AN EXPLORATORY SUDY OF MOBILE MULTIMEDIA AGRICULTURAL ADVISORY SYSTEM: CHALLENGES AND LESSONS FROM TAMIL NADU, INDIA

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ABSTRACT

This paper describes the experiences gained in terms of challenges encountered and lessons learned in an exploratory initiative of mobile phone-based multimedia agricultural advisory System (MAAS), which helps in providing timely agricultural expert advice to farmers on their mobile phone. When a farmer is calling, a call-centre-like interface containing personalized information of that farmer pops up at the expert's end. The expert views the farmer's dashboard and analyses the situation and query based advisory is provided to the farmer. This agricultural advisory system formed part of a research study under National Agricultural Innovation Projects (NAIP), New Delhi. The MAAS is developed by Indian Institute of Technology Madras's Rural Technology and Business Incubator and it was field tested with 1200 farmers in three districts of Tamil Nadu (Kancheepuram, Erode and Dharmapuri), India, during December 2010 to June 2012. The aim of this paper is to describe the experiences, highlighting a number of specific challenges and lessons associated with providing mobile based agricultural advisories to farmers in rural areas.

Keywords: Information and communication technology; Mobile phone; Agricultural advisory; Agricultural extension; Agricultural information; India

1. INTRODUCTION

Agriculture is still the predominant livelihood in rural India, accounting for about 52 per cent of the population though its contribution to the Gross Domestic Product (GDP) has decreased between 1990-91 and 2010-11 from 30.00 per cent to 14.50 per cent (SIA, 2012). Information and Communication Technologies (ICTs) play a key role in communicating knowledge and information to rural farming communities. ICTs include technologies and media that capture, store and disseminate data and information, and they include tools such as video, teletext, voice information systems, radio, mobile telephony, fax and computer-mediated networks among others. ICTs are considered drivers of change for rural and agricultural development. They are efficient tools for reaching rural and remote communities and improving agricultural productivity (Richardson, 1997; Warren, 2002; Harris, 2004; May et al., 2007).

While involving in agricultural operations, a farmer needs different types of information during every stage. For instance, availability of agricultural inputs and input prices information are most useful at planting time whereas information about improved crop production and management practices are mainly helpful to farmers during crop cultivation. Similarly, daily updates on the prices of agricultural commodities in the local markets of the surrounding district are required during harvesting time (Aker, 2011; Kapugama et al., 2011; Glendenning et al., 2010; Mittal, 2012).

Fafchamps & Minten (2012) have reported that the main source of information is the farmer's own observation and experimentation followed by a conversation with other farmers. Radio and television are also the common source of information particularly on the weather aspects. But, Glendenning et al. (2010), who reviewed some of the agricultural extension approaches in India, reported that the majority of farmers in India have no access to external sources of information. So, timely advisory of agricultural information to farmers is of great significance for maximum yield and profitability.

Information and Communication Technologies have also been used in Africa to deliver education modules on farming practices, which are delivered by audio/radio, web-based means, CD-ROM, video and print format (Pye, 2003; Asenso-Okyere & Mekonnen, 2012). In Uganda, ICTs are used to disseminate local agricultural information and knowledge to small scale farmers (Akiiki, 2006). The Swedish government is improving delivery of farm services with the help of mobile phones using SMS technology, which has reached even the rural population of the country. Through their mobile phones, residents from these communities access vital information that will help them to solve issues that hinder them from improving their livelihood. With the similar concept of e-Governance, I-Agri Imus's agricultural network was launched in Philippines. The project provided readily accessible information across the agriculture value chain. In Central Kenya, a pilot project called DrumNet provides marketing, financial services and information over mobile phones. While in Senegal, women are using telecentres (linked to the internet via mobile phones) to access market prices (Hafkin & Odame, 2002; Drumnet, 2007; May et al., 2007).

In India, the existing public agricultural extension system is traditionally providing extension services to meet with the farmers' requirements related to agricultural production. But, it has become less effective, more time consuming and hence unsuccessful and there is a gap between the extension agent and the farmers (Mruthunjaya & Adhiguru, 2005). However, efforts were made to strengthen the system with some innovative schemes by the Department of Agriculture and Cooperation, Government of India, in collaboration with the concerned state government. For instance, Doordarshan is telecasting programs to make the farmer aware of modern technologies and research outcomes related to agriculture and its related areas five to six days a week through National and Regional Kendras within predefined time windows. Similarly, All India Radio is broadcasting 30 minutes of programme for farmers six days a week. Kissan Call Centres have been set up in every state of the country and all the centres are accessible through toll free number from 6.00 am to 10.00 pm on all seven days a week. Call centre agents are answering farmer's queries in their local language. The department has also set up Agri clinics and Agri-Business Centres to provide self employment opportunities for professionally qualified agricultural graduates facilitating delivery of value added extension services (SIA, 1012).

In addition, several modern Information and Communication Technology based agricultural extension initiatives are being implemented by private, cooperatives and non-governmental organizations. For instance, IFFCO Kissan Sanchar Limited (IKSL), BSNL, Reuters Market Light (RML), Nokia Life Tools, Fisher Friend Project, Rubber Board and Department of Agriculture, Haryana State are providing services through SMS and Voice messages about agriculture related information (ICTFSECBP, 2009; Fafchamps & Minten, 2012; Saravanan, 2010). Farmers are seeking agricultural related queries using their mobile phone (Lall & Sahi, 2009). Despite these initiatives, the farmers are still facing a lot of difficulties in getting timely, reliable and relevant information. This is mainly because the technologies developed for farmers were not suited to the farmers' capacity to take risk according to Glendenning et al. (2010) who have reviewed some ICT based agricultural services in India. Mass media like television and radio broadcast programs provide highly generic information rather than addressing the specific needs of individual farmers. This severely affects their ability to increase their productivity, profitability and income.

According to Telecom Regulatory Authority of India, the number of wireless mobile phone subscribers has reached 929.37 million as on 31st May, 2012. The share of rural wireless subscribers has been increasing as compared to urban counterparts (TRAI, 2012). This is because of the availability and affordability of the technology. Therefore the initiative was designed in an appropriate manner with the goal of collecting and updating farm/crop specific information pertaining to each farmer's field through mobile technology that would help the agricultural expert to analyse the situation to give right kind of advisories to farmers.

This multimedia agricultural advisory system, which is an inexpensive technology tools, developed by Indian Institute of Technology Madras's Rural Technology and Business Incubator (IITM's RTBI), Chennai, was field tested in partnership with Tamil Nadu Agricultural University (Coimbatore), National Agro Foundation (Kancheepuram), Erode Precision Farm Producers' Company Ltd (Erode) and Dharmapuri Precision Farmers Agro Services Ltd (Dharmapuri). Three districts namely Kancheepuram, Erode and Dharmapuri in Tamil Nadu, India, have been chosen and a multimedia agricultural advisory system was used to provide advisories during December, 2010 to June 2012. Based on the experiences gained so far from this initiative, this paper has been designed to emphasise lessons learnt in terms of challenges so as to take the innovative technology to other regions as also to scale it up efficiently. The research question of this paper is that what are the challenges encountered and lessons learned in both the mobile phone based farmer's registration/farm updating and expert advice to farmers? The outcome of this study results would certainly help in further deployment of this technology with fewer challenges expected in the field. The rest of the paper is organized as follows: first we describe the technology. Second, we explain methodology in which we describe complete narrative of selecting farmers for participation and farmers' registration process over the mobile technology and the setting up of call centre like platform equipped with multimedia agricultural advisory system (MAAS). Third, we present the results and discussion and finally we conclude.

2. AN OVERVIEW OF THE TECHNOLOGY

The IITM's RTBI developed a multimedia agricultural advisory system (MAAS) which helps in providing timely expert advice to farmers. Farmer can raise a query using their mobile phone to an agricultural expert. When a farmer calls, a call centre like interface with personalized information pops up at the expert's end. The expert views the farmer's dashboard and analyses the situation and query based advise is provided to the farmer. Field testing of MAAS essentially means to give the right kind of advisory to farmer at right time on their mobile phone. Figure 1 depicts the farmer's registration and information flow.

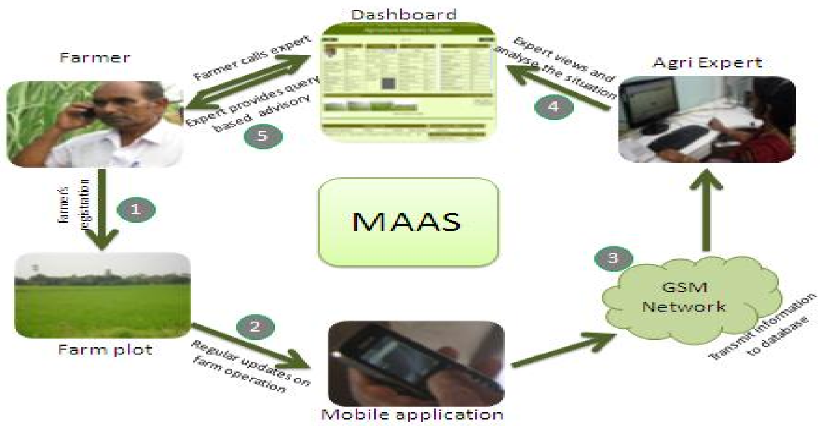

Figure 1 Farmer's registration and information flow

3. METHODOLOGY

The MAAS was field tested with 1200 farmers in Tamil Nadu (Kancheepuram, Erode and Dharmapuri districts), India, during December 2010 to June 2012. These three districts were selected for a purpose, because each of them fits into one of the three agro-climatic zones. These are North Eastern Zone (Kancheepuram district), Western Zone (Erode district) and North Western Zone (Dharmapuri district) (Fig. 2). Another reason for selecting these study areas was that the areas in which the project was piloted are quite contrasting in terms of their geographical and agricultural practice.

Figure 2 Map showing the location of study

3.1 Selecting Farmers for Participation and Farmers' Registration Process

Farming communities in these three districts are not homogenous. Farmers differ in social status, wealth, access to and control over resources. There were different categories of farmers belonging to marginal, small, medium and big based on land size. Four main strategies for selecting farmers to participate in this field testing were adopted. First, a strategy that was frequently used in the farmers' selection process was to choose the interested farmer to register, with other farmers volunteering to participate in the registration process. The second strategy was for volunteers during awareness camp, and from them selects farmers to participate in the project. A third strategy used was to let farmers select participants within their community. In the fourth strategy, farmers were selected by extension staff. In all the strategies, no selection bias was followed against farmers who wish to participate. Nevertheless the farmers' selection criteria included having a mobile phone, cultivating the crops chosen and willingness to take part in this project.

A total of 1200 farmers (400 in each district) across villages in each district covering 182 villages with an average of nearly 7 farmers per village were selected. Nine crops (three from each district) were chosen as focus crops for this field testing: paddy, groundnut & brinjal for Kancheepuram district; turmeric, sugarcane & coconut for Erode district and mango, tapioca & tomato for Dharmapuri district. These crops were chosen because, in all the three districts, they are all grown as prominent agricultural and horticultural crops.

Subsequent to this, an orientation programme was done to create awareness about project goals and objectives among the farmers. The selected farmers were contacted through one to one interaction in their respective village and motivated to register through the newly developed mobile application using mobile phone by providing the personal profile like name of the farmer, gender, age, mobile number, name of village/block/district etc. and farm details such as previous/current crop cultivation practices; farm size etc. The photo of the farmer was also captured with camera in the mobile phone.

All this data was transmitted using General Packet Radio Service (GPRS), which is a wireless data service deployed as a standard feature in many mobile phones. The GPRS transmits data over the mobile operator's network to an internet gateway, further to which it goes to a dashboard for expert's view and analysis. Collection of data is done on the mobile phone using an installed java-based application. Apart from mobile based data collection, GPS devices had been used for geospatial data like geographical location, farm size, contours of the land. This information was further edited using customized software (Photo tagger for Data logger tracks and Map source for Garmin tracks) and the developed farm plots assigned to individual farmers. Each farm plot is saved in a Shape file format and made available in dashboard. The data collected is directly stored in a remote database. During the registration process, the farm plot details in dashboard were refined periodically based on the suggestions and feedback given by the farmers. The farmers and field level staff who facilitated the farmers have been given adequate training.

3.2 Setting up of Call Centre Like Platform Equipped with MAAS

A multimedia agricultural advisory system was set up in IITM's RTBI's premise in Chennai, the state capital of Tamil Nadu in India and it has been functioning since December 2010. One agricultural expert has been engaged to answer the farmer's queries as and when he/she contacts through the call centre number. Once the farmer submits requisite details through the mobile, he/she becomes a registered user in MAAS. The submitted data are available on concerned farmer's dashboard.

The details are geographical location, farm size, contours of the land, soil physico-chemical properties, history of the crops grown, inputs used, crop yields, pest and disease history. By presenting all this information in the context of the farmer query, the agricultural expert will analyze the situation and promptly provide the query based advisories in Tamil (the local language).

The registered user can also upload a picture of pest and disease affected crop using their mobile phone to the system, the expert in turn will diagnose the problem based on the photo submitted and timely crop specific advisory is given to the farmer on their phone. The details of queries by farmers, the responses provided to those queries by expert are recorded as call history. Further, this has helped the expert to revisit the past queries and responses, when there were similar queries from the farmers.

The participating farmers used project mobile phone for initial registration and farm updates, but farmers used their own mobile phone for seeking agricultural advisory from the expert. From December 2010 to June 2012, enthusiastic farmers who had registered to the system from these three districts have been raising agricultural queries to get expert advice.

To monitor field level activities and to provide troubleshooting support to farmers, a project staff was stationed at each of the study areas. This paper comes up with the basic understanding of registered farmers' socio-economic characteristics such as gender, education, type of farmer and years of individual farming experience and challenges encountered and lessons learned during the registration process and agricultural advisories to farmers. The data on month wise number of farmers registered through mobile technology, their socio-economic characteristics, number of queries raised by the farmers, and type of queries were obtained from backend database and simple descriptive analysis was used to interpret the results.

4. RESULTS AND DISCUSSION

In this section, we first present the number of farmers registered through mobile technology and their socio-economic characteristics, this is followed by an analysis of farmers' queries. Subsequently the challenges encountered and lessons learnt during registration/farm updates and agricultural advisories to farmers are meticulously discussed.

4.1 Number of Farmers Registered

After conducting a baseline survey among the farmers followed by an orientation programme, the farmers were asked to register through newly developed mobile application using mobile phone. This was done because only a registered famer can raise the query to agricultural expert. During the registration process, the field level staff did the initial data collection process on behalf of the farmers. The data collected were farmer's personal profile such as district to which the farmers belong to, gender, education, type of farmer and number of years of individual farming experience along with the farm specific information on the details of previous/current crop cultivation practices, farm size etc. Following this, the farmers were instructed and motivated to update the farming operations that are subsequently carried out after the initial registration process. The farmers were also instructed and taught how to update the information and how in case of any clarifications or doubts, they can get in touch with the project staff for smooth functioning of farm/crop updates.

The month wise number of farmers registered through mobile technology is presented in figure 3. It was observed that on average 55 farmers were registered each month starting from April 2010 to January 2012. It took 22 months to achive the target of 1200 farmers' registration (400 from each district) from all the three districts.

The collected farmer's personal profile and farm specific crop details during the registration process were viewed by the researcher to identify the quality of the submitted data. Technical team periodically checked the data for errors and rectification was done in consultation with Tamil Nadu Agricultural University (TNAU), Coimbatore (one of the partners in the project). This has facilitated the customization of both mobile application and dashboard application and it was made sure that the variables available in both the applications are synchronized with each other.

Apart from the initial orientation programme, it was required to conduct several awareness kind of training programmes among the farmers to help them understand clearly the project goals and objectives and to enroll the farmers in the system. In the initial stage, we thought of completing the farmers registration process within a predefined time but it was not possible to do so as it required constant interaction with farmers to build rapport among the farmers.

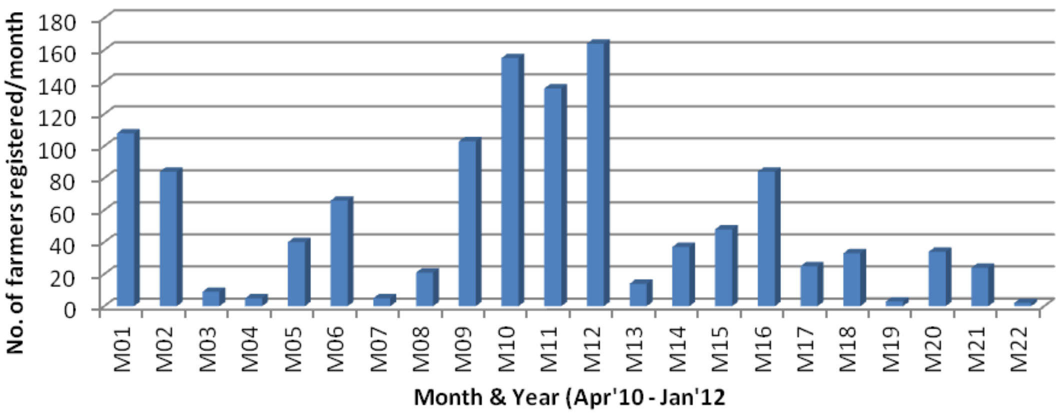

Figure 1 Number of Farmers Registered through Mobile Application (by Month)

4.2 Socio-Economic Characteristics of Registered Farmers

The socio-economic characteristics such as gender, age, education, type of farmer and years of individual farming experience were analysed and given in Table 1. It was observed that gender composition consists of nearly 94 per cent male farmers and only six per cent of them are female. About 39.90 per cent of the registered farmers were middle aged (36 – 45 years), 38.80 per cent old (46 years and above) and 21.30 per cent young (<35 years). The analysis of educational background of the participating farmers (Table 1) show that about 33 per cent of them had studied up to high school level (10^{th} std) while nearly 14 per cent up to higher secondary (12^{th} std), about 10 per cent had graduated after higher secondary school, while nearly 4 per cent post graduation after studying a graduation degree. Only nearly six per cent did not have any formal education. Since most of them are educated till either school or college level, we did not take up any literacy based intervention programme to make them aware of this initiative. The analysis of farmers' classification showed that majority of them were small (34.80%) and medium (34.50%) farmers and this was followed by marginal farmers (20.20%). Only 10.60 per cent of the farmers were large farmers. A majority of the farmers (34%) had been involved in farming activities for more than 26 years.

Table 1 Distribution of Socio-Economic Characteristics of Registered Farmers

Characteristics	Category	Frequency	Percentage
Gender	Male	1127	93.90
	Female	73	6.10
Age (in years)	<35 Years (Young)	255	21.30
	36 – 45 years (Middle)	479	39.90
	>46 years (Old)	466	38.80
Education	Primary school	162	13.50
	Middle school	239	19.90
	High school	396	33.00
	Higher secondary school	165	13.80
	Graduate	122	10.20
	Post graduate	45	3.80

	No education	71	5.90
Classification of farmer	Marginal (<1 ha)	242	20.20
	Small (1–2ha)	417	34.80
	Medium (3-5ha)	414	34.50
	Large (>5ha)	127	10.60
Years of farming experience	0 to 5	63	5.30
	6 to 10	159	13.30
	11 to 15	189	15.80
	16 to 20	229	19.10
	21 to 25	163	13.60
	26 & above	397	33.10
Total		1200	100

4.3 Farmer's Queries

Out of 1200 farmers who had registered with the system, only 243 farmers used the MAAS services provided through call centre approach giving a successful participation rate of 20.25 per cent. The reason for poor participation might be due to lack of constant touch with farmers by the staff who were stationed in the field. It was found that totally 1183 queries with an average of 62 per month were raised by these farmers during December 2010 to June 2012 from all the three districts (Fig. 4).

The analysis of district wise queries revealed that farmers from Erode district (60%) raised more queries than the other two districts (Fig. 5). Mittal (2012) reviewed the impact on adoption of modern ICT tools like mobile phone by farmers in South Asia. It has been reported that there are several important factors like education, social categories, income and landholding size that influence the use of ICTs in decision making. Similarly, Tamil Nadu Agricultural University based in Coimbatore has also reported in one of their documentation reports that the farmers of Erode district are more innovative and try to adopt new innovative technologies it was because they regularly contacts with extension staff and agricultural scientists (DAP, 2008).

The analysis of type of queries (Fig. 6) revealed that plant protection with reference to pest and disease management (62%) and cop cultivation practices (32%) were found to be highest number of queries raised by the farmers. The lowest percentage of queries was on weather information (4%) and market information (2%). From this analysis it could be inferred that farmers were more concerned about pest and disease management and best packages of crop cultivation aspects rather than weather and market information.

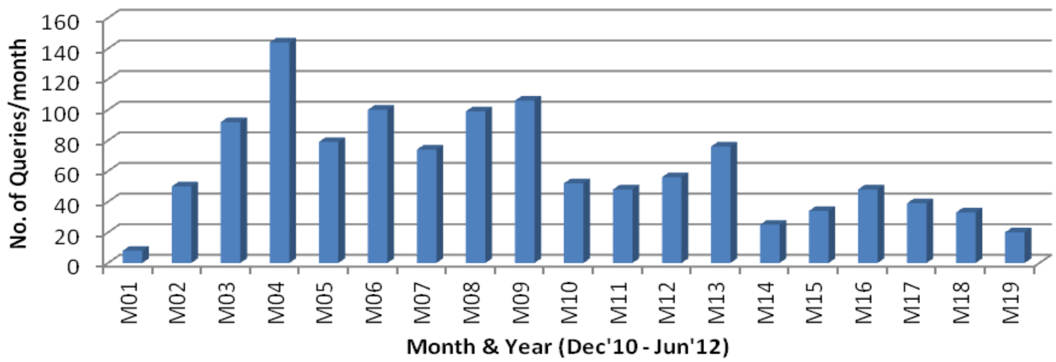

Figure 2 Month wise number of queries

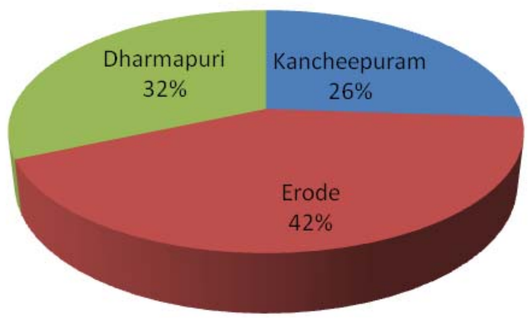

Figure 3 Percentage of Queries by Districts

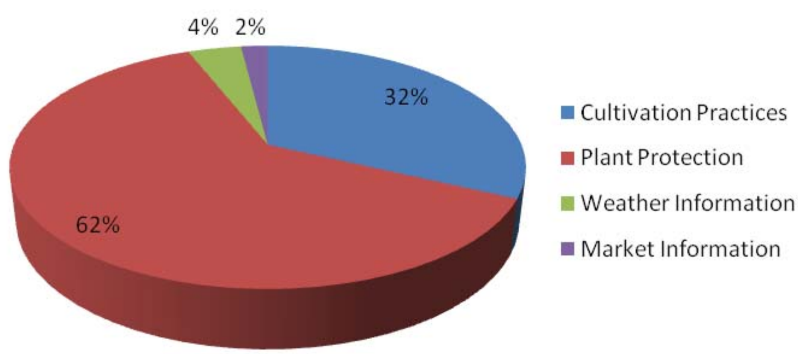

Figure 4 Percentage of Query types

4.4 Challenges and Lessons

There were several challenges encountered and lessons learnt during farmers' registration/farm updates through mobile application and expert advice to farmers. One of the main lessons we learnt was that the data submitted through mobile application had too many spelling mistakes particularly on the names of fertilizers and pesticides. To overcome this, questions were made available with answers in the form of drop down menu options instead of open ended questions. This has facilitated the farmers in choosing the answer and reduced erroneous data.

The mobile application also had the facility of updating the information on farming operations that are carried out between sowing to harvesting of the crops, but this was not used by most of the farmers. It was learnt that the level of English literacy was abysmally poor among the farmers and that the content over mobile application needed to be in the local language (Tamil) to gain wide usage by the famers. To overcome this challenge, the expert from the call centre contacted the farmers over phone and updated the information in the concerned farmer's dashboard by asking questions. But, this took considerable time for the expert rather than spending valuable time on providing agricultural advisories to farmers.

On learning difficulties faced by farmers during farm updates, the project team has developed an Interactive Voice Response (IVR) system in Tamil (the local language), which may eliminate the language barrier and enable the farmer to keep updating the farming operations as and when they undertake them in their respective fields. IVR is emerging to be the most appropriate solution to the defined digital inclusion problem. This voice technology allows representations that are closest to the natural human language and does not require any level of literacy. However, Ganesan et al. (2012), who reviewed the challenges in implementing mobile phone based data collection in developing countries, reported that there are expected voice input errors due to low accuracy of the speech recognizer and noise background environments in IVR.

Apart from this, the project team has also developed a pest and disease image upload application over mobile phone in a local language (Tamil). This can be used for uploading pest and disease affected plant over mobile phone for seeking advisories from the expert. Both these newly developed technologies will be implemented in due course to help in regular updates from the farmers' field.

The other challenges we faced was that some of the farmers showed disinterest in registration over mobile technology during the initial stage. It was learnt that no crops which were chosen in the project were being cultivated in their lands due to unseasonal conditions. This had resulted in unwillingness for those who do not have crops in their field at the time of registration. Hence, the project team had to wait till the farmers start getting involved in the cultivation of crops in their respective fields. In view of this, there was considerable delay in completing the registration process for all the participating farmers within the timeframe set in the timeline.

Similarly, most of the farmers showed disinterest in the use of service during agricultural advisories. It was learnt that the information provided lacked quality, was not timely provided and the information was irrelevant and unreliable. The information provided to them was mainly on best practices for crop production rather than focussing on information about postharvest aspects including processing, marketing, storage and handling. Motivation among the farmers played a crucial factor but, this was not adopted by the staff from the field at appropriate time when they need the information. There was also lack of coordination between the agricultural expert, field staff and farmers. Another reason might be due to the farmers requiring a diversified information needs to support their farm enterprise. It was also noted that lack of expert's knowledge particularly in pest and disease related areas played major role in decreasing the number of calls from the farmers. It was also found that there was a lack of farmers' participation in the project due to poor rapport building by the staff who were stationed in the field. On observing this, the respective field level staff was instructed to meet with every farmer on daily basis but this was not possible for three field staff as each of them was assigned 400 farmers in the respective districts. Another challenge was that each of the farmers' field were scattered around and were located with a minimum distance of 20 to 25 km radius. As a result, number of queries decreased over period of time inspite of considerable number of farmers registered.

The field level staff also faced a lot of difficulties in reaching the farmers field by foot as frequent transport facilities were not available in many of the villages. On some occasions, farmers who had two wheeler facility voluntarily came forward to help the field staff to take him/her to the field but this could not be expected at all the times. This has posed as one of the main challenges in this initiative.

During the queries from farmers to expert for advisories, the expert was not able to provide weather forecasting information at village specific location to farmers. This information was sought by farmers because it would help them make crop management decision which could reduce risk and losses due to extreme climate. The agricultural expert tried to collect weather related information from the website of agricultural universities and meteorological related institutes but there was no village level specific forecasting information available and instead block level information was delivered directly to farmers.

Soil testing is one of the important agricultural practices to be followed by farmers to meet with the nutrient requirement of different crops before the start of the crop cultivation in their respective farm land. The results of the soil testing help the expert to calculate and provide accurate recommendations to farmers that will assist them in integrated management of their farm. But we learnt during the agricultural advisories that the majority of the farmers, who had asked for fertilizer recommendation, did not go for soil testing. It was for this reason that the expert could provide only general fertilizer recommendation rather than the accurate recommendation to farmers.

Interestingly, the farmers who were not registered to the system also contacted the expert for agricultural advisory. It might be because some of the farmers, who had registered, shared the benefits of advisories received from an agricultural expert. Similarly, farmers raised a query for the crops which were not focused on in this initiative. All this shows the farmers' enthusiasm to seek advisories from the expert. One of the hurdles we faced was that different subject matter specialists were not engaged at the call centre when advisories were provided to the farmers. This has clearly affected the advisory part when there was a query about very specific subject related questions. For example one of the farmers raised a query on animal husbandry and dairy related aspects. The expert could not answer directly to farmers; instead this query was communicated to a specialist who was actually not part of this initiative. We are developing a multiparty conferencing system to incorporate into MAAS whereby different subject matter specialists (Agronomist, Pathologist, Entomologist, Livestock veterinarian, Insurance specialist etc) could be interlinked through mobile phone with farmers directly.

5. CONCLUSIONS

In this paper, we have reported the results of a field testing of Multimedia Agricultural Advisory System (MAAS). It is an innovative technology whereby the agricultural expert delivers the advice by analyzing the actual situations on the dashboard rather than visiting the field and viewing the crop in person. The agricultural advisory information is expected to help farmers to adopt improved crop production techniques for increasing the yield of the crops.

The field testing was conducted in collaboration with Tamil Nadu Agricultural University, National Agro Foundation, Erode Precision Farm Producers' Company Ltd and Dharmapuri Precision Farmers Agro Services Ltd. The field testing involved 1200 farmers in three districts of Tamil Nadu (Kancheepuram, Erode and Dharmapuri), India. Participating farmers registered through newly developed mobile applications and subsequently, we motivated farmers for updating of farm information to seek expert's timely advice. The question that is discussed in this paper is as follows. "What are the challenges encountered and lessons learnt in both the mobile phone based farmer's registration/farm updating and expert advice to farmers?"

This paper elaborates various challenges while field testing of MAAS and some of the key challenges are discussed here. For instance, most of the farmers were not able to update the information on farming operations through mobile applications at regular intervals. One of the reasons may be due to language gap in terms of the medium of the language as reported by May et al. (2007). Most of the registered farmers showed disinterest in the use of service during the period of time. This may be because the information provided to farmers lack relevant services that might not meet with information needs of the farmers, resulting in low usage. Glendenning et al. (2007) who have reviewed agricultural extension in India reported that information needs will differ from farmer to farmer based on landholding size and farmer required diversified range of information. So, there is a need to focus in the future to understand what is exactly obstructing the usage of MAAS and the relevance of information provided.

Despite several challenges, the project has been able to accomplish enrolling 1200 farmers (400 from each district) in the multimedia agricultural advisory system using mobile application. Enthusiastic farmers have contacted the call centre during at every stage of crop growth for agricultural advisory purpose. The project was also successful in refining and in customization of a user friendly dashboard application. Apart from this, the farmers participating in the project have acquired enough knowledge on how to register themselves using mobile technology and contact the expert at the call centre for seeking advisory. The farmers were able to get timely and right advisories to successfully control pest and disease. They were also able to adopt improved crop production techniques and management practices during crop cultivation, which contributed to increased the yield of the crop. These results are in line with IFFCO Kissan Sanchar Limited (IKSL), Reuters Market Light (RML), Nokia Life Tools and Fisher Friend Project who are providing services through SMS and Voice messages about agriculture related information (ICTFSECBP, 2009; Fafchamps & Minten, 2012; Saravanan, 2010).

Based on lessons learnt during the field testing of MAAS, and we find some of the key challenges need to be given greater attention during further deployment of this technology among the farmers in rural areas:

- regular updates of farm/crop specific information by farmers
- timely motivation of farmers by project stakeholders
- providing village level location specific weather forecasting information to farmers
- incorporating multiparty conferencing system into MAAS to facilitate interlinking with different subject matter specialists and farmers

The major contribution of this paper is to share the experiences gained so far in terms of challenges encountered and lessons learnt during the field testing of MAAS. All the challenges discussed in this paper must be taken into consideration for further deployment of this technology in order to be effectively implemented among the farmers in rural areas. Further research should focus on testing the effect of MAAS on the performance of agricultural crop yield by adopting a randomized controlled trial (CRT). For example, two treatments can be implemented. Treatment 1, all the participating farmers are offered MAAS services; Treatment 2, a proportionate number of farmers are not offered any of MAAS service and it should be treated as control. Bruhn and McKenzie (2009) have shown that, in randomization controlled trials, stratification improves efficiency. Thus, randomization of treatments across villages in each district can be implemented in future.

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