

Use of Information and Communication Technologies (ICTS) by Intermediaries in the Agriculture Sector

Insights from Mali

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Authors

Kergna A.O Nientao A Diallo D.F Baumuller H



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Corresponding Author

KERGNA A.O (akergna@yahoo.fr)

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Editorials

Dr. Fatunbi A.O and Mr. Benjamin Abugri (babugri@faraafrica.org)

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Forum for Agricultural Research in Africa (FARA)

12 Anmeda Street, Roman Ridge PMB CT 173, Accra, Ghana Tel: +233 302 772823 / 302 779421 Fax: +233 302 773676 Email: Website: <u>www.faraafrica.org</u> : <u>www.faradatainforms.faraafrica.org</u>

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Designed By: Samuel Oti Attakorah - FARA Knowledge Management, Learning & Communications Unit (<u>publications@faraafrica.org</u>)

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Introduction

In the next few decades, one of the major challenges that will confront the world is the feeding of a growing population that is predicted to reach almost 10 billion by 2050 (GSMA, 2020). This population growth combined with the climate change effects will strain the global food systems. Therefore, digital solutions have been pointed to mitigate the challenges that smallholder farmers face in low and middle-income countries. Kunyenje (2019) argues that many African countries have adopted national ICT policies and that the debate is on whether these ICT policies have been implemented and assessed. The main question is: has the use of ICT in agriculture achieved the expected results of improving farmers' productivity? It was observed that in many developing countriethe s, mobile phone is the main information and communication technology (ICT) used by farmers who can be easily reached by extension services through ICT-based information (Kanté et al., 2018). Indeed, smallholder farmers in Mali are facing the challenge of low productivity due to poor soil fertility. For improving productivity, therefore, Malian smallholder farmers require information to enable them to adopt inputs in production systems. Extension agents usually provide information to farmers all over the country.

In Mali, national extension services are provided by the Ministry of Rural Development, which includes agriculture, livestock and fisheries. Within the services, the National Directorate of Agriculture (DNA) is primary responsible for extension and advisory services to farmers. Many actors are involved in providing agricultural extension services; mapping them is complex due to the overlap of extension functions by organizations in the same area. Extension services are provided by both private and public entities, which are government institutions, NGOs, farmers' organizations, agricultural projects and development programmes, etc. There are also various Centres d'Apprentissage Agricole (CAA) which teach extension and practical training to students; they also do extension work. These organizations lack funds and staff to coordinate adequately their activities. However, there are several mechanisms that have been established at the national, regional and local levels to improve communication and coordination among researcher, extension workers and farmers. But many of these mechanisms do not function correctly; one of the constraining factors is the lack of fund for implementing dissemination activities. The supply of inputs involves both private and public sectors, such as government institutions, importers, NGOs, and farmers' organizations.

All actors use ICTs when carrying out their activities; mobile phone is the most information and communication technology used by them. Thus, ICT-based information can reach a high number of farmers and contribute to enhancing small-scale farmers' knowledge and adoption of inputs and, hence, increase agricultural productivity. Several studies showed the numerous ICT initiatives, which have been designed and disseminated in low and middle-income countries. However, the expected results on ICT-based farm input information are far below the expectations in these countries. In Mali, there are essentially five agricultural value added services (Agrivas), which are Senekela (from Orange Mali), Myagro (N'gasene), BuyfromWomen (from UN Women), Mali agro météo, and Itumba.

Senekela is an ICT value added service (VAS) launched by Orange Mali (telephone network provider) in 2014 in the region of Sikasso. It set up a call centre with agronomists who advise farmers in French and Bambara (a local language) on issues related to farming, such as planting methods, use of seeds and fertilisers, sowing times, market prices and other agricultural issues (Kante et al., 2017). Myagro is a private extension service that helps farmers with information on increasing crop yields, such as modern planting techniques. It uses the N'gasene platform (ICT tool for extension services) (Kante et al., 2019). UN Women is piloting BuyfromWomen, a datadriven enterprise platform that combines an open-source end-to-end, cloud-based and mobile-enabled supply chain system to connect women farmers to information, finance and markets (UNwomen, 2017). This innovation enables women farmers to have better understanding of their business lifecycle. It provides real-time reports in dashboard form on key performance indicators, including forecast yields and sales revenue (Unwomen, 2017). The only public tool reported is Mali agro météo, which is deployed at the weather agency (Mali météo). Itumba is an extension platform being tested in the region of Sikasso among maize producers by DNA.

The number of these Agrivas users is still low, compared to the potential in the country's agricultural sector, which employs almost 80% of the workforce. The poor use of ICT-based input information is related to many factors, such as small-scale farmers' perception, information quality, ICT service cost, etc. Kanté et al. (2020) concluded that the ICT policy in Mali does not deal with agriculture. He also pointed out that extension service officers were not empowered enough by the policy to use ICT-based farm input information with farmers. Thus, significant investment is required to upscale the use and impact of digital agriculture. Further, the development of schemes to boost ICT service provision and use in agriculture is needed in order to facilitate adoption of agricultural technologies and, hence, agricultural productivity, especially among small-scale farmers

Agriculture is a critical sector of the economic and social stability of Mali, because of its central

role in the national economy, in food security and job creation. Agriculture and pastoralism provide employment to nearly 80% of the workforce and contribute about 40% of GDP and 70% of exports. The sector has been one of the drivers of growth, growing at the rate of 5% in 2017. The positive performance of the cotton subsector, for example, is partially explained by government efforts to structure the cotton value chain around Compagnie Malienne pour le Développement des Textiles (CMDT), the state-owned enterprise in charge of cotton marketing, as well as other initiatives to promote access to technologies, fertilizers and other inputs. Overall the agricultural sector remains internationally uncompetitive. The sector is highly fragmented, with a dominant subsistence farming model. Only two products, cotton and livestock, account for 90% of total agricultural exports. Given the expected high rates of population growth, Mali faces the challenge of decreasing job opportunities, productivity and incomes in the sector. Access to information and communication technology (ICT) is crucial to enabling labour market participation, entrepreneurship, and further technology adoption.

This report is organized as follows: the next section outlines the method used to collect data from agro-input dealers, agro-output dealers and extension agents. Thereafter, the results are presented and discussed. This is followed by the section on conclusion and policy implications of the findings.

Data and Methods

Intermediaries, otherwise called 'middlemen' (individuals, businesses or organisations) play a role in the transfer or dissemination of innovative information to farmers and other value chain actors to input and output markets and services. To understand how they make use of ICTs in their operations to disseminate or transfer information in Mali, three regions in the southern part of the country were selected: (i) the Sikasso region, dominantly the cotton zone, (ii) the Segou region, mainly the rice zone, and (iii) the Koulikoro region, considered as the rain-fed cereal and legume zone.

These three regions encompassed more than 80% of the total agricultural production in the country. Farmers in Segou and Sikasso regions are relatively less vulnerable than the others due to higher rainfall in Sikasso and the irrigation development in Segou. With the support of CMDT in the cotton area and Office du Niger in the rice zone, they were more equipped and organized and had more access to inputs and technologies.

Extension and advisory services come in various forms, but with the same objective of building capacity, using several methods, such as establishment of resource centres, providing best practices and demonstration plots to showcase improved techniques; they also provide market information, agricultural entrepreneurship training, through the reinforcement of producer cooperatives. Government and NGOs are involved in extension work, organized from national to village levels. Since all extension agents have the ability to read and write, with knowledge to disseminate innovations, they are expected to have access to and use smartphones.

Agro-input dealers are agents who deal with fertilizers, seeds, feeds, veterinary services, herbicides. pesticides, etc. The fertilizer subsector is dominated by a small number of local companies, such as Toguma, Gnoumani, Somadeco, Sengoye and Sogefert, which import and market fertilizers in Mali, generally responding to government tenders. Fertilizer is distributed through dealers, from importers to farmers. Some 30 private companies are involved in seed trade, as well as in local production. These include Faso Kaba, Comptoir 2000, Soprosa, and Camara Semences. They play a critical role in the commercialization, selling and distributing of improved seeds to farmer cooperatives directly or through programmes, promoting and funding access to improved seeds. The other subsectors are not formally organized as the fertilizer and seed subsectors. Not all agro-input dealers are literate; however, they use phones to communicate prices, supply volumes, transport, location, etc.

Agro-output dealers include grain sellers, product sellers, supermarkets and shops; the group has more women and youth involved in their activities. They are from different background and dominated by retailers operating in different markets daily or weekly, with relatively small volumes of products. They have phones for many purposes; for communication on prices, volumes and stocks and for money transfer. There is no formal organization among agro-output dealers.

To collect data on the use of ICT by intermediaries, a multistage sampling technique was used to build a sample size. The first stage was the purposive selection of three regions (Koulikoro, Sikasso and Segou) according to their potential in Malian agricultural production. In each region, three districts, called "cercles" (9 in total) were then chosen according to the diversity of agricultural production system. The target population was the three groups of intermediary, which were extension agents, agro-inputs dealers and agro-output dealers. In each "cercle," localities were identified for their importance in production and trade of agro-products. Since there was a list of actors for the randomly selection of agro-dealers, for each group (agro-input dealers and agrooutput dealers) the research team used the "snow-ball" technique to select 75 respondents for each category by region. Table 1 presents the number of respondents by category of intermediary per region.

Regions	Agro-input dealers	Agro-output dealers	Extension Agents
Koulikoro	50	56	32
Sikasso	77	77	75
Segou	80	96	64
Total	207	229	171

Table 1: Number of respondents per group of intermediaries

Source: Surveys, PARI 2021

Primary data collection was through interview using structured questionnaire through tablets and administered by trained enumerators; secondary data were also sourced. The questionnaire was in French, while the interview was done in the national language, Bamanankan. The data were collected in July 2021 using tablets with Microsoft Excel version 2016 and analysed using descriptive statistics through SPSS version 21.0. The analysis was to determine the use and impact or effect of ICT use among the three groups of intermediaries. Nevertheless, there were some difficulties to get the sample size of 675 respondents. The number of respondents was below expected, because of insufficient government extension agents and the non-availability of private agents. However, the interviewed agents were a sufficient representative of the category in general.

Results

Use of ICTs among Intermediaries ICT use by agro-input dealers

Agro-input dealers are those who practice the sale of agricultural inputs; in our case, they mainly sell pesticides (56%), fertilizers (19%), seeds (14.5%), veterinary products (4%) and animal feed. The average age of agro-input dealers is presented in Table 2. The ages vary from 18 to 77 years, with an average of 41 years: for Sikasso region, this is 39 years, while for Segou, it is 42 years. Young intermediaries are most inclined to use advanced phones with many features, because they are more open to technology adoption. Old intermediaries are somehow reluctant to new technologies and use more usual phones. However, the average age of these intermediaries was such that they were expected to use new technologies and, therefore, more digital devices/ features.

Table 2: Average age of agro-input dealers

Regions	Minimum	Mean	Maximum
Koulikoro	18	40	70
Sikasso	21	39	65
Segou	20	42	77
Average	18	41	77

Source: Surveys, PARI 2021

Table 3 shows that most of the agro-input dealers (98%) were male; there were only 4 female dealers in the sample. Table 4 shows that many of the agro-input dealers (about 42%) had not formal education; 58% achieved at least one level of education, from primary school to university.

Table 3: Gender of the agro-input dealers in (%)

Gender	Koulikoro	Sikasso	Segou	Total
Male	100	99	96	98
Female	0	1	4	2

Source: Surveys, PARI 2021

This situation does not reflect the rural reality of Mali where only a few of the active population have formal education. The respondents have explained that, during the school holidays between July and October, many students are engaged in selling inputs in the rural areas. Most of the students lived in urban centres and practised this job temporary because of the high demand of inputs in rural markets.

Table 4: Agro-input dealers	level of	education	in	(%))
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Education Level	Koulikoro	Sikasso	Segou	Total
Primary school	12	9	20	14
Secondary School	10	12	14	12
Professional School	16	14	10	13
High School	2	10	6	7
University	12	14	11	12
None	48	40	39	42
Total	100	100	100	100

Source: Surveys, PARI 2021

In Mali, agro-input dealership is related to fertilizer, pesticides, herbicides and seeds sales. For selling agricultural inputs, agroinputs dealers use different types of ICTs, including mobile phone, which is used in many sub-Saharan African (SSA) countries. As presented in Table 5, about 97% of the respondents used mobile phone in their activities. The most used type of phone was smartphone (by about 74% of respondents). The three regions present very similar characteristics on ICT use. Computer and tablet were the least used ICTs by agro-input dealers. This finding could be related to the low educational level attained by the respondents.

Table 5: Different IC	T devices use	by agro-in	puts dealers	in (%)
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ICT devices	Koulikoro	Sikasso	Segou	Total
Computer	2	3	1	2
Tablet	0	3	0	1
Features phone	18	14	21	18
Smartphone	72	80	69	74
Basic Phone	8	0	9	5
Total	100	100	100	100

Table 6 shows that smartphone was the most used ICT by agro-input dealers for their daily businesses. Features phone was used by 38% of the respondents, while basic phone was used by only 10% of the respondents. Only a few respondents said they used feature phone or smartphone weekly. The main professional activities, presented in Table 7, undertaken when using ICTs were input imports, buying and selling input from and to other agro-input dealers and selling input directly to customers (farmers). Others professional activities were input transport from/to customers, inputs supply information and credit to producers.

Frequency of Use	Computer	Radio	Tablet	features phone	Smartphone	Basic Phone
Daily	2	0	1	17	73	5
Weekly	0	0	0	1	0.5	0.5
Monthly	0	0	0	0	0	0
Bimonthly	0	0	0	0	0	0
Quarterly	0	0	0	0	0	0
Less than quarterly	0	0	0	0	0	0
Never	0	0	0	0	0	0

Source: Surveys, PARI 2021

The ICTs applications used for professional activities were essentially direct phone call or WhatsApp messages, text messages, photos or voice call, etc. These ICT applications were used for buying and selling inputs, as well as transporting inputs. Retailers used motorcycles for transport, while wholesalers used mostly vans or trucks. Information on inputs was also provided using ICT applications. As detailed in the Table 7, a combined 36% of the respondents used ICTs for selling directly to customers and to other agro-input dealers.

Table 7: Operation related to ICT use for agro-input dealers in (%)

Activities in which ICTs are mostly used	Share of respondents
Inputs imports	17
Buying inputs from others agro-inputs dealers	16
Selling inputs directly to customers	19
Selling Inputs to others agro-inputs dealers	17
Transporting of inputs from agro-inputs dealers	7
Transporting of inputs to customers or agro-inputs dealers	6
Providing inputs information to producers	5
Providing credit to producers	3
Inputs production	1
Total	100

Source: Surveys, PARI 2021

Studies have indicated that there is increased use of ICTs due to the Covid-19 pandemic (GSMA AgriTech 2020; Kante et al. 2020) which forces people to work at home, reducing traffic congestion and air pollution. Contrary to these findings, however, the data in Table 8 show many agro-input dealers stating that Covid-19 had no effect on their use of ICTs. For instance, before the pandemic, 52% of them said ICT use increased a lot, while 59% of them said the pandemic had no effect on the way they used ICTs. This situation can intuitively be explained by two things: first, because there was reduced agro-input business activities due to the restriction in mobility during the pandemic; and second, there were less customers and less revenue, hence, agro-input dealers were not willing to pay for any additional cost, including airtime, and data bundle.

Table 8: Perception of Agro-inputs dealers on ICT use before and during Covid-19

Level of Frequency	Before Covid-19	During Covid-19
Decreased a lot	1.5	7
Decreased a little	4	12
No effect	16	59
Increased a little	27	8
Increased a lot	51	14
Don't know	0.5	0
Total	100	100

Source: Surveys, PARI 2021

The results also show that most of the agroinput dealers had inadequate knowledge on ICT functions and agricultural ICT platforms, which are not many in Mali, especially for this group of intermediaries. Therefore, using ICTs during Covid-19 illustrated both the limitation and opportunities for ICT use. From the agroinput dealers' point of view (Table 9), reasons for the increase in ICT use prior to Covid-19 are: improved network connectivity, better access to ICT devices, more affordable devices, and the changes that occurred in the agro-input business activities.

Table 9: Reasons for increase in ICT usage

Factors leading to increase in ICT usage	Frequency
Network connectivity has improved	15
Access to electricity has improved	6
Devices have become cheaper	9
Using the devices (e.g. cost of SMS, data etc.) has become cheaper	4
Devices offer more functions than before	6
Useful apps/digital services have become available	2
I have become more aware of the usefulness of ICTs for my professional activities.	3
My skills to use ICTs have improved, ICTs have been become easier to use.	3
I have more trust in ICTs	4
My clients/customers have better access to ICTs	11
The nature of my professional activities has changed which made use of ICTs necessary/useful	8
None	29

Source: Surveys, PARI 2021

Input suppliers seek to improve product quality, services and information to farmers and expand distribution networks. For this, good digital literacy can help agricultural input suppliers to improve operations and build capacity to expand outreach and meet farmers' needs. As shown in Table 10, 92.7% of agro-input dealers knew how to check the amount of credit left on their phone, 90.8% of them could top up credit on their phone, 98.5% were able to make or receive phone call, 82.6% and 83.1% could respectively make mobile payment and take a photo with their phone. However, there were some ICTs functions not well known to agroinput dealers; these included the use of social network platform and digital agricultural services, GPS coordinates of current location and to complete an online form. Inadequate knowledge in the use of these ICTs was due to problems of connectivity, literacy, content and costs, coupled with the issue of poor access. Many agro-input dealers were not aware that ICT platform of Agricultural Value-Added Service (Agrivas), GPS, etc. could be used to efficiently expand their distribution networks. This implies that there was still a huge gap in the operational knowledge of agro-input dealers. Although some of them could operate most of the modern/contemporary ICTs, adequate training on efficient operation of modern ICTs should be organised for this group of intermediaries.

Table 10: Agro-inputs dealers Digital Literacy

Digital literacy	Yes		No	
	Number	%	Number	%
Check the amount of credit left on your phone	192	92.7	15	7.3
Top up credit on your phone	188	90.8	19	9.2
Make/receive a phone call	204	98.5	3	1.5
Send/receive an SMS	136	65.7	71	34.3
Access a message on voice mail	123	59.4	84	39.6
Send/receive money	171	82.6	36	17.4
Find out the GPS coordinates of your current location	30	14.5	177	85.5
Take a photo	172	83.1	35	16.9
Record a video	158	76.3	49	23.7
Connect to WiFi	82	39.6	125	60.4
Open an app on your mobile phone	143	69.1	64	30.9
Install an app on your mobile phone	116	56.0	91	44.0
Send/receive an email	69	33.3	138	66.7
Open a file on your phone (e.g. photo, video, document)	136	65.7	71	34.3
Search for information on the Internet	114	55.1	93	44.9
Complete an online form	59	28.5	148	71.5
Use a text messaging application	153	73.9	54	26.1
Participate in video calls	125	60.4	82	39.6
Use a social network platform	0	0.0	207	100.0
Use a digital agricultural services	30	14.5	177	85.5

Source: Surveys, PARI 2021

Use of ICTs among Agro-output dealers

The respondents (agro-output dealers) used ICTs in their daily activities of buying and selling or advertising products. Table 11 presents their ages, which varied between 19 and 79 years old, with an average 43 years. The data are disaggregated according to region. Table 12 presents data their gender, with 97% of them being male; only 6 respondents were female, 4 of whom were are from the Segou region.

Table 11: Average age of agro-output dealers

Regions	Minimum	Mean	Maximum
Koulikoro	20	41	79
Sikasso	20	45	70
Segou	19	43	67
Average	19	43	79

Source: Surveys, PARI 2021

Table 12: Gender of agro-output dealers in (%)

Gender	Koulikoro	Sikasso	Segou	Total
Male	96	100	96	97
Female	4	0	4	3

Source: Surveys, PARI 2021

The data on education levels in Table 13 varied from one region to another. Majority of the respondents (55%) did not attend any form of school. The highest number of agro-output dealers who attended school were from the Segou region. The data on education level and group activities are similar for agro- output dealers and agro-input dealers, as both intermediaries were involved in similar business activities (eg, a fertilizer or seed seller could be a cereal seller in many rural areas).

Table 13: Agro-output dealers' level of education in (%)

Education Level	Koulikoro	Sikasso	Segou	Total
Primary school	14	15	20	17
Secondary School	20	10	15	14
Professional School	4	4	9	6
High School	1	8	1	3
University	9	0	6	5
None	52	63	49	55
Total	100	100	100	100

Agro-input and agro-output dealers mainly used mobile phone, such as smartphone, features phone and basic phone for business. Among these, however, smartphone was the most used (58%) by agro-output dealers, while features phone (38%) was the second most used phone. Table 14 also shows that only 4% of agro-output dealers interviewed used basic phone. Computers and tablets were not used by the respondents.

ICT devices	Koulikoro	Sikasso	Segou	Total
Computer	0	0	0	0
Tablet	0	0	0	0
Features phone	43	29	43	38
Smartphone	55	62	55	58
Basic Phone	2	9	2	4
Total	100	100	100	100

Table 14: Share of different ICT devices used by agro-output dealers

Source: Surveys, PARI 2021

Table 15 presents data on frequency of use of mobile phones by agro-output dealers in their activities. About 97% (aggregate) of agro-output dealers used their mobile phone (smartphone, features phone and basic phone) daily. Agro-output dealers use ICTs to do several operations related to their activities, such as buying, selling, transporting, providing information, etc. For each activity listed in Table 16, agro-output dealers used ICTs, depending on the necessity of each. The main professional activities for which ICTs were used were buying and selling outputs either from producers or other intermediaries.

Table 15: Frequency of ICT use by agro-output dealers in (%)

Frequency of Use	Computer	Radio	Tablet	Features phone	Smartphone	Basic phone
Daily	0	0	0	37	56	4
Weekly	0	0	0	1	2	0
Monthly	0	0	0	0	0	0
Bimonthly	0	0	0	0	0	0
Quarterly	0	0	0	0	0	0
Less than quarterly	0	0	0	0	0	0
Never	0	0	0	0	0	0

Source: Surveys, PARI 2021

Table 16: Operations related to ICT use for agro-input dealers

Activities in which ICTs are mostly used	Share of respondents
Buying output directly from producers (farm gate)	13
Buying outputs from other intermediaries	13
Selling outputs to consumers	10
Selling outputs to other agro-output dealers	14
Transporting outputs from producers and/or agro- output dealers	9
Transporting outputs to consumers and/or agro-output dealers	6
Packaging output	2
Storing outputs	0.4
Processing outputs including milling	0.9
Providing inputs to producers	0.9
Providing information to producers	6
Providing credits to producers	3
None	22

Source: Surveys, PARI 2021

It has earlier been found that Covid-19 did not largely affect the use of ICTs among agro-output dealers. The data in Table 17 also show that 58% of the respondents said that Covid-19 had no effect on their frequency of ICT use, while 47% of them said before Covid-19, the use of ICTs increased. This is in contradiction with other findings in the literature; although, during the Covid-19 pandemic, restriction on gatherings was less concerned with local or weekly markets (FAO, 2021). This less use of ICTs by agro-output dealers for their professional activities could be due to a lack of knowledge on the role of ICTs in business development. Moreover, the data in Table 18 show that the main factors leading to the increase in ICT use prior to Covid-19 were improved network connectivity, better access to ICT devices and cheaper ICT devices.

Table 17: Frequency of ICT use before and during Covid-19

Level of Frequency	Before Covid-19	During Covid-19
Decreased a lot	0	0
Decreased a little	0.5	9
No effect	1.5	58
Increased a little	18	8
Increased a lot	29	14
Don't know	51	11

Source: Surveys, PARI 2021

Table 18: Reasons of ICTs usage increasing

Reasons which led to the increase in usage	Frequency
Network connectivity has improved	16
Access to electricity has improved	6
Devices have become cheaper	9
Using the devices (e.g. cost of SMS, data etc.) has become cheaper	3
Devices offer more functions than before	4
Useful apps/digital services have become available	1
I have become more aware of the usefulness of ICTs for my professional activities.	6
My skills to use ICTs have improved, ICTs have been become easier to use.	4
I have more trust in ICTs.	7
My clients/customers have better access to ICTs.	10
The nature of my professional activities has changed which made use of ICTs necessary/useful	7
None	27

Source: Surveys, PARI 2021

Just as it is with the other categories of intermediaries, the level of digital literacy among agrooutput dealers was low, especially on the types of ICT facilities used (Table 19). They mostly knew how to check amount of credit (90.4%), top up credit (85.6%), make and receive phone call (99.1%) and take a photo (73.1%). But the use of social network platform, digital agricultural services, GPS coordinates of current location, sending and receiving email, and complete online form was very low; this was attributed to the lack of knowledge in these ICT facilities. The gap in agro-output dealers' use of ICTs affirms the need for training to enhance digital literacy among the respondents.

Table 19: Data on digital literacy of agro-output dealers

Digital literacy	Yes		No		
	Number	%	Number	%	
Check the amount of credit left on your phone	207	90.4	12	9.6	
Top up credit on your phone	196	85.6	33	14.4	
Make/receive a phone call	227	99.1	2	0.9	
Send/receive an SMS	111	48.5	118	51.5	
Access a message on voice mail	104	45.4	125	54.6	
Send/receive money	159	69.4	70	30.6	

Find out the GPS coordinates of your current location	21	9.2	208	90.8
Take a photo	168	73.4	61	26.6
Record a video	151	65.9	78	34.1
Connect to WiFi	39	17.1	190	82.9
Open an app on your mobile phone	131	57.2	98	42.8
Install an app on your mobile phone	85	37.1	144	62.9
Send/receive an email	39	17.0	190	83.0
Open a file on your phone (e.g. photo, video, document)	124	54.1	105	45.9
Search for information on the Internet	80	34.9	149	65.1
Complete an online form	30	13.1	199	86.9
Use a text messaging application	142	62.0	87	38.0
Participate in video calls	113	49.4	116	50.6
Use a social network platform	97	42.4	132	57.6
Use a digital agricultural services	11	4.8	218	95.2

Source: Surveys, PARI 2021

Use of ICTs among Extension Agents

Extension agents, who can be from government, NGOs, farmers' organizations, research institutes, universities, professional training centres, etc, particularly provide extension and support services in Mali. Extension agents, who deliver farm, market and processing information in the country, are few compared to the number of farmers they serve. In Mali agriculture, extension services face staffing problems, in terms number and capacity, as well retirement age. The ages of extension agents presented in Table 20 do not reflect the age of retirement, because retired agents were still actively involved in providing services and advising farmers.

Table 20: Average age of extension agents

Regions	Minimum	Mean	Maximum
Koulikoro	25	38	74
Sikasso	25	37	61
Segou	25	38	58
Average	25	38	74

The average age of extension agents was 38 years, with a minimum of 25 years and maximum of 74 years. The minimum ages for the regions were the same. The maximum ages varied from 58 to 74 years. Moreover, most of the extension agents (76%) were male as (Table 21). Sikasso region had the highest number of extension agents, for both male and female.

Table 21: Share of male and female extension agents

Gender	Koulikoro	Sikasso	Segou	Total
Male	16	31	29	76
Female	3	13	8	24

Source: Surveys, PARI 2021

Extension agents' training in Mali is ensured by tertiary institutions, such as the Rural Polytechnic Institute of Katibougou and University of Segou, in addition to several accredited vocational schools. As shown in Table 22, most of the extension agents had attended professional school (48%) or university (45%). Those from the university were mostly graduates in agronomy, while others were generally technicians or technical agents.

Table 22: Extension agents' level of education

Education Level	Koulikoro	Sikasso	Segou	Total
Primary school	0	0	0	0
Secondary School	0.5	4	0	5
Professional School	5	22	21	48
High School	0	0.5	0	0.5
University	13	15	16	45
None	0	0	0	0

Source: Surveys, PARI 2021

Extension agents also utilized mainly mobile phone and particularly smartphone. Table 23 shows that extension agents used all the different types of ICTs items. The smartphone (81%) was the most ICT tool used by extension agents. In addition, the EAs use computer as the second most used ICT device. They also used tablet and radio but in less measures.

Table 23: Different ICT devices use by extension agents

ICT devices	Koulikoro	Sikasso	Segou	Total
Computer	4	5	0	9
Radio	0	0.5	0.5	1
Tablet	2	0.5	0.5	3
Features phone	0.5	0	3	4
Smartphone	12	37	32	81
Basic Phone	0	0.5	1	2

Source: Surveys, PARI 2021

The data on frequency of use of these ICT devices are presented in Table 24. Almost all ICT tools were used daily by EAs. For smartphone, some used it weekly and quarterly, perhaps due to poor network infrastructures in some rural and agricultural areas. The data also show that ICTs were widely used by extension agents despite the few challenges with access. It is noteworthy that ICT devices can be used to accomplish numerous functions in extension service delivery.

Frequency of Use	Computer	Radio	Tablet	features phone	Smartphone	Basic Phone
Daily	9	1	3	4	78	2
Weekly	0	0	0	0	2	0
Monthly	0	0	0	0	0	0
Bimonthly	0	0	0	0	0	0
Quarterly	0	0	0	0	1	0
Less than quarterly	0	0	0	0	0	0
Never	0	0	0	0	0	0

Table 24: Frequency of ICT use by extension agents (in percentages)

Source: Surveys, PARI 2021

As shown in Table 25, the main purpose of using ICT devices was agricultural information on products, prices, production methods, technologies and inputs. This included practices such as farm measurement, farm output estimation, best planting techniques, fertilizer use, etc. All the functions listed in the table are important for extension workers' use of ICTs. In delivering farm information, extension agents focused on cereals, as well as livestock and others subsectors. Admissibly, the study sample had more extension workers with specialization in agronomy than other areas; on the other hand, the situation reflects the agricultural production system in Mali, which is essentially on the production of cereals.

Table 25: Operations related to ICT use by extension agents (in %)

Type of information provided to producers					
Information on production methods/technologies/inputs	20				
Information on agricultural products prices	22				
Information on weather	11				
Information on government agricultural programs	8				
Information on funding sources	7				
Others (information on: agricultural calendar, seed availability, use of pesticide, processing techniques)	6				
Information on buyers and sellers	6				
None	20				

Source: Surveys, PARI 2021

The frequency of ICT use among extension agents before and during Covid-19 is presented in Table 26. The data show that before Covid-19, 74% of extension agents used ICTs. Also, 44.4% of the respondents stated that the Covid-19 pandemic had no effect on their ICT use in professional activities. Despite the use of such ICT facilities as online meeting, the EAs stated that this did not generally affect their frequent use of ICTs. Many of the EAs live in the rural areas where there are very poor network infrastructures; many of them also have inadequate financial support from their institutions.

Level of Frequency	Before Covid-19	During Covid-19
Decreased a lot	0	4
decreased a little	6	8
no effect	20	44
increased a little	32	15
increased a lot	42	29
don't know	0.5	0.5

Table 26: Frequency of ICT use before and during Covid-19 for extension agents

Source: Surveys, PARI 2021

According to the extension agents interviewed, the main factors that led to increased ICT use prior to the Covid-19 pandemic were improved network connectivity, better access, cheap ICT devices and changes in the nature of extension activities. Table 27 shows that network connectivity improved in Mali and many rural areas to enhance access to ICTs through mobile phone. A manager of extension services in Sikasso stated that "Today, a lot of farmers have better knowledge on the use of ICT facilities, even better than some extension agents..." Therefore, there is the need to tackle knowledge gap to enhance EAs' digital literacy.

Table 27: Reasons for increases in ICTs use among extension agents

Reasons which led to the increase in ICTs usage	Frequency
Network connectivity has improved	20
Access to electricity has improved	7
Devices have become cheaper	12
Using the devices (e.g. cost of SMS, data etc.) has become cheaper	6
Devices offer more functions than before	5
Useful apps/digital services have become available	5
I have become more aware of the usefulness of ICTs for my professional activities.	2
My skills to use ICTs have improved, ICTs have been become easier to use.	4

I have more trust in ICTs.	6
My clients/customers have better access to ICTs.	11
The nature of my professional activities has changed which made use of ICTs necessary/useful	12
None	10

Source: Surveys, PARI 2021

Table 28 shows that most of the extension agents had very good knowledge in the use of ICT facilities. Among the ICT functions listed, only two (social network platform and digital agricultural services) were not used by the agents.

Table 28: Extension agents' digital literacy

Digital literacy	Yes		No	
	Number	%	Number	%
Check the amount of credit left on your phone	170	99.4	1	0.6
Top up credit on your phone	171	100	0	0
Make/receive a phone call	170	99.4	1	0.6
Send/receive an SMS	161	94.1	10	5.9
Access a message on voice mail	156	91	15	9
Send/receive money	164	95.9	7	4.1
Find out the GPS coordinates of your current location	147	85.9	24	14.1
Take a photo	162	94.7	9	5.3
Record a video	163	95.3	8	4.7
Connect to WiFi	156	91.2	15	8.8
Open an app on your mobile phone	155	90.6	16	9.4
Install an app on your mobile phone	142	83	29	17
Send/receive an email	162	94.7	9	5.3
Open a file on your phone (e.g. photo, video, document)	162	94.7	9	5.3
Search for information on the Internet	131	76.6	40	23.4
Complete an online form	165	96.5	6	3.5
Use a text messaging application	155	90.6	16	9.4
Participate in video calls	142	83	29	17
Use a social network platform	0	0	171	100
Use a digital agricultural service	0	0	171	100

Comparison data on ICT use among the three groups of intermediaries

The results generally show that the three groups of intermediaries used ICT devices in their activities. However, there were some differences in the reasons and frequency of use of these devices among the groups. The most ICT device used by the groups was the mobile phone; in particular, smartphone. Concerning extension agents, ICT devices used were more diversified than for the others groups; these encompassed mainly smartphone, computer and tablet. The reasons output and input dealers did not use computer and tablet were perhaps their level of education and knowledge on ICTs, and the cost of and accessibility to ICT devices. Extension agents work for institutions and often use these other devices for additional work.

Many of the respondents used ICT devices daily. Agro-input and output dealers used them to purchase and sell products, while extension agents used them to provide information on farm output prices and farm production methods, technologies and inputs. This means that ICT use depends also on the interest of the user, whether it is to buy or sell products or provide farm information.

Contrary to the findings of some studies, ICT use among these intermediaries was not significantly affected by the Covid-19 pandemic. The three groups of intermediaries revealed that Covid-19 had no effect on their ICT use. Some opined that the level of ICT use was even higher before than during the pandemic—perhaps because business for agro-input and output dealers was low during the Covid-19 lockdown; this could also have been due to the fact that access to and knowledge about ICT facilities were low among the actors (both the intermediaries and their partners). The partners included small-scale farmers with very low digital literacy and educational background. Access to ICT devices, such as smartphone, was low because they were unaffordable for many of these actors. Therefore, to enhancing agricultural productivity, there is a need to train intermediaries on the use of ICTs for agricultural business purposes.

Impact of ICT use on service provision, reach, quality and profitability

Impact of ICT use among agro-input dealers

Generally, the use of ICTs among agro-input dealers increased their ability to perform professional activities with ease (Table 29). Almost 94% of agro-input dealers said that ICTs made their work easier, while 6% said that they also made some functions more difficult. According to agricultural inputs dealers, the challenges encountered in the use of ICTs concerned mainly cost of ICT services and devices, and the possibility of being scammed. However, the data in Tables 30-32 show that types of phones had their different impacts on the three categories of intermediaries and their businesses. From the data, it can be concluded that phone use positively impacted on intermediaries' activities; and that smartphone made the highest impact.

Table 29: Changes due to ICT use in the ability to perform the professional activities

Regions	they made it easier	they made it more difficult	they made some things easier and some more difficult	no change	don't know
Koulikoro	48	0	2	0	0
Sikasso	76	0	1	0	0
Segou	70	0	10	0	0
Total	194	0	13	0	0

Source: Surveys, PARI 2021

Table 30: Phone use in professional extension activities

Type of	Koulikoro		Segou		Sikasso	
pnone	Make it easier	Make it more difficult	Make it easier	Make it more difficult	Make it easier	Make it more difficult
Smartphone	48	5	41	14	61	2
Feature phone	36	5	5	0	0	0
Regular phone	2	0	2	0	1	0

Table 31: Agro-inputs dealers and phone performance in professional activities

Type of phone	Koulikoro		Segou		Sikasso	
	Make it easier	Make it more difficult	Make it easier	Make it more difficult	Make it easier	Make it more difficult
Smartphone	34	2	46	9	62	0
Feature phone	9	0	16	1	10	1
Regular phone	4	0	7	0	2	0

Table 32: Agro-output dealers and phone performance in professional activities

Type of phone	Koulikoro		Segou		Sikasso	
	Make it easier	Make it more difficult	Make it easier	Make it more difficult	Make it easier	Make it more difficult
Smartphone	30	1	48	5	41	7
Feature phone	23	1	36	5	20	2
Regular phone	2	0	2	0	6	1

Network between intermediaries

The ICT sector has experienced tremendous progress and its growth has steadily improved. This is attributed to the widespread liberalization of the telecommunications market and the developments in mobile technology. These developments have led to an unprecedented increase in access to ICT services, bringing actors closer.

Extension workers disseminate improved agricultural practices that are relevant to farmers, such as agricultural techniques, commodity prices, and weather forecasts. The utilization of ICTs, especially mobile technologies, helps agricultural producers, who are often unaware of commodity prices in adjacent markets and rely on information from traders in determining when, where, or for how much to sell their produce, to have relevant and timely information. Table 33 presents the share of extension workers involved in networking.

Member of a Group	Koulikoro	Sikasso	Segou	Total
	Share	Share	Share	Share
Yes	25	56	43.75	46
No	75	44	56.25	54

Table 33: Extension agents belonging to formal or informal networks

About 46% of extension agent respondents belonged to formal or informal networks, in which information is shared. These networks included other extension workers, farmers, input and output dealers. Most often, extension agents network among themselves (Table 34). Extension agents are mostly members of associations or professional groups, wherein they share information on farm technologies. Members of the groups vary and include farmers, agro-input and output dealers, researchers and other extension agents (Table 35).

Table 34: Extension agents by group in region

Member of a Group	Koulikoro	Sikasso	Segou
	Share	Share	Share
Associations	10	28	18
Projet (Mouche des fruits, PAFAM, Sassakawa, Padel)	0	8	2
FENABE (Fédération Nationale des producteurs pour une Agriculteurs Biologique durable)	0	0	2
Service local des Productions et des Industries Animales (SNPIA)	0	1	0
Secteur de l'agriculture	0	10	4
Service CMDT	0	0	8
Plateforme de riz, mais et sorgho de Dioila	2	0	0

Coopérative semencière ou Organisation paysanne	4	10	2
Groupe des agents de vulgarisation	0	36	6
Collectif des vétérinaire mandataire du Mali (COVEN)	0	2	0
Cantonnement des eaux et forêt de Bougouni	0	2	0

Table 35: Frequency of members in groups

Group members	Frequency
Producers	9
Agro output dealers	3
Agro input dealers	3
Extension Agents	11
Government Officials	3
ONG	6
Researchers	6
Other	5

Agro-input dealers serve as an important link between manufacturers and the farmers. They disseminate to farmers inputs up to the field level. While purchasing different inputs required for farming operations, farmers naturally try to find out from the input dealers about the use of inputs, both in terms of quality and quantity. However, most agro-input dealers do not have formal training in agriculture. If the government or other organizations can build the capacity of dealers by providing requisite knowledge, they can contribute to bringing a paradigm shift in national agricultural development. About 38% of agro-input dealer respondents belonged to formal or informal networks in which they disseminated information on inputs. Since they were not all literate, they used pictures and signs to demonstrate practices to farmers.

Table 36 presents the share of agro-inputs dealers in their formal or informal networks. Generally, all their networks were built on activity basis, but their main objective was for selling or supplying inputs (Table 37). The highest number of members were from producers and inputs dealers. Although extension agents were in the networks, they were relatively few (Table 38).

T	بالمنام المحالة المراجب	- 1 1	6		
Table 36: Adro-In	put dediers be	elonalna to i	formal or ir	ntormai r	ietworks

Member of a Group	Koulikoro	Sikasso	Ségou	Total
	Share	Share	Share	Share
Yes	12	31	35	38
No	38	46	45	62

Table 37: Agro-inputs dealers by group in region

Name of group	Koulikoro	Sikasso	Ségou
	Share	Share	Share
National Association of mandatory Veterinaries of Mali	5	10	17
Association of inputs importers			
Union of inputs dealers	0	0.4	0.4
National Union of agro-inputs dealers of Mali	0	0.4	0
Association of phytosanitary products traders	0	1.4	0.4
Eléphant vert	0	0	0.4
Group of input traders	0.4	0	0
Association of seed traders	0	0	0.8

Table 38: Frequency of membership in groups

Group membership	Frequency
Producers	8
Agro output dealers	5
Agro input dealers	10
Extension agents	3
Government officials	1
NGO	2
Other	6

Agro-output dealers are not a homogenous group but encompass companies of all sizes in trade output, either as a single activity or as a complement to other trading activities. Some agro-output dealers link small-scale farmers to seed producers and fertilizer suppliers and, at the end of the season (harvest), buy the produce at a prime price. Table 39 presents the share of agro-output dealers who were members of formal and non-formal networks.

Table 39: Agro-output dealers' membership of formal and informal networks

Member of a Group	Koulikoro	Sikasso	Ségou	Total
	Share	Share	Share	Share
Yes	8	25	33	29
No	48	52	63	71

The networks of agro-output dealers comprised associations of cereal traders, livestock sellers, fish traders, producers' association and transporters' association. In Mali, however, the most important association is that of cereal traders. Table 40 presents some of the important associations in the agro-output dealers' network. Members of the network include producers, output and input dealers, extension agents and researchers (Table 41).

Name of group	Koulikoro	Sikasso	Ségou
	Share	Share	Share
Association des commerçants de cereal	0.8	9	3
Association des commerçants de bétail	1.3	6	1.3
Association des commerçants de poisson	3	2	1.7
Association des producteurs de céréale	1.3	5	5
Association des transporteurs	0	1.3	0

Table 40: Important formal and informal associations in agro-output dealers' network

Table 41: Frequency of membership of agro-output networks

Group membership	Frequency
Producers	6
Agro output dealers	7
Agro input dealers	3
Extension Agents	1
Researchers	1
Other	1

Table 42 presents data on the extent that ICTs made communication easy between input suppliers and customers. All the 207 agro-input dealers interviewed confirmed that their ability to interact with clients (such as producers and agricultural input suppliers) improved. But frequency of interaction with clients drastically reduced during Covid-19. Table 31 shows that the number of producers, with who agro-input dealers interacted, decreased by nearly 59% during Covid-19— from 333 producers before Covid-19 to 137 during the pandemic. Measures taken by the government, such as curfew and closing of national borders, had negative effect on all actors, particularly agro-output and input dealers. Inputs and certain foods were imported to Mali; hence, the measures constraining transport activities also adversely affected the availability of market products. The data show that all the intermediaries used ICTs to improve their ability to interact; however, the Covid-19 pandemic had no significant effect on the use of ICTs. Table 43 presents the share of producers using ICT in the 3 regions of study. As the interaction with producers decreased, its frequencies also decreased (Table 44). About 72% of agro-input dealers opined that Covid-19 had reduced their interaction frequency with producers, except in Segou region.

Table 42: Data on ICTs' improvement of interaction between agro-input dealers and their clients

Regions	Improving ability to interact with input suppliers and customers					
	Yes	No				
Koulikoro	50	0				
Sikasso	77	0				
Segou	80	0				
Total	207	0				

Source: Surveys, PARI 2021

Table 43: Share of producers using ICTs before and during Covid-19 pandemic

Regions	Before Covid-19	During Covid-19
Koulikoro	22	42
Sikasso	59	2
Segou	19	56
Total	100	100

Source: Surveys, PARI 2021

Table 44: Interaction frequency with producers during Covid-19 pandemic

Regions	Changes in In	teraction with producers with Covid-19
	Yes	Νο
Koulikoro	9	2
Sikasso	17	5
Segou	15	9
Total	41	16

Source: Surveys, PARI 2021

It is also shown in Table 45 that the frequency of face-to-face communication with producers had diminished with the use of ICTs. But the face-to-face communication frequency did not change with Covid-19 pandemic; however, 68.6% of the respondents said that mobile phone use has considerably affected face-to-face communication, while 22.7% said that Covid-19 influenced face-to-face communication.

Table 45: Face-to-face communication frequency due to ICTs and Covid-19 pandemic

Regions	Frequency of face-to-face communication changes with producers with mobile phone use		Frequency of face-to-face communication changes with Covid-19 pandemic		
	Yes	No	Yes	No	
Koulikoro	32	18	12	38	
Sikasso	55	22	17	60	
Segou	55	25	18	62	
Total	142	65	47	160	

Source: Surveys, PARI 2021

The study results also show that half of the respondents who said that mobile phone use had reduced the frequency of face-to-face communication were in Segou region; and that 62.3% of agro-input dealers' network was within the informal sector. Only 37.7% of the respondents were in the formal sector. The data in Table 46 show that before Covid-19, agro-input dealers mostly used in-person bilateral meetings, phone calls and SMS. The other communication channels were not frequently used by them, perhaps due to their level of digital literacy, as earlier stated.

Table 46: Changes in frequency level ICT use and Communication channels before Covid-19

Level of frequency	Koulikoro	Sikasso	Segou	Total
Decreased a lot	4	14	26	44
Decreased a little	20	15	45	80
Increased a little	5	13	2	20
			1	25
Communications channels	Koulikoro	Sikasso	Segou	Total
In-person bilateral meetings (pre- Covid-19)	1	8	7	16
In-person group meetings (pre- Covid-19)	1	1	1	3
Phone calls	1	4	6	11
SMS	1	3	4	8
Email	0	0	1	1
Video call apps (WhatsApp)	1	1	1	3

Impacts of ICT use among agro-output dealers

The result in Table 47 shows that the use of ICTs among agro-output dealers had helped them to perform their activities of buying and selling agricultural products. More than 90% of agro-output dealers stated that ICT use helped improve work performance, making their work easier; a few, however, noted that ICTs also made it a bit difficult to perform their roles effectively. The major challenges encountered in their use of ICTs related online fraud, price speculation, cost of ICT services and devices, customers' losses/ frustrations due to poor network infrastructures, and reduction in revenue.

Regions	they made it easier	they made it more difficult	they made some things easier and some more difficult	no change	don't know
Koulikoro	54	0	2	0	0
Sikasso	67	0	10	0	0
Segou	86	0	10	0	0
Total	207	0	22	0	0

Source: Surveys, PARI 2021

Only 0.87% of the agro-output dealers said the use of ICTs did not improve their performance at work (Table 48). The number of producers with whom agro-output dealers interacted (see Table 37) before Covid-19 was higher than that during the Covid-19 pandemic. Among the 174 agro-input dealer respondents, 60.3% of said that such interaction was more important before than during the pandemic. For the Koulikoro region, the interaction situation was unchanged before and during Covid-19 (Table 49). As said previously, the restriction protocols imposed during Covid-19 did not significantly affect local and national markets, as they remained open throughout the period.

The decrease in the number of producers during Covid-19 also impacted on the interaction frequency with agro-output dealers (see Table 38). Of the 77 agro-output dealers who responded to the question on the interaction frequency with producers, 79.2% said that Covid-19 reduced their interaction frequency. In all the three regions, the interaction frequency experienced changes (Table 49).

Table 48: Business ability improved by ICT use

Regions	Did ICTs improve your ability to run your business		
	Yes	Νο	
Koulikoro	55	1	
Sikasso	76	1	
Segou	96	0	
Total	227	2	

Source: Surveys, PARI 2021

Table 49: Changes in producers' interaction with agro-output dealers before and during Covid-19

Regions	Before Covid-19	During Covid-19
Koulikoro	48	48
Sikasso	91	48
Segou	150	97
Total	105	69

Source: Surveys, PARI 2021

Table 50 shows the frequency in the use of ICTs during Covid-19 pandemic. In Table 51, about 81% of the agro-output dealers said ICT use reduced face-to-face communication frequency, while 69% said that Covid-19 had no effect on face-to-face communication frequency. However, 31% of the respondents stated that Covid-19 reduced the frequency of face-to-face communication.

Table 50: Share of interaction f	requency	/ with p	producers	during	Covid-19	pandemic
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Regions	Changes in Interaction with producers during Covid-19		
	Yes	Νο	
Koulikoro	12	1	
Sikasso	21	6	
Segou	28	9	
Total	61	16	

Table 51: Percentage decrease in face-to-face communication frequency due to ICT use and Covid-19 $\,$

Regions	Changes in Interaction with producers during Covid-19		Changes in the frequency of face- to-face communication with Covid-19 pandemic	
	Yes	No	Yes	No
Koulikoro	43	13	15	41
Sikasso	62	15	28	49
Segou	81	15	28	68
Total	186	43	71	158

Source: Surveys, PARI 2021

The data in Table 52 show how the frequency change with Covid-19 and the types of communication channels used before the pandemic. About 81.2% of the respondents stated that face-to-face communication frequency decreased, while 18.8% them said it increased. Generally, the frequency of face-to-face communication varied across the regions, depending on the number of respondents interviewed. Moreover, before Covid-19, agro-input dealers used mostly in-person bilateral and group meetings, phone calls, SMS, video call applications, such as WhatsApp and digital agricultural service. Agro-output dealers did not also know the numerous functions of ICT devices because of low digital literacy. Most of them (71.2%) did not belong to any formal or informal networks; only 28.8% of them were in such groups.

Table 52: Changes in frequenc	y level ICT use and Communicatior	channels before Covid-19
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Level of Frequency	Koulikoro	Sikasso	Segou	Total
Decreased a lot	16	16	27	59
Decreased a little	20	24	48	92
Increased a little	1	8	3	12
Increased a lot	6	14	3	23
Communications channels	Koulikoro	Sikasso	Ségou	Total
In-person bilateral meetings (pre-Covid-19)	0	0	2	2
In-person group meetings (pre-Covid-19)	2	4	8	14
Phone calls	1	2	4	7
SMS	0	6	2	8
Video call apps (WhatsApp)	1	1	0	2
Digital agricultural service	0	0	1	1

Impact of ICT use among extension agents

The changes made due to ICT use among extension agents are presented in Table 53. The data show that the use of ICTs helped extension agents to better perform their activities of advisory. About 88% of the extension agents stated that ICT devices made their work easier, while only 11.7% said that they made some things also more difficult.

Regions	they made it easier	they made it more difficult	they made some things easier and some more difficult	no change	don't know
Koulikoro	29	0	3	0	0
Sikasso	73	0	2	0	0
Segou	49	0	15	0	0
Total	151	0	20	0	0

Table 53: Changes due to ICT use in the ability to perform your professional activities

Source: Surveys, PARI 2021

Aker (2011) has affirmed that, since 2007, mobile phone-based applications and services in agricultural sector are providing information on product markets, weather and production techniques in developing countries. Kante et al. (2018) opined that ICT-based farm input information helps enhance farmers' knowledge on inputs. When using ICTs, extension agents encountered such challenges as high cost of ICT devices/ services, spreading fake news online through ICTs, unnstable network connectivity in rural areas, low knowledge on informatics tools, and exposure to health hazards, such as eye problems. Table 54 presents extension agents' opinions on their ability to assist farmers at production and marketing stages with the use of ICTs. The data show that most of the extension agents affirmed that ICT use had improved their ability to provide information at both production and marketing stages. At the production stage, 98.8% of the extension agents said that the use of ICT facilitated how they disseminated farm inputs information, while at the marketing stage, 91.2% of them held a similar opinion on ICT use and increased work ability.

Table 54: Extension agents' ability to assist farmers at the production and marketing stages with ICT use

Regions	improving ability to assist crop and livestock producers at the production stage		improving ability to assist crop and livestock producers at the marketing stage	
	Yes	No	Yes	No
Koulikoro	32	0	27	5
Sikasso	74	1	70	5
Segou	63	1	59	5
Total	169	2	156	15

In Table 55, the number of producers with whom extension agents interacted before Covid-19 was higher than that during Covid-19. For all the three agricultural regions, this number decreased during Covid-19, perhaps due to the social distancing measures by the Malian authorities. This finding is contrary to that of Rachmawati et al. (2021), who indicated that the use of ICTs during the Covid-19 pandemic increased due to the restriction on movement and closure of workplaces. However, telephone use in extension delivery was still limited because of the challenges of higher cost of ICT devices and services and limited network connectivity.

Regions	Before Covid-19	During Covid-19
Koulikoro	61	36
Sikasso	87	73
Segou	305	115
Total	177	82

Table 55: Percent reduction of number of producers before and during Covid-19

Source: Surveys, PARI 2021

In Table 56, the frequency of interaction between producers and extension agents also reduced. Of the 67 extension agents who responded, 77.6% affirmed that the frequency of interaction with producers reduced essentially due to the restriction measures during Covid-19. This reduction in interaction frequency was observed in the three regions of the survey.

Table 56: Percent reduction of	producers' interaction freq	uency during Covid-19	pandemic

Regions	Changes in Interaction with producers with Covid-19		
	Yes	Νο	
Koulikoro	11	2	
Sikasso	17	7	
Segou	24	6	
Total	52	15	

Source: Surveys, PARI 2021

The face-to-face communication frequency also changed as results of ICT use. Table 57 shows that 81.9% of the respondents affirmed that frequency of face-to-face communication reduced with the use of ICTs, such as mobile phone; but 42% others pointed out that this frequency did not change with Covid-19 pandemic.

Table 57: % reduction of Face-to-face communication frequency due to ICT use and Covid-19 pandemic

Regions	Changes in the frequency of face-to- face communication with producers due to mobile phone use		Changes in the frequency of face-to-face communication due to Covid-19 pandemic	
	Yes	No	Yes	No
Koulikoro	28	4	16	16
Sikasso	60	15	26	49
Segou	52	12	18	46
Total	140	31	60	111

Source: Surveys, PARI 2021

The data in Table 58 show that 67.1% of the 140 extension agents who responded to the item affirmed that there was reduction in mobile phone use. In the three regions, respondents stated that mobile phone use had reduced face-to-face communication. Moreover, before Covid-19, extension agents utilized such communication channels as in-person bilateral and group meetings, phone and WhatsApp video call, email and SMS. Thus, extension agents used several communication channels, compare to the other intermediary groups, because of their level of education and digital literacy.

Table 58: Percentage changes in frequency level with Covid-19 and communication channels before Covid-19

Level of Frequency	Koulikoro	Sikasso	Segou	Total
Decreased a lot	7	13	14	34
Decreased a little	8	20	32	60
Increased a little	7	16	1	24
Increased a lot	6	11	5	22
Communications ch	annels			
In-person bilateral meetings (pre- Covid-19)	2	5	1	8
In-person group meetings (pre- Covid-19)	1	1	0	2
Phone calls	0	2	2	4
SMS	0	5	9	14
Email	1	2	0	3
Video call apps (WhatsApp)	2	3	0	5

Summary of Key Findings and Discussion

Generally, there is a much-debated question on the ICT policies and agricultural development in many sub-Saharan African countries and particularly in Mali. According to Kante (2020), research on how ICT use can improve agricultural productivity and economic growth is a growing field, but publications regarding ICT policies in agriculture in developing countries remain sparse. Furthermore, Mali's current ICT policy does not fit well with the agriculture sector and its use has not yet increased agricultural productivity. Therefore, having an appropriate ICT policy in the agriculture sector of Mali should be a priority in increasing agricultural production and food security. FAO (2017) has maintained that ICT policy for agriculture in Mali is inconsistent.

The most dominant ICT channel among extension agents and agro-input and output dealers in Mali is the mobile phone, especially smartphone. The use of mobile phone continues to grow since 1990 when it was first introduced with only one telecoms operator. Today, there are four telecoms company in Mali. According to the ICT system authority, in 2011 there were 10.8 million mobile phone subscribers in Mali (Kante et al., 2017). This study found that all the three groups of intermediaries used ICT devices in carrying out their professional activities. The finding on high interest in the use of mobile phone in Mali has been affirmed by earlier studies in Mali and elsewhere.

The use of ICTs in agricultural has helped bring producers closer to the study intermediary groups. It has made it easy for these groups to mobilize producers and share information in real time, even with people in distant rural areas, far from the markets. ICT use has also helped market actors to promote their produce, as well as expedite actions on market orders—this is highly advantageous in the current state of insecurity in the country. The study, however, found that ICT devices and services incurred for the respondents some additional costs, especially in the purchase of smartphone, credit, data bundles, charges on money transfer, etc.

The use of both hardware and other ICT applications is a necessity for the rapid facilitation and dissemination of farm information and market information. About 91% of the three categories of respondents agreed that the use of ICTs made their work easier. However, they were faced with challenges, such as high cost of ICT devices and services, limited access and unstable network connectivity, especially in rural areas; exposure to online fraud and misinformation or fake news, health hazards, low knowledge on informatics, and low digital literacy.

The findings show that Covid-19 pandemic had little effect on the use of ICTs. This finding is

contrary to earlier findings, which stressed that ICT use increased during Covid-19, especially as office workers remained at home due to the lockdown and other restrictive measures. ICT use was also low, perhaps due to the low level of education and digital literacy, as well as the costs of procuring ICT devices and securing services.

The major ICT functions used by agro-input and output dealers were direct phone call or message, photo, video call, or voice call from WhatsApp. This can be attributed to the level of access and knowledge of the actors with whom the respondents interacted. These actors were mainly smallholder farmers who had limited knowledge in ICT facilities.

Many of the respondents were not aware that such ICT facilities as Agricultural Value-Added Service (Agrivas), GPS, etc. could be used to efficiently reach and expand their distribution networks. Agrivas platforms were not many in Mali, the main ones being Myagro, Senekela and Buy from Women. Rural areas, where the three intermediary groups (respondents) were based, lacked many of the basic ICT-support infrastructures. In addition, ICT services in Mali were not well adapted to the specific needs of the respondents and producers, who were the main clients. Except for extension agents, the respondents had low educational backgrounds and, therefore, could not fully appreciate the importance of ICTs to their work.

Recommendations for Policies and Investments

Based on the findings of this study, the following are recommended:

- Local languages should be used in ICT facilities and platforms in facilitating the use of ICT services in the agricultural sector actors including producers, agricultural product processors, agro-dealers, etc.
- 2. ICT training programmes should be organised for extension agents on opportunities in ICTs for efficient extension service delivery. And they can be encouraged to access and utilize ICTs with financial and material supports by the respective institutions they belong to;
- 3. There should be increased investments in network infrastructures to boost mobile phone connectivity across the country;
- 4. There is the need to develop and support more ICT platforms for each of the study intermediary groups and among the different stakeholders in the agricultural sector;
- 5. Existing rural literacy programmes should be integrated into digital technologies/ devices to improve knowledge and skills in ICT use and services among the various actors;
- 6. Further study could be undertaken to investigate how to improve on the current ICT policy on agriculture development;
- 7. Quantitative study should be carried out to assess the extent that ICT improve smallholder farmers' agricultural productivity;

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