

Status of Use of Information and
Communication Technologies by
Agriculture Sector Intermediaries

Insights from Kenya

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Executive Summary

Agricultural intermediaries in the agricultural sector play an important role of providing linkages between relevant value chain players and thereby introduce dynamism in the agricultural system. The intermediaries include extension agents, input and output dealers, microfinance institutions, equipment suppliers, and seed companies. While some may confine themselves to one role, others play multiple roles. Information and Communication technologies are increasingly being used by intermediaries in Kenya in their diverse roles but no empirical data is available to quantify the extent of this usage. This study therefore sought to assess the extent of ICT use among input dealers, output dealers and extension agents in Kenya. Data were collected from three intermediary categories in three counties with contrasting farming scales; Uasin Gishu (large scale), Tharaka Nithi (small scale) and Nairobi and Kiambu (intensive small scale) with the last two being combined into one due to their similar farming characteristics. A total of 295 intermediaries, consisting of 38% agro-input dealers, 32% agro-output dealers and 30% extension agents (of 54% male and 46% female) were interviewed. Their mean age was 39 years, with majority having college level education and a mean working experience of 14 years. All the respondents owned mobile phones and 91% of these phones were smart phones. Smart phones were owned by 99% of the Extension agents while 20% of agro-output dealers owned feature phones and 14% of agro-input dealers owned basic phones. A combination of smart phone/feature was used by 97% of the respondents, while 91% used smartphone and 15% of the respondents used feature phone and basic phone each. Output and input dealers mainly used ICTs daily to sell outputs and inputs, while Extension agents mainly availed information to producers and conducted group trainings. All intermediaries received and provided information to value chain actors and also received and made payments through ICTs. More than 70% of the sample intermediaries were skilled in the use of mobile phone; 32% of the respondents were not skilled in the use of digital agricultural services and other apps. The most cited hindrances to use of ICTs was lack of relevance to the intermediaries' activities, followed by high cost, particularly for tablet and computer. Reasons for increase in the use of ICTs were: improved network connectivity (44%), useful apps being availed (35%), devices having more functionality (30%) and cost of services and apps being cheaper. Occurrence of Covid-19 led to increase in use of ICT use as cited by 38% of the respondents and this was mainly reported by extension agents. Service delivery through ICTs during the pandemic was said to have been made easier by 94% of the respondents but 4.7% stated that some services became easier and others became more difficult. ICTs were said to have a positive effect on transaction costs where 29% affirmed that it provided easy access to information on production, marketing and eased interaction with producers and buyers. There was a 5% level of significance between interaction with producers and type of phone, intermediary and level of education. ICTs were also cited to ease running of business and facilitated collective action among value chain actors. Three key challenges cited on the use of ICTs included that participation of some group members was reduced (91%), differential access to information (62%) and slow decision making (33%).

In conclusion, the study revealed that, there was variable use of ICTs by the three intermediaries in Kenya both in terms of tools owned and how they are used. Reasons cited for increased ICT

use included improved network and reduced costs of some of the tools. Use of ICTs during the Covid-19 pandemic made service delivery easier especially for extension agents who conducted trainings. This is important especially for the public extension service where budgets and personnel resources have decreased and use of ICT to reach the value chain stakeholders would provide a solution. For increased use of ICTs to be realized, there is need for incentives such as reduction in costs of data transmission, tax reduction on price of ICT gadgets, improved country wide network connectivity and establishment of ICT hubs in the rural areas. These and other area specific measures will help to increase usage of ICT tools by intermediaries with resultant positive effect on the agricultural sector.

Introduction

Agricultural intermediaries who may be individuals, businesses or organizations play an important role in the agricultural sector by linking agricultural value chain actors to information, markets and services (Howells, L. 2006). The most prominent intermediaries (although considered unscrupulous) in the Kenyan agricultural sector context, are brokers or middlemen who procure outputs from one actor such as farmers, livestock keepers or processors in the value chain, to sell to another actor such as a processor, supermarket, exporter or even the consumer. Such middlemen play an aggregation role by gathering small quantities of produce to make large tradable volumes. Other intermediaries provide inputs with a good example being agro dealers while others recruit and supply labour. Another group of intermediaries facilitate access to services such as machine hire, loans and insurance. Intermediaries often play more than one function whereby buyers may also be a source of loans or inputs while farmer organizations, business associations or innovation platforms may also take on a wide range of intermediary roles. They therefore in addition to creating linkages among diverse actors also live and create system dynamism (Perez, et al 2010, Howells, L. 2006).

Within agricultural innovation systems context, intermediaries act as innovation brokers where they catalyse the innovation process as well as uptake and up scaling to support change in socio-technical systems (Kivumaa et al, 2019; Kilelu et al, 2011; Perez Perdomo et al, 2010; Klerx et al, 2009). Before the advent of innovation systems thinking, the main focus of intermediation was primarily on information and technological exchange where extension services used to pass technological information to farmers in a linear manner (Kilelu et al, 2011). Various authors have argued that the nature and positioning of innovation intermediaries is contextually embedded. In Kenya, the evolving demand driven pluralistic agricultural extension services to support emerging agricultural innovation systems frames the debate on intermediaries. This leads to the observation that the role of advisory actors has expanded beyond technology transfer

to organising smallholder producers, establishing market linkages and brokering multi actor networks and linkages (Birner et al., 2009). Innovation intermediaries act as ‘bridging organisations’ that facilitate access to knowledge, skills, services, and goods from a wide range of organisations. Emergence of new actors and repositioning of existing ones has led to new actor roles and even new interaction mechanisms that include increasing use of ICTs. The few studies conducted on use of ICTs in African agriculture have so far shown disconnected and unsustainable initiatives but with new demands and changing circumstances, the situation may be changing (Tsan et al., 2019; Baumuller 2018)

In the Kenyan smallholder sector, three groups of actors play an important intermediary role of linking the producers to other actors. These are agro-input suppliers, agro-output dealers and the public and private extension services. These actors have traditionally used physical interactions in their intermediation between value chain actors but the changing communication environment where ICTs have gained currency is expected to influence the nature of interaction. Little is known about how these agricultural intermediaries make use of ICTs in their operations because there has not been any assessment of the extent of use of ICTs in Kenya. Earlier studies have mainly focused on the adoption and use of dedicated ICT4Ag services only with findings that uptake of ICT4Ag services in African agriculture has been limited, small, disconnected and financially unsustainable (Malabo Montpellier Panel, 2019; Tsan et al., 2019; Baumuller, 2018). This study sought to answer two research questions: i) Does the literature on uptake of ICT4Ag services underestimate the transformative impact of ICTs in the food and agriculture sector? ii) Are intermediaries the drivers of this transformation in Kenya?

The report is organized into five sections as follows. Section one covers introduction which gives an overall view of the subject of intermediaries and their role, while Section two covers methodology giving the study site characteristics, sampling and data collection procedures. Section three is the results section which presents the findings from the interviews with the intermediaries in the study sites. Section four presents the summary of key findings and discussion while section five presents recommendations for policies and investments.

Methodology

| The Study Sites Characterisation

This study was conducted in three counties of Kenya, namely Uasin Gishu, Tharaka Nithi and Nairobi/Kiambu where extension service providers, input and output dealers were interviewed. Due to the proximity of Nairobi and Kiambu, the two counties were merged to form one study site. The three study sites

provided contrasting farming scenarios in which Uasin Gishu is characterized by large scale maize and wheat farming while Tharaka Nithi is characterised by small scale farming. Kiambu and Nairobi are characterised predominantly by a mix of urban and peri-urban farming (Uasin Gishu CIDP 2018, Tharaka Nithi CIDP 2018,

Kiambu CIDP 208 and Nairobi CIDP 2018). Agriculture sector in these counties is served by Extension agents, agro-output dealers and agro-input dealers as intermediaries among others. The intermediaries are defined as individuals, businesses or organisations that link farmers and other value chain actors to information, input and output markets and services.

The extension agents comprise of public and private individuals. The public extension agents are individuals employed by the county governments while others are employed by the national government. They are assigned specific duties in their respective offices in the regions that they serve. Private extension agents are employed by private companies, NGOs and Faith based organizations. They advise farmers and other value chain actors on various agricultural issues.

Agro-output dealers are individuals or businesses who deal with agricultural produce and products. Some of the dealers

are produce or product specific while others deal with a range of produce or products. There are those who specialize in cereals such as maize, sorghum, rice, millets and wheat while others deal with horticultural crops such as fruits, vegetables and spices. There are also those who deal with a mix of cereals, fruits, legumes and other products. Value added products such as flour, dehulled grains and others are also included in addition to livestock products such as meat and milk.

Agro-input producers are individuals or business entities that deal with agricultural inputs and services. The inputs may range from seeds, pesticides, veterinary products, small agricultural equipment, animal feeds and planting materials. Services may include advise or provision of machinery and equipment. In some cases, the dealers may serve as agents of large agro-chemical companies while at times, the companies set up their own outlets. In this study the intermediaries described above were respondents and the analysis considered the broad category and not the finer sub grouping.

Sampling and Data Collection Process

Within each county, comprehensive lists of each of the three intermediary categories were compiled with the assistance of the county agricultural extension staff. These lists comprised of as many intermediaries as possible and their contact information within the three counties and formed our sampling frames. The intermediaries were randomly selected from the various lists using random numbers. A replacement list was also generated, to replace those unwilling to be

interviewed or could not be found during the interview period. Enumerators were recruited and trained ensuring that each of them understood the questions and the responses expected and clarification were made on any issues that were unclear. The enumerators then took turns in mock administration of the questionnaire to ensure that they had understood. The enumerator training was conducted on 26th of April 2021, and data collection followed immediately from 27th April

2021 to 1st May 2021. The interview responses were gathered through the web based Online Data Kit (ODK) and supervisors verified each of the questionnaires before they were submitted to the server.

| Methodology for the Descriptive Data Analysis



Data collected from the field survey were cleaned and analysed and summarized and presented in form of tables, bar charts and pie charts.

Sample characteristics

| General background of sample respondents

The total intermediaries interviewed, their gender and age, education level, experience and business ownership and telephone ownership and usage are described below and presented in Table 1.

Intermediaries, gender, age, education level, work experience and business ownership

The total number of intermediaries interviewed were 295 where 38% of them were agro-input dealers, 32% were agro-output dealers and 30% were extension agents. The intermediaries were distributed in the study sites with Agro-input dealers being more than the other categories across the counties. The gender composition was 54% males and 46% females. There were more

male Agro-output and agro-input dealers while there were more female extension agents. The overall mean age was 44 years with agro-input dealers having the least mean age of 39 years and extension agents having the highest mean age of 51 years. Majority of the intermediaries (39%) had a college level of education followed by 31% who had university education and 18% who had secondary education. The mean number of years worked was 14 years with extension agents having the highest (25 years) and agro-input the lowest (9 years) and all output and input businesses were owned by the respondents.

Mobile Phone Ownership and use

Smartphones were the most prevalent phone type owned by 91% of the respondents

followed by 14% who owned feature phones and 10% basic phones. Smart phones were owned by 99% of the Extension agents while 20% of agro-output dealers owned feature phones and 14% of agro-input dealers owned

basic phones. A combination of smart phone/feature was used by 97% of the respondents while 91% used smartphone and feature phone and basic phones were each used by less than 15% of the respondents.

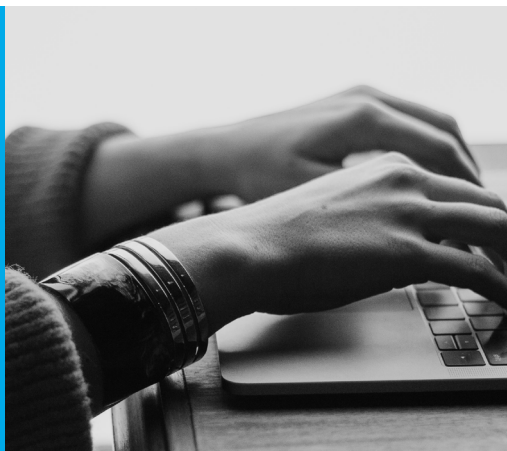
Table 1: General Background of Intermediaries

Regions	Extension Agent (n=89)	Agro-output Dealer (n=95)		Agro-input Dealer (n=111)	Total (295)
A24 Intermediaries interviewed		%	%	%	%
		30.2	32.2	37.6	100.0
County distribution	Uasin Gishu	26.4	30.9	42.7	100
	Tharaka Nithi	32.6	32.6	34.7	100
	Nairobi/Kiambu	31.1	33.3	35.6	100
A25 Gender	Male	49.4	53.7	56.8	53.6
	Female	50.6	46.3	43.2	46.4
A26 Mean Age	Mean years	51	42	39	44
B1.3 Education Level	College	40.4	31.6	44.1	39.0
	University	53.9	11.6	27.9	30.5
	Secondary school	1.1	32.6	18.9	18.0
	Primary school	0.0	21.1	4.5	8.5
	Post graduate	4.5	1.1	0.0	1.7
	Vocational training	0.0	0.0	4.5	1.7
	No formal education	0.0	2.1	0.0	0.7
B1.4 Working Experience	Years	25	10	9	14
A 16 Business Ownership	Yes		100	100	
A19 Type of Mobile phone owned	Smart Phone	98.9	84.2	91.0	91.2
	Feature	7.9	20.0	13.5	13.9
	Basic	5.6	10.5	13.5	10.2
A21 Mobile phone usage	Smart/feature	100.0	94.7	97.3	97.3

	Smartphone	98.9	84.2	91.0	91.2
	Feature	7.9	20.0	13.5	13.9
	Basic	5.6	10.5	13.5	10.2

Intermediary Operations

There were 50% of agro-output dealers who were market retailers; 30% were market wholesalers. Also, 85% of input dealers were market retailers and 7% were market wholesalers (Table 2). The professional activities for output dealers consisted of 73% selling outputs to consumers, 70% buying outputs from producers and 50% buying from other intermediaries in addition to selling outputs to other output dealers and transporting of outputs.



Pesticides, seeds and vaccines were sold by 79%, 78% and 77% of agro-input dealers in addition to other livestock inputs. Three priority commodities for extension agents were maize (54%), dairy (12%) and vegetables (10%), and information provided was mainly to producers (22%), individuals on farm training (22%) and group training (21%).

Table 2: Characterization of intermediaries

Features	Agro-Output Dealers	%
Business category	Market retailer/shop	49.5
	Market wholesaler	29.5
	Aggregator/collector	6.3
	Processors	5.3
	Farmers' organisation incl. cooperatives	4.2

Professional activities	Selling outputs to consumers	72.6
	Buying outputs directly from producers (farm gate)	69.5
	Buying outputs from other intermediaries	49.5
	Selling outputs to other agro-output dealers	32.6
	Transporting outputs from producers and/ or agro-output dealers	13.7
Business Location	City	37.9
	Village	31.6
	Small town	30.5
Business registration	Yes	86.3
Agro-input Dealer		
Business Category	Market retailer/shops/agrovet	84.7
	Market wholesaler, distributors, importer	7.2
	Input company (agrochemicals, seeds etc)	6.3
	Government-based organization	0.9
	Farmers' organisation incl. Cooperatives	0.9
Type of Inputs sold	Pesticides and Insecticides	79.3
	Fertilizer	77.5
	Improved seeds	76.6
	Acaricides	63.1
	Other livestock drugs	41.4
	Vaccines	27.9
	Other	19.8
Business Location	Small town	45.0
	City	28.8
	Village	26.1
Business registration	Yes	97.3
Extension Agent		
Top three Commodities handled	Maize	53.9
	Dairy	12.4
	Vegetables	10.1

Professional activities	Provide information to producers	21.8
	Conduct individual on farm training	21.8
	Provide group training	20.9
	Connect producers and input dealers	18.2
	Connect producers and agro dealers	11.8
	Connect producers and source of finance	9.1
	Connect producers to government officials	9.1
	Others	1.8

Results

Use of ICTS among Intermediaries

The different ICTs used by the intermediaries for professional services

The intermediaries used various ICT tools for professional services, as shown in table 3. Smartphone was used by 86% of the respondents, followed by Computer (42%) and Feature phone (17%). The least ICT used was Television, followed by basic phone and tablet. Extension agents reported the use of Smartphone more than the others (97%), followed by agro-input dealers (85%); a similar trend was observed for the Computer.

Table 3: ICT tools used by intermediaries

	Extension agent (n=89)	Agro-Out-put-dealer (n=95)	Agro-Input dealer (n=111)	Total (n=295)
Smartphone	96.6	78.9	84.7	86.4
Computer	67.4	17.9	42.3	42.0
Feature phone	9.0	24.2	16.2	16.6
Radio	15.7	8.4	20.7	15.3
Tablet	28.1	6.3	9.0	13.9
Basic phone	5.6	14.7	18.9	13.6
Television	12.4	8.4	14.4	11.9
Total	100.0	100.0	100.0	100.0

| The most frequently used ICT tool

The most frequently used ICT was smartphone, as reported by 73%; computer was reported by 16%, while the rest of the ICTs were lower than 5% (Table 4). More extension agents (85%) and input dealers (72%) used smartphones than output dealers (53%).

Table 4: ICT tool most frequently used

	Extension agent (n=89)	Agro-Out-put-dealer (n=95)	Agro-Input dealer (n=111)	Total (n=295)
Smartphone	85.1	52.9	71.6	73.2
Computer	10.4	20.6	19.4	16.1
Feature phone	0.0	17.6	1.5	4.2
Radio	0.0	5.9	6.0	3.6
Basic phone	1.5	2.9	1.5	1.8
Tablet	3.0	0.0	0.0	1.2
Total	100.0	100.0	100.0	100.0

| The frequency of ICT tool use

Overall, about 98% of the intermediaries used smartphones on a daily basis; 2% used them on a weekly basis (Table 5). All agro-output and agro-input dealers and 95% of the extension agents used ICTs on a daily basis.

Table 5: Smart phone use frequency by intermediaries.

	A24. Intermediary category			
	Extension agent (n=89)	Agro-Output-dealer (n=95)	Agro-Input dealer (n=111)	Total (n=295)
	%	%	%	%
Daily	100.0	100.0	94.7	97.6
Weekly	0.0	0.0	3.5	1.6
Fortnightly	0.0	0.0	1.8	0.8

Professional activities where intermediaries used ICT tools

Tables 5, 6 and 7 present the results on the various activities for which the different intermediaries used ICT tools.

i. Agro-output dealers

Selling outputs to consumers using ICTs was practised by 73% of the output dealers, followed by 70% who bought outputs directly from producers and 50% others who bought outputs from other intermediaries (Table 6). Also, 33% of the dealers sold outputs to other agro-output dealers. For all other professional activities, ICT was used by less than 15% of the output dealers.



Table 6: Professional activities where output dealers use ICT

Activity	Intermediary category Agro-output-dealer (%)
Selling outputs to consumers	72.6
Buying outputs directly from producers (farm gate)	69.5
Buying outputs from other intermediaries	49.5
Selling outputs to other agro-output dealers	32.6
Transporting outputs from producers and/or agro-output dealers	13.7
Storing outputs	11.6
Packaging outputs	10.5
Processing outputs including milling	9.5
Transporting outputs to consumers and/or agro-output dealers	7.4
Others	6.3
Providing inputs to producers	5.3
Providing information to producers	5.3
Providing credit to producers	5.3

ii. Agro-input dealers

Selling inputs directly to consumers was practised by 90% of the input dealers, while 69% bought inputs from other input dealers; also, 31% sold inputs to other input dealers and 22% provided information to producers (Table 7). All the other activities were performed by less than 15% of the input dealers.



Table 7: Professional activities where input dealers used ICT tools

Activity	Intermediary category Agro-output-dealer (%)
Selling inputs directly to customers?	90.1
Buying inputs from other agro-input dealers?	69.4
Selling inputs to other agro-input dealers?	30.6
Providing information to producers?	21.6
Importing inputs?	14.4
Packaging inputs?	12.6
Transporting inputs to customers and/or other agro-input dealers?	5.4
Transporting inputs from other agro-input dealers?	4.5
Producing inputs?	2.7
Providing credit to producers?	1.8
Others	1.8

iii. Extension agents

Before the onset of Covid-19, extension officers provided information to producers and conducted group training, as reported by 83% of the extension agents interviewed, while 80% conducted on-farm training. Output dealers were connected to producers by 52% of the respondents, while producers were connected to output dealers by 47% of the respondents (Table 8).



Table 8: Professional activities where extension staff use ICT tools

Activity	Intermediary category Extension agent %
Provide information to producers	83.1
Conduct group training (pre-Covid)	83.1
Conduct individual on-farm training	79.8
Connect producers and agro-output dealers	51.7
Connect producers and agro-input dealers	47.2
Connect producers and government officials	34.8
Connect producers and sources of finance	25.8
Others	5.6

Use of ICT to receive or provide information to value chain actors

All the intermediaries used ICT tools to communicate with the value chain actors, with three are being the most prevalent. The highest use was for receiving and providing information, as reported by 85% of the respondents, followed by contacting value chain actors (74%) and making or receiving payments (64%). About 20% organized and conducted group activities through ICTs, while less than 3% obtained or dispersed credit, or used the tools in other ways (Table 9).

Table 9: Purpose for which ICT used

Purpose	Intermediary			
	Extension agent (n=89)	Agro-Out-put-dealer (n=95)	Agro-Input dealer (n=111)	Total (n=295)
	%	%	%	%
Receive and provide information	97.8	78.9	81.1	85.4
Contact value chain actors	84.3	72.6	67.6	74.2
Make/receive payments	28.1	75.8	83.8	64.4
Organize / conduct group activities	55.1	5.3	3.6	19.7
Obtain or disperse credit	0.0	2.1	5.4	2.7
Keeping records	0.0	3.2	0.9	1.4
Other ways	0.0	2.1	1.8	1.4

Types of information received by intermediaries

Very few agro-input and agro-output dealers responded to the question on the types of information received. The results showed information was mainly on input, outputs and production. Of the 71 extension agents who responded to the item, about 70% reported having received production information, while 57% each received information on weather and government programmes (Fig 1).

Extension agent

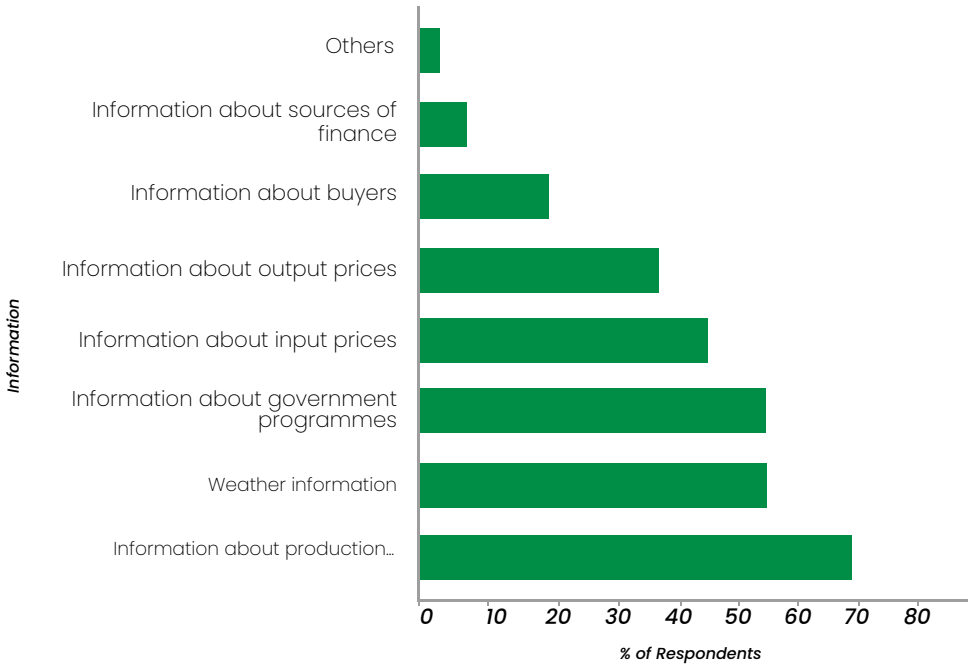


Figure 1: Information type received by extension agents

Types of information provided

There were very few agro-input and agro-output dealers who responded to the item on types of information provided. The results, however, showed the information was mainly on production, input and output prices.



Information provided by extension agents

Information on production methods was provided by 68% of the extension agents, while that on weather and government programmes was each provided by 53% (Fig 2). Input and output prices were by 47% and 36%, respectively. These are important information that, according to Baumuller (2012), reduces information asymmetry and increases farmers' bargaining power. The rest of the information was reported by less than 20% of the extension agents.

Extension agent

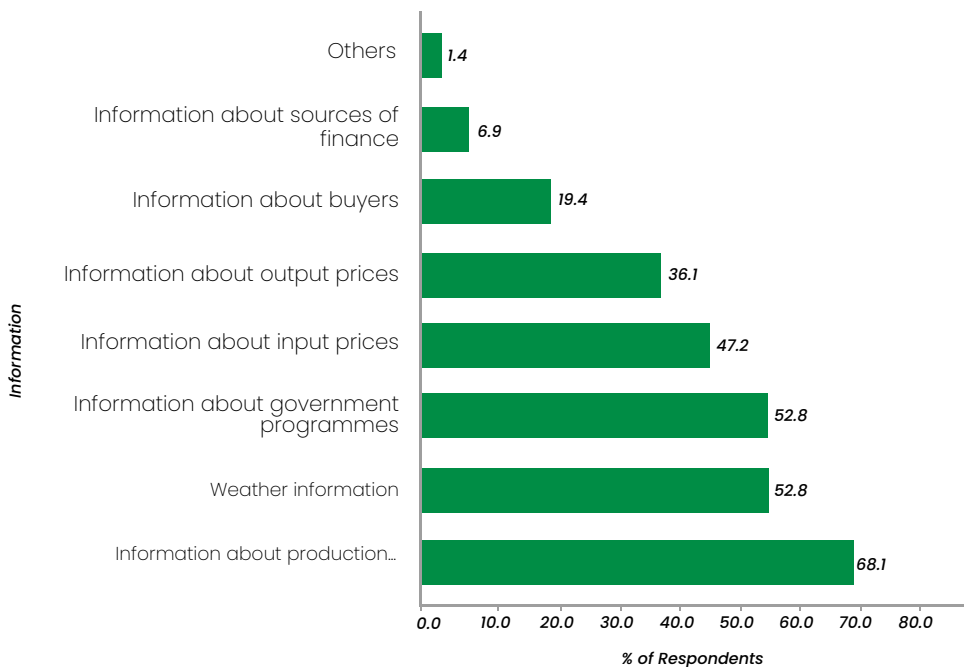


Figure 2: Information provided by extension agents

Hindrances to desired use of ICTs in professional activities

Why radio as not used

The major reason given why 69% of the respondents did not use radio was the perception that radio was not useful/necessary for the intermediaries' professional activities; more agro-output dealers (86%) also gave this as a reason for not using radio (Table 10).

Table 10: Reason for not using radio in professional activities

Reasons	Intermediary			
	Agro-input dealer (88)	Agro-output dealer (87)	Extension agent (75)	Total (n=250)
	%	%	%	%
Not useful/necessary for my professional activities	67.0	86.2	52.0	69.2
Other	11.4	5.7	26.7	14.0

Reasons	Intermediary			
	Agro-input dealer (88)	Agro-output dealer (87)	Extension agent (75)	Total (n=250)
	%	%	%	%
Too expensive to purchase	13.6	5.7	12.0	10.4
Poor/ unstable/unreliable network connectivity / reception	3.4	1.1	9.3	4.4
I don't trust it	3.4	0.0	0.0	1.2
lack of electricity	1.1	1.1	0.0	0.8

Reasons for not using television

The two main reasons given by respondents for not using television were that it was not useful/necessary for professional activities (68%) and it was too expensive to purchase (15%). For those who said it was not necessary, majority (84%) were agro-output dealers (Table 11).

Table 11: Reason for not using television in professional activities

Reason	Intermediary			
	Agro-input dealer(n=95)	Agro-output-dealer (87)	Extension agent (78)	Total (250)
	%	%	%	%
Not useful/necessary for my professional activities	68.4	83.9	48.7	67.7
Too expensive to purchase	17.9	8.0	20.5	15.4
Other)	8.4	5.7	28.2	13.5
Poor/ unstable/unreliable network connectivity / reception	3.2	2.3	2.6	2.7
lack of electricity	1.1	0.0	0.0	0.4
I don't trust it	1.1	0.0	0.0	0.4
I don't know how to use it	0.0	0.0	0.0	0.0
my clients/business partners do not trust it	0.0	0.0	0.0	0.0

	Intermediary			
Reason	Agro-input dealer (n=95)	Agro-out-put-dealer (87)	Extension agent (78)	Total (250)
	%	%	%	%
my clients/business partners don't have access	0.0	0.0	0.0	0.0
Too expensive to use	0.0	0.0	0.0	0.0

Reasons why computers were not used

The main reason the respondents gave for not using computers was that it was not useful/necessary for professional activities (37%) followed by 31% who responded that it was too expensive to purchase and other reasons were cited by less than 9% of the respondents (Table 12)

Table 12: Reason for non-use of computers in professional activities

	Intermediary			
Reason	Agro-input dealer (n=64)	Agro-out-put-dealer (n=78)	Extension agent (n=29)	Total (n=171)
	%	%	%	%
Not useful/necessary for my professional activities	23.4	50.0	31.0	36.8
Too expensive to purchase	45.3	21.8	24.1	31.0
Other	9.4	6.4	10.3	8.2
my clients/business partners don't have access	9.4	2.6	17.2	7.6
I don't know how to use it	6.3	6.4	10.3	7.0
Too expensive to use	4.7	11.5	0.0	7.0
lack of electricity	0.0	1.3	6.9	1.8
Poor/ unstable/unreliable network connectivity / reception	1.6	0.0	0.0	0.6
my clients/business partners do not trust it	0.0	0.0	0.0	0.0
I don't trust it	0.0	0.0	0.0	0.0

Reasons why tablet was not used

Table 13 provides reasons for non-use of Tablet in professional activities. The data show that 37% of respondents found tablet not useful/necessary for their professional activities, while 31% indicated that it was too expensive to buy; 13% gave other reasons. Agro-output dealers had the highest number (53%) that said tablet was not necessary for their professional activities.

Table 13: Reason for none use of tablet in professional activities

Reason	Agro-Input dealer (n=101)	Agro-Out-put-dealer (n=89)	Extension agent (64)	Total (n=254)
	%	%	%	%
Not useful/necessary for my professional activities	31.7	52.8	23.4	37.0
Too expensive to purchase	37.6	28.1	25.0	31.1
Other)	10.9	3.4	28.1	12.6
my clients/business partners don't have access	11.9	4.5	9.4	8.7
Too expensive to use	4.0	4.5	7.8	5.1
I don't know how to use it	4.0	4.5	4.7	4.3
Poor/ unstable/unreliable network connectivity / reception	0.0	0.0	1.6	0.4
lack of electricity	0.0	1.1	0.0	0.4
my clients/business partners do not trust it	0.0	1.1	0.0	0.4
I don't trust it	0.0	0.0	0.0	0.0

Why smartphone was not used

Reasons given by respondents for not using smartphones for their professional activities were that it was too expensive to purchase (38%), not necessary (23%) and too expensive to use (13%) (Table 14).

Table 14: Reason for none use of a smartphone in professional activities

Reason	Intermediary			
	Agro-Input dealer (n=17)	Agro-Out-put-dealer (n=20)	Extension agent (n=3)	Total (n=40)
	%	%	%	%
Too expensive to purchase	52.9	25.0	33.3	37.5
Not useful/necessary for my professional activities	17.6	30.0	0.0	22.5
Other	17.6	5.0	33.3	12.5
Too expensive to use	5.9	15.0	33.3	12.5
my clients/business partners don't have access	0.0	15.0	0.0	7.5
I don't know how to use it	5.9	5.0	0.0	5.0
Poor/ unstable/unreliable network connectivity / reception	0.0	5.0	0.0	2.5
lack of electricity	0.0	0.0	0.0	0.0
my clients/business partners do not trust it	0.0	0.0	0.0	0.0
I don't trust it	0.0	0.0	0.0	0.0

Level of digital skills among intermediaries

Majority of the intermediaries had skills to operate the basic ICT tool functions, as shown by the high number of respondents (80-90%) who positively responded (Table 15). However, only 49% had capacity to use digital apps, while 51% lacked such capacity in the operation of other apps. Of those who could use digital services, majority (70%) were extension agents, followed by agro-input dealers (52%). On the use of other apps, the same trend was observed, where 57% were extension agents, followed by agro-input dealers. The finding on agro-input dealers closely following extension agents in digital apps use could be attributed to their relative higher education level (44% college and 28% university levels) compared to agro-output dealers (32% and 12% for college and university levels, respectively). Earlier studies have shown that level of education is a factor that determines adoption of technologies besides other factors (Riddell et al, 2011; Baumuller and Kah, 2019).

Table 15: Skills of intermediaries

Skill	Intermediary category			
	Agro-In-put-dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
	%	%	%	%
C1.20 Do you know how to use a digital agricultural services	51.9	24.4	69.7	48.8
C1.21 Do you know how to Use other apps not listed above	52.8	42.2	57.3	50.9
C1.7 Do you know how to Find out the GPS coordinates of your current location	63.1	48.4	83.1	64.4
C1.18 Do you know how to Participate in video calls (e.g. WhatsApp video call, Telegram video call, Zoom, Skype)	81.5	56.7	87.6	75.6
C1.5 Do you know how to Access a message on voice mail	87.4	72.6	85.4	82.0
C1.16 Do you know how to Complete an online form	87.0	64.4	95.5	82.6
C1.13 Do you know how to Send/receive an email	84.3	66.7	98.9	83.3
C1.10 Do you know how to Connect to WiFi	83.3	72.2	95.5	83.6
C1.19 Do you know how to Use a social network platform C1.17 Do you know how to Use a text messaging app (e.g. WhatsApp chat, Facebook Chat, Telegram chat....)	89.8	74.4	91.0	85.4
C1.15 Do you know how to Search for information on the Internet	90.7	75.6	97.8	88.2
C1.12 Do you know how to Install an app on your mobile phone	89.8	80.0	96.6	88.9

Skill	Intermediary category			
	Agro-In-put-dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
	%	%	%	%
C1.14 Do you know how to Open a file on your phone (e.g. photo, video, document)	94.4	87.8	96.6	93.0
C1.11 Do you know how to Open an app on your mobile phone	91.7	90.0	98.9	93.4
C1.17 Do you know how to Use a text messaging app (e.g. WhatsApp chat, Facebook Chat, Telegram chat....)	95.4	86.7	100.0	94.1
C1.9 Do you know how to Record a video	94.4	91.1	97.8	94.4
C1.8 Do you know how to Take a photo	94.4	94.4	100.0	96.2
C1.4 Do you know how to Send/receive an SMS	99.1	96.8	100.0	98.6
C1.1 Do you know how to Check the amount of credit left on your phone	99.1	100.0	100.0	99.7
C1.6 Do you know how to Send/receive mobile money	100.0	98.9	100.0	99.7
C1.2 Do you know how to Top up credit on your phone	100.0	100.0	100.0	100.0
C1.3 Do you know how to Make/receive a phone call	100.0	100.0	100.0	100.0

Change in ICT five years pre- Covid-19

Comparing five years prior to the Covid-19 pandemic, there was tremendous increase in the use of ICT by the intermediaries, as expressed by 35% of the respondents. However, 32% of the respondents indicated that it increased a little, while 20% said the pandemic had no effect on ICT use (Table 16). Also, 54% of the extension agents and 31% of agro-input dealers indicated that there was a lot of increase in the use of ICT.

Table 16: Change in frequency of using ICT five years pre-Covid-19 pandemic

	A24. Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
	%	%	%	%
increased a lot	30.6	23.2	53.9	35.3
increased a little	34.2	34.7	25.8	31.9
no effect	23.4	26.3	10.1	20.3
decreased a little	5.4	6.3	6.7	6.1
Decreased a lot	5.4	8.4	3.4	5.8
don't know	0.9	1.1	0.0	0.7

Most common reasons for the increase in ICT use frequency

Various reasons were adduced for the increase in use of ICT, with the main reason (by 44% of the respondents) being network connectivity, followed by availability of apps (35%) and becoming more aware (30%) (Table 17).

Table 17: Most common reasons for increase in frequency of ICT use

Reason for increase	Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
	%	%	%	%
\$C2.13 Network connectivity has improved?	45.8	41.8	43.7	43.9
Useful apps/digital services have become available?	33.3	23.6	45.1	34.8
Devices offer more functions than before?	29.2	30.9	29.6	29.8
I have become more aware of the usefulness of ICTs for my professional activities.?	27.8	23.6	36.6	29.8
Using the devices (e.g. cost of SMS, data etc.) has become cheaper?	31.9	20.0	22.5	25.3

	Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
Reason for increase	%	%	%	%
Devices have become cheaper?	20.8	34.5	12.7	21.7
Access to electricity has improved?	26.4	12.7	18.3	19.7
The nature of my professional activities has changed which made use of ICTs necessary/useful?	13.9	12.7	26.8	18.2
My clients/customers have better access to ICTs.?	20.8	23.6	9.9	17.7
My skills to use ICTs have improved , ICTs have been become easier to use.?	8.3	16.4	23.9	16.2
Other reasons	4.2	7.3	9.9	7.1
I have more trust in ICTs.?	1.4	0.0	1.4	1.0

Change in the frequency of face-to-face communication as a result of using ICT

There was a little reduction in face-to-face communication for 42% of the respondents, whereas for 27%, there was no effect, and 18% reported a lot of reduction (Table 18). Face-to-face communication was reported by 28% of the extension agents to have decreased a lot. This mode of communication mainly referred to output prices, buyers and sources of finance, as reported by 44% and 27% of respondents, respectively.

Table 18: Change in the frequency of face-to-face communication due to ICT

	Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
Extent of change	%	%	%	%
Decreased a little	43.2	41.1	42.7	42.4
No effect	31.5	34.7	12.4	26.8
Decreased a lot	12.6	15.8	28.1	18.3

	Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
Extent of change	%	%	%	%
Increased a lot	6.3	4.2	10.1	6.8
Increased a little	6.3	4.2	6.7	5.8
Don't know	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0

Effects of Covid-19 on the frequency of ICT use for professional activities

The data on the effect of the Covid-19 pandemic on the frequency of ICT use are shown in Table 19. There was a lot of increase for 38% of the respondents, while there was little increase for 31% of the respondents, and 16% reported no effect at all on the frequency of ICT use. For those who reported a lot of increase, 60% were extension agents; while for those who reported little increase, 36% were agro-output dealers. The increases recorded could be attributed to the various measures introduced by the ministry of health to contain the virus, which included the prohibition of physical meetings; hence, majority of the populace resorted to the use of mobile communications.

Table 19: Effect of Covid-19 pandemic on ICT use frequency for professional activities

	A24. Intermediary category			
	Agro-Input dealer (n=111)	Agro-Out-put-dealer (n=95)	Extension agent (n=89)	Total (n=295)
Extent of change	%	%	%	%
increased a lot	27.0	29.5	59.6	37.6
increased a little	28.8	35.8	27.0	30.5
no effect	23.4	18.9	3.4	15.9
decreased a little	14.4	9.5	9.0	11.2
Decreased a lot	6.3	5.3	1.1	4.4
don't know	0.0	1.1	0.0	0.3
Total	100.0	100.0	100.0	100.0

Impact of ICT Use on Reach, Quality and Profitability of Service Provision

This section addresses questions on how ICT affected the ability to address professional activities, transaction costs, support crop and livestock producers, ability to interact with producers and buyers, and ability to run and interact with businesses.

How ICTs changed ability to deliver professional activities

The use of ICT made service delivery easier, as reported by 96% and 90% of agro-input and agro-output dealers respectively (Fig 3).

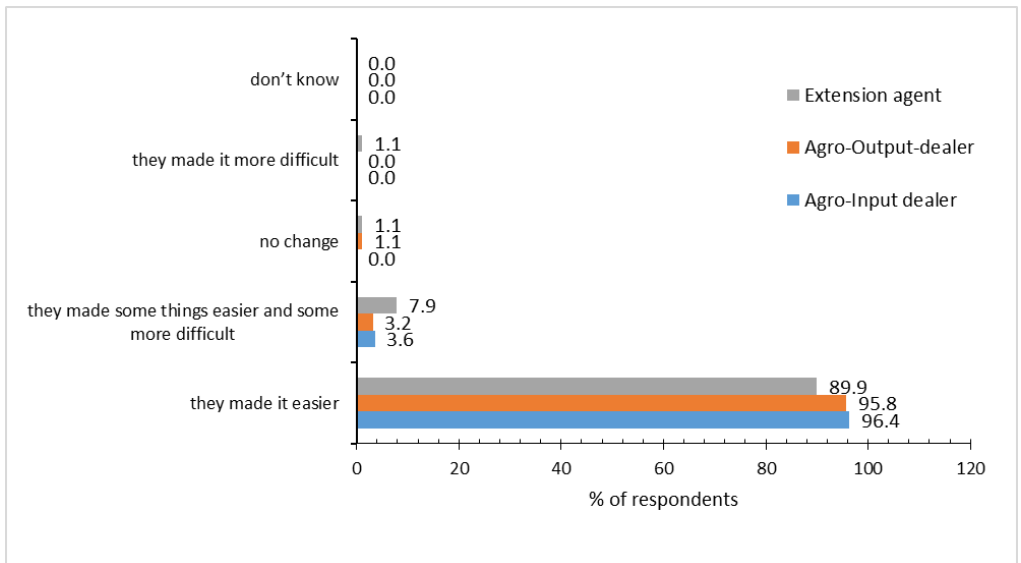


Figure 3: ICT's influence on delivery of intermediary services

Ability to assist crop and livestock producers at the marketing stage

About 93% of the intermediaries expressed the view that ICT assisted them to serve crop and livestock producers at the marketing stage (Fig 4).

Whether ICTs improved ability to assist producers

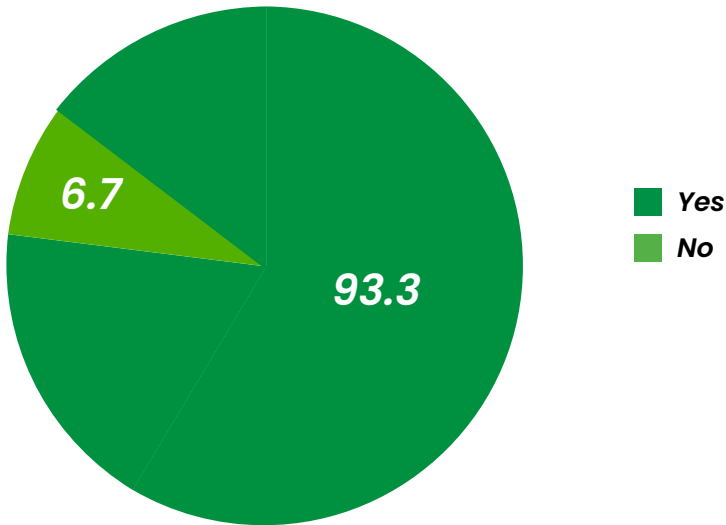
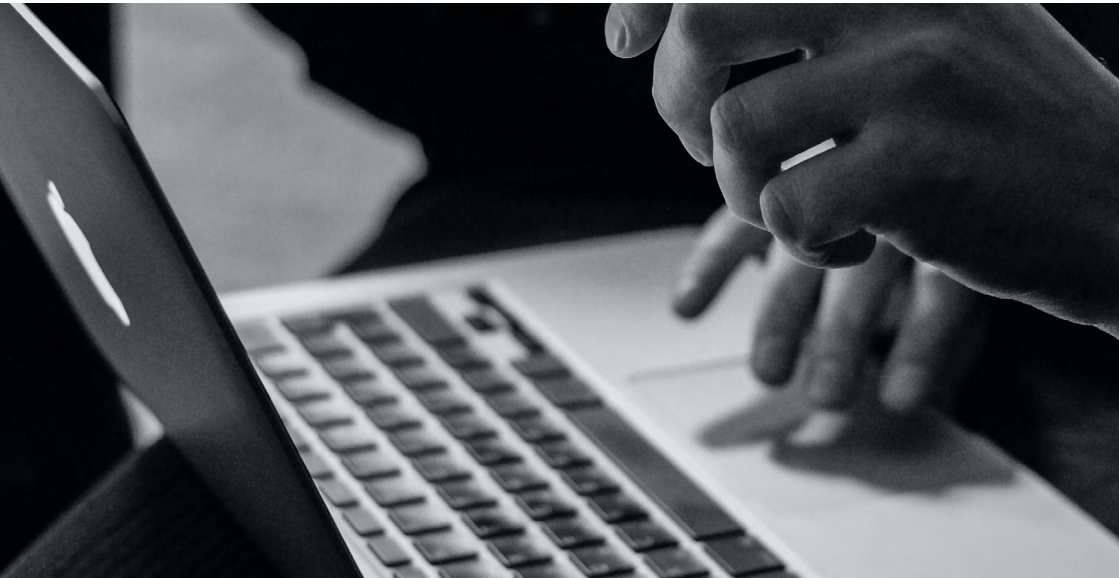


Figure 4: Whether ICT helped intermediaries to improve producers at the marketing stage

ICTs facilitated the intermediaries to get better access to information on commodity (69%) and buyers (49%) and better linkages to more buyers (49%). In addition, they helped reduce travel time (39%) and achieve higher market participation for remote farmers (Fig 5). This result agrees with that of Baumuller (2012) on the many benefits of mobile services.



Major benefits of ICT at marketing stage

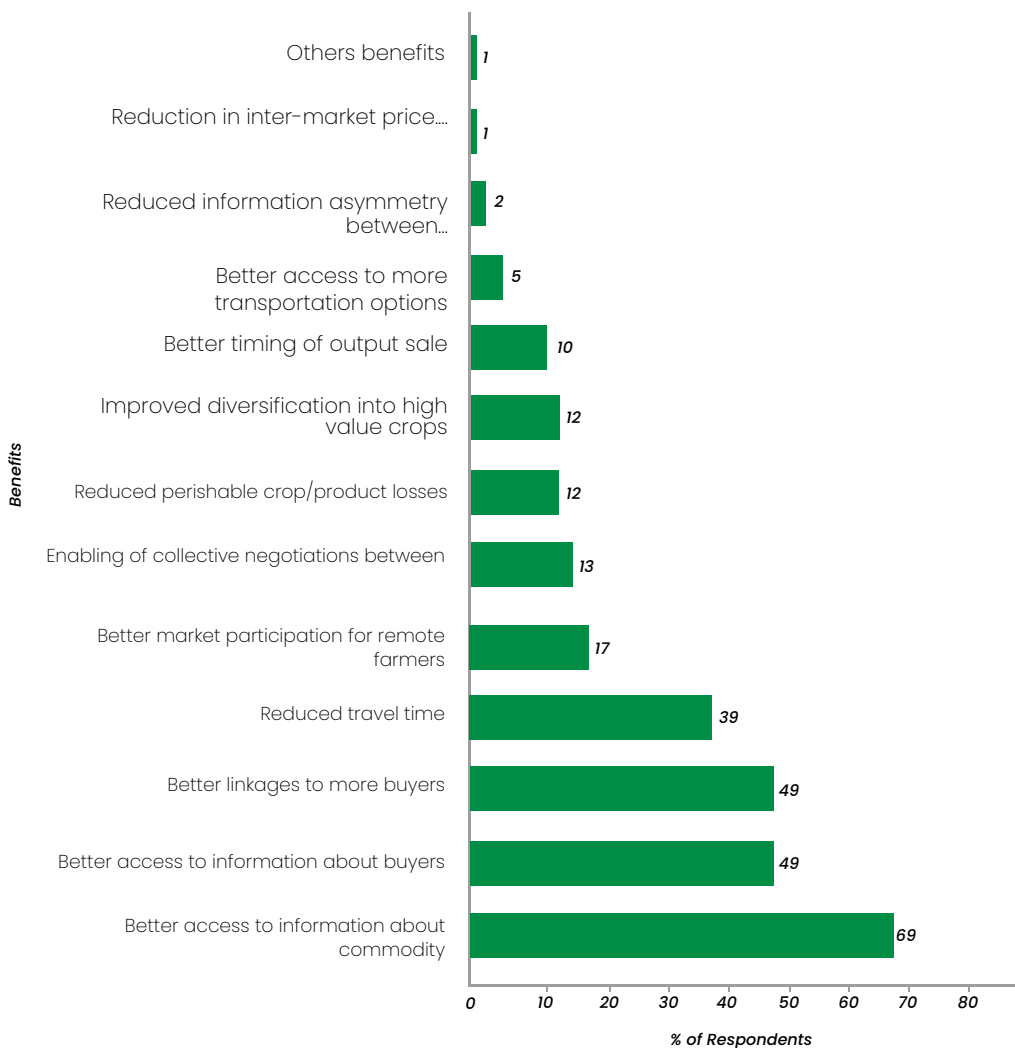


Figure 5: ICTs improved ability to assist crop and livestock producers at the marketing stage

ICTs' ability to interact with producers and buyers

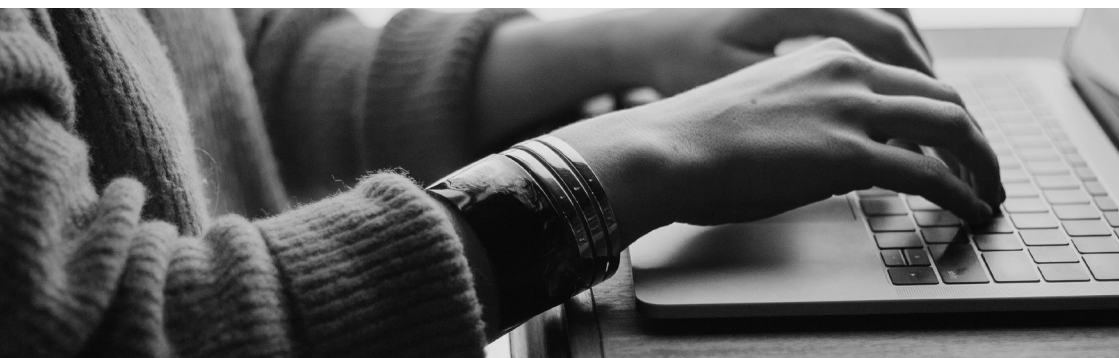
The respondents indicated that ICTs improved ability to interact with producers and buyers, enabling better access to information on buyers (55%) and producers (51%) (Table 20). Also, ease of interaction with buyers and producers was reported by 46% and 45% of the respondents, respectively, while about 24% each stated that there was increase in linkages with more buyers and reduced travel time by the use of ICTs.

Table 20: ICTs ability to improve interaction with producers and buyers

	Intermediary category	
	Agro-Output dealer (n=95)	Total (n=95)
Better access to information about producers	54.8	54.8
Better access to information about buyers	50.5	50.5
Easier interactions with buyers	46.2	46.2
Easier interactions with producers	45.2	45.2
Linkages with more buyers	23.7	23.7
Reduced travel time	23.7	23.7
Linkages with more producers	20.4	20.4
Better access to more transportation options	3.2	3.2
Other benefits	3.2	3.2
Total	100.0	100.0

Whether ICT improved the ability to run businesses

The study showed various benefits of the use of ICTs, of which faster payment from customers was reported by 74% of the respondents, followed by better access to information on commodity prices (70%). Also, 51% of the respondents stated that there was better timing of output purchase and sale; there was reduced perishable crop/product loss (21%), as well as better bookkeeping (13%) (Fig 6).



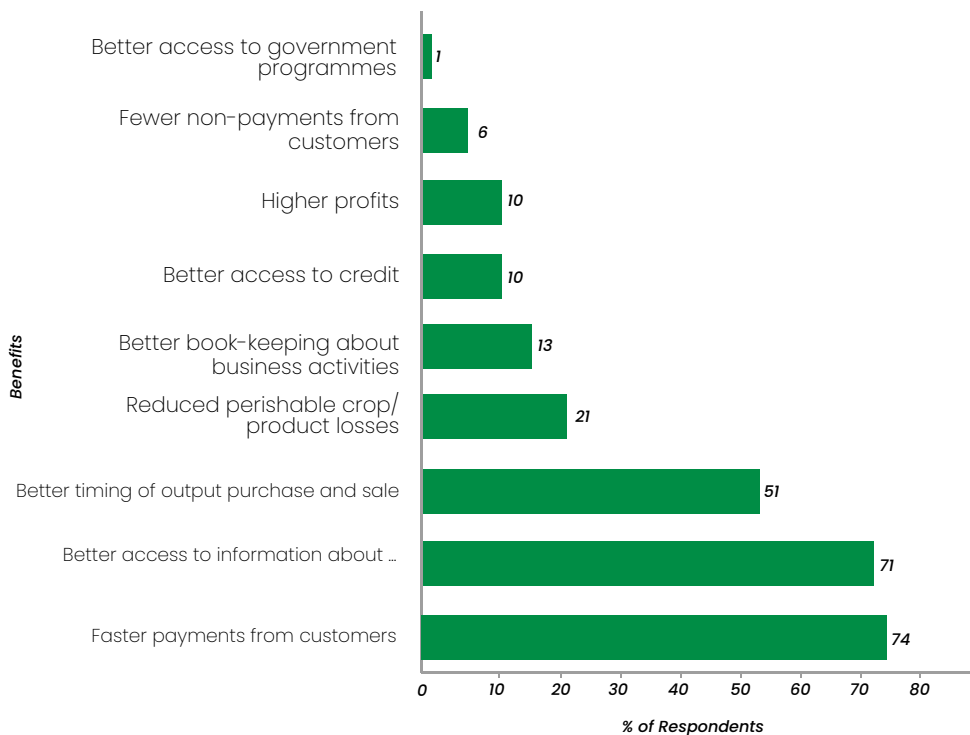


Figure 6: Effect of ICTs on ability to run business

Note: Chi square test for ability to run business was not significant

Benefits and Challenges for Collective Action

How ICTs facilitated collective action

ICTs were reported to have improved group activities by speeding up communication costs for 100% output dealers, 96% agro-input dealers, and 89% extension agents (Fig 7). Also, 57% of extension agents and 54% input suppliers reported reduction in the cost of communication, while 21% of agro-input dealers reported improved access to inputs for producers.

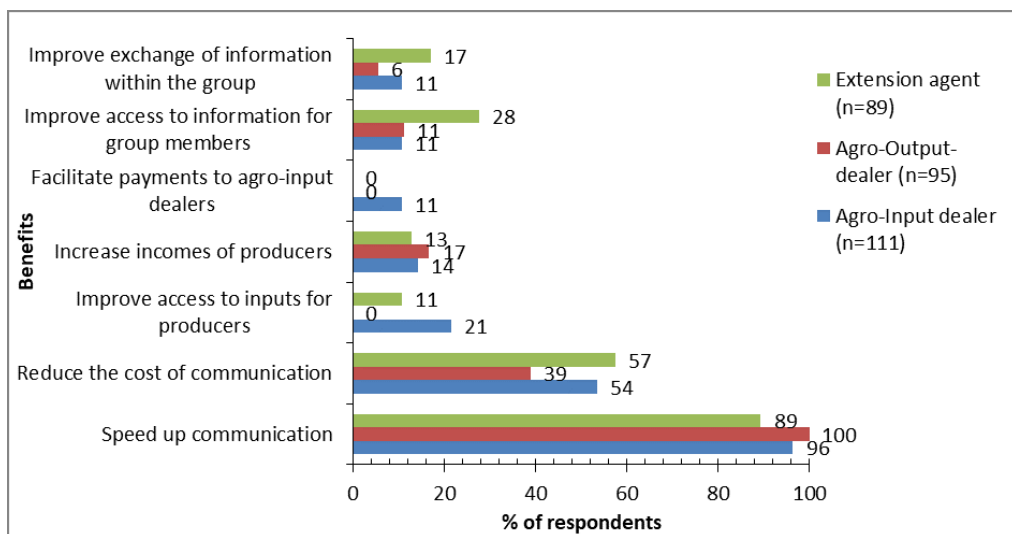


Figure 7: Benefits of ICT to group activities

Relationship between the use of ICT to benefit group activity and type of phone used

There was relationship between benefits to group activities and type of phone used, intermediary type and education level at 5% level of significance (Table 21(i), (ii) and (iii)). This may be attributed to the efficiency of communication of the type of phone that was used. It may also depend on the targeted recipients or other reasons.

Table 21(i): Relationship between benefit to group activity by type of phone used

	Phone			
	Basic phone	Feature phone	Smartphone	Smart/Feature
	%	%	%	%
Speed up communication	100.0	85.7	93.3	93.5
Reduce the cost of communication	20.0	42.9	53.3	52.7
Increase incomes of producers	20.0	21.4	14.4	14.0
Empower women	0.0	14.3	3.3	3.2
Empower youth	0.0	14.3	5.6	5.4
Increase resilience against shocks	0.0	7.1	4.4	4.3

	Phone			
	Basic phone	Feature phone	Smartphone	Smart/Feature
	%	%	%	%
Improve access to inputs for producers	20.0	0.0	12.2	11.8
Reduce the cost of inputs	0.0	7.1	1.1	2.2
Increase revenues of input-dealers	0.0	0.0	1.1	1.1
Facilitate payments to agro-input dealers	0.0	7.1	2.2	3.2
Increase the network of producers and agro-output dealers	0.0	14.3	4.4	5.4
Facilitate the selling process between producers and agro-output dealers	0.0	7.1	5.6	6.5
Increase revenues of output-dealers	0.0	0.0	1.1	1.1
Facilitate payments for produce sold to agro-output dealers	0.0	0.0	1.1	1.1
Facilitate sourcing from a large number of producers	0.0	0.0	2.2	2.2
Improve access to information for group members	40.0	7.1	20.0	19.4
Improve exchange of information within the group	60.0	7.1	13.3	12.9
Improve dissemination of information outside of the group	40.0	0.0	6.7	6.5
Jointly develop innovations	0.0	7.1	3.3	3.2
Adapt innovations to the needs of group members	0.0	0.0	1.1	1.1
Improve quality of training	0.0	0.0	2.2	2.2
Improve frequency of training	0.0	7.1	0.0	1.1
Increase number of group members who can be trained	0.0	0.0	2.2	2.2
Pearson Chi-Square Tests - P-Value	0.013*			

Table 21(ii) Relationship between benefit to group activity by type of phone used

	A24. Intermediary category			
	Extension agent	Agro-Out-put-dealer	Agro-Input dealer	Total
	%	%	%	%
Speed up communication	89.4	100.0	96.4	93.5
Reduce the cost of communication	57.4	38.9	53.6	52.7
Increase incomes of producers	12.8	16.7	14.3	14.0
Empower women	2.1	5.6	3.6	3.2
Empower youth	4.3	5.6	7.1	5.4
Increase resilience against shocks	4.3	5.6	3.6	4.3
Improve access to inputs for producers	10.6	0.0	21.4	11.8
Reduce the cost of inputs	2.1	0.0	3.6	2.2
Increase revenues of input-dealers	2.1	0.0	0.0	1.1
Facilitate payments to agro-input dealers	0.0	0.0	10.7	3.2
Increase the network of producers and agro-output dealers	0.0	22.2	3.6	5.4
Facilitate the selling process between producers and agro-output dealers	2.1	27.8	0.0	6.5
Increase revenues of output-dealers	0.0	5.6	0.0	1.1
Facilitate payments for produce sold to agro-output dealers	0.0	5.6	0.0	1.1
Facilitate sourcing from a large number of producers	4.3	0.0	0.0	2.2
Improve access to information for group members	27.7	11.1	10.7	19.4
Improve exchange of information within group	17.0	5.6	10.7	12.9

	A24. Intermediary category			
	Extension agent	Agro-Out-put-dealer	Agro-Input dealer	Total
	%	%	%	%
Improve dissemination of information outside of the group	8.5	0.0	7.1	6.5
Jointly develop innovations	4.3	0.0	3.6	3.2
Adapt innovations to the needs of group members	2.1	0.0	0.0	1.1
Improve quality of training	4.3	0.0	0.0	2.2
Improve frequency of training	2.1	0.0	0.0	1.1
Increase number of group members who can be trained	4.3	0.0	0.0	2.2
Pearson Chi-Square Tests - P-Value	0.005*			
Significant at 5% level				

	Level of education (TABLE TITLE???)					
	College	University	Secondary	Primary	Post graduate	No level of education
	%	%	%	%	%	%
Speed up communication	85.7	97.5	100.0	100.0	100.0	100.0
Reduce the cost of communication	54.3	57.5	30.8	66.7	100.0	0.0
Increase incomes of producers	14.3	12.5	15.4	33.3	0.0	0.0
Empower women	5.7	0.0	0.0	0.0	0.0	100.0
Empower youth	5.7	5.0	0.0	0.0	0.0	100.0
Increase resilience against shocks	8.6	2.5	0.0	0.0	0.0	0.0
Improve access to inputs for producers	22.9	5.0	7.7	0.0	0.0	0.0
Reduce the cost of inputs	2.9	0.0	7.7	0.0	0.0	0.0

	Level of education (TABLE TITLE???)					
	College	University	Secondary	Primary	Post graduate	No level of education
	%	%	%	%	%	%
Increase revenues of input-dealers	2.9	0.0	0.0	0.0	0.0	0.0
Facilitate payments to agro-input dealers	0.0	2.5	15.4	0.0	0.0	0.0
Increase the network of producers and agro-output dealers	5.7	2.5	15.4	0.0	0.0	0.0
Facilitate the selling process between producers and agro-output dealers	5.7	2.5	23.1	0.0	0.0	0.0
Increase revenues of output-dealers	0.0	0.0	7.7	0.0	0.0	0.0
Facilitate payments for produce sold to agro-output dealers	0.0	0.0	7.7	0.0	0.0	0.0
Facilitate sourcing from a large number of producers	0.0	5.0	0.0	0.0	0.0	0.0
Improve access to information for group members	28.6	20.0	0.0	0.0	0.0	0.0
Improve exchange of information within the group	11.4	20.0	0.0	0.0	0.0	0.0
Improve dissemination of information outside of the group	8.6	7.5	0.0	0.0	0.0	0.0
Jointly develop innovations	5.7	2.5	0.0	0.0	0.0	0.0
Adapt innovations to the needs of group members	2.9	0.0	0.0	0.0	0.0	0.0
Improve quality of training	0.0	5.0	0.0	0.0	0.0	0.0

	Level of education (TABLE TITLE???)					
	College	University	Secondary	Primary	Post graduate	No level of education
	%	%	%	%	%	%
Improve frequency of training	0.0	0.0	7.7	0.0	0.0	0.0
Increase number of group members who can be trained	2.9	0.0	0.0	0.0	100.0	0.0
Pearsons Chi square test (p value)	0.000***					
***Highly Significant						

Group-related Challenges

Challenges encountered

About 64% of agro-input and 94% agro-output dealers and 77% of extension agents felt that group activities were not limited by ICTs, while 36% agro-output dealers and 23% extension agents felt that there was limitation of activities (Fig 8)

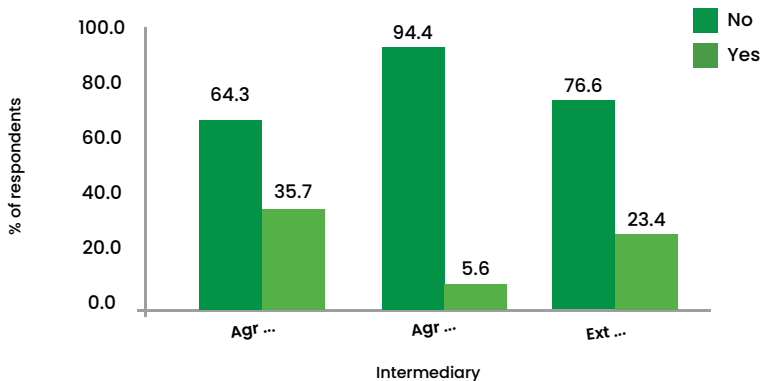


Figure 8: Challenges from use of ICTs to implement group activities
 Figure should be adjusted to distinguish between agro-input and agro-output dealers

| How ICTs limited participation

When asked about how ICTs limited group participation, 100% of agro-output dealers, 90% of agro-input dealers and 82% of extension agents felt that ICTs limited some group members. All agro-output dealers also reported that ICTs led to differential access to information (Table 21).

Table 21: How participation is limited by ICTs

	Agro-Input dealer	Agro-Out-put-dealer	Extension agent
Limit participation of some group members	90	100	82
Lead to differential access to information	80	100	36
Slow decision making	40	0	36
Reduce interest in group activities	0	0	9
Reduce trust in group decisions	0	0	9
Other	0	0	18

Summary of Key Findings and Discussion

The Kenyan agriculture sector contributes significantly to the country's economy and there is need to support its growth through an understanding of the operations of its stakeholders, especially the intermediaries. These intermediaries conduct their operations using various tools at their disposal, including ICT tools that facilitate the use of various digital solutions. To investigate the use of ICT tools by intermediaries, a total of 295 intermediaries (consisting of 38% agro-input dealers, 32.2% agro-output dealers and 29.8% extension agents) with the mean age of 39 years were interviewed. The prevalent education level was college level, with highest being university level. About 54% of extension agents had university education, compared to 28% agro-input dealers. Also, 33% of agro-output dealers had secondary education and 21% primary education, in addition to 2% with no formal education. There was 91% ownership of smartphone, followed by 14% feature phone, with all extension agents owning both while 91% of input dealers had both. This could be attributed to ease of access due to competing phone companies, as well as to education level.

About 97% of the respondents used a combination of feature phone and smartphone, followed by smartphone alone (91%), while feature and basic phone trailed behind. Extension agents were the highest users of phone, closely followed by agro-input dealers. As Riddell et al. (2011) posited, educated workers tend to adopt new technologies faster than those with less education (Riddell et al, 2011). The adoption of ICTs by the intermediaries was, therefore, expected to be influenced by level of education. Age has also been shown to be a factor in adoption of technologies, with a higher age bracket having low tendency to embrace sophisticated communications technology (Baumuller, 2012).

The intermediaries had a mean experience of 14 years, while extension agents had a mean age of 25 years and agro-input dealers had 9 years. According to Webster's dictionary, experience is the "knowledge or practical wisdom gained from what one has observed, encountered, or undergone. It is specific knowledge acquired in a previous problem-solving situation" (Anon, 2001). It is useful for future reuse and may be stored tacitly in human brains or explicitly in documents (Bergmann, 2002). The intermediaries may not document their experience but store it in their brain, to be shared with colleagues at work. The duration of experience is important in determining the knowledge and skills that an individual accumulates in their profession; this study assumes that this is applicable to the intermediaries.

The intermediaries had their respective ways of conducting business and professional services. The

agro-output dealers mainly conducted retail and wholesale businesses and played aggregation and processor roles. This concurs with what Kilelu et al. (2011) averred: that intermediaries often overstep their core role, to link with value chain actors, as dictated by the prevailing circumstances. The professional activities practised by input dealers included selling inputs to producers, selling inputs to other intermediaries and transporting, and extension officers deal with three main commodities. Most agro-output businesses were based in the city, while input businesses were in small towns. This is understandable, considering that the output businesses deal with products that are needed by urban dwellers and, hence, there is demand for the products. Input dealers' businesses, on the other hand, tend to thrive in the rural areas, villages and small towns. The study found that 85% of the input dealers involved themselves in market retail and wholesale and sold pesticides, fertilizers and veterinary products. Their businesses were in small towns and cities; 97% of the businesses were registered. Extension agents provided information to producers and conducted on-farm training, as well as linked value chain actors with government programmes. With regard to different ICTs, 86% of the respondents used smartphones, followed 16% who used the computer. Tablet was not commonly used owing perhaps to its high cost. The smartphone was used daily by 98% of the respondents, which was understandable, since intermediaries need the phone for daily communication. The intermediaries used the ICT tools for various professional activities, such as selling outputs to consumers and buying output at farm-gate. Input dealers sold to customers, bought inputs from agro-input dealers and sold to other input dealers. Hindrances to the use of radio, television, computer, and tablet included the fact that they were considered irrelevant to work and were too expensive. Most of the intermediaries, except extension agents, had capacity to use the phones but not digital apps. This is an area needing attention in order to improve efficiency of service delivery. As pointed out by Baumuller (2012), ICT use facilitates farmer-to-farmer or farmer-to-buyer relations and helps increase incomes of producers and exchange of group information.

Use of ICTs was reported to increase in relation to the period before and during the Covid-19 pandemic— there was as high as 95% increase. The increase in ICT use was seen to be due to improved network connectivity, availability of apps and reduction in app prices. It is noteworthy that in 2015, there was an increase in teledensity of 88% in Kenya, which was surprising, considering that the Internet was banned in government offices through a notice from the Kenya Posts and Telecommunication in 1999 (CAK, 2015; Muriuki, 2016). Another factor that may have led to growth in the use of ICTs was the high rate of mobile telephone penetration, which was estimated at 120% by 2020 (CA, 2020). The findings from the current study that there was an increase in the use of ICTs five years pre-Covid-19 therefore puts credence to the happenings within that five-year period. With the outbreak of Covid-19 and the lockdown of services, there was a new spike of ICT activity, which also reflected in the findings of this study. It is, however, worth doing further research to accurately relate these occurrences.

With regard to the impact of ICTs on professional activities, transaction costs and people's ability to run businesses, the study found that 96% of the respondents had improvement in service delivery. Such improvements included facilitating easy access to information, and aiding producers at the

market stage. Tests of significance using chi-square test revealed a 5% level of significance for type of phone, education level and intermediary type and interaction with producers; but the tests were not significant for other impacts.

ICTs facilitated better access to commodity prices and information about buyers, as well as helped establish linkages with buyers and reduce travel time. They also increased the ability to interact with producers. Other benefits included better timing of commodity prices, reduced perishability, better bookkeeping, speeding up communication and reduced cost. As Baumuller (2012) posited, mobile phones have the potential to reduce costs and allow for more regular and timely access to information, as shown by m-services, which help deliver information to farmers on demand or through SMS or audio recording. Challenges encountered included reduction of implementation time of group activities, limited participation by group members and differential and slow decision-making process.

In conclusion, the intermediaries showed various characteristics that have potential to be harnessed for improved utilization of ICTs. The age, experience and education of agro-input dealers are features that avail a springboard for a digital community. They also owned the basic tools for enhancing growth of their businesses. This study has revealed that even though only 32% of the intermediaries had digital app skills, there was scope for capacity building in this important area. A major obstacle to the use of ICTs was the perception that they were not necessary or relevant to the intermediaries' businesses. This may seem justifiable, but recent Covid-19 containment protocols have illustrated the importance of digital communication in business sustainability, especially through mobile telephony. Increase in the use of ICTs was attributed to such factors as improved network, and prices of devices and apps—these factors can be boosted to take advantage of infrastructure and build ICT hubs in the rural areas. Government programmes on ICT hubs in different counties and the fibre network infrastructure throughout the country will go a long way in boosting efforts to increase ICT use. As reported by the intermediaries, ICTs have led to an improvement in service delivery, transaction cost and access to information, which will help both at production and marketing stages. Use of ICTs to access market prices is a very important development besides facilitating collective action. The challenges encountered, especially with group activities, should be converted to opportunities to improve the agricultural sector in Kenya. This should be through government intervention in the sector. With respect to the services offered by the intermediaries, there is still room for ICTs to help make services offered more efficient. This is especially more so for the extension agents whose limited budgets and decreasing human resources call for innovative strategies to reach value chain actors.

In an earlier study, it was observed that many ICT4Ag service providers were still in the formative stages. While the outbreak of Covid-19 devastated many sectors, it created a window of opportunity to enhance ICT tool usage. Even though restrictions imposed to the public are being lifted, it is important to build on this foundation that has been laid in order to take advantage of ICT usage. For this to be effective, there is need for incentives to be provided to the target receivers/users of services. This could be in the form of reduction in data transmission costs, tax reduction on price of ICT gadgets, improved network connectivity, countrywide establishment of ICT hubs in the rural areas, besides digital literacy to all stakeholders. These and other measures will help increase the usage of ICT tools by intermediaries and other users; it will also spur growth in the agricultural sector.

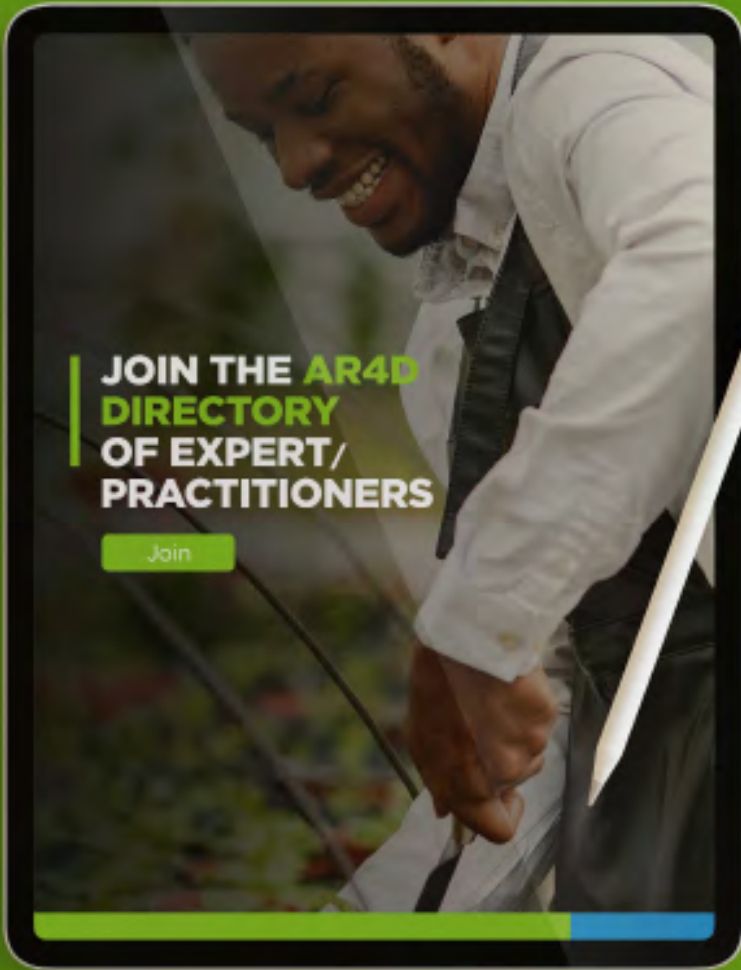
Recommendations for Policies and Investments

This study has illustrated that the three intermediaries play an important role of linking value chain actors in diverse ways. In order to increase their effectiveness, therefore, a few policy recommendations are listed below:

- High cost of some ICT tools, such as computers, tablets and television, may need to be addressed, as demonstrated by the low usage in the study results. As cited by respondents, high cost is an obstacle to the usage of some of these tools.
- Campaigns to build the level of digital literacy in the rural counties of the country would be instrumental in increasing usage, especially in such areas. The current initiative by the government to set up ICT hubs for the youths should also include agricultural intermediaries and other agricultural value chain actors.
- Reduction in data transmission costs can spur ICT usage, an area that should be explored besides initiatives to increase digital literacy to increase the number of citizens who are able to use ICT tools.

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