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Role of Mobile-Based SMS in Agricultural Information Dissemination: A Case Study of Kordofan and Sinnar States, Sudan

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ABSTRACT

Background and Objective: Technology plays a pivotal role in disseminating information where farmers can receive updated information via Short Message Services (SMS). This research was conducted from 2020 to 2023 while implementing the Integrated Agriculture and Marketing Development Project (IAMDP) activities in North, West, South, and Sinnar States, Sudan. The objective of this research was to investigate the effectiveness of mobile-based SMS technology in the dissemination of farm-related information to smallholder farmers. Moreover, to understand the extent of use of SMS information; and how best the technology be promoted. **Materials and Methods:** Data were collected through a structured questionnaire and group discussion involving 97 communities by a purposive selection method, characterized by network services availability. Additionally, interviews were conducted in each community where on average 5 respondents were interviewed per community. Results were analyzed using a T-test, Chi-square test, and correlation at a significant level of ($p<0.05$). **Results:** It revealed that the majority of respondents (91.8%) accessed, read, and benefited from the SMS. As high as 84.4 and 70.1% of respondents showed interest in joining SMS and WhatsApp groups respectively. The Chi-square test showed a highly significant association ($p\leq0.000$) between the distance of the states from the call center and active mobile numbers. A highly significant association ($p\leq0.000$) between the status of benefiting from the SMS and reading SMS was detected. There was also a highly significant association ($p\leq0.000$) between the participants' interest to continue receiving the message and the status of benefiting from the SMS. **Conclusion:** The study concluded that SMS successfully achieved its objectives and is promised to be adopted in all the states provided strengthening the network to secure wide dissemination and immediate access by farmers is done. Moreover, the SMS system is promised and it supports extension and agriculture development.

KEYWORDS

Communication, smartphones, smart agriculture, knowledge transfer, network service

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INTRODUCTION

Human resource development is pivotal to the integration of technology and the advancement of sustainable development. The information-driven, decision-making agricultural system, known as precision agriculture, aims to optimize agricultural output and is frequently characterized as the next significant advancement in agriculture[1,2]. Agricultural extension is essential for the dissemination of information necessary for sustainable and productive agriculture[3]. Extension services may connect scientific discoveries with practical applications via methodical and evidence-based methodologies. Consequently, as extension services progressively integrate digital tools, climate-smart practices, participatory methodologies, and inclusive strategies into their operations, as well as marginalized communities[4]. The quality, timeliness, and trustworthiness of information are three critical characteristics that must be provided to the farmers to fulfill their requirements and expectations[1].

Agricultural extension, informed by frameworks like communities of practice (CoP) and the technology acceptance model (TAM), utilize diverse methodologies, including field demonstrations and the incorporation of information and communication technologies (ICTs), to actively involve farmers and advocate for innovative practices that enhance agricultural sustainability[5]. Information and communication technologies (ICTs) have become an essential instrument for the interchange of information providers and users at any time and location. Currently, SMS is the most practical, cost-effective, and widely accessible tool for sharing and exchanging knowledge and ideas in poor nations[6]. Despite the growing penetration of mobile networks and devices[7] and the continues advancement of ICT utilization in extension services, including tele-centers, the internet, television, radio broadcast, SMS voice, SMS text, and videos[8], these developments are anticipated to significantly enhance the accessibility of information for small farmers[7,9]. Nevertheless, even these channels possess distinct characteristics. Television and radio, as conventional ICT media, may achieve wider reach; yet, the rising schedules for agricultural information may still limit farmers access to pertinent data[10]. While smartphones can provide innovative methods for disseminating information to farmers[11,12], essential factors such as the ability to operate smartphones and financial resources required for a functional internet connection may still prevent many resource-poor farmers from accessing the information[13]. Mobile phones conserve energy and time for the farmers, consequently enhancing their income. It provides an opportunity for the farmers to communicate directly with market dealers to sell their products at a good price[14]. The dissemination of ICTs in developing countries provides much opportunity to transfer knowledge and information to private companies[14,15]. Besides its roles in business and communication, SMS and voice recording have given improvements in social relations[14,16]. Educated farmers use SMS to get the latest updated agricultural information such as marketing information that facilitates the farmer in making logical decisions[17]. Therefore, the system of agricultural extension has limited reach even after decades of having been set up[7], and sharing information via technology and access among stakeholders e.g., experts of agricultural knowledge (academe) and knowledge end-users (farmers) is a dire need[6]. Lack of access to information and knowledge transfer can hamper agricultural production in rural farming communities in Sub-Saharan Africa (SSA)[18]. This paper looks at the impact of access to SMS information through mobile phones across Sudanese agriculture, particularly for small-scale farmers.

The objective of this study was to address the following questions: Are mobile phones in practice being used for agricultural purposes? Is agricultural information is being beneficial and of value to farmers? Was the SMS information system practically efficient and possible to be generalized? In addition, is there any evidence for adopting SMS agricultural information systems in the area?

MATERIALS AND METHODS

Study area: This study was conducted in four States North Kordofan, West Kordofan, South Kordofan, and Sinnar States during the implementation of the Integrated Agriculture and Marketing Development Project (IAMDP) by the Government of Sudan (GoS) with financial aid from the International Fund for

Agricultural Development (IFAD), GoS, Private Sector participants and the beneficiaries. The project aimed at improving incomes and resilience to climate change of the smallholder farmers, rural women, and youth in rain-fed areas of Sinnar, North, South, and West Kordofan States. Moreover, the project aimed at better access to improved agricultural inputs, services, and climate-resilient technologies, rural finance and appropriate marketing support, and better organization of the producers' associations. Among its working packages, the project implemented Short Messaging Services (SMS) in 97 out of 140 of its communities that were characterized by network service availability. The communities continued to receive the SMS services provided by IAMDP from 2020 until 2022. The SMS services were directly sent to participants who had mobile phones and were interested in receiving the services.

Data collection: In total 97 communities from all four states were targeted, and data were collected using a structured questionnaire. Where the respondents were purposively selected as they are included in the project area, simultaneously on average 5 respondents were interviewed. For this purpose, initial contact was made with the farmers face-to-face, and they explained the objectives of the study, and their consent was taken for participating in the study. The structured questionnaire consisted of three forms: Investigation form, interest to join WhatsApp group form, and interest to join SMS group form. These developed forms were first tested in the field before critical data collection. Each form was filled through a personal interview with the respondents, the topics covered in the forms included: the presence of the participants in the community, availability of the participants, active mobile phone numbers, access to SMS, recipients of SMS, benefiting from SMS, forwarding the information to others, interest of non-participants to join SMS service and interest in joining proposed WhatsApp group.

Statistical analysis: All the data collected from individual face-to-face interviews and group discussions were compiled and organized into meaningful tables for analysis. Descriptive statistics such as mean, frequency, and percentages were calculated. The analysis was carried out using Statistical Packages for Social Sciences (SPSS, version 22.0) and Microsoft Excel. However, the T-test, Chi-square test, and correlation were tested using significant level ($p<0.05$).

RESULTS

General characteristics of the respondents: The total respondents as per their interest in joining the group (Table 1) show 682 for joining SMS and 230 for WhatsApp.

Distribution of the communities targeted by the project, registered participants for extension message services, distance from SMS center, and status of the network: The distribution of communities targeted by the IAMDP project in four states is shown in Fig. 1. The highest targeted community was in South Kordofan State (33%). Additionally, the number of participants who access SMS from the call center is shown in Fig. 2, whereas the number in the range of 46-60 registered participants in the particular communities is called the appropriate number.

Table 1: General characteristics of the respondents

Statistic	Total	Avg	STD	Max
Number of participants in all communities	2747	28	16	58
Compatible names	2553	26	15.4	56
Active numbers	2295	24	14.3	55
Existence of participants	2459	25	14.9	54
Access to SMS	2057	21	14.3	52
Receiving SMS	2003	21	14.1	52
Benefiting from SMS	2016	21	14.2	52
Interest in receiving SMS	2143	22	14.8	56
Changing to Sudani SIM card	117	1	2.4	12
Interest in joining the SMS service	682	7	7.3	40
Interest in joining WhatsApp group	230	2	2.7	16

Avg: Average participant within community and STD: Standard Deviation

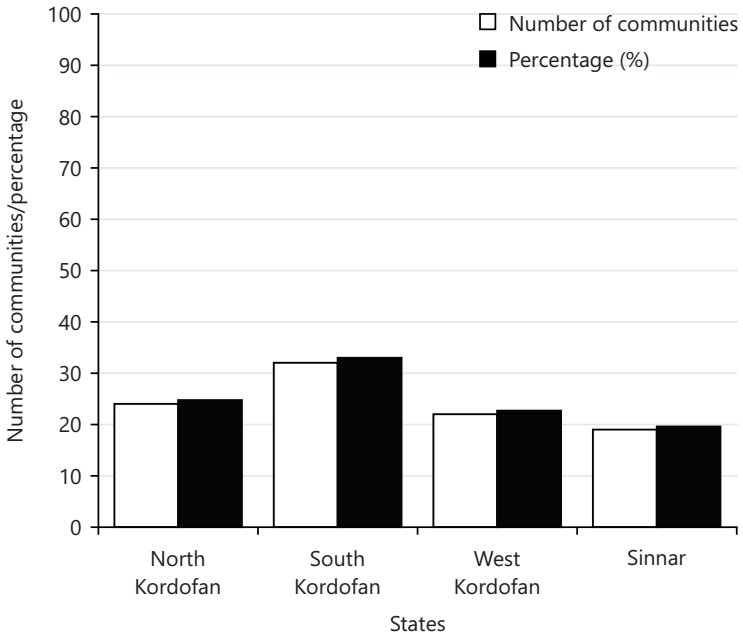

Fig. 1: Distribution of the communities targeted by the project

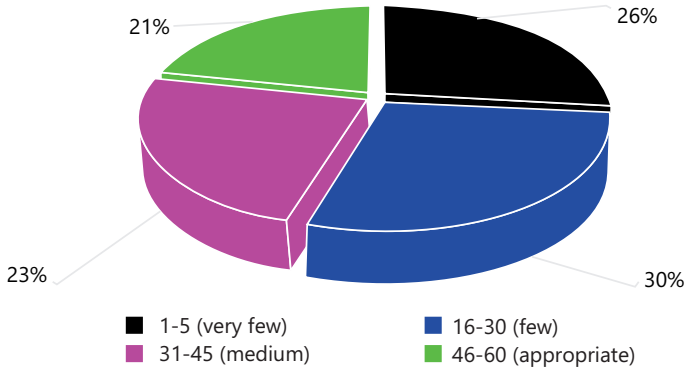

Fig. 2: Distribution of registered participants for extension message services in the community

The distance between cell centers varies from one community to another. This variation could affect the network status. However, Fig. 3 and 4, indicate the distance of the targeted communities within the states from call center and network status respectively, North Kordofan State is located in the near zone while Sinnar is located in the far zone, on the other hand, West Kordofan and South Kordofan States were partially located in medium and far zone. The status of the network depends mainly on the distance from the call center and varies between weak and strong.

Receiving, reading, interest in joining SMS groups, access to message, and change of SIM by respondents: The majority of farmers (91.8%) are interested in receiving information via SMS. However, 84.5% of respondents showed their interest in joining the SMS group to receive any updates or information regarding farming information. Additionally, the number of farmers who read the SMS received is equal to farmers who benefited from SMS services (Fig. 5). Despite that, 71.1% are interested in using the Zain SIM card compared to 28.9% who are willing to change to the Sudani SIM card company could be because there is fluctuation in Zain services in their area.

Farmers benefited and read messages compared with the active number: Most farmers (56.7%) indicated that they read the SMS message lower than the active number and 55.7% reported that they benefited from SMS in terms of lower than the active number (Fig. 6). A study by Hamad *et al.*[19] showed

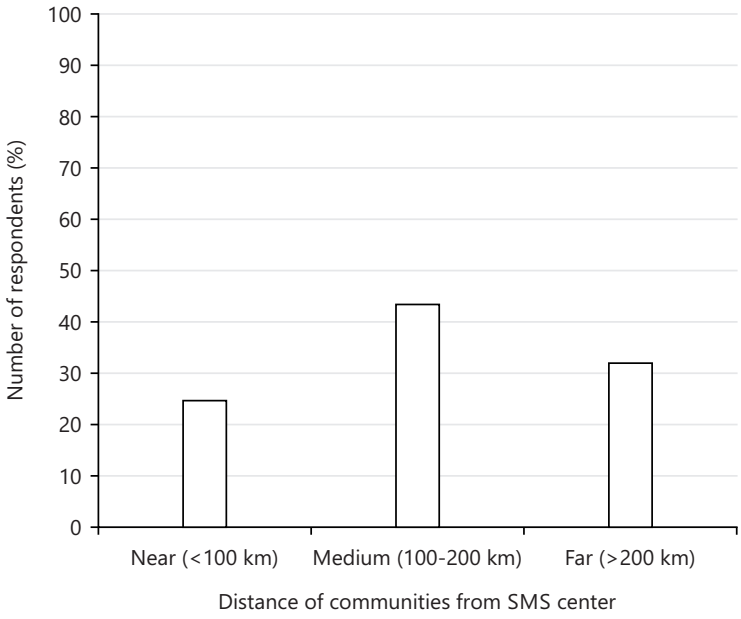

Fig. 3: Distance of communities from SMS center

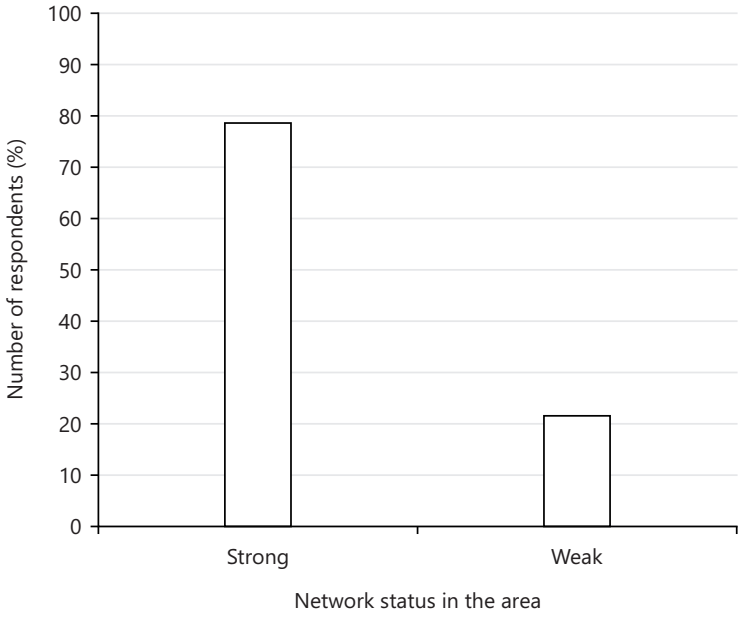

Fig. 4: Status of the network in the study area

that there is high interest from farmers in agricultural information due to its benefits for them as stated by more than 75% of respondents.

The result in Table 2 shows the p-value is 0.000 (≤0.05), therefore, we can decide with 95% certainty that there is a highly significant association between the distance of the states from call centers and active mobile numbers (actually mobile working among the community). This is evidence that if the call center is near the target community the extension message will be received immediately and successfully. Additionally, there is a significant association between the number of registered participants for extension message services in the community and farmers who benefited from the messages compared with an active number (Table 3). However, a statistically significant difference was observed (p = 0.001), indicating the majority of those who benefited from SMS services belonged to the few (16-30) followed by other categories (Table 4). Meanwhile, no significant difference was found (0.28) among those interested in

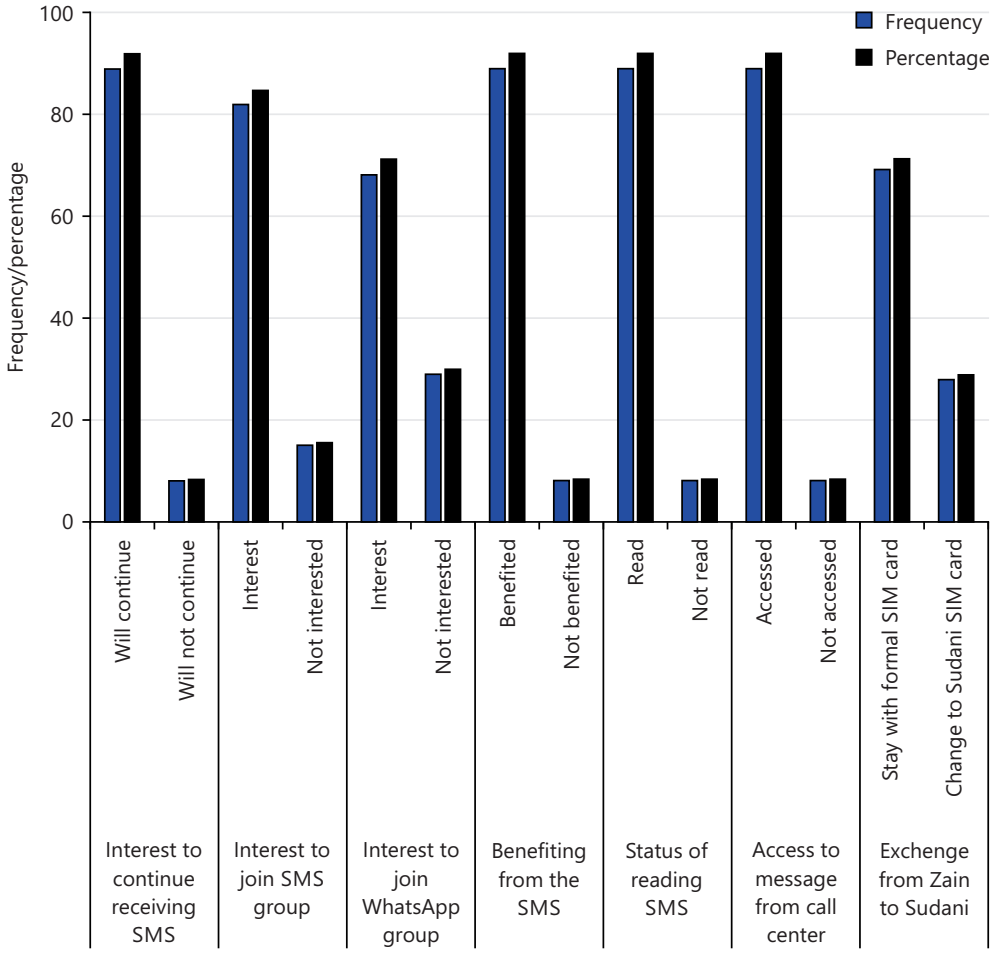

Fig. 5: Receiving, reading, interest in joining SMS groups, access to message, and change of SIM by respondents

Table 2: Chi-square for significant differences between the distance of the states from the call center and active mobile numbers

	Active mobile numbers				
Parameter	Few	Medium	Appropriate	Standard	Significant
Near (<100 km)	2	7	13	2	0.000
Medium (100-200 km)	11	11	16	4	
Far (>200 km)	21	10	0	0	

$p \leq 0.05$ = Significant, indicating by Chi-square test and $\chi^2 = 33.3$

Table 3: Chi-square test for differences in registered participants benefited farmers and active users of extension message services

	Farmers benefited from SMS compared with active number			
Parameter	Typically to active number	Lower than active number	More than active number	Significant
Very few (1-15)	13	13	0	0.02
Few (16-30)	15	11	1	
Medium (31-45)	10	13	0	
Appropriate (46-60)	2	17	2	

$p \leq 0.05$ = Significant, indicated by the Chi-square test and $\chi^2 = 14.97$

joining the SMS group. (Table 5), even though the interest of farmers in joining WhatsApp groups was statistically significant ($p = 0.04$) among the categories (Table 6). Conversely, a highly significant relationship was found ($p = 0.000$) between farmers who benefited from the SMS services reported reading messages compared to non-beneficiaries (Table 7).

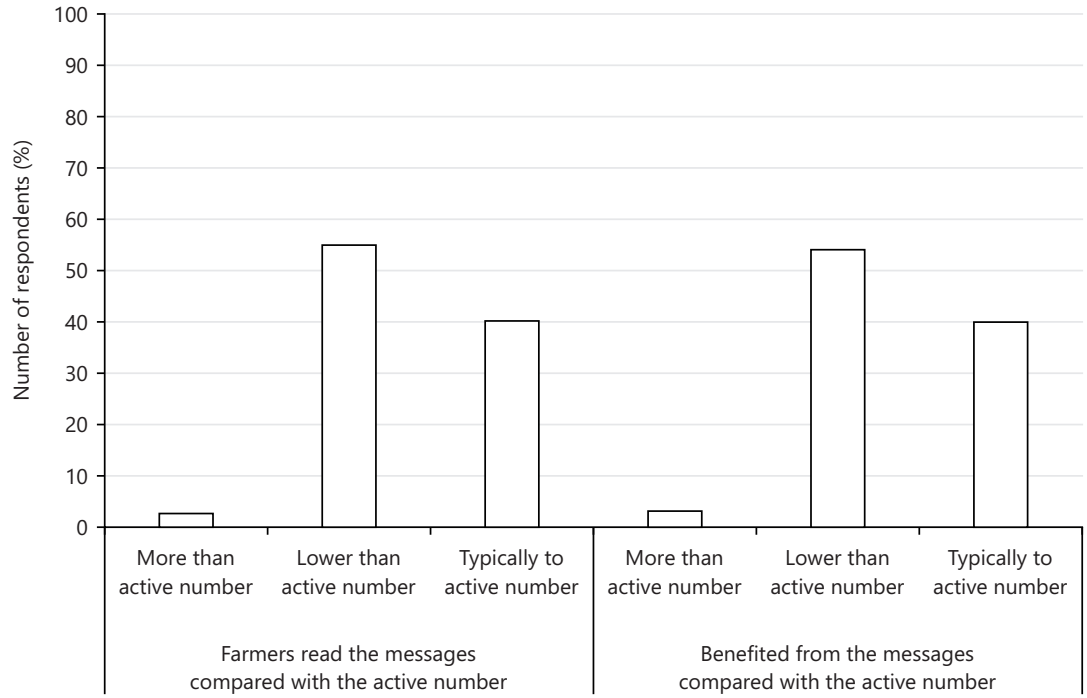

Fig. 6: Farmers benefited and read messages compared with the active number

Table 4: Chi-square test differences between registered participants and benefiting status in extension message services

	Status of benefiting from SMS		
Parameter	Benefited	Not benefited	Significant
Very few (1-5)	19	7	0.001
Few (16-30)	26	1	
Medium (31-45)	23	0	
Appropriate (46-60)	21	0	

$p \leq 0.05$ = Significant, indicated by the Chi-square test and $\chi^2 = 16.7$

Table 5: Chi-square test for differences between registered participants and interest in joining the SMS group

	Interest in joining SMS group		
Parameter	Interested	Not interested	Significant
Very few (1-5)	25	1	0.28
Few (16-30)	22	5	
Medium (31-45)	18	5	
Appropriate (46-60)	17	4	

$p \leq 0.05$ = Significant, indicated by the Chi-square test and $\chi^2 = 3.8$

Table 6: Chi-square test for differences between registered participants and interest in joining the WhatsApp group

	Interest in joining WhatsApp group		
Parameter	Interested	Not interested	Significant
Very few (1-5)	18	8	0.04
Few (16-30)	24	3	
Medium (31-45)	12	11	
Appropriate (46-60)	14	7	

$p \leq 0.05$ = Significant, indicated by the Chi-square test and $\chi^2 = 8.2$

Table 7: Chi-square for significant differences between the status of benefiting from SMS and reading SMS

	Status of reading SMS		
Parameter	Read	Not read	Significant
Benefited	89	0	0.000
Not benefited	0	8	

$p \leq 0.05$ = Significant, indicating by Chi-square test, $\chi^2 = 97$

Table 8: Chi-square test for differences between benefiting status, messages recipients, and active users

	Farmers received the messages compared with the active number		
Parameter	Completed	Incompleted	Significant
Benefited	42	47	0.01
Not benefited	0	8	

$p \leq 0.05$ = Significant, indicating by Chi-square test, $\chi^2 = 6.7$

Table 9: Chi-square for significant differences between interest to continue receiving the message and status of benefiting from the SMS

	Status of benefiting from SMS		
Parameter	Benefited	Not benefited	Significant
Will continue	89	0	0.000
Will not continue	0	8	

$p \leq 0.05$ = Significant, indicating by Chi-square test and $\chi^2 = 97$

In addition, the result found a significant difference ($p = 0.01$) between farmers completing the process and their number are active compared to remain not completed (Table 8). Finally, regarding the farmer's perception in the future status of SMS, the majority of farmers who benefited stated that they would continue using SMS indicating a significant difference (0.000) compared to non-beneficiaries (Table 9).

DISCUSSION

According to this study, 91.8% of the farmers accessed, read, and benefited from the SMS-based extension messages, while 84.4 and 70.1% showed interest in joining SMS and WhatsApp groups, respectively. The Chi-square test revealed a highly significant association ($p \leq 0.000$) between the distance of the states from the call center and active mobile numbers, as well as between the status of benefiting from SMS and reading SMS. These results confirm the effectiveness of SMS in agriculture knowledge dissemination and its potential to bridge the information gap among smallholder farmers in Sudan. The use of SMS for agricultural extension has been widely recognized as a cost-effective and accessible tool for reaching farmers in remote areas. Similar studies in developing countries have demonstrated the positive impact of SMS-based information services on agricultural decision-making. Conversely, SMS significantly improved farmers' access to timely and relevant agricultural information, leading to better productivity[20,21]. Likewise, Camacho and Conover[22], found that SMS-based price and weather information improved smallholder farmers' decision-making in Colombia. A study by Sharma *et al.*[7] highlighted that SMS services enhanced farmers' knowledge about climate-smart agriculture and risk management strategies. Additionally, Hamad *et al.*[19] observed that mobile phones played a crucial role in agricultural information transmission, with farmers preferring SMS over traditional media like radio and television. Meanwhile, SMS-based advisory services are particularly beneficial in areas where internet penetration is low, making it a vital tool for smallholder farmers[23,24].

However, despite the high adoption rates of SMS services in this study, some challenges remain. The findings indicated that some registered participants did not fully utilize the service due to network connectivity issues and literacy constraints. This finding aligns with previous research by Nyaplue-Daywhea *et al.*[9] who found that while mobile phone-based extension services improved information dissemination, challenges related to literacy, digital skills, and internet connectivity affected their overall effectiveness. Additionally, Krell *et al.*[18] observed that smallholder farmers in Sub-Saharan Africa still have barriers to fully utilizing mobile-based agricultural information due to economic constraints and limited access to technical support.

This study provides empirical evidence on the effectiveness of SMS in agricultural extension services in Sudan, contributing to the growing body of literature on mobile-based knowledge dissemination in agriculture. The results highlight the importance of strengthening ICT infrastructure, particularly mobile

networks, to ensure wider adoption and improved accessibility for farmers. The study also underscores the need for integrating additional digital platforms, such as WhatsApp, which has gained popularity among farmers as an interactive tool for knowledge exchange.

Despite its contributions, this study has certain limitations. First, the reliance on SMS assumes that all farmers can read and interpret the messages, which may not always be the case due to literacy barriers. Second, network fluctuations in some areas affected message delivery, impacting accessibility. Last while the study provides insights into farmer preferences and adoption rates, it does not measure the long-term impact of SMS-based information on productivity and income, which require further research.

Future studies should focus on assessing the impact of SMS-based extension services on actual farm productivity and income levels. Additionally, exploring the integration of voice-based messaging services could help address literacy challenges among farmers. Policymakers and agricultural extension services should work towards expanding ICT infrastructure and developing more inclusive digital communication strategies to enhance agricultural knowledge dissemination in rural communities.

CONCLUSION

The study concluded that transformation from the local traditional way of delivering agricultural information is crucial. Nevertheless, late initiation, the current SMS achieved a high percentage of coverage, which exceeds 87%. On the other hand, analysis of the results assured the efficiency of the system particularly when paired with basic factors such as message accessibility, receivability, benefit ability, and dissemination. Finally, the study recommended some actions, that might pave the way toward wide coverage, extend and beyond effect as well as increase adoption rate. These are establishing SMS centers and network enhancement in each state to ensure excellent service. WhatsApp groups are highly recommended besides audio SMS.

SIGNIFICANCE STATEMENT

This study provides empirical evidence on the effectiveness of SMS in agricultural extension services in Sudan, contributing to the growing body of literature on mobile-based knowledge dissemination in agriculture. The results highlight the importance of strengthening ICT infrastructure, particularly mobile networks, to ensure wider adoption and improved accessibility for farmers. The study also underscores the need for integrating additional digital platforms, such as WhatsApp, which has gained popularity among farmers as an interactive tool for knowledge exchange.

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REFERENCES

1. Mittal, S. and G. Tripathi, 2009. Role of mobile phone technology in improving small farm productivity. Agric. Econ. Res. Rev., 22: 451-459.
2. Mittal, S., 2012. Modern ICT for Agricultural Development and Risk Management in Smallholder Agriculture in India. CIMMYT, Mexico, ISBN: 9786079584429.
3. Ponnusamy, K. and R.N. Padaria, 2022. Research in agricultural extension: Review of its contribution and challenges. Indian J. Agric. Sci., 91: 659-665.
4. Sarku, R., S. Whitfield, S. Jennings and A.J. Challinor, 2025. Approaches to participation and knowledge equity in agricultural climate impacts modelling: A systematic literature review. Int. J. Agric. Sustainability, Vol. 23. 10.1080/14735903.2025.2464509.

5. Kamruzzaman, M., A. Chowdhury, A. van Paassen and W. Ganpat, 2018. Extension agents' use and acceptance of social media: The case of the Department of Agricultural Extension in Bangladesh. J. Int. Agric. Ext. Educ., 25: 132-149.
6. Galeon, D.H., P.G. Garcia Jr. and T.D. Palaoag, 2019. SMS-based ICT tool for knowledge sharing in agriculture. Int. J. Adv. Sci. Eng. Inf. Technol. 9: 342-349.
7. Sharma, U., P. Chetri, S. Minocha, A. Roy, T. Holker, A. Patt and J. Joerin, 2021. Do phone-based short message services improve the uptake of agri-met advice by farmers? A case study in Haryana, India. Clim. Risk Manage., Vol. 33. 10.1016/j.crm.2021.100321.
8. Clarke, R.N., 2014. Expanding mobile wireless capacity: The challenges presented by technology and economics. Telecommun. Policy, 38: 693-708.
9. Nyaplue-Daywhea, C., J.K. Ahiakpa, O.A. Mensah, F. Annor-Frempong and S. Adjei-Nsiah, 2021. Mobile phone-assisted agricultural extension services: User competency and usage frequency in Eastern Ghana. Afr. J. Food Agric. Nutr. Dev., 21: 18886-18911.
10. Benard, R., F. Dulle and H. Lamtane, 2020. Challenges associated with the use of information and communication technologies in information sharing by fish farmers in the Southern highlands of Tanzania. J. Inf. Commun. Ethics Soc., 18: 44-61.
11. Kenny, U. and Á. Regan, 2021. Co-designing a smartphone app for and with farmers: Empathising with end-users' values and needs. J. Rural Stud., 82: 148-160.
12. Kamal, M. and T.A. Bablu, 2023. Mobile applications empowering smallholder farmers: An analysis of the impact on agricultural development. Int. J. Social Anal., 8: 36-52.
13. Birthal, P.S., S. Kumar, D.S. Negi and D. Roy, 2015. The impacts of information on returns from farming: Evidence from a nationally representative farm survey in India. Agric. Econ., 46: 549-561.
14. Emeana, E.M., L. Trenchard and K. Dehnen-Schmutz, 2020. The revolution of mobile phone-enabled services for agricultural development (m-Agri services) in Africa: The challenges for sustainability. Sustainability, Vol. 12. 10.3390/su12020485.
15. Zhang, Y., L. Wang and Y. Duan, 2016. Agricultural information dissemination using ICTs: A review and analysis of information dissemination models in China. Inf. Process. Agric., 3: 17-29.
16. Stafford, L. and J.D. Hillyer, 2012. Information and communication technologies in personal relationships. Rev. Commun., 12: 290-312.
17. Kiambi, D., 2018. The use of information communication and technology in advancement of African agriculture. Afr. J. Agric. Res., 13: 2025-2036.
18. Krell, N.T., S.A. Giroux, Z. Guido, C. Hannah, S.E. Lopus, K.K. Caylor and T.P. Evans, 2021. Smallholder farmers' use of mobile phone services in central Kenya. Clim. Dev., 13: 215-227.
19. Hamad, M.A.A., M.E.S. Eltahir, A.E.M. Ali and A.M. Hamdan, 2018. Efficiency of using smart-mobile phones in accessing agricultural information by smallholder farmers in North Kordofan-Sudan. J. Web Semant., 10.2139/ssrn.3240758.
20. Aker, J.C., 2011. Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. Agric. Econ., 42: 631-647.
21. Dhaka, B.L. and K. Chayal, 2010. Farmers' experience with ICTs on transfer of technology in changing agri-rural environment. Indian Res. J. Ext. Educ., 10: 114-118.
22. Camacho, A. and E. Conover, 2019. The impact of receiving SMS price and weather information on small scale farmers in Colombia. World Dev., Vol. 123. 10.1016/j.worlddev.2019.06.020.
23. Lahiri, B., T.S. Anurag, S. Borah, N.R. Marak and S.T.P. Kumar *et al*., 2024. Designing a user-centric mobile-based agro advisory system for sustainable development of smallholder farming systems in the Eastern Himalayas, India. Inf. Technol. Dev., 30: 665-695.
24. Khan, N.A., G. Qijie, S.F. Sertse, M.N. Nabi and P. Khan, 2019. Farmers' use of mobile phone-based farm advisory services in Punjab, Pakistan. Inf. Dev., 36: 390-402.