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Mobile phone technology for increasing banana productivity among smallholder farmers in Uganda

William Tinzaara[1*], Elias Oyesigye[2], Christophe Bocquet[3], Jamie Arkin[4], and Vincent Johnson[5]

[1]Bioversity International, Uganda.
[2]Mbarara University of Science and Technology, Uganda.
[3]Dalberg Data Insights (DDI)-, Belgium.
[4]Viamo Uganda office, Uganda.
[5]Bioversity International, France.

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This study aimed at assessing the level of mobile phone use in Ugandan agricultural extension, and to establish the extent to which mobile phone Viamo's 3-2-1 service, hosted by Airtel Uganda, was being accessed and how the facility can be improved to boost banana productivity. The results of the study indicate that use of mobile phones for increased banana productivity were dependent on age, gender, household size, income and farming experience. Data collected show that the major information source by farmers was extension agents followed by phones and televisions. Focus group discussions revealed that most farmer participants owned phones (94.3%), had Airtel SIM cards and accessed Viamo service (65%). All respondents were aware of the Viamo service and majority got to know about the service through Airtel SMS notifications (83.3%). Farmers indicated that the four most sought after information elements for increasing banana productivity included material on weather forecasts, pest and disease control, fertilizers and their usage, and markets and their location. The study reveals information gaps with respect to pests and disease diagnosis and management, market prices, weather information, mulching and weeding in different terrains, and sources of clean banana planting material. It was concluded that the service is relevant and contributes to improving farmer knowledge on good banana farming practices. A further step will be to scale up use of the 3-2-1 service for agricultural purposes at country and regional levels.

Key words: Agricultural information, banana, information technology, innovations, IVR system, smartphones.

INTRODUCTION

Uganda constitutes about 40 million people (UBOS, 2017), 80% of whom are smallholder farmers engaged in agriculture both at commercial and subsistence levels. These farmers require agricultural information mainly on pest and disease management, weather forecasting, farming, land management and market. Agricultural

*Corresponding author. E-mail: w.tinzaara@cgiar.org.

information is a key component in improving smallholder agricultural productivity and linking increased production to more remunerative markets, thus leading to improved rural livelihoods, food security and national economies. Improvement of agricultural productivity is more likely to be realised when farmers are linked to market information. However, one major problem in many rural areas is that farmers and small entrepreneurs generally have no way of knowing the prices before they travel to the market because of poor communication channels. Most of the farmers depend on old traditional methods to access agricultural information such as radios and extension service. They largely rely on extension workers who are often too few. For instance, in Uganda under the Ministry of Agriculture Animal Industries and Fisheries, the current ratio of extension to farmer is 1: 33,000 (UBOS, 2017). This does not meet the World Bank recommended ration of 1:500. Not only does this overstretch extension workers, but less service will be delivered during bad weather (Haruna et al., 2014).

There is a crucial need for an approach which is more user friendly, and provides a quick, flexible and timely information delivery service that is also not weather dependent. Information Communications Technology (ICT) applied to agricultural extension offers such an approach. Mobile phones have the potential to amplify the speed and ease, and to introduce new ways of sharing information. The use of mobile phones in agriculture has already been known to increase production (Abraham, 2007; Jensen, 2007; Bhavnani et al., 2008; Nakasone et al., 2014; Ogbeide and Ele, 2015; Amir et al., 2016; Hoang, 2020; Thimnu, 2020). Phones can enable interactive communication flow unhindered by space, volume, medium or time, thereby influencing the existing communicative ecologies (Deribe, 2016; Misaki et al., 2018). A study conducted in Uganda demonstrated that farmers can use mobile phones to find out the latest crop prices and in Tanzania mobile phones helped farmers to save travel time and cost (Adel, 2005). Phones provide other uses as recording tools, listening devices, and catalysts for dialogue. Community radio stations are incorporating mobile phone technology into programming for advisory services in agriculture (Misaki et al., 2018). The potential of mobile phones in revitalizing the small-scale agriculture in Africa was assessed (Munyua et al., 2009; Blauw and Franses, 2016; Misaki et al., 2018; Thimnu, 2020) and results revealed that they have become important tools in improving small-scale agriculture in rural areas. Likewise, Bolarinwa and Oyeyinka (2011) assessed the use of cell phones by farmers in Nigeria and found that farmers using cell phones were better informed and made greater and more effective use of current production technologies resulting in higher productivity and incomes. Mobile phones may help users to substitute phone calls for travel, which reduces farmers' time and cost burdens. Time savings are important for agricultural households, because many crops have extremely time-sensitive and labour-intensive production cycles (Kevin, 2011).

There are studies that dwell on factors affecting mobile phone use in developing countries (Falola and Adewumi, 2011; Yakubu et al., 2013; Hadi and Lee, 2010; Hoang, 2020) but these are limited in the Uganda context. The extent of rapidly spreading mobile phone usage in developing countries for agricultural development faces several challenges. Hoang (2020) summarized the main challenges and factors that influence the use of mobile phones and ICTs in general as: high cost of available technologies, inadequate infrastructure, low ICT skills, poor and expensive connectivity, inappropriate ICT policies, language barriers, low bandwidth, and inadequate and/or inappropriate credit facilities and systems. In effect, the combination of these constraints would result in a digital divide between urban and rural communities. Furthermore, in remote areas farmers are still facing many problems in use of technologies due to lack of infrastructure and awareness among farmers' communities.

Several studies have generally revealed that access to communication technologies has significant impact on economies, poverty reduction and agricultural development (Abraham, 2007; Jensen, 2007; Bhavnani et al., 2008; Aker and Mbiti, 2010; Misaki et al., 2018; Hoang, 2020; Thimnu, 2020). In Uganda, a few studies on the application of mobile phones in agricultural information access have been completed (Masuki et al., 2010; Muto and Yamano, 2009; Blauw and Franses, 2016; Munyegera and Matsumoto, 2016; Sekabira and Qaim, 2017). Information on use of mobile phone and other digital applications for increasing banana productivity is limited. This paper aims to present the contribution of Viamo's (https://viamo.io/about-viamo/) mobile phone application towards agricultural information delivery and revitalise applicable services to better the application. Viamo is a mobile phone service provider with a mission to connect individuals and organizations using digital technology to make better decisions. Its 3-2-1 Service[1] is an interactive voice response-(IVR), short message service (SMS), and unstructured supplementary service data (USSD) based service that allows Airtel subscribers to access a toll-free number and listen or read messages on banana information developed with an aim of assisting farmers to access all information on banana production.

The specific objectives of the study were to: (1) understand the demographic characteristics of Ugandan farmers accessing and using mobile phone technologies; (2) better understand Uganda banana farmers' needs especially in terms of information access and use; (3) assess the farmers experiences regarding use of the current 3-2-1 Service in Uganda; and (4) assess farmers opinion on how to improve the content to be more useful

[1] The 3-2-1 Service is known locally as the Airtel 1-6-1 Service due to the short code to access messages being 1-6-1 in Uganda.

Table 1. Number of call back respondents that use the Viamo 321 service from selected districts.

District	Number of call back respondents per district
Kibale	1
Mubende	2
Kiboga	3
Kyenjojo	1
Kayunga	2
Ssembabule	1
Bukomasimbi	1
Kalungu	1
Mityana	1
Iganga	1
Mayuge	1
Kaliro	1
Luwero	1
Buyende	1
Observations	18

to the smallholder banana farmers.

MATERIALS AND METHODS

Sampling and data collection

The study used three different tools, namely: (1) call back phone surveys, (2) focus group discussions (FGDs), and (3) individual interviews.

Call back phone surveys

The Viamo service utilizes an IVR system whose working is quite simple. When a customer calls the short code 3-2-1, the call is automatically received by the IVR system. The caller is then provided with a menu of basic multiple-choice queries and is requested to choose among the options using the keypad. The 3-2-1 Service is available nationwide in Uganda to anyone with an Airtel SIM and was launched in 2016. We collected direct feedback from users as well as measures on how to improve the tool. The call back phone survey was conducted with any caller who accessed content in English or Luganda to gather information on: who is accessing information by phone, reason for accessing information, satisfaction with the service and content, knowledge and farming practices, and how to improve the content to be more useful to the farmer. The survey embraced 18 call back respondents across 14 districts and had famers of different ages and had both genders (Table 1).

Focus group discussions

Four separate focus group discussions (FGDs) were conducted in Nyabubale sub county, Bushenyi district, Uganda. At least eight individuals per FGD of different ages, gender, household size, farming experience and farm size were involved in the discussions. The farmers were selected randomly based on the farmer's list obtained from the District Agriculture Department. The total number of respondents in all FGDs was 35 representing four banana-based villages in the subcounty. Open ended questions were discussed aimed to generate information on understanding the farmer and his/her needs, farming practices, desired information on banana farming, and mobile phone access and usage/interest for the 3-2-1 Service. The data collection was done at farmers' convenient places in their local language and then converted into English.

Individual interviews

The survey was conducted using 10 lead farmers selected from each of the four villages of the Nyabubale subcounty. A total of forty (40) farmers were interviewed using open ended questions aim at generating data on: farmer household demographics, banana production constraints, access and use of information, source of information about banana farming, and knowledge of mobile phones and usage.

Statistical analysis

Qualitative data was aggregated and disaggregated using queries to generate the required tables for analysis. Exploratory analysis to eliminate outliers and to cross-check suspicious entries were undertaken using the filter function of Microsoft Excel. The cleaned data was then analysed using both the Pivot Table function of Microsoft Excel and STATA version 15 to generate descriptive and inferential statistics. Descriptive statistics such as averages, ranges and percentages were used to make cross-tabulations, frequency tables and graphs. Inferential statistics such as correlation analysis was conducted to find major predictors of factors that influence the use of mobile phones for banana production.

RESULTS

Farmers attributes regarding mobile phone use

According to the call back interviews; there were more

Table 2. Percentage of respondent to phone call backs by gender, age and source of income.

Variable	Number	Percent
Farmer gender		
Male	12	66.7
Female	6	33.3
Age of farmer		
20-30	11	61
31-40	3	17
41-50	2	11
51-60	2	11
Source of income		
Small holder farmer income	13	72
Hair dressing	1	5.6
Shop keeper	1	5.6
Day labourer	1	5.6
Teacher	1	5.6
Driver	1	5.6
Belong to a group		
Yes	16	90.0
No	2	10.0
Banana is the main crop		
Yes	16	90.0
No	2	10.0

Source: Phone data.

male (66.7%) respondents than females (Table 2). Most of the farmers interviewed were between the age of 20 and 40 which represents about 78% of the sampled respondents. The majority (72%) were smallholder farmers with an average of around 4 years' experience in banana production on an average area of 1.7 acres (Table 2). Additionally, Table 3 shows results based on direct interviews which show that the farmers had an average land size of 4 acres of which about 42.5% was allocated to banana production. The data also show that all interviewed farmers had spent more than a year in banana production with some individuals recorded to have spent 7 years.

Farmer information needs and access to Viamo 321 service

Information needs/access

Data collected during individual interviews show the major information source being the extension agents, followed by phones and televisions (Table 4).

Nevertheless, respondents during the interview pointed out the unreliability of extension workers given they have a huge coverage area. Such dissatisfied farmers opted for phones (20.4%) and TVs (20.4%). In addition, with varying climatic conditions, it was recorded that these individuals (8.75%) had very little access to weather information. Mulching to conserve water was reported as the main activity to cope up with weather changes especially during the dry spell (Table 4).

Phone ownership/use and Viamo access

For the phone call back interviews, many of the respondents (70%) owned and used their phones all the time while 30% of respondents used phones sometimes. None of the respondents used the phone rarely. This implies that indeed, targeting banana messages to farmers with phones is likely to reach the target clientele. During the FGDs, most of the farmers owned phones (94.3%), had Airtel SIM cards and accessed the 3-2-1 Services (65%) (Table 5). Only two respondents within FDGs never possessed phones. At home, farmers mostly

Table 3. Mean land size and period spent under banana production by respondents.

Variable	Obs	Mean	Std. Dev.	Min.	Max.
Estimated land size	10	4.0	2.58	1	9
Area under banana	10	1.7	0.68	1	3
Number of years banana production	10	4.3	1.95	1	7
Number of years in area	10	3.5	1.78	1	7
Family size	10	3.3	1.06	1	5
Members who manage banana	10	4.6	2.17	1	8

Source: Direct interview data.

Table 4. Percentage of farmers accessing and utilising different information sources.

Information source	Number of respondents	Percentage
Radio	9	18.37
Phone	10	20.41
TV	10	20.41
Extension worker	14	28.57
Neighbour	6	12.24
Access to weather information		
Yes	3	8.57
No	32	91.43
What happens when weather changes		
Mulching to keep water soil	31	72.09
Gullies for water conservation	2	4.65
Do nothing on weather change	1	2.33
Plant trees to reduce on wind breaks	9	20.93

use solar power (45.7%) followed by electrical power (42.9%), to charge their phones. Phone ownership may not necessarily mean phone usage, so to understand if respondents were active phone users, an interview was held to discern extent of calling, sending message and presence of credit meant for any of the two (Table 6). In presence of credit, majority of respondents (74.3%) prefer phone calls as opposed to SMS phone messages.

Information relevance and sharing

An assessment of information dissemination through farmer-to-farmer diffusion was examined during call back surveys and 13 out 18 farmers reported that they shared information with fellow farmers. To further understand the endpoint sharing of this information, it was revealed that 33% of farmers find it easy to share this information with family members, but information sharing within neighbours and friends was also noticeable (28%) (Figure 1).

Access and use of the Viamo service

Overall, all call back respondents were aware of the 3-2-1 Service and the majority got to know about the service through Airtel SMS notifications (83.3%) (Table 7). Additionally, 89% of the call back respondents had personally used the service based on the reason that in the first place, they were banana farmers and needed to get more ideas, and secondly, the required information on good banana production practices.

Information on service needs and relevance was also sought to aid improvement going forward. All the respondents 100% indicated that they still need the service with the reason being that the information was relevant and useful (66.7%). Most of the farmers (59%) access the information at least once a month. On appropriateness of information provided and packaging of messages, it was found that farmers rate the message to be on average unique, easy to understand, and generally relevant. Rating on farmer action as a proxy measure of adoption based on messages was however low (with an

Table 5. Percentage of respondents owning and using a phone.

Category	Number of respondents	Percentage of respondents
Own a phone		
Yes	33	94.3
No	2	5.7
Phone charging		
Umeme at home	15	42.9
Solar at home	16	45.7
Solar away	2	5.7
Neighbour	2	5.7
Have Airtel SIM card and access the 3-2-1 service		
Yes	23	65.7
No	12	34.3

Table 6. Percentage of respondents using the phone for SMS or phone call.

Phone activity	Number of respondents	Percentage of respondents
Made a call today		
Yes	26	74.3
No	9	25.7
Sent an SMS		
Yes	7	20.0
No	28	80.0
Have credit on phone		
Yes	22	66.7
No	11	33.3

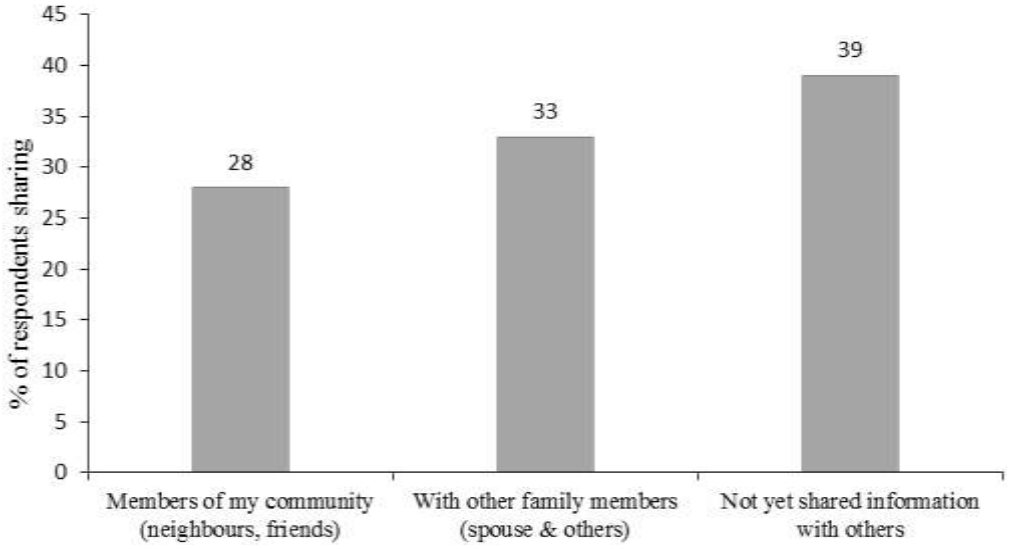

Figure 1. Percentage of respondents sharing information with other members of community.

Table 7. Percentage of farmers accessing Viamo messages.

Variable	Number of respondents	Percentage of respondents
Can access the 321 service	18	100
Have you personally used the 3-2-1 Service		
Yes	16	89.0
No	2	11.0
How farmer first heard of the 3-2-1 Service		
Told by a neighbour	2	11.1
Received notification from Airtel	15	83.3
Told by friends and relatives	1	5.6
Reason for selection of banana topic		
Want to know what to do in my garden	1	5.6
Need more ideas	13	72.2
interested in banana farming	1	5.6
Want to learn more	1	5.6
Banana is the main food in my place.	1	5.6
Reason for accessing information on banana		
Interested to get information about banana production	10	55.6
Interested in agriculture information	2	11.1
I was just browsing the service	2	11.1
I was planning to plant banana	3	16.7
My neighbour told me, and I called to inquire about service	1	5.6

Table 8. Percentage of respondents giving different reasons for considering use of the 3-2-1 service again.

Reason	Number	Percent
The information is very relevant and useful	12	66.7
The information is very new to me	4	22.2
To always check whether there is new content	1	5.6
I wanted music not farming	1	5.6
How often do you need this information		
Once a season	7	41.2
Multiple times a week	1	5.9
Once a month	5	29.4
Once a week	4	23.5

average score of 3.8 out of 10) which alerts implementers on message insufficiency and thus, the need for improvement of message packaging (Table 8). Majority of the respondents (61%) rated the information on bananas as very valuable with a score of 10 (Table 9). Using the call back survey, respondents rated all the messages obtained through the 3-2-1 Service. Most farmers rated messages as valuable, adoptable, easy to understand, and relevant.

Effect of the 3-2-1 Service on farming practices and banana production

The results showed that majority of the respondents (66.7%) did not change much in the matooke practices

Table 9. The average score given by respondents to Banana messages.

Banana subject information/message	Average score (on a scale of 1-10)	Min.	Max.
The 3-2-1 Service provides information not known	5.23	1	8
Information provided on matooke is valuable	4.83	1	6
The matooke message made me take an action in my field	3.78	1	10
Information on matooke was easy to understand	5.17	1	10
The section on matooke is relevant to me	4.89	1	8

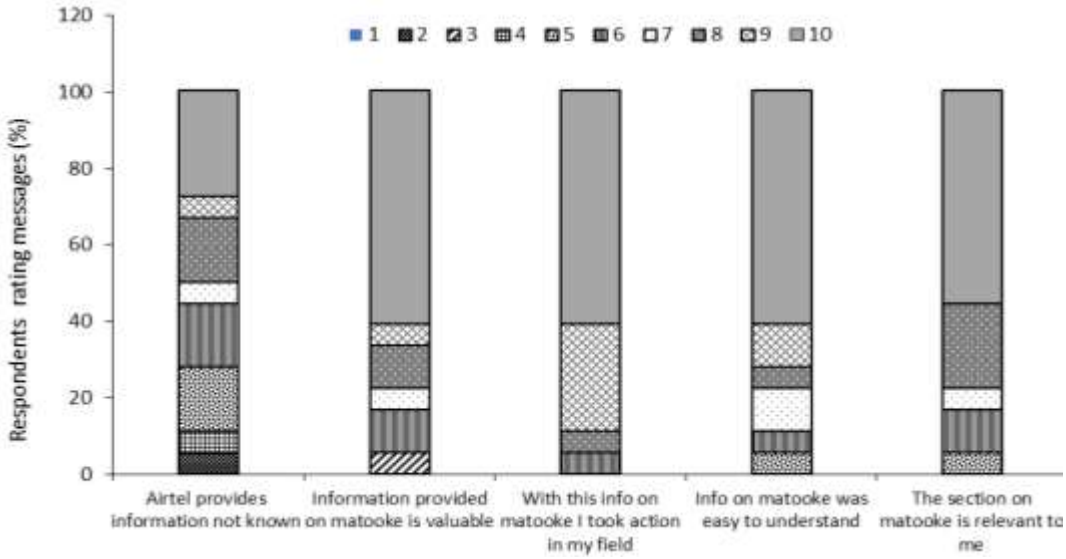

Figure 2. Percentage of respondents giving the rating of banana messages.

Table 10. Percentage of respondents indicating change in matooke production practices with help of the 3-2-1 Service.

What have you changed based on information gotten	Number	Percent
Not yet changed	12	66.7
Stopped using the same tools in infected gardens	1	5.6
Weed management	1	5.6
Washing my tools with Jik (bleach)	1	5.6
Digging trenches across the slop to control erosion	1	5.6
Mulched my gardens	2	11.1

despite access to the 3-2-1 Service (Figure 2). However, for the few farmers (33.3%) that made changes in their production practices based on the banana messages, reported that changes were implemented about mulching, disinfection of tools, and digging contour trenches (Table 10). Based on the Pearson correlation coefficients, use of the 3-2-1 Service was positively correlated with gender, age, income source, reason for use, and frequency of use. Importantly, the need for information on diseases was the most factor correlated with use of the Viamo airtel service (Table 11).

Improving the Viamo 3-2-1 service to meet farmers needs

The farmers indicated that there are gaps in the service with respect to pests and diseases signs and symptoms,

Table 11. Correlation between use of Viamo service and selected variables.

Variable	Correlation coefficients (with use of the 3-2-1 Service)
Respondent gender	0.125
Age	0.263
District	0.039
Income source	0.153
Reason for using 321 service	0.212
Frequency of use of service	0.334
Disease	0.433*
Pests	0.265

Table 12. Percentage of respondents indicating the information gaps in the Viamo 3-2-1 service.

Information that needs to be added	Number	Percent
Pest and disease diagnosis	7	41.2
Information on market prices	1	5.9
Information on Weather	3	17.7
Mulching and weeding for different terrain	1	5.9
Where to find clean planting materials	1	5.9
How to manage and control BXW	4	23.5

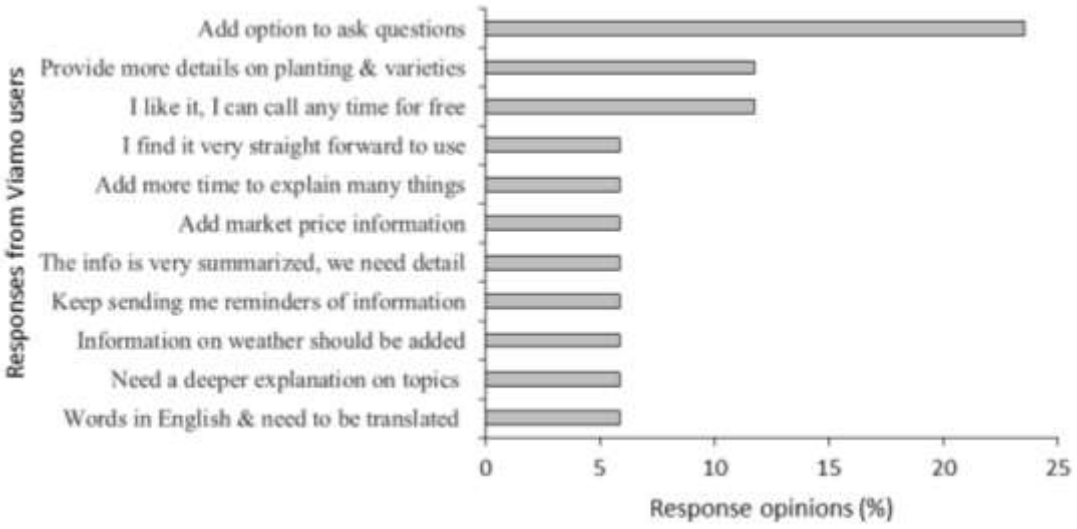

Figure 3. Percentage of respondents giving their different suggestions to improve the Viamo 3-2-1 service.

market prices, weather information, mulching and weeding in different terrains, source of clean banana planting material and management of BXW (Table 12). For any service to deliver optimum impact to its target clientele, there is need for constant improvement especially following feedback from those for whom the service is intended. In this case, Viamo aims to leverage ICT solutions to ease access to extension services. The phone interviews showed that most respondents would like to have in the service: (i) an option of asking additional questions, (ii) adding more details on planting and (iii) that the service should be free to call any time (Figure 3). Fewer respondents indicated the need to improve the service through adding market price and weather information.

As an avenue for improvement, FGDs also generated

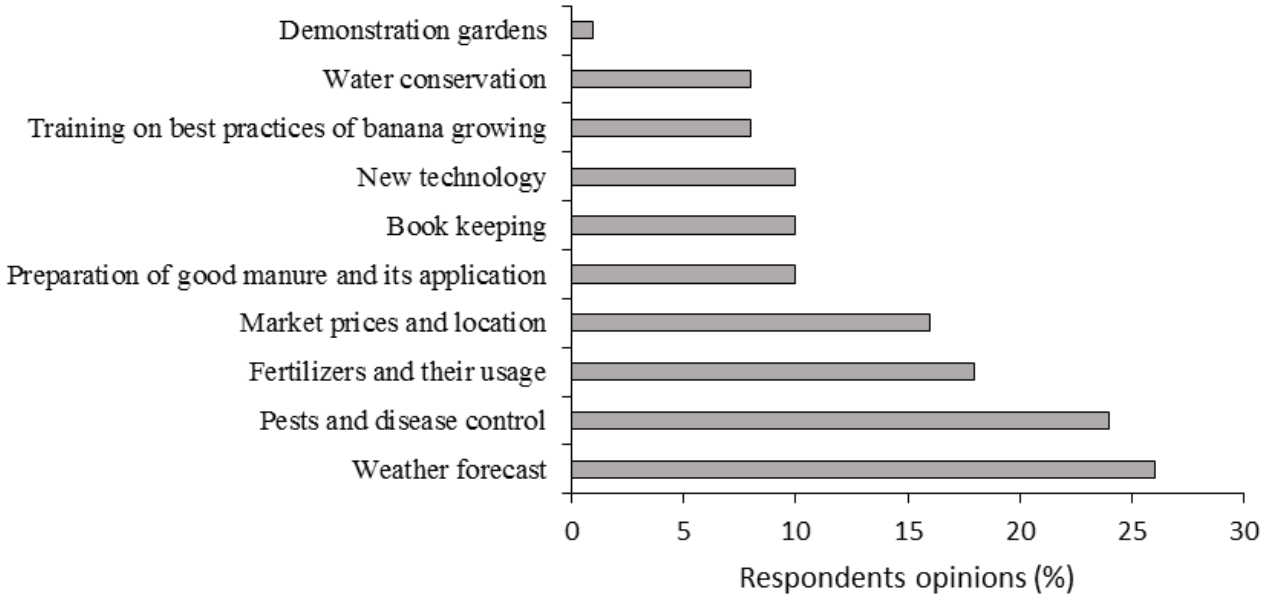

Figure 4. Number of respondents indicating the type of information required for improvement of the Viamo 3-2-1 service.

Table 13. Percentage of respondents indicating preferred medium of receiving information and frequency of sharing.

Preferred medium of receiving information	Number	Percentage
Both phone and radio	9	25.7
Radio alone	5	14.3
Phone alone	21	60
Frequency of receiving information		
Weekly	4	24
Monthly	12	70
Many times in a week	1	06

information on what should be added to the 3-2-1 Service and in line with sentiments from the phone interviews, there was convergence on the need to add weather information, prices, pests and diseases (Figure 4). Other information pointed out includes information on fertilizers and record keeping. It also emerged that phones and radio are the most preferred mediums of information channeling which is consistent with the findings in the phone interviews. Most farmers also recommend that information should be delivered monthly (Table 13).

DISCUSSION

Farmers' attributes regarding mobile phone use

The call back exercise enabled the team to characterize farmer attributes regarding use of the 3-2-1 Service with respect to banana production in Uganda. The study's results indicate that over 78% of the farmers were 40 years of age or younger (Table 2). This suggests that most of them were in the active age group that were more receptive to new technologies such as use of mobile phones. Farmer's adoptions of ICT are highly connected to farmer age (Das, 2014; Mittal and Mehar, 2016). The overall gender analysis of the 3-2-1 Service usage showed that more male farmers (67.7%) made use of the phone than female farmers (33.3%). This could be because men control most farm resources. Similar findings were previously reported in Uganda (Masuki et al., 2010) that women had 36% fewer ICT-related opportunities and benefits than men. The study findings indicate that more than half (54.4%) of 47 the household heads had attended secondary school education and 9.4% had diploma or equivalent level of education. Few, 4.7% of the respondents had no formal education. Nearly

three-quarters (72.8%) of households had family size of 4-9 (Table 4) showing that households in the study area are generally with large sizes of family. It's expected that a large household size is generally associated positively with mobile phone use by increasing the probability of using mobile phone than a smaller household size (Senthilkumar et al., 2013; Ogutu et al., 2014).

The study results indicate that nearly half (52.2%) of the respondents had more than 10 years of experience in farming (Table 4). Farmers having more years of farming experience might have tendency to use mobile phone for accessing agricultural information. According to Adegbidi et al. (2012), the farmers' experience in agriculture is expected to have a positive relationship with ICT use. Those farmers with more farming experience tend to use technology more than those with less experience (Abebe and Mammo Cherinet, 2018). This might be that longer experience in farming increase exposure to ICTs that is used in agricultural activities including market access (Hoang, 2020).

Farm size in hectares is an important factor in agricultural production. In the study area, land is scarce mainly due to the population pressure. For instance, 72.8% of the respondents reported owning less than one hectare of farmland (Table 6). Therefore, this scarcity of farmland might have led to lower incomes and in turn to less access to technologies use such as mobile phones, since farm size is often correlated with farm incomes. Some studies have reported that farmers with larger farm size have more income and that the larger the farm, the better access to technologies (Adegbidi et al., 2012; Senthilkumar et al., 2013; Ogutu et al., 2014). These results suggest that households with large farm sizes should be targeted for use of smart phones in banana production.

Farmer information needs and access to the 3-2-1 Service

Access to extension services is still a challenge to farmers in Uganda due to resource constraints both by the farmers who need the information and the agents meant to deliver the information. One of the ways to alleviate resource constraints and deliver farming advice to farmers is by harnessing ICT solutions and leveraging digital applications to deliver information in real time. In that regard, the 3-2-1 Service was developed to enable farmer access to information on banana production. This study was set out to establish whether the 3-2-1 Service was being accessed and how it can be improved.

Majority of published literature that examined farmers' information needs and behaviours came from studies in developed countries with only a few in developing countries. Farmer information needs and information sources have been analysed (Ogbeide and Ele, 2015; Deribe, 2016; Misaki et al., 2018), and others have examined factors influencing farmer information search strategies (Okwu and Iorkaa, 2011; Solomon, 2011; Mittal and Mehar, 2016; Hoang, 2020). In this study, farmers were asked to state the sources where they got the information. Respondents indicated that, the major information source being the extension agents followed by phones and televisions (Table 4). These findings concur with a study by Deribe (2011) in Ethiopia.

For the phone call interviews, most respondents (70%) owned phones and most FGD participating farmers owned phones (94.3%). The widespread use of mobile phones should add to more use of voice and SMS solutions as they offer easy accessibility. However, Misaki et al. (2018) asserts that mobile users also face challenges because the SMS carries only a limited amount of information and requires a basic level of literacy. Mobile phones on the other hand only require basic literacy, and therefore are accessible to a large portion of the population. Finally, mobiles enjoy some technical advantages that make them particularly attractive for development. In addition to voice communication, mobile phones allow for the transfer of data, which can be used in the context of applications for the purposes of agricultural development (Masuka et al., 2016; Misaki et al., 2018).

The call back exercise enabled to find out who has been using the 3-2-1 Service to access information with respect to banana production in Uganda. It has been found that access to the 3-2-1 Service was positively correlated with male farmers, farmers' age, education level, and the need for information on pest and diseases. Similar results were report by Deribe (2016), who indicated that farmer access of information is influenced by several factors including age, level of education, distance to the nearest town, mobile phone ownership time frame and amount of money spent on mobile phone. In our study, of all factors, the need for information on diseases had a correlation coefficient of 0.43, while other factors had correlation coefficients of less than 0.04 to 0.33 signifying a not very strong correlation. It also emerged that to improve the service, there is need to include information on weather and prices which should be channelled largely through the phones and radio in a monthly interval while also providing an option for real time feedback.

Effect of Viamo 3-2-1 Service on farming practices and production

In Uganda, Martin and Abbott (2011) observed that farmers use their phones for a range of farming activities, especially to coordinate access to agricultural inputs (such as training, seeds or pesticides) (87% of farmers), accessing market information (70%), requesting agricultural emergency assistance (57%), monitoring financial transactions (54%) and consulting expert advice

(52%). In the present study, farmers agreed to various benefits of the mobile phone (Table 8) and indicated access to banana production information as the highest perceived benefit. Even if a majority of farmers indicated no change in their banana management practices, a number of related studies revealed that access to updated agricultural information through digital applications significantly helped the farming communities (Kikulwe et al., 2014; Tadesse and Bahiigwa, 2015; Gichuki and Mulu-Mutuku, 2018; Misaki et al., 2018; Thimnu, 2020). It is argued that the mobile phone use has enabled the farmers to negotiate at local markets to sell their products more profitably and establish networks with various stakeholders in agriculture like traders, consumers and many institutions.

Improving the 3-2-1 service to meet farmers' needs

In the discussions with farmers, the four most sought information items for increasing banana productivity include: weather forecast, pests and disease control, fertilizers and their usage, and markets and location. This information was already available on the service, but farmers were struggling to find it. Similar results were report by Mazuki et al. (2010) in the study carried out in western Uganda. Accordingly, the three most important types of agricultural information that farmers required for improvement of the 3-2-1 Service are information on: pests and diseases signs and symptoms, weather information and management of BXW. Adding an option for asking questions and adding more detail on banana planting were clearly indicated as key information gaps in the 3-2-1 Service. Although information was already available on the service, farmers were struggling to find it, so easier access needs to be developed.

CONCLUSIONS AND RECOMMENDATIONS

Based on interviews conducted, the service appeared relevant and has contributed to improving farmer knowledge on good banana management practices leading to increased banana production. Although the farmers clearly identified the role of mobile phones in the banana productions, the role of the 3-2-1 Service is not yet widely utilized in the different banana growing communities. It can play a role in reaching a wider farmer audience particularly, through radio since it was reported to be the most preferred communication channels. The extension services in Uganda should be improved such that farmers are lead players in extension service delivery through public-private partnerships. In this case, there are opportunities for farmers to use phones to contact service providers once they have a problem. For example, use of phone web systems can be a convenient medium of communication between farmers and extension workers. Also, a multimedia messaging service (MMS) application can help farmers to take a photo for example in the case of disease incidence and diagnosis and send it to an extension worker to enable more specific and precise advisory service delivery. On the other hand, in the case of farmer learning groups, consultations with subject matter specialists could be enhanced through a group virtual (e.g. Zoom) meetings using a hands-free mobile phone application, where a group could ask questions directly to the technical person and receive answers promptly. A follow up study that goes beyond initial exploration is needed to provide further information on the determinants of adoption of the technology and ascertain factors that impede its use with gender perspectives, especially for women. The other opportunity for research is understanding use of the 3-2-1 Service for agricultural purposes at country and regional levels since the scope of this study was limited to cover only a few areas in Uganda.

CONFLICT OF INTERESTS

The authors have not declared conflict of interests.

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