mASK: A Functioning Personalized ICT-based Agriculture Advisory System

Implementation, Impact and New Potential

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Abstract: While Indian agriculture contributes merely 13.9% of the country's Gross Domestic Product, nearly 52% of the population still depends on agriculture for its livelihood. Close to half of the farmers are small farmers (owning 1.0 ha or less) facing near-stagnant productivity. This is due to several factors, but farmers often indicate that access to the right information at the right time is one of the most sought after need. Addressing this need to aid in the development of a productive and sustainable agricultural sector has certainly emerged as one of the major humanitarian challenges in India. There have been numerous efforts in this direction with the setting up of agricultural advisory systems, to provide information to farmers, but not many have succeeded in the objective of providing easily accessible, sustainable, personalized advisories to farmers. Recognizing this, the Indo-UK Advanced Technology Centre of Excellence in Next Generation Networks, Systems and Services (IUATC), a major technology transfer initiative, supported by the Department of Science and Technology (DST) in India and UK Government under the Digital Economy Theme is attempting to address the challenges in Indian agriculture through Information and Communication Technology (ICT) networks. This paper presents a functioning Agricultural Advisory System that has been built with the aim of bridging information gaps between farmers and agriculture knowledge workers (such as agricultural scientists and extension workers) and is an extension of a technology effort that has been previously presented. While our earlier work only discussed the potential of using an innovative ICT approach to providing personalized agricultural advisories, this paper covers details of the technology implementation, presents a brief summary of the impact analysis carried out with the farmers registered into our system and discusses new features that could make the system more effective.

***Index Terms*—Agricultural Technology, Mobile telephony applications, Agriculture Advisory System, Call Centre, Dashboard for farmers, Interactive Voice Response System**

I. INTRODUCTION

The State of Agriculture report has noted that the contribution of Indian agriculture to the overall GDP of the country has come down to 13.9% [1] and yet a large section of the Indian population –close to 52% - depends on agriculture for their livelihoods. Majority of Indian farmers are small or marginal farmers who own 1 ha or less and face challenges such as small landholdings, decreasing yield, decreasing profitability, uncertainty of water availability, vulnerability to world commodity prices and many more. On the other hand, with urbanization and income growth, consumption patterns have shifted from cereals to non-cereal food (pulses, edible oils, fruits, vegetables, dairy and other livestock, fisheries).Supply of these commodities do not match up to the demand and not surprisingly, food inflation has increased in recent years. Farmers should have been able to take advantage of this demand and increase their profitability but lack of timely information at many levels has prevented them from doing so. Many farmers can be better-equipped to handle these challenges if they are provided the right information at the right time, personalized to meet their specific needs [2]. However, with around 88 million farmers in India, with 98.5 million holdings (operating an average area of 1.1 hectare) [3], the problem of how to provide personalized advisories to each might seem to have no solution.

The ICT revolution in the country heralded by the mobile telephony boom brought with it an opportunity to look at the problem afresh. India currently has 900 million wireless subscribers with over 350 million from the rural areas [4]. Villages are well-connected, with 2G GSM (Global System for Mobile Communications) and GPRS (General Packet Radio Service) networks offering good voice connectivity. More importantly, nearly every farmer or a farming family is able to afford a mobile handset and is comfortable with

voice communication. ICT certainly seems to have provided us the ability to carry out personalized interactions with this large and dispersed base of farmers, through mobile phones.

We have in an earlier work [5] highlighted the potential of building an Agricultural Advisory System that would leverage the power of two-way communication over mobile phones and help bridge the information gaps existing between farmers and experts. We had discussed how by combining this access with innovative methods, a system could be developed to provide services to farmers that could not even be envisaged till yesterday. The authors have successfully developed such a system – **m**obile based **A**dvisory **S**ystem for **K**rishi, hereafter referred to as mASK-which has been functioning to serve a small group of farmers by providing them with personalized agricultural advisories. This paper will review existing agriculture advisory systems and their limitations in section 2, highlight features of the fully developed system deployed on a pilot basis, in section 3, a brief impact analysis carried out with registered farmers will be presented in section 4 while possible new features that could make the system more effective will be discussed in section 5. The paper concludes with a note on the role such systems could play in addressing major humanitarian challenges.

II. Review of Existing Agriculture Advisory Systems and their limitations

There are a number of initiatives in the market that use only mobiles to communicate agriculture related information to farmers.

a. IFFCO Kisan Sanchar Ltd. (IKSL) in collaboration with Airtel (IFFCO Kisan Sanchar Limited) [6] – Provides very generic, pure voice-based advisories where information is pushed to farmers over voice calls.
b. Digital Mandi [7] – Interface with Ministry of Agriculture, NIC, BSNL and State Agriculture Marketing Boards (Punjab and Haryana). Application to access commodity pricing. Facing deployment issues and mobile application limitations.
c. Reuters Market Light [8] - Proprietary product that needs to be purchased by a farmer and then customized to his preferences. Messages are then sent through SMS, in local language.
d. Nokia Life Tools [9] – Available only on Nokia mobiles through subscription packages. Information about local weather, market prices and input prices are made available.

In addition there are initiatives that use mobile phones in combination with an ICT approach.

a. E-Sagu [10] – Depends purely on internet access to deliver information. Aims to provide personalized agro-advisory services to farmers registered for its service. However, coordinators or farmers need access to computers to be able to receive or update information.
b. Lifelines [11] – Uses computing technology with mobile phones to deliver advice. However, advisories are very generic in nature.
c. aAqua [12] – A purely web-based Question-Answer forum set up to answer questions asked by farmers in the local language.
d. mKrishi [13] – Proprietary mobile application that allows personalized advice to be given to farmers in the local language. However, farmers have to use this application for accessing any information or updating their farm-crop data.

There are also web portals that act purely as information repositories – Tamil Nadu Agricultural University (TNAU) Agritech [14], AGMARKNET [15], Agropedia [16], e-Krishi [17], Agriwatch [18], and iKisan [19].

We would like to highlight the common limitations found in many of the above initiatives.

- Advisory systems are region specific

Today most of the agricultural advisories being delivered (whether through mobiles or web) are generic and block-specific. They fail to take into account variances at individual farm level. Modern agriculture did enhance productivity with these generic block-level advisory in the past, but the gains are tapering off. The next cycle of growth, experts predict, can come only from farm-specific advisory.

- Advisory as a one way communication

Most agricultural portals today prove to be a one-way communication system; at most, they are query-based systems where specific questions are answered by an expert. Rarely has ICT been used as an interactive medium, where the knowledge from the farmers can also be captured.

- In-person, one-to-one communication does not scale

Given the large population that is dependent on agriculture and farming as an occupation and the geographical spread of our countryside, it is impossible to scale an in-person, one-to-one delivery of advice. However, ICT has the potential to bridge distances and bring farmers, extension workers and experts together.

- Limited Communication Mode

While the computer and Internet portals are very powerful knowledge sharing tools, access to these systems by farmers is highly limited. The information available on web portals can be vast and at times be misleading. Further, the issue is not just access to computers, Internet and power, but also of multi-level literacy. One does not have to be just literate, but generally have to be somewhat knowledgeable in English and computer/Internet savvy. Each of these adds a level of difficulty and for years to come will remain as obstacles for the majority of the farmers in India. On the other hand, mobile phones are fast reaching farmers, access is far more widespread and voice based conversation in local language is almost universal.

Hoping to overcome these limitations and build on the access that mobile phones provide, RTBI's Agriculture Advisory System has leveraged today's cutting edge technologies to provide interactive, personalized farm-plot specific advice to farmers.

III. A FUNCTIONING AGRICULTURE ADVISORY SYSTEM (MASK)

A. Personalized Dashboard for every farmer with Crop and Advisory Timeline

The most integral component of the mASK system is a personalized dashboard, developed for every farmer who has registered in the system.

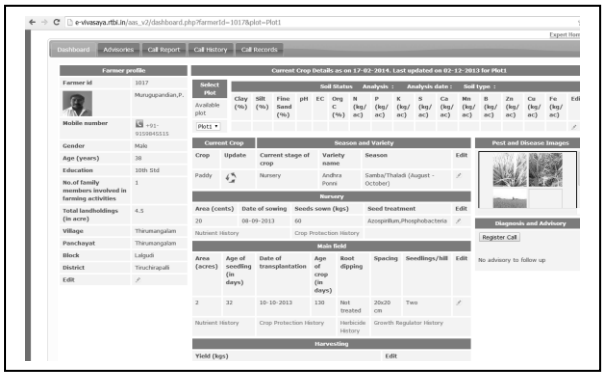

Fig.1. Dashboard showing farmer profile, current crop information and uploaded PDIU image

The objective of the dashboard is to provide all the essential information that would be needed by an agricultural expert to provide personalized advisory to the query raised by the particular farmer. A call-centre approach was adopted in which the farmer dashboard was displayed to the expert as soon as the farmer called in to the system with a query, by utilizing the Caller Line Identification (CLI) – in other words, the unique mobile number. ***It was important that the information be presented to the expert consultant through a user-friendly interface so that the expert could quickly and efficiently navigate through all the content.***

The highlights of the dashboard [see Fig.1] are as follows.

- Contains farmer profile, farm and current crop details. Current crop details cover the plot/crop soil test report, seed variety, age of crop, spacing, seed treatment, nutrient history, pesticide history and weedicide history. 50 farmers have been registered into our system with initial details collected by the field coordinator during registration. Later, all farm activities are regularly updated by the farmers by calling into the call-centre. We believe that if the farmers are convinced of the benefits that personalized advisories can deliver (which can work only if the details are updated), they will begin to call in to update and continue to do so regularly.
- As mentioned earlier, when the farmer calls in to seek advisory the farmer-specific dashboard will pop up enabling the expert to view relevant crop details. Instead of spending valuable time in gathering background/history information from the farmer (all of which is already available on the dashboard), the expert can engage the farmer to understand in greater details the problem faced by him/her and provide a truly personalized advisory. At the same time, any new information that the farmer may share during the interaction, is also recorded.

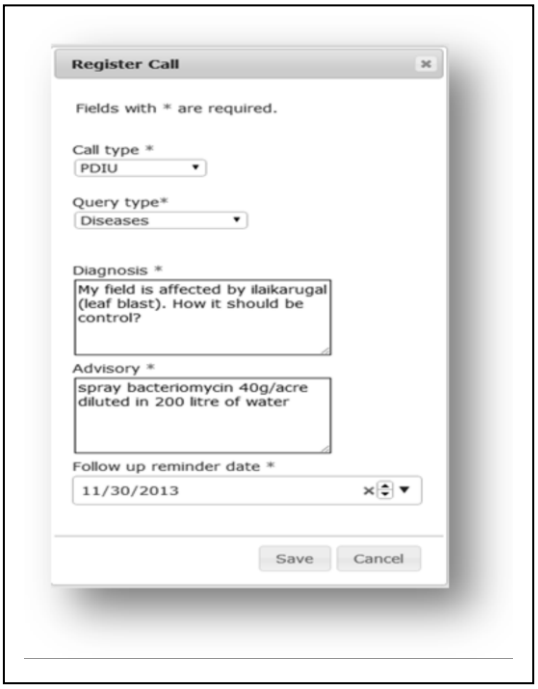

Fig.2. Registering call details for future reference

While giving advisory to the farmer, the expert records the query raised, diagnosis made and suggested recommendation [see Fig.2.]. The conversation is also recorded allowing for later reviews on the quality of recommendation and assessing the comfort of the farmer during the conversation. The expert can also indicate a follow-up date when the system will prompt the expert to call the farmer and understand if the suggested recommendation had been followed and if not, understand why.

- A Crop History Timeline allows the expert to track the crops traditionally cultivated by farmers during various seasons. It allows the expert to make recommendations about growing high-value agricultural crops that the farmer might not be aware

of. The advisory reference timeline quickly enables the expert to understand previous pest-disease infestations affecting the crop and make future recommendations.

B. Pest and Disease Image upload application (PDIU):

When the farmer is faced with a pest/disease infestation in the field and they call into the mASK system, it is not easy for them to describe the nature of the problem or mention the name of the pest/disease as they very often do not know the same. If an image of the site of attack is made available to the expert, it will then assist the expert in identifying the cause and provide a solution. A visual tool that could capture the pest/disease infestation and assist the expert in identifying the cause, and provide a solution was the need of the day. This led to the development of the Pest and Disease Image Upload (PDIU) application. A Java based mobile application requiring GPRS connectivity, it provides farmers with a simple tool to capture photographs of their pest/disease infested crop and upload it to the mASK system [see Fig.3.]

Fig.3. Pest Disease Image Upload (PDIU) Application

These images would be integrated into the farmer-specific dashboard and just as with a call, the dashboard would immediately come up before the expert [see Fig.1.]. The images act as an excellent aid for the expert to understand the nature of the pest or disease and provide personalized advisory to the farmer.

C. Resources:

Resources are a collection of tools and information sources that provide the expert easy reference while giving advisory. To start with, the mASK system includes a fertilizer calculator, updated list of input suppliers in and around the region of registered farmers, database of common pest and disease infestations and recommendations on tackling them, integrated pest management (IPM) for rice and a well-compiled list of Frequently Asked Questions (FAQ).

IV. Impact Analysis of providing personalized advisories using mASK

On a pilot basis, 50 farmers from two villages – Nagar and Thirumangalam – from the district of Tiruchirapalli, in the State of Tamil Nadu were registered into the system. A baseline survey was conducted with these farmers in December 2012 - the system became functional in March 2013 with personalized dashboards for all the farmers and an agricultural expert (for our pilot phase, we hired an expert who had a Ph.D. in Agricultural Entomology), used the call-centre approach to provide advisories to farmers who call in. The advisory intervention is the crux of this system – we envisage it to begin with semi-trained experts (trained, fresh agriculture graduates) and for escalation support, refer the calls to expert on different domains based on the nature of the problem.

After the system has been functioning for close to a year and at the completion of the most important Samba season for farmers (October 2013-February 2014), a comprehensive survey was conducted with 43 registered farmers who grew paddy (the others had opted for a crop other than paddy), out of which 34 farmers had regularly interacted with the mASK expert. We provide a brief summary of our survey results to illustrate the impact our technology has had on the farmers in various aspects.

A. Reduction in cost:

Nearly all farmers benefitted from a reduction in the cost of cultivation. Compared to previous seasons, this season, based on recommendations provided by the expert, they used only relevant quantities of inputs. Most farmers typically apply only chemical fertilizers. Since the mASK expert also suggested applying bio-fertilizers, the quantity of chemical fertilizers applied was reduced, bringing down the costs of inputs. Future studies can try to explore this aspect further looking at whether different varieties or brands made a difference; also how this would vary for different crops and agro-ecologies.

Average Cost of cultivation in Samba seasons in INR	
2013: 20960	**2014 : 15350**

For example, one farmer had spent INR 28500 in the last Samba season but this year, with regular advisories from the mASK expert, his cost of cultivation has been brought down to INR 15000.

B. Increase in yield:

28 farmers have mentioned yields higher than the preceding season. In fact, one farmer whose yield was only 1550 kg/acre last Samba season had an increased yield of 2400 kg/acre this year. While it is difficult to single out one factor responsible for the same, an important obvious difference was change in agricultural practices. In the preceding season, farmers had not applied any organic

nutrients and growth regulators. In this season 21 farmers followed the best agricultural practices advised by the expert.

Average Yields in Samba seasons in kg/acre	
2013: 2292	**2014 : 2420**

Increase in yield could be considered to be a tricky indicator but what we have been able to establish is that mASK advisories had an overall positive impact on the productivity and profitability of the farmer.

C. Usefulness of advisory

Of the 29 farmers who received personalized advisories from the expert, 90% said the advice given to them was of benefit to them – the break-up of the benefits as perceived by farmers is in Fig.4. Those who did not implement could not do so as the recommended input was not immediately available or the infestation for which they had sought advice had been naturally eliminated.

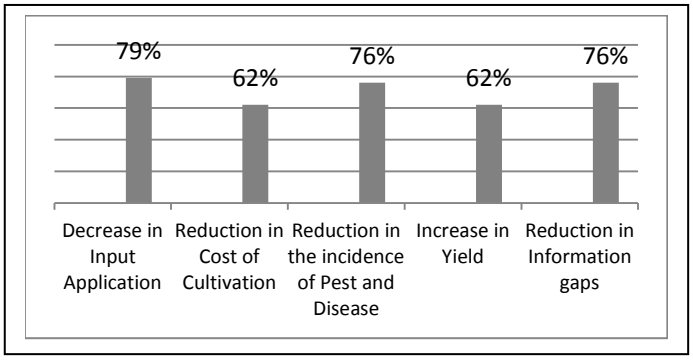

Fig.4. Perceived benefits by farmers

D. Awareness of the tools and technology of mASK:

Of the 34 farmers actively interacting with the system, 91% were aware of the objective of the dashboard and the importance of regularly updating their information.

E. Willingness to pay:

14 farmers were willing to pay for information relevant to them – they identified these as market/price information and information on Government schemes & subsidies. ***We would like to point out that, while in the baseline survey only 2 farmers had expressed willingness to pay for any kind of information, our recent survey has indicated that more farmers are willing to consider payment, up to INR 15 per month, for specific information.*** It is also important to mention that we are still not looking to contextualize the amount that farmers are willing to pay. The objective was to understand if after using the technology, farmers would be willing to pay for information they find useful. Our studies have demonstrated this willingness to pay.

Our studies have also shown that farmers place a lot of value on market/price information as that helps them manage their risk better. Recognizing this, the system aims to provide market/price as also future prices wherever possible.

Future research can possibly include using a control group that will not use the application and comparing their experiences with farmers who have used the mASK system. This should help us in gathering more robust results and identifying specific areas where our intervention is having a positive impact.

V. FUTURE IMPLEMENTATION

A. Improved Pest-Disease Image Upload Application

The current mobile application has been developed in the local language (Tamil) and works on a Java platform. Efforts are on to develop an Android version of the same. More importantly, farmers believe in the potential of the application but have given feedback that they would prefer a much simpler version of the same. This will be looked at while developing the next version of the application.

B. Multi-party conferencing with web-page sharing

There is recognition of the fact that farmers will have queries across a wide variety of topics, some of which the expert will not be able to answer, at least not right away. Farmers typically require information on priority and hence the idea of conferencing in experts from other disciplines, no matter where they are physically located. This will help reduce the information gap even further and thereby enrich the quality of advisory. Experts also suggest enabling other farmers to be able to provide advisories through this conferencing feature. It is important to recognize that experienced farmers have valuable information that can enrich the eco-system and therefore have to be looped into any advisory system. mASK is positioned to be a 2-way knowledge gathering process, not just from experts but also from farmers.

C. Mobile applications for data collection and updating

For the initial deployment in the pilot phase, data collection was done with the help of a field coordinator and subsequent updates were conveyed to the expert by the farmer calling into the mASK system. Efforts are on to see if simple mobile applications can be used for capture of data as also if Interactive Voice Response Systems (IVRS) can be developed in the local language to enable farmers to update important farm information.

D. Pest-Disease Prediction System

The system could be used to predict pest-disease outbreaks to groups of farmers, based on information received from neighbouring farmers. In fact, once sufficient data has been collected, a predictive model could also be

built which could specify what combination of parameters could lead to specific outbreaks.

E. Scaling up the system

Currently the system has registered 110 farmers but is hoping to be able to work with commercial and knowledge partners to be able to scale this to a few thousand very soon. Challenges during scaling would be finding, motivating and retaining trained agricultural graduates to competently handle farmer queries.

VI. CONCLUSION

The vision of a food secure India is inextricably linked to the health of the agriculture sector in the country. To turn this vision into reality, it is crucial to increase the profitability and productivity of farmers, especially of the millions of small and marginal groups. mASK has taken a small, but important step in indicating how this humanitarian challenge can be addressed through the means of modern communication technologies. While there is no doubt that this system will rely on dependable resources such as dynamic information on market prices, capable experts and many others, the attempt here is to put forth that skeleton proposing a solution that can address the inefficiencies in our current agricultural extension system through technology as also use the available data more effectively for the benefit of farmers. We believe that personalized advisories will play a crucial role in revitalizing agriculture. More importantly, our technology could create opportunities for more innovation that will aid in the ushering in of a better era of growth and sustainability for the Indian farmer.

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