Transactions on Quantitative Finance and Beyond

www.tqfb.reapress.com

Trans. Quant. Fin. Bey. Vol. 1, No. 1 (2024) 114–131.

Paper Type: Original Article

A Literature Review on the Usage of Mobile Financial Services for Smallholder Farming

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Citation:

Received: 16 June 2024 *Revised: 11 August 2024* *Accepted: 02 September 2024*	Olamide Aliu, I. (2024). A literature review on the usage of mobile financial services for smallholder farming. *Transactions on quantitative finance and beyond, 1* (1), 114-131.

Abstract

Although it is unclear whether these services are reaching their full potential, mobile technology may assist smallholder farmers in receiving better financial services. This article fills the lacuna by providing an exploratory overview of the research on the effects of financial services offered by mobile phones on farmers, with a slight focus on Africa and other developing countries. The review emphasizes how little empirical data there is in this field. Results imply that farmers profited from advances in risk management, input management, post-harvest sales and loan disbursement ease. The evaluation also identifies several methodological flaws, most notably the use of lack of creditworthiness data and the diversion of resources by smallholder farmers.

Keywords: Agriculture, Mobile finance, Smallholder farming.

1 | Introduction

The adoption of Mobile Financial Services (MFS) has been transformative for smallholder farmers in Africa, providing access to financial tools and services that were previously out of reach. Smallholder farmers, who constitute a significant portion of the agricultural workforce in Africa, often face limited access to traditional financial services. The widespread adoption of mobile phones across the continent has paved the way for innovative financial solutions tailored to the needs of this demographic.

The swift development and adoption of digital technologies is called the "Fourth Industrial Revolution" [1], [2], [3]. This revolution is typified by a fusion of technologies which is blurring the lines between the physical, digital, and biological spheres. It is a common belief that the modifications have enormous potential for agriculture in underdeveloped nations [4], [5]. The strategic application of Information and Communication

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Technology (ICT) to the agricultural industry, the largest economic sector in most African countries [6]; it offers the best opportunity for economic growth and poverty alleviation on the continent [7], [8].

The use of mobile phones to provide farmers with services referred to as m-services has drawn a lot of interest in particular. By bridging gaps in geography and social status, the rapidly expanding use of mobile phones in developing nations presents chances to reach farmers who are frequently isolated, scattered, and underserved [6]. The future range and applicability of agricultural m-services are expected to be expanded due to the rapid advancements in mobile technology [9]. The word m-service is used in this article to refer to a broad category that includes often-used subcategories like "m-banking, m-payments, and m-commerce.

The provision of mobile content, that is, electronic media that can be accessed via a mobile device, such as photos, audio files, graphics, videos, or text or mobile phone functions such as banking services, online stores, or social media networks, is considered as m-service. Agricultural mobile services have yet to reach their full potential [10]. In an assessment conducted by the GSM association, they account for just 8% of all m-services connected to development [11], [12]. Scale and financial sustainability are challenges that many face [13], [14].

That being said, little is currently known about the causes and solutions for this deficiency. A thorough analysis of the empirical data on the effectiveness of agricultural m-services is presently lacking, and discussions on their usefulness are lacking. Solid information is needed regarding the impact of previous initiatives, including lessons learned, to inform the design and approach of future efforts, the FAO writes in its 10-year assessment of e-agriculture [13]. Adeniran and Akanbi [15] and Duncombe [16] provided the most thorough assessments of the use of mobile phones for rural and agricultural development. Nonetheless, rather than m-services, the majority of studies conducted on the subject matter discuss mobile phone usage in general. The bibliography is not comprehensive, and the latter are only briefly discussed.

Additionally, a different assessment evaluating the effect of ICTs on agricultural growth published by Nakasone et al. [17] does not consistently discriminate between other ICTs or m-services from mobile phones. Furthermore, the review's purview is limited to the effects of two ICT impact channels: the influence of market information on pricing and the influence of information on agricultural practices. A limited selection of the literature, case studies, and anecdotes is often included in other papers on this topic [12], [13], [18–22]. Previous reviews of the literature on mobile phones and m-services have concentrated on m-commerce [23], financial services [24], [25], and micro and small businesses [26]. However, these reviews do not provide any information about farmers.

This review examines the current state of research on the usage of MFS among smallholder farmers in Africa, with a focus on key drivers, challenges, and opportunities for enhancing financial inclusion, agricultural productivity, and resilience to economic shocks. The role of mobile loans in improving access to credit will also be discussed, particularly as it pertains to the experiences of farmers in some African countries.

The study adds to the body of knowledge in several ways. Rather than discussing the use of mobile phones in agriculture more broadly, it first examines the empirical literature on services related to agriculture that are created specifically for and provided through mobile devices (such as a service that regularly provides subscribers with information on market prices rather than using the phone to call a buyer to ask about the current price). The choice to concentrate on m-services was made in part for methodological reasons, in addition to the potential benefits they may provide.

It is now difficult to evaluate the effects of mobile phones on farming operations due to the ubiquitous availability of mobile networks and phones, as well as the lack of control groups without access to the technology. Researchers can distinguish between users and non-users through experimental designs, concentrate on particular service types that can be provided through mobile phones, and supplement survey data with usage data obtained through the device by conducting studies on m-services (although, as demonstrated in the following texts, this opportunity is rarely taken advantage of).

Secondly, the evaluation concentrates on a wide range of m-services instead of a specific subset (such as banking or information delivery) to provide a thorough understanding of their (anticipated and actual)

potential. Third, by comparing the methodologies employed in previous studies and highlighting overarching research gaps, the paper critically examines the general condition of the linked literature in addition to summarizing and evaluating the findings of the published research.

2 | Method

An exploratory literature review was conducted, building on the methodology proposed by Arksey and O'Malley [27]. The review sought to identify research gaps in the body of literature about the following research issue as well as to summarize and disseminate the available research findings: what is known about how m-services affect farmers in developing nations based on the empirical research that is currently available. The literature did not lend itself to a more comprehensive systematic literature review or a meta-analysis due to the modest number of accessible research (especially from peer-reviewed sources) and the major variances in the methodology and data employed.

Using academic databases and internet search engines (Google and Google Scholar) with keyword combinations such mobile phone, ICT, ICT4D, m-agricultural, m-payments, agriculture, farmer, innovation, service, and technology adoption, pertinent empirical papers (in English) were found. Throughout the evaluation, the terms were improved through an iterative method. The snowball technique was also used to extract pertinent literature from evaluated publications.

The publication date, the kind of intervention, and the research type were inclusion criteria used to narrow down the search results. Only research that used data or was published after 2000, when mobile penetration rates in underdeveloped nations began to rise noticeably, was chosen. Instead of concentrating on the usage of mobile phones by farmers in general, research should be done on m-services for farmers in developing nations. An empirical impact evaluation of an m-service, together with an explanation of the methodology, should be included in the study.

Studies were only included if the data were relevant to farmers in developing countries and broken down by the various channels (apart from mobile phones) where services are provided, as the other research does not provide any particular insights into the use of m-services. The literature review also covers grey literature, as long as the publications disclose details about the data and methods utilized because there is not much pertinent research that has been published in peer-reviewed journals. Consequently, the quality of the study was not a criterion for exclusion.

Forty-eight publications in all, comprising 19 journal articles, 9 conference papers, 7 book chapters, 9 reports, and 4 webpages, were found to be pertinent. The effects of information m-services, such as data on pricing, farming, and weather, are evaluated in most studies. The research looks into mobile money services. Five studies examine farmer-focused social networks that are facilitated by mobile phones. There are just three studies that looked at m-services that provide access to labour and training. While twenty-one researchers used qualitative approaches to collect data, all studies employed quantitative data. The majority of the study uses data from surveys.

Nine survey-based research solely surveyed the treatment group, while seven survey-based studies surveyed households as a whole. Twenty-five survey-based studies comprised both treatment and control groups. The sample size ranged greatly from 41 to 1300. Merely seven research papers examined utilization statistics obtained via the mobile service. Only descriptive statistics were used in twenty-five studies, although inferential statistics were used in nineteen studies.

After compiling the study findings and arranging them thematically based on four types of m-services, the literature was examined. A survey of the literature [12], [20], [22] and the m-services connected to agriculture being offered in developing nations served as the basis for the identification of the categories.

The categories include the following:

I. Services that provide training or distribute information on topics like weather, disease outbreaks, or agricultural methods.

II. Financial services include banking, insurance, lending, and payment services.

III. Services that make it easier to get inputs (such as labour, water, power, seeds, fertilizer, pesticides, or markets) by providing supplier information or virtual marketplaces, for example.

IV. Services that make it easier to access output markets, including supply chain management systems, virtual marketplaces, and information on pricing and customers.

The literature evaluation also assisted in identifying research gaps about certain m-service kinds, spanning various services and including the whole research field. This research, in contrast to Arksey and O'Malley's [27] methodology, also includes the quality rating employed in the literature, but only overall and not about the particular methods and analytical approaches in each study.

3 | Review of Empirical Evidence: Facilitating Adoption of Innovations among Farmers

The next part evaluates the data that is currently available and identifies research gaps by utilizing the four categories described in the texts that came before it to summarize and analyze important results from empirical research.

4 | Information and Learning

Because they enable decoupling of information from its physical repository, m-services can add to information access [28]. In particular, the updates provided by m-services may assist farmers in determining whether an invention is appropriate, including where and when to utilize it, how to minimize risks, and where to sell their output [15]. One of the informational services that is most accessible to farmers is advice on farming techniques. Furthermore, m-services that provide data on the production environment (weather, crop diseases, etc.) might help farmers better recognize and control risks. By providing venues for knowledge exchange and social learning, m-services are also utilized in educational endeavours [29].

Some studies have examined the widespread dissemination of farming information using m-services. Among the few advantages of voice-based information services are highlighted by three studies evaluating their effects. According to research on Lifelines, a phone-based consulting service for Indian farmers, most of the farmers surveyed noted that the program had raised their income and savings, enhanced production, and reduced their need for loans [30]. Avaaj Otalo, an m-service that uses voice messages recorded to deliver and exchange information, is also used in India. It was found to change management practices, increase the use of effective pesticides, and expand the use of cumin, a profitable but dangerous crop [31].

When evaluating effects, the authors do not distinguish between the various features of the service, such as automated voice messages, a hotline, and a social networking platform. Divergent opinions exist on how m-services would advance agricultural knowledge overall. Regarding Avaaj Otalo, farmers seem to take the advice at face value, but their general level of expertise in agriculture has not increased [31]. However, a study of the knowledge help extension technology initiative in India finds that farmers knew more about agricultural practices and were more aware of them; it does not examine if these improvements affected farmers' behaviour [32].

The m-service uses customized phones run by the "munnas," who record brief dialogue strips (voice and graphics) to exchange queries and answers about regional agricultural issues. The authors argue that the reason uneducated, impoverished, and landless farmers appear to have benefited the most from modern ICTs may be because they had previously believed that these tools were exclusively beneficial to the well-educated and wealthy [29]. Male and female farmers' effects are compared in a study of M-solution in India, which provides

meteorological and farming-related information via SMS and voice messages [33]. Most users said they had become more knowledgeable about agricultural techniques, raised yields, and cut expenses.

The most relevant information often seems to be on the weather, then seeds and nutrient management. The information that has been prioritized, however, is not always related to the things that have been heard or done. As a result, even while respondents gave lower importance to some topics, listening rates, that is, the average amount of time spent listening to a message, were nevertheless comparable to those of priority concerns. Males and women listen at equal rates, but women reported acting on less advice. For example, only a majority of males claimed to have utilized weather information to plan irrigation and input use. The author ascribes this discrepancy to women's seldom direct participation in relevant decision-making.

Regarding the m-service Reuters Market Light (RML)'s ability to influence agricultural practices, two studies conducted in India on farmers who use it to obtain information on pricing, weather, and farming methods reach divergent findings. A portion of the farmers in both surveys stated that employing RML has caused them to alter their methods. Nearly two-thirds of the farmers in the IMaCS poll said the knowledge had slightly assisted them in adopting improved techniques, and 19% said it had a lot benefited. According to Fafchamps and Minten [34], about one-third of farmers in the second research had switched crops between the two survey years.

According to a poll conducted among Indian farmers who received frequent weather reports via RML, the majority of them, 85%, thought the information was helpful. However, compared to control farmers, Fafchamps and Minten [34] do not discover that RML users reduce crop losses following storms. According to Raj et al. [35], an SMS and voice alert service in India that provided information on the proper use of soil nutrients resulted in a perceived 15% increase in incomes for intervention farmers compared to the control group. This increase was primarily due to cost savings from the application of appropriate or lower amounts of seeds and nutrients.

The observed benefits may thus say more about the usefulness of the instructions than the mobile phone as a dissemination tool. There has been little empirical study using m-services to support education and learning among farmers. One study looks at the impact of the Lifelong Learning for Farmers initiative in India, where training modules are recorded and distributed to female livestock producers via mobile phones [36]. Farmers were given individualized instructions for nutrient management and other crop cultivation practices via SMS and voice alerts, which they were then required to implement.

Because individuals could access the recordings at a time and location that worked for them, the study concluded that participants found mobile phone-based training to be more practical and helpful than in-person interactions. Single research has looked at an m-service to promote social learning and interaction; however, the majority of the attention is on consumption rather than effects. The social media component of Avaaj Otalo, an Indian platform that allows farmers to ask questions via recorded audio messages and receive responses from service provider staff or other farmers, is evaluated by Patel et al. [37]. The users especially appreciated the ability to hear recorded responses to queries posed by other farmers. It is interesting to note that most people (65%) wanted to get the information only from employees. Not one farmer was interested in hearing from other farmers alone, and only 35% were willing to respond in addition to staff recommendations.

5 | Financial Services

M-payments enable farmers to sell goods and pay for related inputs and technologies. Farmers who use mobile phones to access and repay loans might acquire the funds they need to buy innovations and become more ready to take on financial risks if the technology fails to meet expectations. Additionally, by managing and earning interest on their savings, m-banking services can assist farmers in better dealing with the seasonality of agricultural revenue and provide them more flexibility regarding "when and where" to buy which inputs.

By eliminating the need for in-person visits to insurance claimants, for example, tracking weather occurrences via weather stations or distributing reimbursements via mobile payments mobile phone-enabled insurance services can make insurance affordable for smallholders. Three studies examining the usage of financial services facilitated by mobile phones in the agriculture industry evaluate the effects of mobile payments on farmers. The studies focus more broadly on the use of m-payments than they do on various service providers.

Two of the studies show how m-payment systems are spreading quickly throughout Africa. Adoption among coffee farmers in Uganda climbed from 15% in 2012 to 54% in 2015, while adoption among banana producers in Kenya increased from 60% of farmers in 2009 to 91% in 2010 [38], [39]. According to the statistics, mobile money is the most popular payment method for farmers. According to Kikulwe et al. [38] and Sekabira and Qaim [39], the most popular usage of the service is money withdrawal from mobile accounts (60 and 70% of farmers, respectively), using m-payments to send or receive money is less widespread.

It is unknown how much of the money taken out was utilized for agricultural output. The only sources of information about the real spending of the received funds are Kirui et al. [40]. They demonstrate that most of the money collected through m-payment services, 32%, is used for agricultural purposes, with school tuition and food purchases coming in second and third, respectively, at 20% and 10%. On the other hand, m-payments are utilized less frequently for costs associated with agriculture, such as inputs (7%) and farmworkers (6%). Divergent findings are reached by the studies about the factors that influence the use of mobile payment services. In addition to the distance to banks and mobile money agents, other significant predictors include higher education levels, larger households, and phone ownership.

The authors note that the lack of a substantial impact from distance to roads underscores the promise of mobile money in rural places [38], [39]. Richer male farmers are more likely to employ m-payments, according to Kirui et al. [41] and Kikulwe et al. [38], although Sekabira and Qaim [39] find no evidence to support this claim. Conversely, they opine that female farmers could gain more from mobile payments than their male counterparts. According to research done in Kenya, the usage of mobile payments significantly increased revenue, input utilization, and commercialization levels [38], [41].

Similarly, m-payment users are more inclined to sell coffee to consumers in higher-value marketplaces than to local vendors, allowing them to get a 7% premium for their coffee [39]. But Kikulwe et al. (2014) [38] also discovered that higher remittances are the primary source of income gain resulting from the adoption of m-payments. Remittances are not as important to Sekabira and Qaim [39] as other non-farm revenue streams, including operating small-scale m-payments-enabled companies in commerce, transportation, and handicrafts. The usefulness of m-payment systems for savings is also highlighted by Kikulwe et al. [38] and Sekabira and Qaim [39].

6 | Agricultural Inputs

MFS play a huge role in the supply chain of agricultural inputs, albeit this is not how they are being applied extensively. For example, m-services might offer trading platforms for inputs or distribute information about input sources and pricing. Certain services also contribute to the availability of water. For instance, farmers may turn on and off water pumps using their phones. In a somewhat indirect way, mobile phones enable access to electricity since local communities receive extra power from mobile network carriers' base stations. Although there are now several virtual labour marketplaces, their application in the agriculture industry is still somewhat restricted.

Furthermore, the financial services provided by mobile phones and mentioned in the previous texts might make it easier to get inputs. Seldom has the application of m-services to streamline access to agricultural inputs been evaluated. One research examines the effectiveness of Sri Lanka's Berendina Employment Resources Centre, which matches labour supply and demand in rural regions using mobile phones and a computerized database. Due to their lack of faith in employment offers obtained over the phone, the study reveals that very few users accepted the positions offered by the centre [42].

7 | Output Markets

Market pricing for cattle and crops is provided by a variety of MFS, which may aid farmers in determining the potential profitability of new technologies or in obtaining higher prices for their produce (e.g., by negotiating or having access to buyers who are willing to make better offers). Good market access is also necessary to facilitate the selling of excess produce for a profit and generate money. Farmers can connect with alternative customers or marketplaces using mobile phone-enabled "virtual" markets for agricultural products, and m-payments can make transactions between farmers and purchasers easier. Supply chain management systems, which employ mobile devices to handle sales and streamline procurement from numerous smallholder farmers, are another rapidly growing type of mobile service.

Numerous research works have examined how smallholder mobile financial solutions help people participate in markets by evaluating the effects of pricing data and market connections on income, producer–buyer interactions, and production scheduling. According to three studies, farmers can plan more effectively thanks to the new mobile financial platforms that provide pricing information. According to Lokanathan et al. [43], TradeNet users in Sri Lanka reported that the information helped them make sound decisions on optimal harvest and selling periods. The evaluations of M-Farm in Kenya [44] and Esoko in Ghana [45] demonstrate that pricing information was most crucial at the sales stage; it was also somewhat utilized earlier in the production cycle when choosing what to grow.

The studies did not measure the real changes in technology adoption, productivity, or income; instead, they evaluated outcomes using questionnaires. Mixed results have been found in the research on how pricing knowledge affects the prices that farmers receive. According to three studies, farmers who use m-services sell their crops for more money. All Bangladeshi farmers who used PalliNet to obtain price information regularly reported revenue increases because of service utilization [46]. Nakasone [47] discovered through randomized control trials that Peruvian farmers who got regular price updates via SMS reported higher prices, especially for perishable products. He credits the rise to the farmers' increased ability to negotiate.

In a similar vein, Sri Lankan TradeNet members reported earning greater money for their goods [43]. They thought that traders gave them higher prices because they understood that farmers were aware of pricing in other marketplaces, even though they did not appear to utilize the knowledge for negotiating. However, the results of an experimental investigation conducted in Colombia are different. According to the study, many farmers who got daily price updates by SMS were more informed about market pricing, but they did not see an increase in sales prices over their non-user counterparts [48].

The Corporación Colombiana Internacional gathered average daily prices compared with prices recorded by farmers in the research, but the findings are not explained. The two RML investigations also show limited effects on pricing.

Farmers who received a free one-year RML membership did not see a substantial increase in average prices, according to Fafchamps and Minten [34]. They also point out that neither transaction costs nor farmers' decision to cut expenses on pricing information searches were affected by the RML membership. According to the authors, most farmers minimize their prospects for arbitrage by selling at the closest wholesale market. Nakasone [47] further hypothesizes that the study's focus on market-oriented farmers who could already be aware of market pricing may account for the lack of influence. Two Esoko studies further highlight the difficulties in reaching definitive results about pricing impacts.

According to one research, customers did not receive higher prices for maize, cassava, or gari (processed cassava; [45], but they did receive higher prices for yam (11%). The authors note that yam marketing is more likely than other crop marketing to include negotiating, which helps to explain the discrepancy. The fact that over two-thirds of farmers stated they had negotiated better prices with dealers lends credence to this theory. On the other hand, a different Esoko research finds that farmers who had access to the m-service got farmgate prices that were 7% higher for groundnuts and 10% higher for maize than for the control group [49]. Three studies that have examined how m-services affect trading patterns have not found any appreciable shifts.

According to a PalliNet survey conducted in Bangladesh, almost one-third of farmers who had access to pricing data had moved markets at least once; most of them preferred to stay in their current market since they were unfamiliar with the workings of other markets' business structures [46]. Comparably, the TradeNet research observes that users who relied on the merchants as a source of loans and information continued to sell to them despite having access to information on other traders through the TradeNet marketing platform [43]. Baumüller [44] evaluated M-Farm, a pricing information service in Kenya, and found few indications of any shifts in sales trends. The efficacy of agricultural marketplaces enabled by mobile phones has not been evaluated in earlier studies.

Anecdotal information indicates that to reach smallholder farmers, "virtual" market venues could require additional assistance. When Kamal Quadir, the creator of Cellbazaar, and his colleague Naeem Mohaiemen look back on previous experiences, they note that adoption was quicker in urban than rural regions [50]. It was discovered that to reach farmers, more work would need to be put into "human translation or help, including training through public and private institutions." There is currently a lack of empirical studies on the efficacy of supply chain management apps provided by mobile phones. Virtual City, a Kenyan firm, conducted an internal analysis of its Agrimanagr service, which tracks product delivery from small farmers to processors and sellers using mobile technology.

In particular, the review reveals that the system decreased the time it took to pay farmers from 120 to 31 days by consolidating reports more quickly, shortened the time it took to make purchases from 3 minutes to 22 seconds, and increased the average weight of produce per transaction by 9-13 per cent by using electronic weighing technologies.

8 | The Role of Mobile Financial Services in Africa

MFS has been recognized as a transformative tool for improving financial inclusion among farmers, offering services such as:

Mobile money: services like M-Pesa in Kenya have been widely adopted by smallholder farmers to send, receive, and store money securely [38]. In Nigeria, mobile money services like Paga and Firstmonie have gained traction among rural populations, including farmers, allowing them to make payments and access financial services without needing a traditional bank account. These services have facilitated transactions, reduced costs associated with moving money, and helped streamline the agricultural value chain.

Mobile credit and loans: short-term loans offered via mobile platforms, such as M-Shwari in Kenya or Carbon and KwikCash in Nigeria, have empowered farmers by providing much-needed access to credit, particularly for purchasing inputs such as fertilizers and seeds [51]. In Nigeria, mobile loan platforms have provided smallholder farmers with alternative financing options, enabling them to purchase farm inputs and mitigate seasonal cash flow issues.

9 | Financial Inclusion and Access to Credit

Financial inclusion has been a persistent challenge for many smallholder farmers in Africa, particularly in Nigeria, where formal financial institutions are often out of reach for rural farmers. MFS offer a solution by allowing farmers to access credit, save money, and manage their finances remotely.

For instance, mobile money services like Paga in Nigeria have extended financial inclusion to rural farmers by enabling them to save and receive money without relying on traditional banking infrastructure. A study in rural Kenya found that mobile money services improved household resilience and savings among users [52]. In Nigeria, mobile loan services such as RenMoney and QuickCheck have enabled farmers to access credit for agricultural purposes, improving their ability to invest in their farms and increase productivity.

10 | Cross-Cutting Issues and Research Gaps

The preceding sections have emphasized the definitive information about the effectiveness of particular categories of mobile services. Moreover, there are several broad research gaps in the literature. Very little research has examined the behavioural elements that affect farmers' readiness and capacity to employ mobile services. For example, risk attitudes have a big impact on how agricultural technology is adopted.

Studies on MFS use, in general, emphasize the significance of trust as a requirement for people to use their phones in business transactions, even though none of the studies examined the role of risk attitudes in the adoption of m-services [53–56]. Comparisons of various MFS designs, such as how the service is supplied (such as phone, SMS, and Internet), how it may be accessed (such as push or pull), or how much should be paid, are necessary for research on the usability of MFS. In a single research, farmers were given access to market information either automatically (the "push" group) or on demand (the "pull" group) via an m-service. Islam and Grönlund [46] conducted the study.

Farmers in the push group found the information to be significantly more useful than those in the pull group. It has not gotten much attention to how useful mobile phones are for delivering services in comparison to other channels or how different channels work well together. Information on MFS research has produced some proof. Two studies examine how preferred information sources changed before and after the MFS were introduced. In India, weather information (previously from TV), market pricing (previously from merchants), crop advice (previously from other farmers), and government initiatives (previously from local newspapers; were all mostly obtained by SMS from RML.

In a similar vein, dealers and market purchasers lost significance as a source of pricing information when M-Farm was introduced in Kenya [44]. Even while some farmers still got their information via middlemen, most people thought that the quality of the information was inferior to M-Farm. According to the KHETI survey, most farmers who have received treatment believe that m-services are quicker and of higher quality than conventional extension services [32]. Veeraraghavan et al. [57] evaluated the Warana Unwired initiative, which entailed transferring information between members of an Indian sugarcane cooperative via SMS instead of a PC.

Farmers could use a phone at the village kiosks, which also included PCs, to obtain information, or they could use their mobile phones. Owners of kiosks gathered data on water and fertilizer usage. In general, the SMS-based approach was favourably welcomed. The battery life, portability, quick access at any time, and democratization of access are advantages over PCs. PCs were still preferable, nevertheless, for typing lengthy text—for instance, on the usage of fertilizer. The radio is shown to be a popular medium in two studies that compare various pricing information transmission channels. According to the M-Farm research, radio is thought to be a competitive substitute for the m-service, especially in the first phases of development.

Because price information may be stored on a mobile device and that information is time-sensitive, M-Farm becomes more significant during the sales phase [44]. Ferris et al. [58] found that even though virtually all farmers had access to a cell phone, they preferred to obtain market information through local radio stations when comparing information delivered by radio and mobile phones. Many farmers were not familiar with utilizing their cell phones to get business information, nor were they aware of the pricing information service that was offered by SMS. On the other hand, because SMS is less expensive and easier to access and update, the authors believe that it will gain greater appeal over time [1].

Impact studies seldom make a distinction between user groups based on factors like gender, wealth, social class, or religion. However, there can be significant differences in usage and effects among different populations. For example, research on farmers' usage of mobile payments in the texts that came before indicates that better-educated farmers are more likely to utilize the services. Although gender-related issues are seldom included in the studies that have been done on agricultural m-services, they can potentially be quite relevant.

The research of M-Farm in Kenya found that women felt empowered by their involvement in the training on how to use the m-service since it had familiarised them with the usage of the mobile phone, which they were then able to use for other purposes. Furthermore, as previously discussed in the texts that come before it, Mittal [33] demonstrates that although women seem less able to act on the knowledge, they are as interested in it. How those who possess a phone and those who use someone else's differ in how they use m-services also requires more investigation.

According to one research comparing mobile phone owners, non-owners, and non-users in Tanzania, owners used their phones for a wider range of activities, whereas non-owners mostly used them for business or to contact relatives [59]. According to research done on farmers in Uganda, even families without access to a cell phone may still profit from having one in the community. For example, if someone in the village coordinated the collection of products with a trader, that household could still benefit from having a cell phone [60]. Comprehending these variations is especially crucial when researching the effect and consumption of m-services in low-income populations, where phone sharing is more prevalent [61].

Lastly, as Duncombe [16] noted, the context in which the MFS is offered is not given enough attention to help determine how other elements could affect the service's usefulness. In an attempt to explain their limited effects, some studies of marketing-related m-services have pointed to barriers that keep farmers from utilizing price information or marketing options [34], [43], [46]. There is just one research that evaluates several elements methodically.

According to the findings, additional restrictions like a lack of funding or the possibility of crop losses matter much more to farmers than the lack of knowledge about pricing and customers [44]. Numerous studies on the use of mobile phones in marketing in general also discover that other elements like market linkages or price information have less of an impact on sales decisions than do established business relationships, perishable produce, limited storage facilities, or trust [53], [54], [56], [62–66].

11 | Mobile Loans and Their Impact on Smallholder Farmers

Mobile loans have had a significant impact on smallholder farmers across Africa. In Nigeria, mobile loan platforms like KwikCash and Carbon offer short-term loans without the need for traditional collateral, helping smallholder farmers gain access to credit for purchasing inputs such as seeds and fertilizers.

Access to agricultural inputs: in both Kenya and Nigeria, mobile loans enable farmers to purchase essential inputs that directly improve yields. Kirui et al. [41] found that farmers using mobile money services in Kenya had 35% higher profits compared to non-users, primarily due to better access to inputs. In Nigeria, the increased availability of mobile loans has helped smallholder farmers invest in quality seeds and fertilizers, contributing to higher crop yields.

Cash flow management: mobile loans also help farmers manage cash flow more effectively, bridging the gap between planting and harvesting seasons. In Nigeria, mobile credit services like Branch and FairMoney provide farmers with liquidity during critical periods, reducing the risk of financial stress during the farming cycle.

Building credit history: mobile loan platforms in countries like Nigeria use alternative data to assess creditworthiness, allowing farmers to build credit profiles. This data, such as phone usage and payment history, helps smallholder farmers improve their chances of accessing larger loans in the future [52].

12 | Agricultural Productivity and Income

The use of MFS has been shown to impact agricultural productivity and income positively. By enabling farmers to access financial services more easily, MFS allows for better investment in inputs, which leads to higher productivity and profits. For example, Kirui et al. [41] found that mobile money users in Kenya had

significantly higher profits compared to non-users, largely due to their ability to purchase better inputs and tools. Similarly, in Nigeria, the ability to access credit through mobile platforms has enabled farmers to increase their investment in high-quality seeds, fertilizers, and equipment, thereby boosting productivity and income.

13 | Risk Management and Resilience

MFS have proven to be effective in managing risks associated with managing farming from upstream to downstream. In Nigeria, services like Thrive Agic, and Crop2Cash are examples of mobile platforms that provide financial inclusivity, quality inputs, digital payments, agricultural advice and market linkage to smallholder farmers in Nigeria. While filling the role Nigeria banks have for years shied away from due to fragmented agricultural value chains, lack of monitoring data and payment channels [67].

MFS also improve farmers' resilience by helping them manage income shocks. For example, Jack and Suri [68] found that M-Pesa users in Kenya were better able to smooth consumption during times of financial distress compared to non-users. In Nigeria, mobile money services like Paga have helped farmers build resilience by allowing them to save and access funds during periods of financial uncertainty.

14 | Challenges and Shortcomings

The literature evaluation highlights various methodological flaws in the agriculture m-services research. These kinds of flaws are not unique to our industry. The majority of studies' designs and methodologies lack rigour, according to a survey of evaluations of m-health apps in low- and middle-income nations [69]. Some of the literature examined is based on survey data collected from farmers rather than time series data collected by data collectors or analysis of real consumption patterns.

According to two studies, m-service customers occasionally tend to overstate their benefits. Regarding RML, a significant number of farmers within the treatment group cited the m-service as the source of motivation for altering their farming methods. It was, therefore, reasonable to assume that a greater number of farmers in the treatment group had altered their methods. However, as previously stated in the texts that came before it, the researchers were unable to locate any evidence to support this claim [34]. Regarding M-Farm, farmers stated that they often obtained prices that were on par with or more than what M-Farm had indicated. However, the study discovered that real prices were nearly always lower when comparing M-Farm sweet potato prices with those obtained [44].

A significant limitation of current research is that the majority of studies fail to evaluate the impact in connection to consumption. Instead, research often compares the effects for all groups, regardless of usage patterns, by first separating users (or those with access to the m-service) from a control group. For example, Haider Rizvi [30] notes that LifeLines were used seldom, ranging from once a week to twice a year, but he did not break out usage frequency in his effect study.

Fafchamps and Minten [34] observe that a mere 59% of farmers who received a free RML membership utilized it. However, the majority of the study is based on intent-to-treat estimates for farmers who received a free RML subscription, regardless of whether they utilized it or not. Cole and Fernando [31] employ the same strategy as Avaaj Otalo; however, only 58% of the farmers who attended had phoned the hotline, and 65% had listened to push material. In a similar vein, no m-payment study links the evaluation of factors and effects to the real use of m-payments in agriculture.

Sekabira and Qaim [39] and Kikulwe et al. [38] noted that there is a lack of information about the use of mobile payments in the agriculture sector. Although Kirui et al. [40], [41] provide these data, at least in aggregate form, their study does not use them. It is challenging to determine a causal relationship between the MFS and observable changes in the absence of consumption statistics [1]. However, it is crucial to remember that there are several methodological issues with MFS impact studies [70]. It might be challenging

to separate the effects of the m-service from phone use in general. Farmers may use their phones more frequently for other purposes if they are exposed to m-services.

According to the M-Farm research, female farmers who had taken part in the program began utilizing the phone for more business-related activities [44]. Additionally, the KHETI study reveals that after beginning to use the MFS, treated farmers were often more receptive to utilizing new agricultural and mobile technology [32]. Study [47] attempted to address this problem by prohibiting the participants from making or receiving additional calls on the mobile phone provided to them to access the service. The researchers would not prevent the participants' use of their phones, though.

When an m-service performs many tasks (such as providing various information kinds, delivery channels, or service types) or is a component of a broader support program, it becomes even more difficult to isolate consequences. Indeed, a large number of researchers [31], [34] do not try to discern between the various roles. According to research that evaluates the effects of selling services and pricing information separately, M-Farm consumers frequently cannot tell the difference between the two effects. The effects that the farmers saw were really the outcome of the local partner's umbrella project, but they were also credited to the m-service [44].

Because service providers may regulate and track usage, randomized control trials might be the most appropriate method for studying mobile services. Nevertheless, because the environments in which the treatments are carried out are sometimes challenging to regulate, such research runs the danger of contamination [71]. For example, anybody is free to subscribe to m-services that are made available to the public. According to Lokanathan et al. [43], farmers in the control group were also aware of Tradenet through advertising and word-of-mouth, despite the fact that the service was only discussed with the treatment group. Cole and Fernando [31] noted that information services present a unique challenge in terms of preventing contamination since information travels quickly, especially via mobile devices.

It is hard to say how much information spillage there will be. According to Baumüller's [44] research, 38 and 62 per cent of farmers, respectively, communicate pricing information they get via SMS with other farmers inside and even more regularly outside of their farmers' organization. Evidence of pricing information spillover is also found by Courtois and Subervie [49], but more frequently within than outside the community. In a similar vein, Mittal [33] demonstrates that nearly all farmers communicate prices with other farmers, sometimes on a daily or weekly basis. Nakasone [47], on the other hand, discovers no effects on marketing results among the same village families without access to pricing information services.

15 | Challenges in Scaling Mobile Financial Services

Despite the numerous benefits of MFS for smallholder farmers, several challenges hinder their widespread adoption:

Digital literacy: low levels of digital literacy among rural populations impede MFS adoption. Many smallholder farmers find mobile technology unfamiliar and struggle to navigate financial applications. Asongu and Nwachukwu [72] identify limited digital literacy as a significant barrier. In Nigeria, many rural farmers lack adequate training to use mobile financial platforms effectively.

Infrastructure limitations: inadequate mobile network coverage and poor internet connectivity present substantial obstacles. Gosavi [73] highlights infrastructure constraints as a key barrier to MFS expansion in sub-Saharan Africa. In Nigeria, rural communities often lack stable access to mobile networks, limiting their ability to utilize these services fully.

Trust: building trust in financial institutions and mobile operators is crucial for sustained usage of MFS. Farmers may hesitate to adopt these services due to concerns about security and fraud.

Creditworthiness data: the absence of reliable creditworthiness data hampers access to credit for smallholder farmers. Traditional credit assessments often overlook informal financial histories. Developing alternative

methods for evaluating creditworthiness using mobile transaction data is essential, though still an issue as seen from literature from MFS platform who have tried. Lack of central creditworthiness data to totally prevent bad actors from that advantage of these essential services [74].

Addressing these challenges—digital literacy, infrastructure, trust, and creditworthiness—will be vital for unlocking the full potential of MFS and enhancing the livelihoods of smallholder farmers.

16 | Conclusion

The literature review highlights that MFS hold transformative potential for smallholder farmers in Africa, particularly in addressing key challenges such as limited access to credit, financial inclusion, risk management, and improved agricultural productivity. As demonstrated throughout the review, mobile financial platforms—spanning mobile money, loans, and insurance—have proven to be critical tools for overcoming the structural barriers that smallholder farmers face in the African agricultural sector.

MFS have improved financial inclusion, offering an alternative to traditional banking for rural farmers. Services such as M-Pesa in Kenya and Paga in Nigeria have empowered smallholder farmers to send, receive, and save money securely, which in turn facilitates smoother transactions and enables better financial planning. The significance of this inclusion cannot be understated, as it provides a foundation for greater economic participation, access to markets, and financial stability for farmers who previously lacked these opportunities.

Access to mobile loans has had a particularly positive impact on smallholder farmers by providing them with the necessary financial resources to invest in agricultural inputs, such as fertilizers and seeds, which directly impact yields. Studies reviewed in this literature indicate that mobile loans have been instrumental in improving agricultural output and farm profitability, as seen in the case of Kenyan and Nigerian farmers. The ability to access small loans without needing traditional collateral or physical banking services represents a significant innovation for the agricultural sector, where access to credit has historically been a major challenge.

Risk management through mobile-based insurance services, such as weather-indexed insurance in Kenya, provides another key benefit of MFS. These services allow smallholder farmers to mitigate the impact of environmental risks, such as droughts and floods, by ensuring timely payouts based on weather data. In Nigeria, platforms like Thrive Agric and Crop2Cash have further helped smallholders manage agricultural risks, offering input financing and market linkages that provide a layer of security in an unpredictable agricultural environment. Such innovations enhance the ability of farmers to take calculated risks and invest in higher-yield crops, improving overall productivity.

However, despite the clear benefits of MFS, several challenges hinder the broader adoption of these services. First, digital literacy remains a significant barrier. Many smallholder farmers, particularly in rural Nigeria, lack the skills necessary to use mobile financial platforms effectively. Additionally, infrastructure limitations continue to restrict access to mobile networks and digital services in rural regions, thereby excluding some farmers from benefiting from these innovations. Building reliable infrastructure and providing digital literacy training are essential steps to scaling the use of MFS among the farming population.

The issue of trust is another challenge, as farmers may be wary of adopting new technologies, particularly when it involves managing their finances. Service providers and governments need to ensure that these platforms are secure and user-friendly to build confidence among smallholder farmers. In Nigeria, concerns about fraud and data privacy have created hesitation among users, highlighting the need for transparent, secure platforms.

Looking forward, there are significant opportunities for government and regulatory bodies to support the expansion of MFS in rural areas. By creating an enabling environment through policy frameworks, governments can facilitate the growth of MFS and ensure they are accessible to even the most underserved farmers. Collaborative efforts between private sector providers and government institutions will be essential in promoting digital inclusion and financial literacy.

In conclusion, MFS present a tremendous opportunity for smallholder farmers in Africa to enhance their agricultural productivity, improve financial stability, and mitigate risks. By addressing the challenges of adoption and scaling these services, particularly in rural areas, MFS can contribute significantly to economic growth and poverty alleviation across the continent. Continued innovation and commitment from all stakeholders—farmers, governments, and service providers will be crucial in ensuring the sustained success of these services.

17 | Direction for Future Studies

Future research should focus on addressing key gaps and challenges identified in the literature on MFS for smallholder farmers.

First, more empirical studies are needed to assess the full impact of MFS on risk management, input use, post-harvest sales, and loan disbursement, as there is currently limited data on these areas. Specifically, research should explore how MFS contributes to long-term economic development and poverty alleviation in rural farming communities.

Second, addressing the lack of creditworthiness data is essential. Future studies should investigate how mobile financial platforms can better assess farmers' creditworthiness and track financial behaviours such as resource allocation to mitigate issues like the diversion of funds.

Third, overcoming digital literacy barriers and improving infrastructure remains critical for the wider adoption of MFS. Research should explore effective strategies for increasing farmers' understanding of these platforms and improving mobile network access in remote areas.

Finally, the role of governments and regulatory bodies in creating supportive policies for MFS expansion requires further examination. Future studies should explore how regulatory frameworks can ensure secure, transparent, and inclusive financial systems for smallholder farmers.

By addressing these areas, future research can contribute to the continued development and effective utilization of MFS in transforming smallholder agriculture across Africa.

Funding

Not applicable

Data Availability

There are no datasets generated from participants and/or analyzed during the current study.

Conflicts of Interest

The authors declare no conflict of interest.

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