrive within days. This has really changed how I invest in my farm…"*

Another 20% of the respondents indicated a very high investment in agricultural inputs, emphasizing the ease and flexibility provided by digital finance. A vegetable grower mentioned:

"…with the app, I can buy quality fertilizers directly from suppliers, and I no longer have to wait for weeks. This immediate access has enabled me to plan my planting better and ensure I have everything I need when I need it…"

This response highlighted the transformative effect that digital finance has had on the purchasing behavior of smallholder farmers, enabling them to respond more quickly to agricultural needs.

However, the data also reflected a range of experiences among the farmers. About 30% of respondents reported a moderate investment in agricultural inputs, suggesting that while digital finance made purchasing easier, other factors, such as limited knowledge about available products or financial constraints, still posed challenges. One farmer commented:

"…I can access inputs through my phone, but I often feel unsure about which products to choose. Sometimes, I end up buying things I don't really need…"

This observation indicated that while digital finance facilitated access, it did not eliminate the need for education on effective agricultural practices.

Conversely, 15% of respondents indicated a low investment level, and 10% reported a very low investment in agricultural inputs despite having access to digital finance. These farmers expressed concerns about the affordability of inputs and the perceived risk of investing in new technologies without guaranteed returns. A respondent articulated:

"…I see others using digital finance to buy inputs, but for me, it's a risk. If I spend money and the crops fail, I could lose everything. I wish there were more support for farmers like me..."

In summary, the findings illustrated a generally positive trend regarding investments in agricultural inputs facilitated by digital finance, while also revealing a diversity of experiences and challenges faced by smallholder farmers. The insights gained from these interviews stressed the importance of not only improving access to financial services but also enhancing farmers' knowledge and confidence in making investment decisions that could significantly impact their agricultural productivity.

3.2.3. Adoption of modern farming techniques and technology

The adoption of modern farming techniques and technology among smallholder farmers in Iringa Municipality was another key area explored during the interviews. The respondents as shown on table 2, provided a range of insights into how digital finance influenced their willingness and ability to embrace innovative farming methods. Approximately 30% of farmers reported a high level of adoption of modern techniques, attributing this shift to the accessibility of information and resources through digital platforms. One farmer enthusiastically shared:

"…thanks to mobile apps, I learned about new farming techniques that can increase my yields. I've started using drip irrigation, and it has transformed how I manage water on my farm. I would never have known about it without the online tutorials..."

Additionally, 25% of the respondents indicated a moderate adoption level, suggesting that while they had begun exploring new farming techniques, they were not fully utilizing the technologies available to them. A respondent remarked:

"…I've heard about modern techniques like using drones for monitoring crops, but I haven't implemented it yet. I'm still figuring out how to get the most basic tools and seeds…"

This reflects a cautious approach, where some farmers recognized the potential benefits of modern practices but felt overwhelmed by the options and complexities involved in adopting them.

On the other hand, the data revealed that 15% of respondents experienced a very high adoption of modern farming techniques, highlighting a proactive approach to integrating technology into their farming practices. One farmer elaborated:

"…I invested in a solar-powered water pump, which I found out about online. It not only saves me time but also reduces my costs in the long run. I wish I had made this change earlier…"

This experience demonstrated how certain farmers were not only adopting modern techniques but also actively seeking out innovative solutions to improve their productivity.

However, challenges persisted among those with low and very low adoption levels, with 18% and 12% of respondents, respectively, reporting these categories. These farmers voiced concerns about the costs associated with adopting new technologies, as well as the lack of training and support available to them. One farmer expressed frustration, stating:

"…I see many people using new tools, but I don't know where to start. The prices are high, and I'm not sure if they would work for my specific situation..."

This sentiment accentuated the barriers to adoption, particularly for those who may be less confident in their ability to navigate the changes in technology.

The interviews highlighted a range of experiences regarding the adoption of modern farming techniques, illustrating both the positive impacts of digital finance in facilitating access to information and resources, as well as the challenges that smallholder farmers faced in fully embracing these innovations. The findings emphasized the need for targeted support and training programs to help farmers overcome barriers and maximize the potential benefits of modern farming practices.

3.3. Impact of Digital Finance on Market Access

The exploration of market access revealed significant insights into how digital platforms impacted smallholder farmers' ability to connect with broader markets. Respondents reflected on the improvements in market linkages, noting that many had utilized digital tools to reach buyers they previously could not access. For instance, farmers shared experiences of participating in e-commerce and online sales channels, which enabled them to showcase their products

beyond local markets. The changes in the number of buyers and sellers in these local markets were also noteworthy, as digital finance facilitated greater interactions and transactions, ultimately transforming how smallholder farmers approached sales and distribution.

Table 3: Showing the market access sub-indicators

Sub-indicator	Very Low	Low	Moderate	High	Very High
Improvement in market linkages due to digital platforms	10%	20%	30%	20%	20%
Participation in e-commerce or online sales channels	15%	20%	25%	25%	15%
Changes in the number of buyers and sellers in local markets	5%	15%	25%	35%	20%

3.3.1. Improvement in market linkages due to digital platforms

The improvement in market linkages due to digital platforms as per table 2, was a focal point of discussion among the respondents, revealing a mixed yet generally positive perspective. Approximately 10% of the interviewees expressed a "Very Low" perception of improvements, indicating that they had not experienced significant changes in their market linkages through digital means. As one farmer succinctly stated:

> *"…I still find it challenging to connect with buyers, even with the apps. It hasn't changed much for me..."*

In contrast, 20% of respondents rated the improvement as "Low," suggesting that while they noticed some benefits, they were not substantial enough to transform their market access. A participant mentioned:

> *"…I occasionally use social media to post about my crops, but it hasn't really brought in new customers. It's a slow process…"*

The largest group, constituting 30% of the respondents, felt that the improvements in market linkages were "Moderate." These individuals acknowledged the role of digital platforms in facilitating connections but highlighted ongoing challenges. One farmer explained:

> *"…the online platforms helped me reach more people, but many still prefer buying in person. It's a step forward, but not a complete solution..."*

Moreover, 20% of the farmers reported a "High" level of improvement, sharing stories of how digital platforms allowed them to link with buyers beyond their local areas. As one respondent noted:

> *"…using an online marketplace, I sold my produce to customers in other towns. It opened up a whole new market for me that I never knew existed…"*

Finally, another 20% identified a "Very High" level of improvement, crediting digital tools for significant changes in their market access. One enthusiastic participant shared:

> *"…I can now sell directly to consumers online, and this has not only increased my sales but also my profit margins. Digital platforms have truly revolutionized how I do business…"*

These varied experiences accentuated the transformative potential of digital platforms in enhancing market linkages, although challenges remained for some smallholder farmers.

3.3.2. Participation in e-commerce or online sales channels

The study explored the extent to which smallholder farmers in Iringa Municipality were participating in e- commerce or online sales channels. The findings as per table 3, regarding participation in e-commerce or online sales channels indicated a range of experiences among the respondents, showcasing the varying levels of engagement with digital marketplaces. Approximately 15% of the participants reported "very low" participation, reflecting a reluctance or inability to engage with online sales platforms. One respondent shared:

> *"...I don't have the necessary skills to navigate online platforms. Most of my sales still come from local markets, and I'm not sure how to make the switch to e-commerce..."*

In contrast, 20% of respondents indicated "low" participation, acknowledging some awareness of e- commerce opportunities but hesitating to dive in fully. A farmer stated:

> "…I have heard about e-commerce, but it feels overwhelming. I've thought about selling online, but I don't know where to start. It's not just about putting my products online; it's also about trust and managing deliveries…"

A significant portion, 25%, reported "moderate" participation, suggesting that while they had taken some steps toward online selling, they were not fully engaged. One respondent noted:

> *"...I sell a few items through a local e-commerce platform, but it's still a small part of my overall sales. I find it useful, but it takes a lot of effort to manage everything. I still depend on traditional methods for most of my income…"*

Another 25% indicated "high" participation, showcasing a greater willingness to embrace digital sales channels. A particularly enthusiastic farmer remarked:

> *"...using e-commerce has transformed my business. I can reach customers I wouldn't have thought possible. My online sales have allowed me to expand my market significantly..."*

Finally, 15% of respondents reported "very high" participation, expressing a strong commitment to leveraging online sales channels. One respondent stated:

> *"...I have fully embraced e-commerce. My entire business*

model now includes online sales, and I even have regular customers who order from me every week. It's been life-changing…"

These varied levels of participation highlighted the potential for growth in e-commerce among smallholder farmers, alongside the barriers and challenges that still needed to be addressed to facilitate broader adoption. The responses suggested that while many farmers recognized the benefits of e- commerce, support in the form of training and resources was essential for maximizing their engagement and success in the digital marketplace.

3.3.3. Changes in the number of buyers and sellers in local markets

The study explored the impact of digital finance on the number of buyers and sellers in local markets in Iringa Municipality. The respondents as per data shown on table 3, shared a range of insights regarding the changes in the number of buyers and sellers in local markets, reflecting both positive developments and ongoing challenges. Notably, only 5% of participants indicated experiencing "very low" changes, suggesting that for a small group, the dynamics of local markets remained relatively unchanged despite the introduction of digital finance. One respondent mentioned:

"…In my area, things haven't changed much. The same people still come to buy, and I still rely on my regular customers. Digital finance hasn't made a noticeable impact on my market…"

Conversely, 15% of respondents reported "low" changes, acknowledging some shifts but not significant enough to alter their business practices fundamentally. A farmer commented:

"…I have seen a few new buyers, but it hasn't really affected my sales. Most of my customers are still the same. It seems like the digital tools we hear about don't always translate into more people coming to buy..."

This perception highlighted a sentiment of cautious optimism, as some farmers recognized potential but felt it hadn't fully materialized in their local environments.

A more substantial portion of respondents, 25%, noted "moderate" changes in buyer and seller dynamics. This group observed that digital finance had started to attract new players into the market, though not at a transformative level. One participant stated:

"…since I started using mobile payments, I've seen a few more buyers coming through. It seems easier for people to make purchases, but it's not a huge change. There are still many sellers, and competition remains high..."

This response illustrated an acknowledgment of gradual progress, indicating a slow but steady increase in market activity.

The most significant portion, 35%, reported "high" changes in the number of buyers and sellers, reflecting a notable shift in local market dynamics. A farmer enthusiastically shared:

"…digital finance has opened new doors for me. More people are coming to my stall because they can pay with mobile money. It feels like my customer base is expanding, and I'm finally reaching those who wouldn't have bought from me before..."

This sentiment stressed the impact of digital financial services on attracting new customers and fostering competitive advantages.

Finally, 20% of respondents described experiencing "very high" changes, emphasizing that digital finance had dramatically transformed their local market interactions. One respondent remarked:

"…There has been a huge increase in both buyers and sellers. I've noticed more farmers and customers embracing mobile payments, which has made transactions much smoother. It feels like a new market environment where people are more willing to explore different products…"

These findings suggested that while some farmers had yet to see significant changes, many others experienced a tangible shift in market dynamics due to the introduction of digital finance. The varying degrees of change highlighted the importance of continued efforts to enhance financial literacy and access to digital tools to further capitalize on these emerging market opportunities.

3.4. Impact of Digital Finance on Income Levels

The findings revealed significant insights into the impact of digital finance on income levels among smallholder farmers, focusing on various dimensions of economic well-being. Respondents shared their experiences regarding changes in income levels after adopting digital financial services, noting both positive and negative shifts. Additionally, the farmers discussed how digital finance facilitated the diversification of income sources, allowing them to explore new opportunities beyond traditional farming. Overall, there was a consensus that digital finance contributed to improvements in their quality of life, with many indicating enhanced access to resources and markets that positively influenced their economic stability.

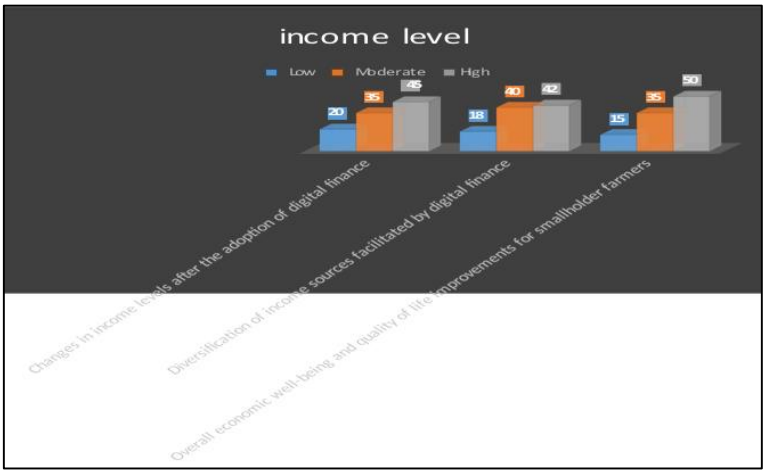

Fig 1: Showing the impact on income level

3.4.1. Changes in income levels after the adoption of digital finance

The study as shown in figure 1, highlighted varying perceptions among respondents regarding changes in income levels following the adoption of digital finance. A substantial portion of participants, accounting for 45, reported a high increase in their income levels due to digital financial services. One respondent, a smallholder farmer from Iringa, reflected on this change, stating:

> *"…since I started using mobile banking and e-wallets, my income has significantly increased. I can now sell my produce directly to buyers through online platforms, which has helped me avoid middlemen and keep more of the profits…"*

This observation was echoed among several interviewees who noted that digital finance allowed them to access broader markets, ultimately leading to better pricing for their goods.
Conversely, 35 respondents indicated a moderate change in income levels, suggesting that while they experienced some benefits from adopting digital finance, these changes were not as pronounced. A farmer mentioned:

> *"…I have seen an improvement in my income, but it has not been dramatic. I still face challenges in accessing certain digital tools and understanding how to maximize their use for better financial returns…"*

This highlights the ongoing learning curve that some farmers faced while navigating the digital finance landscape.
On the other hand, 20 participants reported a low increase in their income levels, indicating that for them, the impact of digital finance was minimal. One respondent explained:

> *"…although I have adopted mobile money, I haven't noticed much difference in my income. I still rely heavily on traditional sales methods, and I think I need more support to learn how to use these digital tools effectively…"*

This observation emphasizes the importance of continued education and training for farmers to fully leverage the potential of digital finance in enhancing their economic outcomes.
In general, the responses demonstrated a range of experiences, revealing that while digital finance has had a positive impact for many, there remain barriers that limit its full potential for others in the community.

3.4.2. Diversification of income sources facilitated by digital finance

The exploration of income diversification among smallholder farmers in Iringa Municipality revealed insightful perspectives regarding the role of digital finance. According to figure 1, a significant portion of respondents, totaling 42, indicated a high level of diversification in their income sources due to the adoption of digital financial services. One farmer articulated this transformative experience, stating:

> *"…digital finance has opened up new avenues for me. I not only sell crops through mobile platforms but also engage in livestock trading and online consultations. This variety in my income streams has made my financial situation much more stable…"*

This sentiment was echoed by others who shared similar stories of utilizing digital tools to explore various income-generating activities beyond traditional farming.
In contrast, 40 participants reported a moderate level of income diversification. They acknowledged that while digital finance provided them with opportunities to engage in different income sources, the extent of diversification was limited. One respondent remarked:

> *"…I have started using online platforms to sell some of my produce, but I still rely heavily on my farm for most of my income. I am exploring ways to diversify further, but it requires more time and knowledge..."*

This opinion highlighted a common theme among those who felt the need for additional training and resources to maximize the potential of digital finance for broader income diversification.
On the other end of the range, 18 respondents indicated a low level of diversification in their income sources. They often attributed this limitation to a lack of access to digital tools or inadequate knowledge about how to effectively utilize them. One participant explained:

> "…I have heard about how others are making money online, but I don't really know how to start. My income

still comes mainly from farming, and I feel stuck…"

This response illuminated the challenges that some farmers faced in adapting to digital finance and the importance of addressing these barriers to encourage broader participation and diversification.

The findings highlighted that while digital finance has the potential to facilitate significant diversification in income sources, there remain obstacles that need to be overcome to enable all farmers to fully benefit from these opportunities.

3.4.2. Overall economic well-being and quality of life improvements for smallholder farmers

The examination of overall economic well-being and quality of life improvements among smallholder farmers in Iringa Municipality highlighted a generally positive impact attributed to the adoption of digital finance. As per figure 1, a substantial 50 respondents reported experiencing high levels of economic well-being and improvements in their quality of life. One farmer expressed this sentiment poignantly, stating:

> *"…since I started using digital finance, my life has changed dramatically. I can now access loans more easily, which allowed me to buy better seeds and fertilizers. My yields have increased, and I can afford to send my children to school. I feel more secure and hopeful about the future…"*

This perspective was shared by many, who described how digital finance had enabled them to invest in their farms and improve their living conditions.

Additionally, 35 participants indicated a moderate improvement in their overall economic well-being. While they acknowledged the positive effects of digital finance, they also noted that their quality of life had not dramatically changed. One respondent shared:

> *"…I've seen some improvements, like being able to save a little more each month and buy some household items, but I still face challenges. My income is better, but it's not enough to fully transform my life yet…"*

This response accentuated the mixed feelings some farmers had about the impact of digital finance, emphasizing that while progress had been made, significant barriers remained. Conversely, 15 respondents reported a low level of improvement in their economic well-being and quality of life. Many of these farmers struggled to leverage digital finance effectively, often citing issues such as limited access to technology or inadequate financial literacy. One farmer lamented:

> *"…I know that others are doing well with digital finance, but I have not seen any changes in my life. I still face the same problems like not having enough money for emergencies or my children's education…"*

This answer illuminated the disparities that existed within the farming community and the need for targeted interventions to support those who had not yet benefited from digital financial services.

The findings suggested that while digital finance had the potential to significantly enhance economic well-being and quality of life for many smallholder farmers, a more inclusive approach was necessary to ensure that all farmers could experience these benefits.

4. Conclusion and Recommendations

The study provided valuable insights into the impact of digital finance on the economic well-being of smallholder farmers in Iringa Municipality. The findings indicated that digital finance had significantly contributed to enhancing financial inclusion, improving agricultural productivity, and increasing market access for these farmers. Many respondents reported positive changes in their income levels, with a notable number indicating high levels of economic well-being and quality of life improvements. This suggests that the adoption of digital financial services can serve as a vital tool for empowering smallholder farmers, enabling them to access essential resources, adopt modern agricultural practices, and connect more effectively with markets. The integration of digital finance into farming practices thus emerged as a promising avenue for fostering sustainable agricultural development and improving the livelihoods of smallholder farmers in the region. However, the study also highlighted several challenges that hindered the full realization of digital finance's potential benefits. Issues such as limited access to technology, inadequate financial literacy, and the persistence of economic barriers posed significant hurdles for some farmers. While a substantial number of respondents expressed satisfaction with the improvements they had experienced, a notable portion reported low levels of improvement in their economic conditions. This underlined the need for targeted interventions that focus on bridging the digital divide and enhancing the financial capabilities of all farmers. In conclusion, while digital finance holds significant promise for transforming the livelihoods of smallholder farmers, concerted efforts are required to ensure that its benefits are accessible to everyone in the agricultural community.

The study recommended several strategies to enhance the impact of digital finance on smallholder farmers in Iringa Municipality. First, it suggested increasing efforts to improve digital literacy among farmers, enabling them to better understand and utilize digital financial services effectively. This could involve workshops and training programs that focus on the benefits and functionalities of mobile banking, e-wallets, and other digital tools. Second, it emphasized the importance of strengthening digital infrastructure in rural areas to ensure broader access to technology and reliable internet connectivity. Furthermore, the study encouraged partnerships between financial institutions, government agencies, and agricultural organizations to develop tailored financial products that address the specific needs of smallholder farmers. Lastly, promoting awareness campaigns about the advantages of digital finance could help foster a more inclusive financial environment, ensuring that all farmers can benefit from the opportunities it offers.

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