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Information technologies as a tool for agricultural extension and farmer-to-farmer exchange: Mobile-phone video use in Mali and Burkina Faso

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ABSTRACT

Mobile phones are widespread in the rural areas of Mali and Burkina Faso, but their potential as a tool for knowledge transfer by extension services in the region remains largely unexplored. The aim of this contribution is to evaluate the potential of video on mobile phones as a tool for farmer-to-farmer exchange and agricultural extension in Western Africa's rural reality. This aim was addressed by interviewing 460 farmers in Mali and Burkina Faso. Third generation (3G) mobile phones with video and Bluetooth technology were found to be widespread in the study area. Furthermore, videos on 3G phones were found to have a high frequency of contact and a high information utility. The participating farmers reported that 3G phones are readily accessible: including to people who had previously had limited access to information sources, such as young women. Video based information is particularly advantageous to illiterate farmers, and has potential to transform the typically top-down nature of information flow from extension agents to farmers. The farmers, in this case, hold ownership of video based information, which thereby extends its outreach. These findings allow the conclusions that video on mobile phones has tremendous potential as a tool for agricultural extension and farmer-to-farmer exchange in developing countries. The use of video on mobile phones is a novel approach to farmer-to-farmer exchange, which could contribute to transforming and amplifying extension efforts and thereby enabling the necessary intensification of land use, while also enabling more resilient, inclusive and democratic farming systems.

Keywords: *Information and communication technology (ICT), mobile phone, video, agriculture development, rural extension, farmer-to-farmer exchange, Africa*

1. INTRODUCTION

Researchers and other developers of new technologies in agriculture face the issue of how to promote uptake of their innovations. Although Kiptot et al. (2007) found that the process of adoption of new technologies is highly dynamic and variable, Aguilar- Gallegos et al. (2015) point out that adoption of new or improved technologies tends to be quite low. Kiptot et al. (2007) reported several factors that influence uptake of innovations, including financial incentives and practical issues, but also including information transfer. They point out that researchers who wish to see their research findings widely adopted must attune themselves to the needs and demands of farmers and convince them of tangible benefits (Kiptot et al., 2007). Innovation is often the result of informal learning processes, in which social networks play an important role, with farm managers learning by creating networks of colleagues and advisers (Gielen et al., 2003). Early adopters tend to be those with better information networks, which suggests that information flow between different growers and other actors should be encouraged if innovations are to be adopted (Aguilar-Gallegos et al., 2015).

A range of information transfer techniques has been reported in the literature. For example, Ramkumar (2007) implemented a farmer-usable touch screen information kiosk in a veterinary institution, which helped cattle owners treat their animals at an early stage of disease condition. Farmers in the U.K. were found to be informed by a relatively stable network of other communities of practice (or networks of practice), which Oreszczyn et al. (2010) called a 'web of influencers on practice'. However these techniques may not be suitable in environments such as in rural Mali and Burkina Faso, which have neither a developed web of influencers nor an institution that could host an information kiosk. Aguilar-Gallegos et al. (2015) point out that diversified and tailor- made extension strategies should be designed for the conditions of specific target groups. One such extension strategy is the use of information and communication technologies (ICT) for dissemination of information to farmers.

A number of projects using ICT have taken place in different rural areas around the globe. Digital Green in India produces videos and provides public screenings in villages to transfer information and enable exchange of best agricultural practices that can boost farm productivity and improve nutrition (Gandhi et al. 2009). The African Cashew Initiative provided an ICT-based pricing and weighing system that can be used by farmers during the marketing season, with farmers being updated directly via their mobile phones (Kachelriess-Mathess et al. 2011). The Lifelong Learning for Farmers program in Uganda provides an interactive SMS service with relevant agricultural information for farmers (SIANI 2012). Mobile phones have been successfully used in Niger to communicate prices of agricultural products directly to farmers (Aker 2008). Baributsa et al. (2010) showed that videos on mobile phones were an effective tool for spreading information on cowpea hermetic storage practices and other agricultural innovations. Cai and Abbott (2013) demonstrated that the use of video in farmer training is a useful complement to agricultural extension strategies and that it can help overcome the gender barriers in information access.

Sulaiman et al. (2012) reviewed the use of ICT as a tool for enabling innovation in South Asia and found that the potential of ICT as a communication tool had not been adequately utilized. They argue ICTs could better reach their potential by acknowledging and integrating the roles of intermediaries and their capacities for innovation, and by enabling networks so that communities can make use of the information provided (Sulaiman et al., 2012). A successful application of ICT was achieved by Van Mele et al. (2010), who found that open-air video presentations facilitated unsupervised learning; unleashed local creativity and experimentation; and built confidence, trust, and group cohesion among rural people, including the poor, youth, and women. However, Sulaiman et al. (2012) argued that ICT based initiatives will be enhanced if they are embedded in a pragmatic world of communication and innovation process, which could be achieved when the power of distribution and intermediation of ICT content lies with farmers.

Rural Africa has experienced a particularly high uptake of information and communication technology (ICT) in the last 3 to 4 years (Jere and Erastus 2015), which is changing the way farmers communicate and the way they access and exchange information, especially among younger generations (Odiaka 2015). This fast penetration of ICT thus brings new opportunities for African farmers to improve their knowledge and livelihoods (Asongu 2015; Aker and Mbiti 2010; Demombynes and Thegeya 2012). The use of ICT in rural extension may prove to be even more relevant in a context of widespread illiteracy and the sometimes limited, or even inexistent, access to extension services in much of rural Africa (Aker 2011; Cole and Nilesh 2012; Gurumurthy A. 2006; Zossou et al. 2010). The use of ICT for agricultural extension in Mali and Burkina Faso has historically been approached from the top-down, with a particular focus on radio and television shows that have been organized by structured extension services (Bentley et al., 2014a). However, Bentley et al., (2014a) also cite farmers and local extension officers as having reported that other promising and already existing technologies, such as video on mobile phone and Bluetooth, remain essentially unused in agricultural extension in Mali and Burkina Faso.

Mobile phones have become an important tool for communication in rural Africa (Asenso-Okyere and Mekonnen 2012; Simba 2014; Mwombe et al. 2013). With the availability of cheaper third generation (3G) mobile phones, which are imported mainly from Asia, video and Bluetooth technology have become increasingly accessible to the rural population (Bello-Bravo et al. 2013; Hosman 2012; Botha et al. 2010; Momo 2005). Lawal-Adebowale (2012) argues that mobile phones are the most widely used ICT device in Western African rural areas, with 62.9% of farmers in rural Nigeria owning such a device. There are no available statistics that provide detailed data on how many of these are 3G, which would indicate how many West African farmers have access to video and Bluetooth technology. In any case, the potential of video use in 3G phones as a component of an agricultural extension strategy remains quite underexplored by research.

This paper aims to describe the potential of 3G phones as a tool for farmer-to-farmer exchange in African rural areas. To address this aim, we use the examples of Mali and Burkina Faso, and evaluate the reach of 3G phones in the dissemination of agricultural innovations.

2. METHODOLOGY

The technology acceptance model (TAM) (Davis, 1989) provided the theoretical framework for the methodology and analysis in this study. TAM is an adaptation of Ajzen's (1985) theory of reasoned action (TRA) in which the attitude construct has been removed (Venkatesh et. al., 2003). TAM proposes that 'perceived usefulness' and 'perceived ease of use' combine and interact to form a behavioural intention. TRA was itself expanded to include control beliefs and was renamed the theory of planned behaviour (Ajzen, 1991). The application of TAM in this study, in which behavioural control is dominated by simply whether an individual has access to the technology, suggests that the same expansion should be adopted. The theoretical framework guiding this research is therefore based on the understanding that perceived behavioural control, perceived ease of use, and perceived usefulness combine to create a behavioural intention and lead to behaviour. These theoretical considerations are expressed in practical terms as whether people have access to a 3G phone, whether they have the skills to use it, and whether they perceive its use to be beneficial to them.

2.1 Methods

Data were collected by means of face-to-face interviews with 460 farmers in Mali (N=400) and Burkina Faso (N=60). The survey instrument included a mixture of open and structured questions, so both qualitative and quantitative data were collected. The questions covered the topics of local access and use of 3G technology and other information sources, which enabled a comparison of 3G phones and other sources and thereby allowed some assessment of the potential for videos to be used as an agricultural dissemination tool in Mali and Burkina Faso.

Of the 460 interviews, 180 were conducted with organic and 280 with conventional farmers. From the sample in Burkina Faso, 30 of the organic farmers were involved in the Syprobio project. Syprobio is a EuropeAid funded project running from 2011 to 2015 that aims to promote farmer lead innovation in an organic farming context in Burkina Faso, Mali, and Benin. The sampling strategy was guided by the principle of maximum variety, (Patton 1990), which was chosen to ensure that both genders and a variety of farming systems, socioeconomic groups, and age groups were represented in the sample. The final sample consisted of male (72.8%) and female (27.2%) farmers, of whom 39.1% were organic farmers and 60.9% were conventional farmers. The median age of the participating farmers was 35 years.

The available agricultural information sources were evaluated according to the methodology applied by Demiryurek et al. (2008). This methodology calculates an information score for each component of the farmer's agricultural information system, by multiplying the weights of information contact with the degree of information usefulness. Specifically, the available information sources were identified in consultation with local farmers and technicians and an information score for each source was calculated for each farmer (N=460). The score was calculated using the equation: ***IS = FC x IU,*** where FC is the frequency of contact and IU is the information utility. FC is the number of times the farmers had contact with the information source in one year. IU is the weight, or degree of usefulness, that farmers attributed to each source. The 30 farmers participating in the Syprobio project in Burkina Faso have a more regular and intensive interaction with extension agents and researchers than farmers who are not involved in research projects. They were therefore excluded from the estimation of the information score, to avoid skewing of results.

A latent class analysis was conducted to determine whether socio-demographic variables significantly influence the likelihood of mobile phone ownership or the number of information sources that an individual participant uses. This statistical methodology is a widely applied modelling technique that is used to identify unobserved heterogeneity in a population (Nylund et al. 2007). For latent class modelling, the age variable was separated into 4 age groups: less than mean (35.9 years) minus standard deviation (10.1 years); between mean minus Standard deviation (SD) and mean; between mean and mean plus SD; and finally greater than mean plus SD. Thus, the first group was younger than 25.8, the second was between 25.8 and 35.9, the third was between 35.9 and 46 years and the fourth was older than 46. Ownership of a 3G phone was used as the indicator variable, with age, gender, purchasing power and farm type entered as covariates into the model. TV ownership was used as an indicator of purchasing power, in the absence of other clear data that could provide an insight to the population's economic composition.

3. RESULTS AND DISCUSSION

3.1 Access to Information Technologies (IT): Third Generation Mobile-Phones

Third generation mobile phones (3G) with video and Bluetooth technology were found to be widespread in the study area, with 58.5% (N=460) of farmers owning such a device (table I).

Similar proportions of 3G phone ownership were found in each country, with 63.3% in Burkina Faso (N=60) and 57.8% in Mali (N=400). It is reasonable to suspect that the presence of such technology may be similarly widespread in other countries in the region with similar socio-economic circumstances. Our results are consistent with the findings of Lawal-Adebowale (2012) who found 62.9% of the population in rural areas of Nigeria owned mobile phones. Most farmers (91.5%, N=460) in the study area had a family member who owned a 3G phone so had at least indirect access to 3G technology. This proportion was slightly higher in Mali (92.5%, N=400) than in Burkina Faso (85.0%, N=60). All respondents (100%, N=460) in both countries knew someone who possessed a 3G phone. Furthermore, the qualitative data show that locals watch videos on mobile phones mostly in groups and very frequently in public places of the village.

These findings indicate that the whole sample had potential access to the technology.

Table 1. *Population with direct and indirect access to 3rd MP technology*

Owns 3rd MP	Burkina Faso		Mali		Total	
	N	%	N	%	N	%
Yes	38	63.3	231	57.8	**269**	**58.5**
No	22	36.7	149	37.3	**171**	**37.2**
Broken/lost	0	0.0	20	5.0	**20**	**4.3**
Total	60	100	400	100	**460**	**100**
Family member owns 3rd MP	**Burkina Faso**		**Mali**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
Yes	51	85.0	370	92.5	**421**	**91.5**
No	5	8.3	30	7.5	**35**	**7.6**
Doesn't know	4	6.7	0	0.0	**4**	**0.9**
Total	60	100	400	100	**460**	**100**
Neighbour/friend owns 3rd MP	**Burkina Faso**		**Mali**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
Yes	60	100	400	100	**460**	**100**
No	0	0.0	0	0.0	**0**	**0.0**
Doesn't know	0	0.0	0	0.0	**0**	**0.0**
Total	60	100	400	100	**460**	**100**

The percentage of the population (of sampled farmers) who own 3G phones has increased steadily since 2008, when it was still residual. The increase in the percentage of the sampled population owning a 3G phone was found to be very similar in the two countries, with the threshold of 50% of the population possessing 3G phones being crossed between 2012 and 2013 in both cases (figure 1).

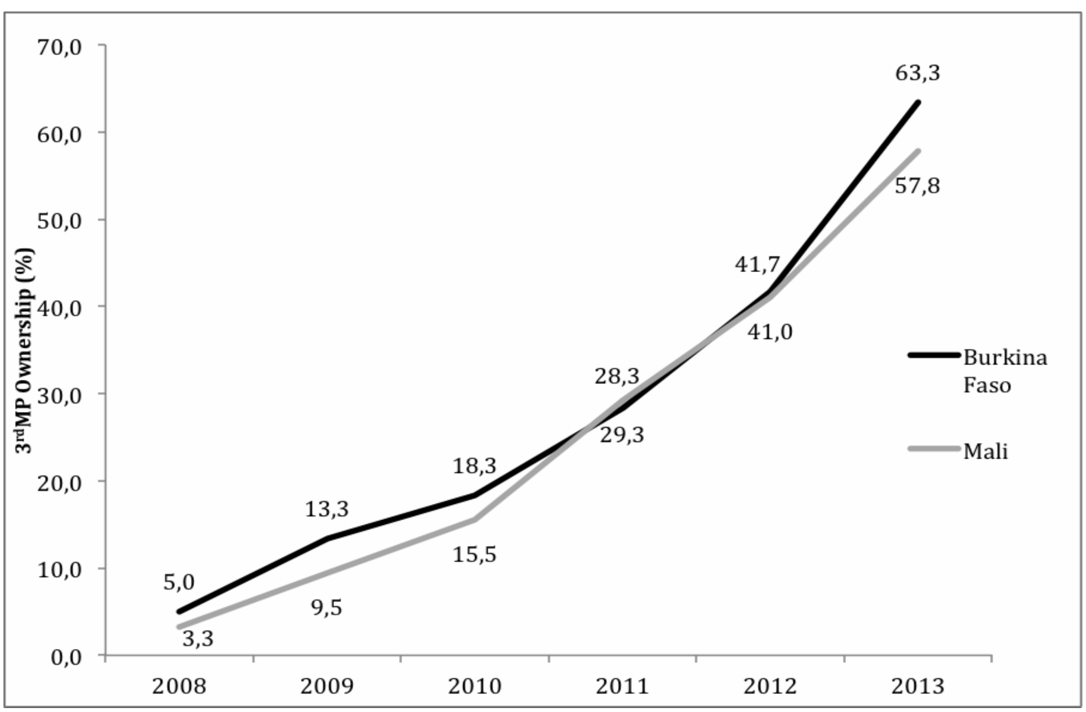


Figure 1. *Evolution of 3G phone ownership (%) since 2008 in the studied area (Mali, N=400; Burkina Faso. N=60)*

For the latent class analysis to examine 3G phone ownership, the most parsimonious model, with lowest Bayesian information criterion (BIC), was found to be the 2-cluster model with a p-value of 0.11. Examination of the classification statistics revealed a model R-squared of 0.579. The R^2 value indicates how much of the variance of mobile phone ownership is explained by this 2-class model. Application of the model revealed 7.97% classification errors, which is considered acceptable (Bray 2008). The p-values for age (P=0.0017), purchasing power (p=0.023) and gender (p= 0.025) were found to be less than 0.05, while agriculture type was found to have a p-value greater than 0.05(p=0.84). Thus, for age, purchasing power, and gender, the knowledge of the response for that indicator contributes in a significant way towards the ability to discriminate between the classes. The profile of the clusters is shown in Table 2.

Table 2. *Cluster profile of the latent class analysis with mobile ownership as the indicator and age, gender and purchasing power (TV ownership) as covariates*

		Cluster1 (%)	Cluster2 (%)
Cluster size		50.8	49.2
3G ownership	No	2.0	76.1
	Yes	98.0	23.9
Age groups	1	20.7	9.7
	2	47.8	30.8
	3	25.2	34.5
	4	6.8	24.9
TV ownership (Purchasing power)	No	51.9	64.3
	Yes	48.1	35.7
Gender	Male	96.8	49.5
	Female	3.2	50.5

These results show that 98.0 percent of cluster 1 own a 3G phone, 68.5 % of them are below the mean age, 48.1 % of them have a TV, and 96.8 % of them are male. Of cluster 2, 76.1 % of them don’t own a 3G phone, 59.4% are above the mean age, 64.3% don’t own a TV, and around half of them are male.

Despite the higher probability of male farmers to own a 3G phone, the use of video was found to overcome the gender and age gap, because videos are regularly watched in groups with family and friends. The qualitative responses indicated that this technology is used by all population groups, with locals often saying that “no one is excluded”. The use of video in 3G phones was therefore found to be a democratizing tool in terms of information sharing; regardless of gender, age and economic activity. This finding is in line with the results of previous studies that have concluded that video can be used to address women’s knowledge needs and can overcome barriers that hinder access to information by women (Cai and Abbott 2013, Zossou et al. 2010, Munyua 2000).

The results relating to ownership and access to 3rd MP indicate that direct or indirect access to video and Bluetooth technologies is a cross-country and recent phenomenon. Furthermore, these results answer one of the present study's main questions: of whether 3G phones are widespread in the study areas, and satisfy the requirement in the technology acceptance model (Davis, 1989) of access to the 3G technology. Access to the technology is fundamental to the behavioural control component in the model because the technology can only be adopted by people with the physical means of doing so.

3.2 Current Use of 3G phones in the Studied Area: Video and Bluetooth

Bluetooth technology is widely used to share video and music, but only 38.5% of farmers are able to manipulate it (177, N=460) (Table 3). Yet, in 91.1% of all households (418, N=460), there is someone who can use the technology; especially among younger relatives.

Table 3. *Bluetooth manipulation know-how*

Manipulates Bluetooth	**Burkina**		**Mali**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
Yes	29	48.3	148	37	177	38.5
No	31	51.7	252	63	283	61.5
Total	60	100	400	100	460	100
Family member does	**Burkina**		**Mali**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**
Yes	53	88.3	365	91.3	418	90.9
No	5	8.3	31	7.8	36	7.8
Doesn't know	2	3.3	4	1.0	6	1.3
Total	60	100	400	100	460	100

The technology acceptance model (Davis, 1989) includes a requirement that potential users of a particular technology must possess the skills needed to use it. This requirement appears to be satisfied in this case, because the farmers usually have access to somebody with the requisite skills: even if they don't possess those skills themselves. The final requirement in the technology acceptance model (Davis, 1989) is that the technology is useful, which can be deduced from its frequency of use in other contexts.

The use of video in 3G phones is widespread, with 92.1% of farmers (421, N=460) reporting that they regularly watch videos on 3G phones (table 4). The data support the findings of Bello-Bravo et al. (2013), who reported increasing cell-phone video use in developing nations. The average frequency that the participating farmers watch videos on 3G phones is 4.52 times per week (N=421), which is more frequent than their TV viewing; at 3.52 times per week (N=341). The most commonly watched videos are music videos; short videos extracted from popular films of African, Western and Asian origin; African soap operas; and football. Video watching frequency is not notably different between countries, with 4.31 times per week (N=59) in Burkina Faso and 4.55 times per week (N=369) in Mali.

Table 4. *Frequency and average video use on 3G phones (times/week)*

Frequency	Burkina			Mali			Total		
	N	%	Average	N	%	Average	N	%	Average
Regularly	59	98.3	4.31	369	92.3	4,55	428	92.1	4.52
Occasionally	0	0.0		10	2.5		10	3.5	
Never	1	1.7		21	5.3		22	4.4	
Total	60	100		400	100		460	100	

The qualitative data show that locals watch videos on mobile phones more frequently during evenings and days of rest. Video watching frequency depended mostly on the availability of a power supply (table 5) to charge 3G phone batteries. Most farmers (78.7%) get their power supply from solar panels, which were reported to have become widespread in the studied area in the last five years. Only one farmer obtained energy from the public grid, which shows that local populations have a low reliance on public energy sources.

Table 5. *Power Supply for the studied area*

	Power source	No source	Battery	Solar panel	Generator	Public grid	Total
Burkina Faso	**N**	3	3	34	1	1	42
	%	7.1	7.1	81.0	2.4	2.4	100
Mali	**N**	49.0	33.0	309.0	1.0	0.0	392
	%	12.5	8.4	78.8	0.3	0.0	100
Total	**N**	53.0	38.0	343.0	2.0	1.0	436
	%	12.2	8.7	78.7	0.5	0.2	100

Although conclusions can be drawn about the usefulness of the technology in the contexts of entertainment, questions remain as to whether the technology is useful for the transfer of agricultural extension information. Bello-Bravo et al.'s (2013) finding that animated cell-phone videos are a promising training tool for agricultural topics, but that their use is hindered by a scarcity of videos with appropriate content, was supported in this study. From the whole sample of 460, only 30 (6.5%) farmers had watched agriculture related videos on their 3G phones, and these consisted of home-made videos that had been made by other farmers. All of the interviewed farmers (N=460) expressed interest in accessing learning videos on their 3G phones, although they didn't know where to get them. According to Van Mele (2011), extension agents who wish to use videos as support material for agricultural extension, also find it difficult to find them. Online platforms that host a wide range of agricultural videos, such as the recent *Access Agriculture* website, can provide a source of relevant agricultural learning videos, which may then be distributed by extension agents. In this way, extension agents can act as a bridge between farmers and the available online content by transferring the videos from the web to their mobile phones and then sharing with farmers via Bluetooth during field visits. This intermediary role is necessary because farmers in Mali and Burkina Faso rarely, if ever, have access to the

Internet and can therefore not directly access video online platforms.

While events such as film projections in trainings provided by extension services are popular, farmers reported that it is difficult to retain the information. They forget most of it since they cannot write it down. This finding is in contrast to those of Bentley et al. (2014b) who found that farmers in Benin remembered agricultural videos that had been shown 5 years previously. Regardless of the farmers' capacity to remember the video content, one of the most commonly mentioned advantages of videos on 3G phones was that the farmers can store the information and access it whenever they want. The other obvious advantage is that each farmer becomes the owner of the information and is able to show it and transfer it to other farmers.

3.3 Information Score Analysis

The identified information sources were family; other farmers; extension agents; researchers; video on mobile phones; farmer training events; radio; television and internet. None of the interviewed farmers (N=460) reported other available information sources.

3.3.1 Estimating IU, the utility of each information source

The information utility (IU) of each component of the local agricultural information system was calculated using the perceived usefulness degree that farmers attributed to each information source. Participating farmers could rate each information source from five levels of usefulness: coded 0, 0.25, 0.5, 0.75, and 1, to give the IU value. The sum of the values obtained for each information source was then divided by the total of respondents (N=430) to give the average degree of usefulness for each information source. Video on mobile phones had the highest value, at 0.83 (0.87 in Mali and 0.78 in Burkina Faso), followed by radio, 0.72 (0.74 in Mali and 0.69 Burkina Faso). Personal interactions with family members had a value of 0.68 (0.75 in Mali and 0.61 in Burkina Faso), which was comparable to interactions with other farmers (IU=0.68, with 0.71 in Mali and 0.65 in Burkina Faso), and to interactions with extension agents (IU= 0.67 with 0.69 in Mali and 0.64 in Burkina Faso). The value for TV was 0.66 (0.64 in Mali and 0.68 in Burkina Faso), which was higher than farmer trainings (IU= 0.62, with 0.62 in Mali and 0.61 in Burkina Faso). Contact with researchers had the second lowest value, with 0.54 (0.46 in Mali and 0.61 in Burkina Faso).

The lowest value was for the use of Internet, with 0, since it was never used by any of the farmers to find agricultural information (figure 2.).

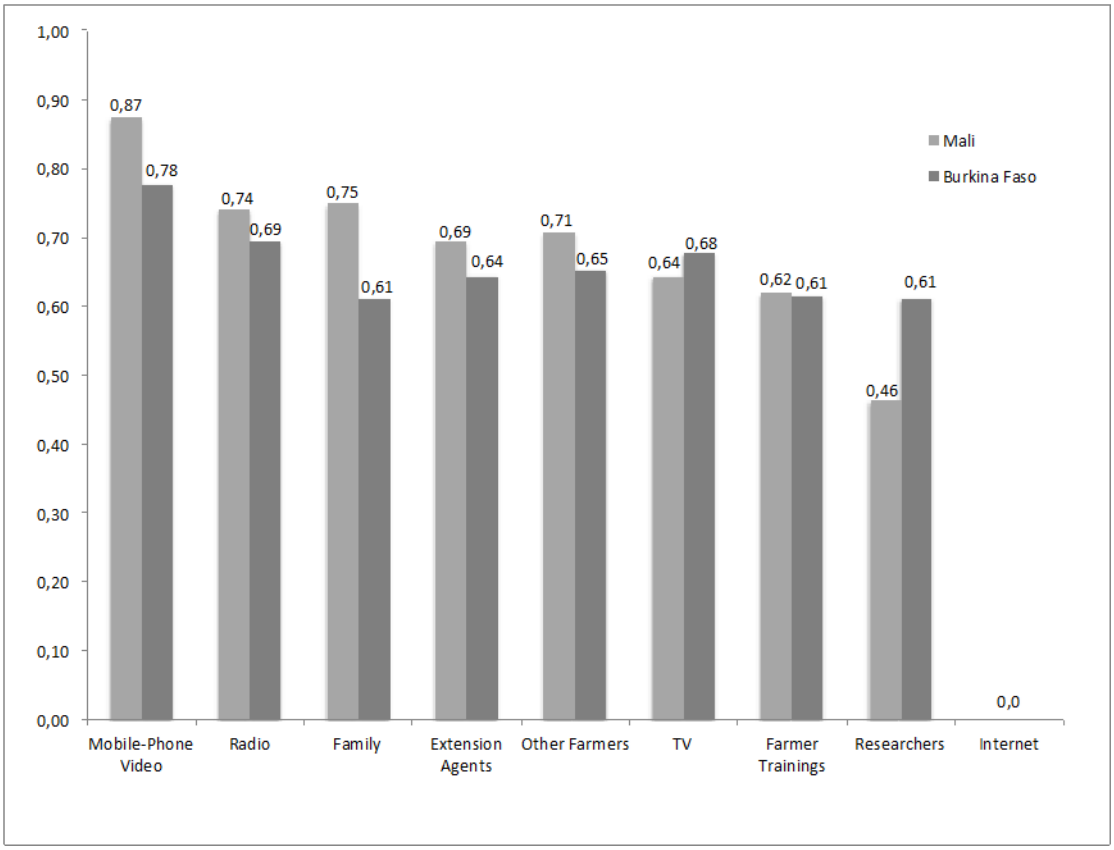


Figure 2. *IU, or Usefulness Index, according to all farmers (N=430)*

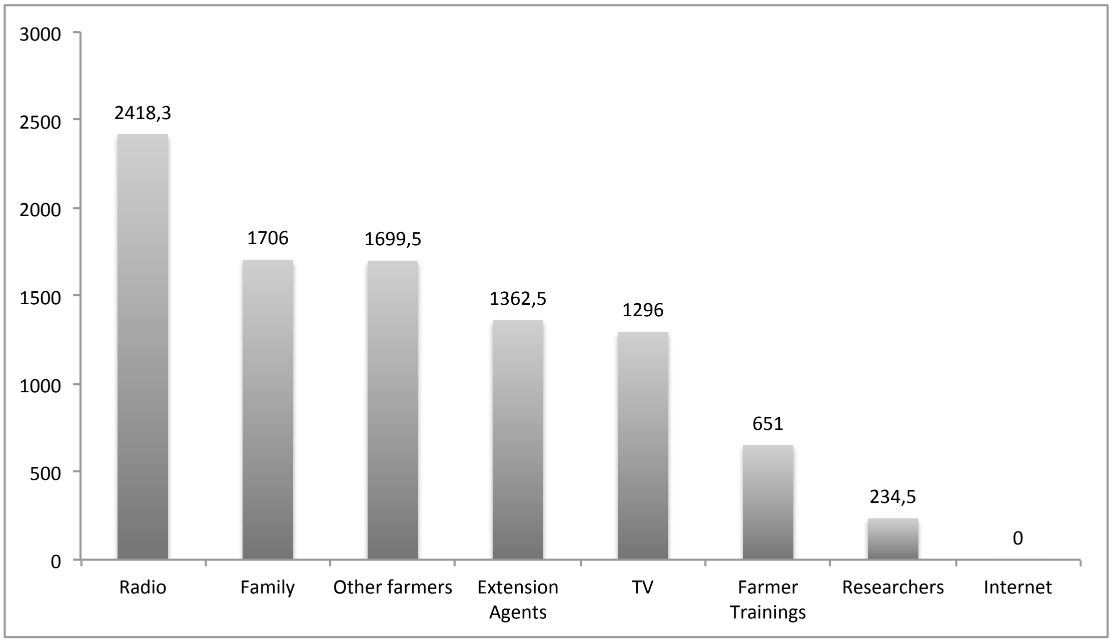
These results allow a better understanding of what information sources are more useful to farmers. The IU (Information Utility) attributed to different information sources was similar in both countries, which may be due in part to general resemblances in both rural realities in economic and social terms. A further explanation is the similarity in how extension and farmers' structures such as UNPCB (Burkina Faso) and MOBIOM (Mali) interact with farmers. Video on 3G phones had a very positive appreciation in both countries, although this is a potential evaluation because the technology is not yet used as an agricultural information source by farmers.

3.3.2 Estimating IS, the information score

The final information score (IS) was generated by multiplying the information utility by the frequency of contact with each information source (FC): ***IS = FC x IU*** (Figure 3).

Radio (IS=2418.3) stands out as an important information source for farmers, which is especially due to the frequency of contact (FC). The FC for radio is high because it is controlled by the farmer, but also because rural radios have special transmissions dedicated to farming topics (Okry et 2013; Van Mele et al. 2013). Family members (IS=1706) and other farmers (IS=1699.5) also provide important information sources for farmers because of their proximity and regular contact. Extension agents (IS=1362.5) have the fourth highest IS, followed by TV (IS=1296), which is mainly due to the agricultural weekly transmission on Malian national TV: *terroir*.

Farmer trainings (IS=651) have the sixth highest IS, followed by researchers (IS=234.5), which is probably due to the little direct contact they have with farmers. Video on mobile phones is not yet used as an agricultural information source so the FC could not be determined and the IS could not be calculated.



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3.3.3 Considering, the frequency of contact FC

When studying the frequency of contact with the locally available information sources, we also obtain information about how many farmers have access to that information source. This allows a better understanding of which information sources are more widely accessible to farmers. In table 6, N refers to the number of farmers who have ever had access to a particular information source, and FC is the number of contacts with a particular source in one year. The most widespread information source is 'family', with 423 references, followed by 'other farmers' with 408; 'radio' with 358; technicians with 317; farmer trainings with 285; TV with 276; researchers with 121; and internet with zero. If we look at the FC column, radio (2527) has the highest frequency of contacts, followed by other farmers (2449), family (2140), TV (1705), extension agents (1294), farmer trainings (877), researchers (257), and internet with zero.

Table 6. *Number of farmers per information source (N) and frequency of contacts (FC) for each information source*

Information Source	N	FC
Family	423	2140
Other Farmers	408	2449
Radio	358	2527
Extension Agents	317	1294
Farmer Trainings	285	877
TV	276	1705
Researchers	121	257
Internet	0	0

Estimating the average number of information sources per subgroup (combining age and gender) provides an indicator of which sections of the population are more likely to access agricultural information and which are more excluded. For the total sample, the average number of information sources to which farmers have access is 5.1. A comparison of means from independent samples (male/female) found a significant difference ($p<0.001$) in the number of sources used by males and females, with males accessing more (mean = 5.5, S.D = 1.235) sources than females (mean = 4.0, S.D =1.663).

A correlation analysis between age and number of information sources was conducted and the correlation ($p<0.001$) was found to be significant at the 0.01 level (2-tailed) with a Pearson correlation coefficient of 0.26.

If we consider both gender and age, the discrepancies become even more evident. Older males have a more privileged access to information than any other group, with 5.8 sources. Younger males follow, with 5.2 sources. Females have a lower access to information sources; especially younger women, with only 3.7 per person. To assess whether these differences can be attributed to chance, we conducted a latent class analysis. The number of information sources was entered as the indicator variable, with age and gender entered as covariates. The ages were grouped using the same method as for table 2. The 2-cluster model was most parsimonious (Lowest BIC), with a P-value of 0.55. The R^2 was found to be 0.4027. Application of the model revealed an acceptable 7.79% of classification errors (Bray 2008).

The p-values for age ($P<0.001$), and gender ($p< 0.001$) were found to be less than .05. The profile of the clusters is shown in Table 7.

Table 7. *Cluster profile of the latent class analysis with number of information sources as the indicator and age and gender as covariates*

		Cluster 1 (%)	Cluster 2 (%)
Cluster size		61.1	38.9
Number of information sources	0	0.0	1.7
	1	0.0	2.2
	2	0.2	12.5
	3	1.7	25.2
	4	5.3	20.7
	5	22.7	23.6
	6	43.8	12.2
	7	26.2	1.9
Age groups	1	4.2	35.3
	2	38.6	38.8
	3	37.1	18.3
	4	20.0	7.7
Gender	Male	95.1	37.8
	Female	4.9	62.2

These results confirm the finding that older male farmers have privileged access to information, with younger females at the opposite extreme. Acknowledging both the gender and age gaps may help define more inclusive extension strategies to provide wider access to agricultural information. Inclusive access to agricultural information can be of extreme importance, since all age and gender subgroups of the local rural population are involved in farming and most depend on it for subsistence and income. The results of this study suggest that the use of 3G phones satisfies the final requirement of the technology acceptance model (Davis, 1989) in that it is perceived as being at least potentially useful. The likelihood that the technology will be accepted is further enhanced by its accessibility and perceived usefulness to those who tend to have less access to information from other sources.

4. CONCLUSIONS AND RECOMMENDATIONS

This study addresses, in terms of information transfer methods, Kiptot et al.'s (2007) challenge for researchers to better attune themselves to the needs and demands of farmers if they wish to see their research findings widely adopted. In particular, the study addresses the concerns of Sulaiman et al. 2012 who pointed out the need to find ways of effectively utilizing ICT in communication, innovation and extension, and supports the findings of Van Mele et al. (2010) who pioneered the use of video to encourage unsupervised learning and to encourage innovation. The adaptation of the technology acceptance model (Davis, 1989) to provide an explanatory framework was found to be useful in this study. The expression of this theoretical consideration into the overarching questions of whether people have access to a 3G phone, whether they have the skills to use it, and whether they perceive its use to be beneficial to them, allowed several conclusions to be reached. All of the conditions are met, so 3G phones with video and Bluetooth technology appear to have potential as a means of information transfer across a wide section of the community.

Third generation mobile phones with video and Bluetooth technology are widespread in rural parts of Mali and Burkina Faso and appear to be changing the way farmers access information. They replace the top-down information transfer and create a horizontal platform of information exchange among the rural population. Our data show that these information technologies could transform and amplify agricultural extension efforts, by using videos on 3G phones to spread information through existing extension structures to farmers. This strategy may provide a platform for specific projects dealing with change, development and innovation (such as Syprobio), and facilitate farmer-to-farmer exchange of the projects' innovative achievements. Furthermore, using this already existing technology could lower extension costs and efforts, because active video transfer is only needed in an initial period, and becomes self-propagative afterwards.

This horizontal way of knowledge transfer contrasts with pure video or radio use (Okry et al. 2013; Van Mele et al. 2013), which need an intermediary agency and are typically top-down approaches. Videos on 3G phones can also be a valuable source of information for the illiterate (Bello-Bravo et al. 2013; Aker 2011), which is the majority of the local population in the study area, since the videos can be easily translated to other vernacular languages. Another democratizing aspect of this approach is that video on 3G phones are viewed in groups and on a regular basis, which provides a rare source of information for parts of the rural population who are usually excluded from agricultural extension and information. Such excluded groups include women and younger generations. To help overcome the gender and age gap that was detected in our analysis, we recommend that agricultural learning videos on 3G phones be integrated into extension strategies, to provide a more inclusive and wider access to agricultural information. In agreement with the findings of Cai and Abbott (2013), this study found that a 3G video-based strategy can both reinforce, and be maximized by, interactions with existing information sources. Information sources that were detected by the information score analysis included family members, other farmers, extension agents, farmer trainings and researchers. In this way, videos can act as a bridge and catalyzer of information sharing among all actors and has the potential to transform farmer extension from an exclusively top-down process to a more horizontal process. Application of this strategy with subsistence farmers enables the farmers to become, in an unprecedented way, the owners of relevant and easily shareable information.

As Lawal-Adebowale (2012) may have predicted, the availability of video and Bluetooth technologies was found to be widespread in the rural areas in this study. Furthermore, the participating farmers expressed interest in agricultural learning videos. However, the finding that farmers don't know where to get them or how to produce them highlights the importance of further study and development of this approach. We thus recommend to organizations with an interested in encouraging innovations to further test and improve the use of video on mobile phones as a mode of dissemination. The public sector would be well advised to support this approach as it provides wide reaching and efficient communication with farmers. The side benefit of the approach is that it potentially enhances trust between researchers and farmers, or more widely between the public sector and farming communities (Bennett and Cattle 2013).

The prerequisites according to the technology acceptance model (Davis, 1989) appear to be met, which implies that the approach will be adopted. We conclude with the recommendation that any agencies or individuals who have an interest in providing agricultural information to a wide audience, particularly in the developing world, should consider a dissemination strategy based around video on mobile devices.

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