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State of Agricultural E-Government Services to Farmers in Tanzania: Toward the Participatory Design of a Farmers Digital Information System (FDIS)

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Abstract: The projected population increase and drastic climate changes are a great setback to food security through sustainable agriculture. However, governments need to play key roles in supporting the agriculture sector, which creates considerable employment and contributions to most countries' Gross Domestic Product (GDP) outcomes. In many countries, the governments already support the agriculture sector with services based on Information and Communication Technology (ICT) to reach many stakeholders, including smallholder farmers. This paper investigated the status of e-Government services in the agriculture sector for farmers in order to understand the functions and scope of e-services, the challenges faced by farmers, both addressed and unaddressed, and the challenges of ICT-based services for farmers and other stakeholders in Tanzania. We used a qualitative research approach to interview the Ministry of Agriculture, farmers, extension workers, and agriculture processing industries. The main finding reveals that e-government services play a major role in the agriculture sector in Tanzania. Our results show that the pre-existing ICT services identified for farmers cannot meet the needs of farmers in a complete farming cycle. Moreover, lack of awareness, digital illiteracy, and poor infrastructure are the major challenges faced by farmers and other stakeholders when it comes to ICT-based services. These results justify the need for a comprehensive digital platform, particularly the proposed Farmers Digital Information System (FDIS) to enable farmers and other stakeholders to access essential services in a complete farming cycle for a more sustainable agriculture.

Keywords: agriculture; e-Government services; ICT services; sustainable agriculture; Farmers Digital Information System (FDIS); Tanzania

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1. Introduction

Food insecurity and extreme poverty are among the major challenges of low- and mid-income countries, including Sub-Saharan Africa. The major threat to food insecurity on the continent include climate change and projected population growth, with Sub-Saharan Africa leading the way with a growth rate of 114% in 2050 [1]. Moreover, the global political crisis, such as the war between Russia and Ukraine, has led to food shortages, particularly in African countries [2]. The digitization of agriculture services is essential to enable farmers to adopt climate-resilient practices for the development of the agrifood system [3]. Governments, particularly in low- and mid-income countries, can play a major role in supporting the agriculture sector, which makes a significant contribution to countries' GDP and provides employment for more than half of the population [4]. According to the Organization for Economic Co-operation and Development (OECD) [5], Information

and Communication Technologies (ICTs) can help governments to improve services to citizens in a cost-effective, transparent, accountable, and highly convenient way through e-Governments.

e-Government is a concept that emerged from the impact of ICTs on development, and which has led to the reform of public administration. e-Government has many different definitions based on the purpose and context of use. For instance, the OECD [5] defines e-Government as the use of Internet and ICT as tools for better governance, while the United Nations [6] refers to the phrase "digital government" as the use of ICT to communicate information and services to citizens and businesses. The United Republic of Tanzania [7] defines it as:

> "The use of ICT to enhance work efficiency and improve service delivery in order to meet the needs of the public in a responsive and transparent manner. e-Government is expected to facilitate the interaction between the Government and its clients including the citizens (G2C) and business communities (G2B), as well as within the public administration itself (G2G)".

Generally, we can define e-Government as the use of ICT to deliver services and interact not only with its citizens, but all stakeholders involved in government and business activities in a transparent, accountable, and timely manner. Indeed, developed and developing countries alike have adopted an e-Government strategy, which plays a major role in delivering information and services to citizens in a more comprehensible environment [8,9]. The agriculture sector, in particular, has witnessed a number of e-Government initiatives designed to help farmers and other stakeholders increase production. A few examples include the Online Fertilizer Recommendation System (OFRS) in Bangladesh, which generates location-specific fertilizer recommendations to help farmers use inputs efficiently, thereby reducing input costs and safeguarding the environment and consumers' health [10]; e-Government in India, which provides services in general agriculture activities, i.e., farming, livestock keeping, and fishing [11]; China's digitization of agricultural and food supply chains, which focuses on empowering the majority of rural farmers [12]; and agricultural mobile applications that support different crops and livestock management, developed by the Kenya Agricultural and Livestock Research Organization (KALRO) [13].

The Tanzanian government has supported the agriculture sector since its independence by developing optimal policies, maintaining subsidy programs for farmers and finding markets for agricultural products. As part of the implementation of the e-Government strategy [7], the Ministry of Agriculture (MoA) introduced e-services, taking advantage of the increased use of mobile technologies and the Internet to reach a wide range of stakeholders, particularly farmers. While there is evidence of some digital government services in the agriculture sector, there is less literature on existing active services for stakeholders, particularly for the majority of smallholder farmers in rural Tanzania.

This paper is part of a wider study to design and implement a state-owned (or public–private) Farmers Digital Information System (FDIS) so that farmers can access all essential services under one roof. We conducted a comprehensive literature review of advances and experiences in digital technology in developed and developing countries, including Sub-Saharan Africa and Tanzania in particular [14]. The literature review identified the challenges facing smallholder farmers in Tanzania, and the knowledge gaps that could be addressed through digital technology. We used the problems identified by farmers to develop the preliminary design of the FDIS for sustainable agriculture among smallholder farmers [15]. In addition, we planned to study e-Government services in agriculture and the opinions of farmers and other stakeholders in Tanzania for the future design of a concrete FDIS. Therefore, this paper aims to investigate e-Government services in agriculture for farmers in order to understand the functions and scope of e-services, the challenges of farmers that have been addressed and those that have not, and the challenges of ICT-based services for farmers and other stakeholders in Tanzania. The results of this study are essential to the future participatory design of the Farmer Digital Information System

(FDIS)—a proposed government digital platform that provides services to farmers as part of a complete farming cycle.

2. Methods

Using a qualitative research approach and cross-sectional design, we interviewed the Ministry of Agriculture (MoA), 22 crop farmers, 4 processing industries as customers for agricultural products, and 9 extension workers (qualified agricultural personnel responsible for training and technology transfer from research centers to farmers, with a view to increasing agricultural production [16]) in different regions in Tanzania. We focused on the crop farmers, as there are no e-Government services for livestock farmers. We considered the regions producing the main cereal crops, with the selection of farmers and extension workers evenly distributed across regions. Data collection took place from December 2022 to April 2023. The study aimed to identify active digital services provided by the government to the farmers, and the strength and challenges of ICT-based services. The approach was useful in gathering all stakeholders' opinions on the identified themes. We used purposive sampling to select participants from the MoA because of their central and unique roles in providing services to agriculture stakeholders in the country.

The study areas (regions, district, and wards) were selected based on the criteria of higher production among the three major cereal crops, which were maize, wheat, and paddy (see Figure 1). Extension workers were purposely selected because they were the only source of information on the performance of digital services for farmers at ward and village levels. We used a simple random technique to select farmers in the identified wards as all farmers at this level possessed common characteristics. The study targeted access to digital services by smallholder farmers in rural and semi-urban areas. Indeed, we collected essential data to understand the status of e-Government agricultural services to empower farmers and the challenges of all stakeholders involved. Figure 1 below shows the sites visited as part of this study.

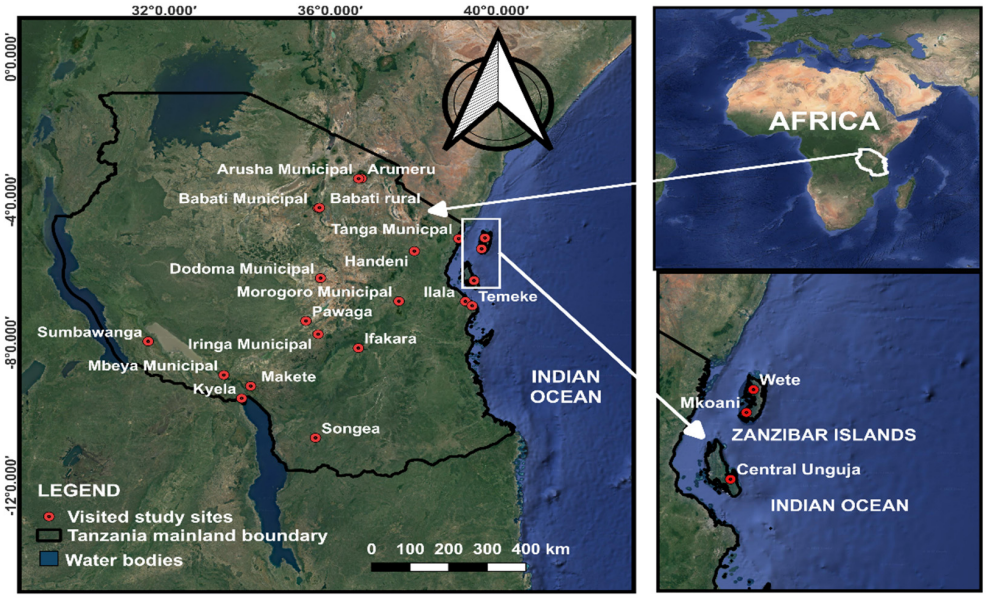

Figure 1. Map of Tanzania showing study districts and sample distributions.

3. Results

We adopted a thematic analysis approach and used the ICT-based services offered by the MoA to farmers as themes for presenting the results of the study. The findings show three active ICT-based services to farmers offered by the Tanzanian government through the MoA. The themes include a Mobile Kilimo (M-Kilimo) application with a web-based extension services, a call center, and the Digital Fertilizer Subsidy Distribution System (DFSDS). All three services are managed in the extension services section of the

MoA. Our study examined the findings on platform operation, stakeholder awareness, usage, and challenges related to farmers' access to digital services. Table 1 below shows the demographic characteristics of the cereal crop farmers that took part in this study.

Table 1. Demographic data of crop farmers (n = 22).

Variable	Category	Frequency (n)	(%)
Location (Regions)	Mbeya	4	18
	Rukwa	4	18
	Iringa	3	14
	Tanga	3	14
	Morogoro	2	9
	Manyara	2	9
	Ruvuma	2	9
	Mjini Magharibi	2	9
Location status (ward level)	Rural	15	68
	Semi-urban	7	32
	Urban	0	0
Gender	Male	14	64
	Female	8	36
Age group (years)	21–30	3	14
	31–40	3	14
	41–50	10	45
	51–60	4	18
	61 and older	2	9
Educational level	No formal education	0	0
	Primary education	17	76
	Secondary education	4	18
	Diploma	1	6
Farming activity (occupation)	Maize farming	9	41
	Rice (paddy) farming	8	36
	Wheat farming	5	23
Farm size	Below 3 hectares	1	5
	4–6 hectares	14	64
	7–9 hectares	7	31

Source: field data [17].

3.1. M-Kilimo Application

M-Kilimo is a mobile application and a web-based extension service freely accessible to farmers for consultations on various issues related to agriculture (crop farming, livestock keeping, and fishing). The service was launched in May 2020 and is available on the Android operating system, via Unstructured Supplementary Service Data (USSD) and on a website (http://exts.kilimo.go.tz/) (accessed on 12 December 2023). The MoA mentioned that the aim of M-Kilimo was to reach many farmers across the country with extension services. The services that farmers and other stakeholders can access on this platform include price information, the sale and purchase of agriculture products, and advisory services.

Extension service refers to knowledge and technology transfer from experts to farmers for the development of agriculture. Anaeto et al. [18] argued that effective agricultural extension services are critical to the development of the agriculture sector in any nation. For this reason, the Tanzania government has taken various steps to strengthen the agriculture extension system by recruiting grassroots extension workers at the national level, building the capacity of extension workers, and developing appropriate methods for delivering extension services [16]. However, the number of extension workers recruited is low in relation to the needs of Tanzania's farmers. To overcome this lack of extension workers, M-Kilimo is the digital approach that enables extension services to be provided to most farmers, including in areas where there are no extension workers.

Farmers can register through a USSD code, the website, or by downloading the M-Kilimo application. The findings show that most farmers used the USSD to register and use the M-Kilimo application. Farmers are encouraged to register themselves, but the system transmits the data to an extension worker in the relevant ward or district, who checks the farmers' data to ensure data quality. Extension workers are registered on the USSD and then work through the website. Potential buyers must also register for the service to meet farmers and facilitate the agribusiness. Farmers and other stakeholders can access the following services through M-Kilimo:

1. To access the prices of agriculture products: the farmer selects the price and the type of crop to receive a summary of the different markets and price information.
2. To sell: the farmers select this option to indicate the amount they want to sell (in kilograms, sacks, or tons) and the price. This information is made available to the public, and potential buyers can consult it and contact the farmer to achieve their business goal.
3. To buy: the farmers can select the agriculture products they wish to buy and receive a list of sellers with full details, such as contact and crop information.
4. Advisory service: stakeholders (farmers or buyers) can submit their requests by selecting the type of agriculture activity (crop farming, livestock keeping, or fishing), then write and submit a request. The system forwards the request to the sender's ward or district extension worker for a response. Requests that have not been answered at the ward level for a certain period of time are automatically transferred to the sender's district and regional level, and to the MoA for a response. Extension workers at all levels can also direct the requests to experts for answers.

M-Kilimo features a feedback option, enabling stakeholders to send comments on the provided services or opinions on other agriculture-related issues. Table 2 below shows the data on the M-Kilimo extension services offered to farmers by the MoA.

Table 2. M-Kilimo application service.

Name of the Platform	When Launched	Registered Stakeholders		Usage Statistics	
M-Kilimo application	May 2020	Farmers	7,269,106	Number of consultations (advisory services)	75,623
		Extension workers and experts	9985		
		Customers	24,523		
		Agricultural products sellers	26,927	Replied queries	73,839

Source: field data [17].

This study identified the challenges posed by the M-Kilimo digital extension services proposed to the various stakeholders, in particular the extension workers, buyers, and farmers. The findings reveal that the extension workers play significant roles in the M-Kilimo application. Extension workers are people trained in agriculture and employed by the government to provide training and transfer technology from research centers to farmers in order to increase agricultural production and productivity [16]. Extension workers also play a key role in farmers' adoption of digital services, as they help promote the M-Kilimo application to farmers and other stakeholders, help farmers register, approve farmers' data for registration, train farmers to use the services, and answer farmers' inquiries. However, many extension workers have not been properly trained or provided with the tools they need to deliver their services. The extension workers could only access the M-Kilimo application via the Internet, using advanced digital devices such as smartphones, tablets, and computers, but they were not provided these devices as working tools. On the other hand, no incentives were provided to extension workers to perform the job, despite using their own devices and money to purchase Internet bandwidth. Generally

speaking, the results show that extension workers make little or no use of the M-Kilimo application to provide services, due to various limitations.

Moreover, the MoA mentioned farmers' digital illiteracy as an obstacle to using the M-Kilimo application. According to the MoA, the majority of farmers use the USSD method for self-registration, which is challenging to most farmers. The slow typing speed observed during farmers' self-registrations in USSD leads to incomplete data and inquiries due to the system time-out. The study ascertained that there were approximately 400,000 incomplete registrations out of around 7.2 million registered farmers. USSD has a word limit per Short Message (SMS), but some farmers and extension workers exceeded the word limit when expressing or answering questions, leading to incomplete services. Furthermore, the MoA reported that telecommunication services were limited in some rural areas, to the extent that it was impossible to connect to at least the USSD network during the farmer registration outreach program. All farmers and processing industries interviewed in this study were not aware of the M-Kilimo application and extension services provided by the MoA.

The MoA acknowledged that the provision of services through the M-Kilimo application had suffered significant setbacks, particularly in terms of the support provided by extension workers. However, the government plans to acquire and distribute digital devices to all extension workers in the country. It also plans to establish partnerships with telecommunication companies so that extension workers can access the Internet free of charge.

3.2. A Call Center

The Tanzanian government through the MoA launched a call center service in July 2022 to enable wider access of extension services to the majority of farmers. This was performed to achieve a better inclusion of farmers who could not access the M-Kilimo application for various reasons, such as digital illiteracy or poor Internet services in rural areas. Farmers are free to call the center with any questions they may have about the agriculture sector and receive rapid answers or a callback. All stakeholders can ask anything about the agriculture sector, whether they relate to crops, livestock, fishing, marketing, or agro-inputs, to name but a few.

The call center is open 15 h a day (07:30–22:00 h), 7 days a week, with staff qualified in general agriculture. Moreover, queries that cannot be answered instantly by the staff are submitted to experts for professional consultations, then communicated to the sender through a callback service (see calls stats in Table 3). The service is only accessible in Tanzania through a public mobile number. The findings reveal that the method used for awareness campaigns are broadcast media (radio and television) and the website. The MoA has indicated that digital extension services through the M-Kilimo application and a call center aim to fill the gap of the required extension workers. The government has employed around 6704 extension workers out of the 20,538 needed, which represents only 32%, meaning that the majority of farmers have no access to extension services. The established and future digital services to farmers can fill the gap by reaching more farmers who have access to mobile phones and other digital devices. Table 3 below shows data of the call center extension service offered to farmers by the MoA.

Table 3. A call center extension service.

Name of the Platform	When Launched	Registered Stakeholders	Usage Statistics	
A call center	(July 2022)	All agricultural stakeholders are encouraged to call for suggestions, complains, request information, or seek professional advice	Total calls	5202
			Callbacks	2301

Source: field data statistics [17].

The study investigated the challenges posed by digital extension services via a call center. The findings reveal that low stakeholder awareness of the proposed service is a barrier to access, particularly for the majority of farmers living in rural areas. This is due to a weak campaign to promote the service in the short-term mass media and on websites. An MoA officer argued that "many rural farmers are not aware of the call center yet, but we are planning to promote the service through live media coverage in radio and televisions, and social media" (MoA, Dodoma).

3.3. Digital Fertilizer Subsidy Distribution System (DFSDS)

Since independence, the Tanzanian government has maintained its subsidy program, particularly for fertilizers for farmers. Until recently, subsidy distribution was performed manually through the local government from the ministry level to regional, district, ward, and village administrations. This distribution process faced many challenges, including corruption, cheating, and fraud, which resulted in poor access to subsidies by many smallholder farmers. Large- and medium-scale farmers used corrupt leaders to access large amounts of the subsidies and deny access to most smallholder farmers. On the other hand, agro-input traders used the opportunity to illegally export subsidized inputs to neighboring countries [19]. Therefore, this method of distribution was ineffective and had little impact on the farming community.

The government has realized the potential of digitizing the subsidy distribution service to eliminate or minimize the challenges of the old distribution method. In September 2022, the government launched the DFSDS to manage the distribution of fertilizer to all farmers in Tanzania. The DFSDS is managed by a government agent, the Tanzania Fertilizer Regulatory Authority (TFRA), and services are housed in the extension services section of the MoA. The findings reveal that, despite some challenges, the farmers who are registered receive the subsidies as expected. The findings also show that many farmers receive fertilizer subsidies for the first time under the new digital distribution system. This justifies the claims about the vulnerability of the manual distribution method and the effectiveness of the digital distribution approach. The DFSDS registers the main stakeholders in the fertilizer supply chain, which include importers, manufactures, agro-dealers, and farmers. Table 4 below presents statistical data from the DFSDS.

Table 4. Fertilizer distribution statistics.

Name of the Platform	When Launched	Registered Stakeholders		Usage Statistics
Digital Fertilizer Subsidy Distribution System (DFSDS)	September 2022	Farmers	2,828,300	Over 350,000 farmers received subsidies by 16 January 2023
		Importers	29	
		Manufacturers	3	
		Agro-dealers	3181	

Source: field data statistics [17].

Farmers are registered at village and ward levels by extension workers in collaboration with the local government administration. The study findings show that some telecommunication companies were used to speed-up the registration process, but the government stopped their participation due to poor-quality data for the registered farmers. Important registration information includes personal details, such as national identity and mobile number, location, and size of the farm. Once a farmer is registered, the system generates a unique number and sends it to a farmers' mobile number through a Short Message (SMS). A farmer can use the unique number and identity card to claim subsidized fertilizer from the nearby contracted and registered agro-dealer. Farmers are allocated a number of subsidized fertilizer bags based on the size of their farm, as indicated during the registration process. The system also sends an SMS to the farmer for each bag of fertilizer

sold, with its unique number, to prevent the use of other peoples' contact details to claim the subsidy (see Figure 2).

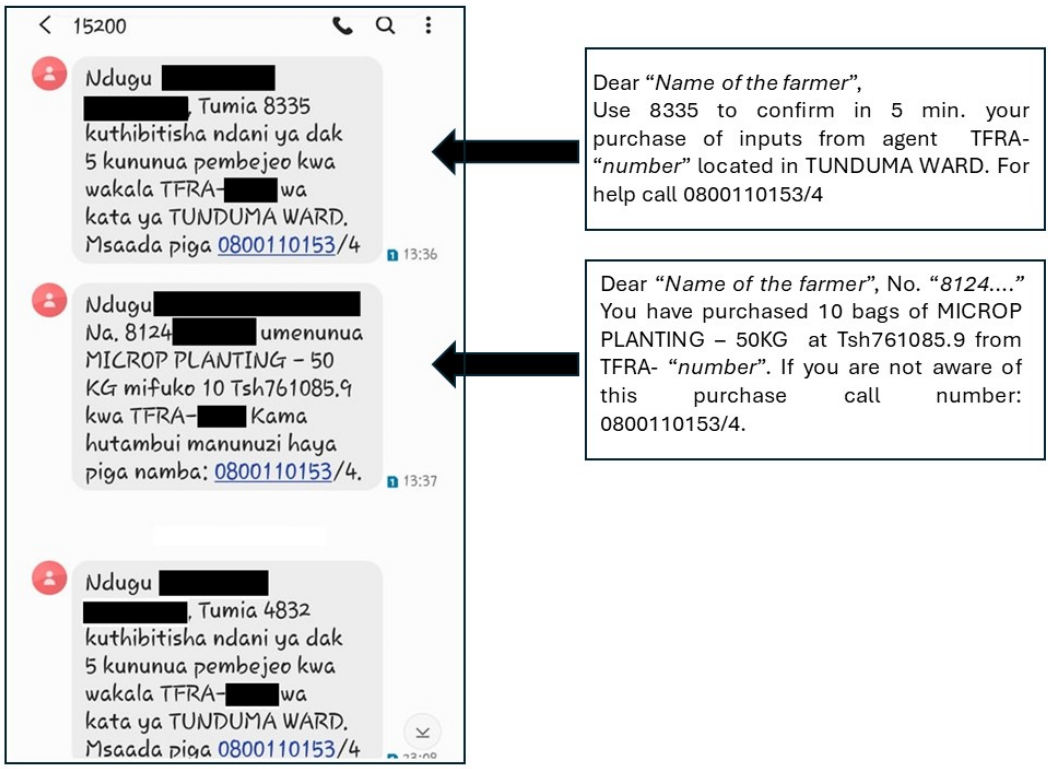

Figure 2. An example of an SMS sent to a farmer via the DFSDS.

The government selects and registers the importers and manufacturers involved in the subsidy program. Normally, the agreement with importers and manufacturers is to distribute and sell fertilizer to all farmers in the country at a half market price, with the government compensating for the other half. Importers and manufacturers select and work with agro-dealers in all regions in the country. The agro-dealers sell at a half price and record the transactions of the sales to all subsidized farmers with their unique numbers. This information is submitted to the importers and manufactures, then to the government for reimbursement. In this case, the government only compensates for fertilizers to which farmers have access, which improves accountability and transparency in the supply chain.

The main challenge identified for the DFSDS is the low quality of data from registered farmers. This can be due to farmers' lack of awareness of the service's objectives, and intentional cheating by farmers and extension workers. For instance, some farmers reduced their farm size during registration due to the fear of tax impositions on their land. This automatically affected the number of subsidized fertilizer bags assigned to their unique number. Some farmers exaggerated the size of their farm in order to be allocated numerous bags of subsidized fertilizer, which they could claim at half the market price and sell at a higher price on the black market. This fraud provides access to subsidized fertilizer for illegal export to neighboring countries. For instance, 400 bags of subsidized fertilizer were seized in the Songwe region, while being transported to Malawi [20]. A lack of resources has contributed to this situation of poor data quality, as an extension worker looks after an average of 2000 households, making it difficult to verify each farmer's holdings. Thus, the registration process was slow, and many farmers were not registered for the subsidy program. To speed up the registration, the government allowed some telecommunication companies and banks to register farmers through their branches in the country. However, the government immediately halted the approach due to incorrect data entries during farmers' registrations.

4. Discussion

4.1. General Observations

The Tanzanian government has played a major role in the development of the agriculture sector since its independence. The digital services introduced are part of the e-Government project aimed at serving the growing population and meeting service demands with limited resources [7]. The main strength of the government is to adopt ICT for development and encourage the digitalization of services in various sectors. However, ICT-related projects face various challenges in low- and middle-income countries, including Tanzania. The major setback to e-Government agricultural services for farmers in Tanzania is the approach to implementing digital services, the digital divide, and financial and other barriers [8]. Existing digital services were implemented using a top-down approach; key stakeholders, including users, were therefore not involved in the initial design phases. The approach is cited as one of the main factors in the failure of ICT-based projects in developing countries, including Africa [21]. The top-down approach to implementation is characterized by decision making and control; thus, stakeholders are not involved in the early stages of service design, and the key factors and environmental conditions for successful implementation are inadequately taken into account [22]. This study also revealed that the M-Kilimo application and the DFSDS were for the first time introduced to extension workers and farmers for actual use. It involved a short training course for a few regional representatives of extension workers, in the form of a Training of Trainers (ToTs) to train other extension workers in their respective regions. Next, the extension workers had to train farmers and register them on the digital platform so that they could use it. Indeed, users of digital services are not equipped and motivated to adopt and use the system, as the results indicate.

This study was purposely carried out in rural and semi-urban areas where agriculture is the main economic activity for the majority of small-scale farmers. Therefore, apart from constant power outages in all regions in Tanzania, some areas, such as Ngana (Kyela district), Lumemo (Ifakara district), and Mollo (Sumbawanga district), have not been electrified, affecting access to technology. In addition, it was observed that digital illiteracy and inadequate ICT infrastructure, particularly in rural areas, were major obstacles to farmers' and extension workers' access to technology. For instance, poor network coverage was observed in Mkata ward (Handeni district), Lumemo ward (Ifakara district), Galapo ward (Babati district), Ngana ward (Kyela district), Mollo ward (Sumbawanga district), and some villages in the Matogoro ward (Songea district).

Moreover, the existing agricultural e-Government services do not meet the farmers' needs in a complete farming cycle. Farmer's unmet needs, as identified by Mushi et al. [14], include access to farm-specific advisory services, farm management information, credit, and insurance services. Duplicating efforts in existing digital services wastes time and resources. This is due to the absence of digital innovation plans that build on and leverage existing systems and services. For instance, the M-Kilimo application, established in 2020, registered more than 7.2 million farmers while the DFSDS launched in 2022 started registering farmers from scratch. This duplication of effort would not have happened if an integrated data-sharing system had been in place. Figure 3 shows existing non-integrated e-Government services for farmers in Tanzania.

Although the e-Government services offered to farmers help solve a variety of problems, such as extension services to farmers in remote areas, and reducing fraud and cheating in the distribution of government fertilizer subsidies, these services do not solve the critical problems of a complete farming cycle, such as access to specific farm advisory, credit, and insurance services. Figure 3 shows the duplication of existing digital services, in particular, farmer registrations for the M-Kilimo application and the DFSDS. Moreover, these services operate independently leading to low-quality services and inconveniences. For instance, call center experts and consultants have no access to farmer data in any of the existing systems for specific farm advisory services. What is more, a farmer registered in the M-Kilimo application will also have to register on the DFSDS, and so on for future systems.

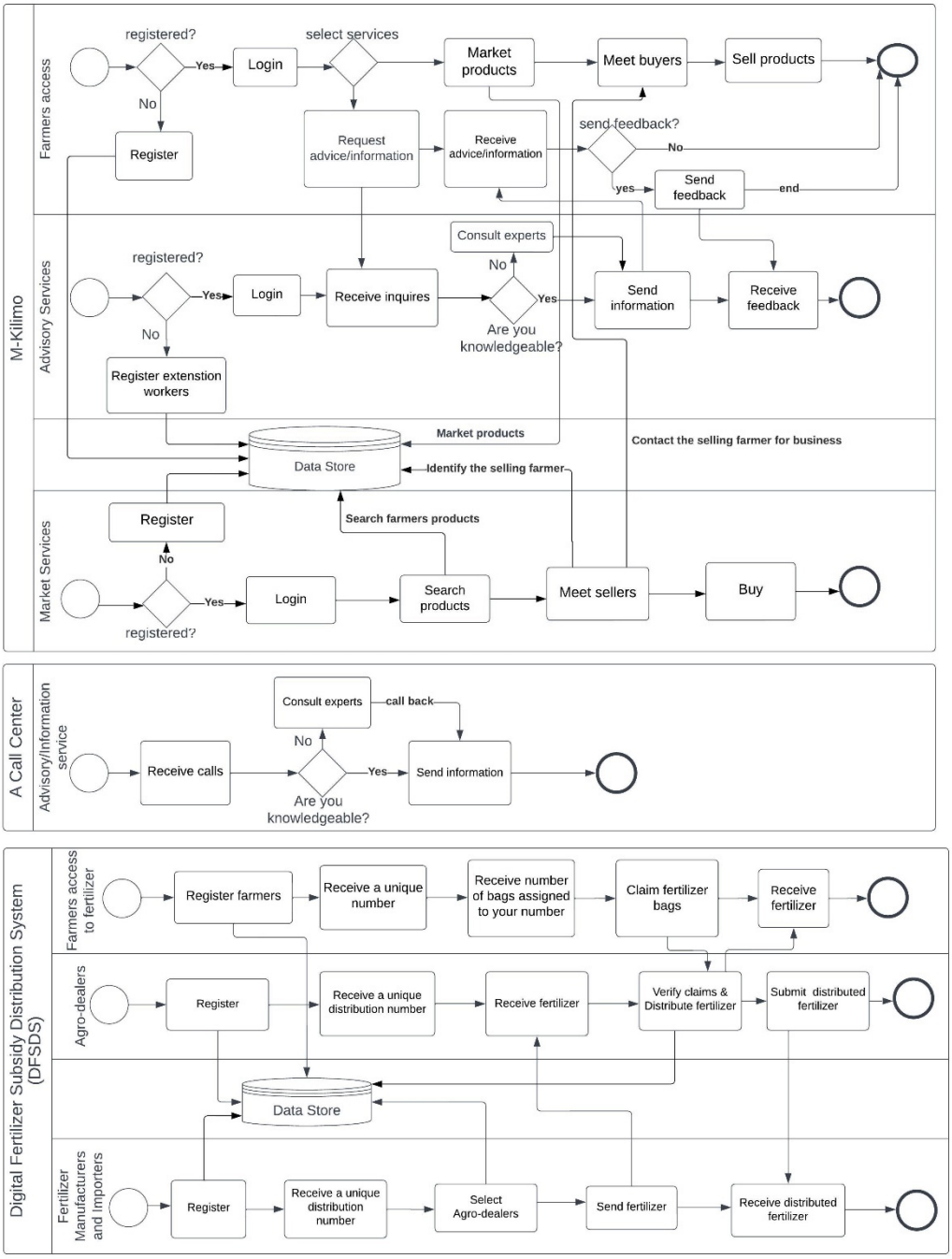

Figure 3. Existing non-integrated e-Government services for farmers, represented in the form of a Business Process Model and Notation (BPMN).

The use of USSD codes was the predominant method of smallholder farmers' access to the M-Kilimo and DFSDS services. This is because most smallholder farmers have basic mobile phones and few own smartphones. A study by Silver and Johnson [23] found that Tanzania was the Sub-Saharan country with the lowest rate of mobile device ownership by adults, whereby 62% of adults owned basic mobile devices, 13% owned smartphones, and 25% had no phone at all. Therefore, the use of USSD codes was seen as an effective method for enabling the majority of smallholder farmers to access e-Government agricultural services. Moreover, USSD codes operates well, even in limited network-coverage situations, making it effective for most farmers in rural areas [24,25]. The major obstacle to the use of USSD codes revealed by this study is the digital illiteracy of many farmers in rural and

semi-urban areas. Otherwise, USSD code services remain an effective method of reaching the majority of people living in remote areas with limited ICT infrastructure.

The study also revealed that many farmers and other stakeholders were unaware of the digital services offered by the government. Indeed, the M-Kilimo and DFSDS services, which involve farmer registration, have not registered even half of Tanzania's estimated 20 million farmers (12 million households) [26]. Moreover, all interviewed participants, except the extension workers, indicated to be unaware of these services. The extension workers did not make effective use of digital platforms to deliver services to farmers as planned due to various limitations, including the lack of digital devices and Internet services. Furthermore, the agriculture sector is still dominated by elderly and illiterate people. The study by Guo et al. [27], Zou et al. [28], and the European Commission [29] also reported similar results that the aged population dominates the agriculture sector, which poses a threat to agriculture development. The envisaged FDIS platform could face similar challenges if appropriate implementation measures are not considered, such as stakeholder involvement, awareness campaigning, resources availability and encouraging young people to participate in agribusinesses, to name but a few.

4.2. Toward a Farmers Digital Information System (FDIS)

We are working on an innovative integrated digital system, which is essential to enable farmers' access to services in a complete farming cycle and allow future services to be built upon. Indeed, the comprehensive data on farmers, farms, and other stakeholders contained in the proposed FDIS platform can solve these problems, as current and future services will empower farmers and offer them services throughout the complete farming cycle under one roof. The FDIS will strengthen the existing digital services in the areas of marketing agriculture products, subsidy distribution, and access to credit, insurance, and quality farm inputs to protect the environment and consumers' health. Unlike the current systems, the FDIS will enable extension and advisory services to be coordinated, as experts and consultants will access the comprehensive farmer and farm data for specific advice. Furthermore, it will provide access to all other services around the farmer through a network of agricultural players, such as financial and insurance service providers, input suppliers, agricultural processing industries, and other players throughout the country. Chandra and Collis [30] argued that many developing countries' agriculture sectors face similar challenges. Therefore, although the FDIS platform is designed for a specific country, the platform can be adopted to other lower- and mid-income countries.

4.3. Implications of the Study Findings

The results of this study can contribute to policy development and future e-Government services. We therefore recommend the following:

- e-Government services should involve key stakeholders from the earliest stages of design to understand the social, infrastructural, and environmental contexts for successful and sustainable implementation.
- e-Government services should not be introduced to users unannounced. The government must use its resources to raise awareness and educate users about the importance of these services, while gathering their opinions on the changes.
- Closely examine the working environment, including the availability of digital devices and the cost of Internet for service providers such as extension workers.
- The proposed digital services must be well planned and designed to enable their successful use on existing platforms.
- The government should invest in awareness campaigns to influence the use of e-services and achieve the service objective for targeted stakeholders.
- The government should implement an integrated digital platform with comprehensive data that meet the needs and enables stakeholders' access to all essential services in the complete farming cycle.

4.4. Limitations of the Study

This study focused on the state of e-Government agricultural services in Tanzania. Consequently, digital agricultural services and startups offered to farmers by the private sector were not included in the study. The e-Government agricultural services studied are only available in Tanzania. As there is no evidence of e-Government services for livestock farmers, this study was also limited to Tanzanian's three main cereal crops: maize, paddy, and wheat.

4.5. Future Work

The study examined existing e-Government services and the challenges to be met in order to pave the way for the future integrated platform called FDIS, which will enable stakeholders to access all essential services in a comprehensive way. We will collect the views of all key stakeholders to create a participatory design and assess an enabling environment for FDIS implementation, addressing stakeholders' needs and motivation for successful adoption and use. In the future, the FDIS platform can be integrated with blockchain technology, which looks promising for the evolution of agriculture and sustainable developments in developing countries, as it offers robust mechanisms for securing the various transactions required [31,32].

5. Conclusions

Generally, e-Government services are essential for the development of the agriculture sector through the efficient and effective delivery of services to stakeholders. Despite some difficulties, existing ICT-based services for farmers, particularly DFSDS, have enabled many registered farmers to access government subsidies. Despite some 60 years of government subsidy programs in Tanzania, most registered farmers reported that they were receiving fertilizer subsidies for the first time. Therefore, the system of the manual distribution of subsidies has limited government services and their impacts on farmers and the agriculture sector as a whole. The call center has enabled extension services to be expanded, as most farmers have access to mobile phones that they can call to receive professional advice on best farming practices. However, the challenges posed by the approach to implementing e-Government services, the lack of motivation among extension workers due to a poor working environment, and low stakeholder awareness of existing e-services have all contributed to reducing the impact of e-Government services in Tanzanian agriculture. In addition, the lack of integration between digital e-Government platforms has led to the duplication of efforts and disadvantages in the provision of services to farmers and other stakeholders. As a result, FDIS—a more comprehensive integrated digital platform—is potentially useful for sustainable agriculture in Tanzania and can be adopted in many other developing countries.

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