# Dissemination and Implementation of Agricultural Innovations Using Video on Mobile Phones in Mali

***Fernando Sousa[1], Gian Nicolay[1], Robert Home[1]***
***[1]FiBL – Research Institute of Organic Agriculture, Switzerland***

## Abstract

A challenge for researchers and other developers of new technologies in agriculture is to find ways of communicating their results and recommendations. This challenge is particularly acute in regions in which farmers have limited access to education and where illiteracy is widespread, such as in the rural areas of Mali. One approach that shows potential, yet remains largely unused by extension services, is the dissemination of educational video on mobile phones with video and Bluetooth technology, which are widespread in the region. This article aims to explore the potential of video on mobile phones as a tool for farmer-to-farmer exchange and agricultural extension in Western Africa. Three videos showing agricultural innovations were shown and shared with 200 farmers in twelve villages in Mali. The villages were revisited 10 months later and farmers were asked about their experiences with the videos that had been shared and their previous knowledge of the innovations shown in them. It was found that participating farmers had shared the videos on their phones with an average of 5.9 other farmers, and had shown the videos to an average of 9.9 other farmers. Of the farmers who had watched one of the videos (N=148), 60.1% had adopted at least one of the videos' innovations. Mobile-phone videos could be accessed by people who have previously received limited access to information sources, such as younger women, and video based information was found to be understandable for illiterate farmers. These results allow the conclusion that use video based information transfer can enhance information transfer and thereby expand its outreach. The use of video on mobile phones is a novel approach to farmer-to-farmer exchange and has tremendous potential for enhancing dissemination programs or specific research and development projects to enable more resilient, inclusive and democratic systems.

**Key words:** Information and communication technology, mobile phone, video, agriculture development, rural extension, farmer-to-farmer exchange, Africa

## 1. Introduction

Developers of agricultural innovations typically find that adoption of their new technologies tends to be quite low (Aguilar-Gallegosa et al, 2015), although Kiptot et al. (2007) found that the process of adoption of new technologies is highly dynamic and variable. The technology acceptance model (TAM) (Davis, 1989) suggests that new technologies will be adopted if they are perceived to be both useful and usable. The TAM was formulated to explain technology adoption across a broad range of innovation types, but it has not yet been investigated whether the model is applicable to the adoption of agricultural innovations: in other words whether agricultural innovations can be considered to be new technologies. Researchers in the field of agriculture must be in tune with the needs and demands of farmers, and convince them of tangible benefits, if they who wish to see their research findings widely adopted (Kiptot et al., 2007). The implication of this is that there are two steps in the process of encouraging adoption of innovations. Firstly the innovations themselves must be perceived to be useful and usable in the intended context. Secondly, their use and

usability must be communicated in a way that is understandable in the specific context so that it is able to convince the farmers of the benefits.

The aims of this contribution are to identify the conditions that enable adoption of agricultural innovations and to investigate whether the TAM can be applied to encourage adoption of innovations. Given that application of the TAM is context specific, we address these aims in the context of rural Mali in western Africa. We first examine existing literature to find a context-appropriate means of information transfer. Once an appropriate means of information transfer are identified, we determine whether innovations are actually implemented after they have been communicated. The logic follows the argument that, if innovations have been implemented, both the first condition: that the farmers perceived them to be useful and usable; and the second condition: that the farmers have learned of the innovations, must have been met. In other words, implementation of innovations, in this case, provides experimental support for the TAM in predicting adoption of rural innovation.

## Appropriate means of Information transfer

Aguilar-Gallegosa et al. (2015) point out that diversified, and tailor-made, extension strategies should be designed for the conditions of specific target groups. Radio and television shows, which have usually been approached from the top-down and organized by structured extension services, have historically formed the bulk of information and communication technology (ICT) for agricultural extension in Mali (Bentley et al., 2014). However, social networks play an important role in the creation, as well as in the adoption, of innovation in agricultural contexts, with farm managers learning in informal processes within networks of colleagues and advisers (Gielen et al., 2003). This suggests that information transfer between peers, in this case between farmers, may be an effective approach to knowledge creation and/or dissemination. Furthermore, subsistence farmers in Mali may however face special challenges in the organisation, storage, and communication of the created knowledge, which suggests the value of user operated ICT systems to support the farmers.

Methods for transferring information to farmers have been the focus of research for some time, but methods have to be suitable for the target groups (Aguilar-Gallegosa et al., 2015), which suggests that methods can't just be copied from other places without consideration of context. Ramkumar (2007) implemented a farmer-usable touch screen information kiosk in a veterinary institution, which helped cattle owners to 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, which have neither a developed web of influencers nor an institution that could host an information kiosk. Sulaiman et al. (2012) argue that acknowledgement and integration of intermediaries, and their capacities for innovation, could enhance the potential of ICTs by ensuring that the information is provided in ways that enable communities to make use of it. Effective use of ICT must be appropriate to rural realities, which, in much of rural Africa, is within the context of widespread illiteracy and sometimes limited, or even non-existent, extension services (Aker 2011; Cole and Nilesh 2012; Gurumurthy A. 2006; Zossou et al. 2010).

A number of projects using ICT have taken place in different rural areas around the globe to enable top down communication of content. Digital Green in India produces videos and provides public screenings in villages to transfer information and enable exchange on best agricultural practices that can boost farm productivity and improve nutrition (Ghandi 2007). 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. 2013). The Lifelong Learning for Farmers programme 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). The iCow initiative in Kenya is a centralised cattle management system, and which has adopted the use of text messages and video (Kahumbu, 2012).

Videos on mobile phones have been effectively used to spread information on cowpea hermetic storage practices and other agricultural innovations (Baributsa et al., 2010). Cai and Abbott (2013) demonstrated that agricultural extension strategies can be complemented by the use of video in farmer training and that it can help overcome the gender barriers in information access. 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. Although the use of video appears to be a promising means of information transfer, 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. One way of placing control of content and distribution in the hands of farmers is to use ICT systems that farmers already own. Bentley et al., (2014) cite farmers and local extension workers in Mali as having noted the promising potential of video on mobile phone and Bluetooth technology but that these technologies remain essentially unused in agricultural extension in Mali.

In recent years, third generation mobile phones (3rdMP), with video and Bluetooth capability, have become an important tool for communication in rural Africa (Asenso-Okyere and Mekonnen 2012; Simba 2014; Mwombe et al. 2013). 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). 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. Sousa et al (under revision) found that 92.5% of their sample of 400 farmers in Mali had a family member who owned a bluetooth capable phone and all knew someone who possessed one so had at least indirect access to 3rd MP technology. Furthermore, Sousa et al. (under revision) found that Malians watch videos on mobile phones; mostly in groups and very frequently in public places of the village. These findings underline the potential of video use in 3rdMP as a component of an agricultural extension strategy.

While this review of relevant literature was able to identify the potential of 3rd MP as a means of information transfer in Mali and Burkina Faso, there is little reported evidence of a connection between information transfer and the implementation of innovation. Primary data is needed to determine whether the conditions for adoption of innovations have been met and whether the TAM provides a useful framework for understanding the conditions.

## 2. Methods

Several videos were produced in 2013 as part of Syprobio's project dissemination strategy. Syprobio (Systèmes de Production Biologiques) (Nicolay G. 2013)1 was a EuropeAid funded project running from 2011 to 2015 that aimed at promoting farmer lead innovation in an organic farming context in Burkina Faso, Mali, and Benin. These videos were produced in a format that was easily comprehensible to farmers to portray different innovations that had

[1] *www.syprobio.net*

been tested in Mali and neighbouring Burkina Faso. Three of these videos were selected after pilot interviews had identified topics that were of interest to farmers in the Bla area of Mali. One video described the production and use of a bio-pesticide using Neem and hot pepper. A second video compared three different ways of applying compost: uniformly, in rows, and in pockets. A third video showed different crop associations. The three videos were shown and shared with 200 farmers, using Bluetooth technology at no cost to the farmers, in September/October 2013. None of the 200 farmers were informed that there would be a second round of interviews after the initial contact. The same team returned to the area in July/August 2014, and were able to find and interview 95 of the 200 farmers with whom the videos had been shared ten months earlier. This sample was supplemented by a further 84 farmers with whom the video had not been shared in the initial introduction of the videos. The final sample size was 179 farmers.

The theoretical framework used in this analysis is the technology acceptance model (TAM) (Davis, 1989), with the extension applied by Sousa et al. (under revision) to include control beliefs. The extended TAM suggests that new technologies will be adopted if they are perceived to be useful, perceived to be usable, and that the technology is available. Given the widespread availability of 3rd MP, and the access to people with the technical skills to use them, the, suggests that the video's will be shared if they are perceived to be useful. A second level, in this case, is whether technologies portrayed in videos will be adopted, and the same theoretical framework can be applied. The theory suggests that if the innovations are perceived to be useful and are perceived to be easy to use, they will be adopted. These theoretical considerations are expressed in practical terms as whether people have implemented the innovations contained in the videos.

## 3. Results and Discussion

### 3.1. How 3rdMP videos were shared and how they spread

From the farmers who received the videos in their mobile phone in September and October of 2013 (N=95), 73 shared the video via Bluetooth with other farmers (76.8%) and 22 did not (23.2%). The main reasons stated by those who did not share the video were: "lost the video before able to share" (9, N=22); "other people already had the video" (5, N=22); "Other people saw it, but didn't ask for it" (7, N=22); and "no knowledge of Bluetooth" (1, N=22).

Those who did share the video via Bluetooth (N=73), shared it with a total of 431 farmers, to give an average share rate of 5.9 people per farmer. This rate is similar to that found by Baributsa et al. (2010) in a study of farmers in Niger and their sharing a cowpea storage video. It is impossible to track how many shares happened in second degree but if we assume a slightly lower share rate of 5 shares per farmer, the number of second-degree video users would rise to 2155. If we go further and assume a third degree share with the same rate, the number would be 10775, from the initial 73 farmers (figure 1). These are however projections and it is impossible to know the real number of farmers who have the video on their 3rd MP. Population density and mobile phone penetration are probably the factors that will most influence the real numbers.

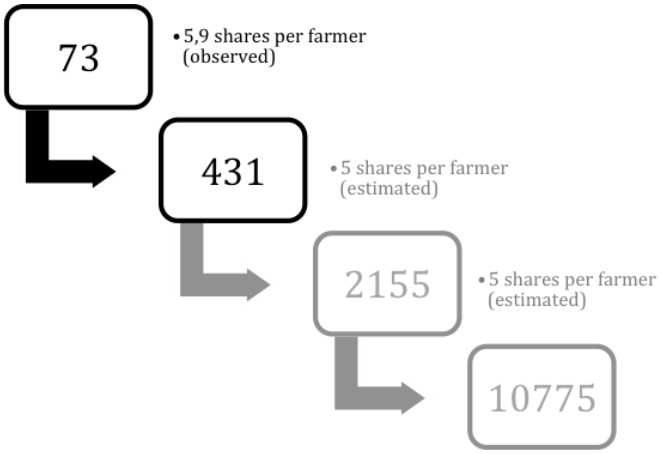


**Figure 1.** Video shares via Bluetooth: observed values (black) and estimated (grey).

Video transfer via Bluetooth is not the only way of describing the information flow, since videos are also visually shared with those who do not own a 3rdMP. Farmers who received the video showed it to 9.9 other people on average, which is a higher number than the average share rate of video via Bluetooth. This result has implications for the real number of people who had access to the information. From the sample with whom the videos were not shared in 2013 (N=84), 53 (63.1%) had been shown the videos by other farmers. Our data supports the notion that the Bluetooth and visual sharing of videos by farmers can scale-up information in a self-propagative way; not only within villages but also to people outside of them.

The videos spread to other villages and towns according to the movements of farmers who initially received the video, as well as through contacts with visiting farmers from other places. The 73 farmers who received the videos said they transferred them via Bluetooth to farmers from 34 new villages. This brings the total of villages in which the videos were present from 12 to 46 in 10 months. On average, each farmer (N=73) transferred the video to farmers from 1.99 villages, with a minimum of 1 and a maximum of 6. Most of the new villages to which the videos were spread were located within 50 km of the centre of the study area (Figure 2).

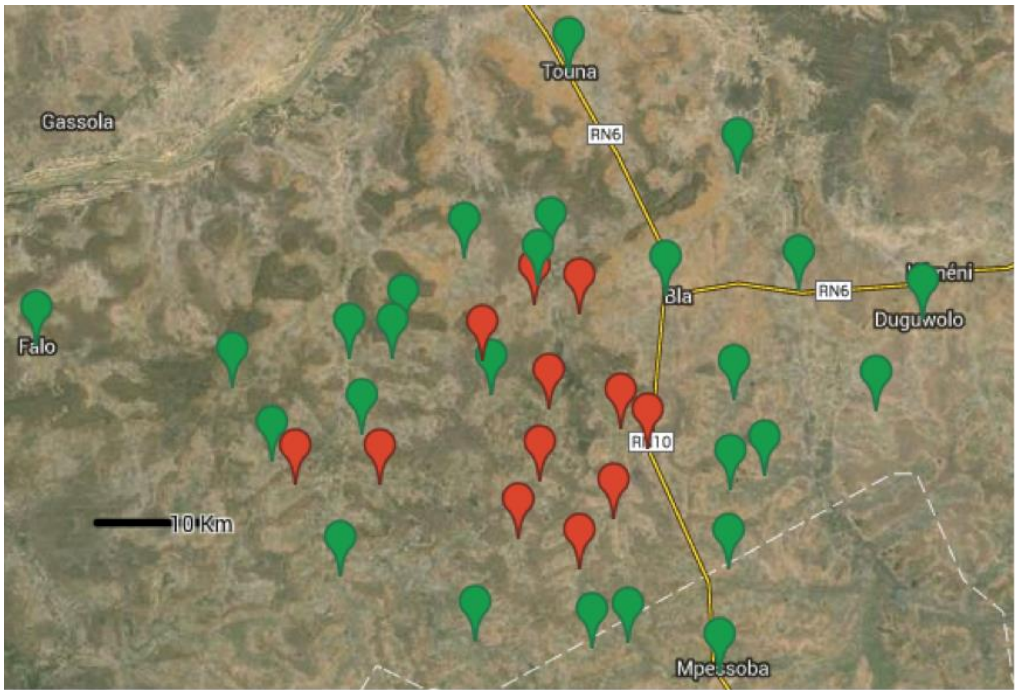

Figure 2. In red, the villages where the videos were initially shared in 2013, and in green, the villages where videos had been transferred via Bluetooth after 10 months.

The video transfer flowed more frequently to neighbouring villages, where contact with friends and family is more regular and likely. However, internal temporary migrations and other types of travel (family visits, ceremonies, trainings etc.), mean that some transfers occurred outside the 50 km range. Video presence was recorded in Kolokani (in the region of Bamako, 250 km northeast); Bledioni (in the region of Sikasso, 120 km south); Markala (in the region of Segou, 90 km north); and Tominian (in the area of San, 145 km east). It is impossible to know the full extent to which the videos were shared in Mali. Some farmers with whom the videos had been shared in 2013 were not present in their villages at the time of the last fieldwork. Furthermore, we don't know the extent to which second and third degree transfers took place.

### 3.2 Rate of video innovation adoption

A further means of evaluating the reach and usefulness of the videos was to assess whether the videos had enabled innovations to be implemented. Farmers were considered to have adopted an innovation (enabled by the videos) if it was specifically stated that it was the first time they had applied the technique and that the video was the information source. An exception is the case of crop associations, which is an old practice that has fallen out of use. Farmers were considered have adopted this innovation (enabled by the videos) when they stated having been explicitly motivated by the video to apply this technique.

Of the farmers who had watched the video (N=148), 89 (60.1%) had applied at least one of the videos' innovations; 46 (31.1%) had not applied any of the innovations; and 13 (8.8%) of the farmers either didn't know or didn't answer. The innovation with the highest implementation rate was the 'compost application technique', which was implemented by 74 of the 89 (83.1%) farmers. Despite the video referring to cotton, many farmers applied this technique to other crops, such as maize, sorghum, millet, okra and watermelon. The higher rate of implementation seems to be related mainly to the perception by farmers that compost is a scarce resource and must be maximized to improve productivity. For the farmers who adopted the innovation, it was important to see the results in the video and to hear the testimonies of farmers talking about their results. Many applied the compost in pockets or in lines, as was suggested in the video. The farmers reported that their main limitation was the availability of workers. All of the farmers who had implemented the innovation had previously applied compost in a uniform way in their fields before watching the video.

The 'crop associations' innovation was applied by 14 (15.7%) farmers. The most commonly used varieties were maize, sorghum and cowpeas, which were the crops shown in the video. Some farmers included sesame and cotton in the mix. Two farmers applied both compost application techniques and crop associations. The third video provided information about a biopesticide using Cassia nigricans and hot pepper, which had been tested in Burkina Faso. This innovation was hardly applied since Cassia nigricans is not used in the area, and the most widely used biopesticide is based on neem seeds. The implementation rate of the three videos is summarized as in table 1.

**Table 1.** Summary table describing innovation implementation rates.

| Innovation | N | % | Observations |
|---|---|---|---|
| Compost application techniques | 74 | 83.1 | Farmers applied compost in pocket or in line instead of uniform as they used to. |
| Crop associations | 14 | 15.7 | Farmers restarted mixing crops or did it for the first time with the mix suggested in the video. |
| Biopesticide (*Cassia*+pepper) | 1 | 1.1 | *Cassia* is unknown in the area. |
| Total | 89 | 100 | |

## 4. Conclusions

As demonstrated by Sousa et al. (under revision), farmers in the rural areas of Mali have generalized access to third generation mobile phones (3rdMP), as well as the skills to use it, and perceive its potential use as an agricultural information tool to be beneficial to them. The technology acceptance model (Davis, 1989) requires that these three conditions be met in order to consider a technology as having potential to be adopted. In the light of this explanatory framework, the results of this study support 3rdMP as having a strong potential as a means of farmer-to-farmer information transfer, since it was widely used by farmers to share the innovations portrayed in the videos, with some being implemented in their fields. The results of this study reinforce the proposal that videos can play an important role in enabling farmers to implement innovative practices. This finding is in line with Ghandi et al. (2007), who showed that video based diffusion strategies can increase the adoption rates of agricultural practices by a factor of six to seven times the classical person-only agricultural extension. Similarly, Zossou et al. (2010) found that a video on rice parboiling in rural Benin reached three times more women than did training workshops that had been organized by local NGOs.

The use of videos was shown to create a horizontal platform of information exchange among the rural population, relying on farmers' own personal contacts and being independent from the typically top-down information transfer from extension structures (Vanclay et al. 1994) or pure video or radio transmissions (Okry et al. 2013; Van Mele et al. 2013). The participatory production of videos for mobile phones; involving farmers and their own messages, further enhances the dissemination and implementation of innovations because of the trust among peers who share similar circumstances and problems, and the same vernacular language.

Widespread illiteracy is recognized as a major constraint in the process of dissemination and implementation of agricultural innovations in most of Western Africa's rural areas (Aker 2011). Videos on mobile phones provide an opportunity to overcome this obstacle, allowing the production of messages that can be easily understood by farmers and easily translated to local vernacular languages. This type of information exchange can greatly amplify agricultural extension efforts and prevent the exclusion of specific groups, such as women and younger farmers. Furthermore, the self-propagative characteristics of this technology could lower extension efforts while increasing the rates of dissemination and adoption of agricultural innovations.

The implementation of the compost application technique in rows, as opposed to uniformly, was by far the most popular innovation; answering to some of the farmers' main concerns such as crop productivity and low soil fertility. The crosscutting characteristics of this information transfer provided that the technique was implemented not only with cotton, as portrayed in the video, but also in other crops grown by farmers. This flexibility in the implementation of the acquired knowledge implies that more democratic information transfer

tools can have a deep impact in a rural society that is eager to access new agriculture related information; further adapting it to its needs. This communication strategy ultimately enables, in an unprecedented way, farmers to become the owners of relevant and easily shareable information, which can then be adapted to their needs. We conclude that a communication strategy involving videos on mobile phones has tremendous potential to be effective and may increase the rates of dissemination and implementation of agricultural innovations, particularly in the rural areas of the developing world.

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