ICT Intervention for Agriculture Development: Designing an IVR System for Farmers in Pakistan

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ABSTRACT

This paper presents results of a field study of an interactive voice response (IVR) system developed for the agricultural community of Punjab, Pakistan. We studied the information requirements and the user demographics to develop a basic IVR system which disseminates agro-information such as weather forecast, pesticide and fertilizer information etc. In terms of usability and information extraction, simple menu-based navigation was, relatively, easily understood and used. The usage was evaluated and results show that such a system is a viable option to deliver agro-information.

CCS CONCEPTS

Human-centered computing → Human computer interaction (HCI) → Interactive systems and tools

KEYWORDS

Farmers, Agriculture, ICT4D, HCI4D, Interactive Voice Response (IVR), Pakistan,

1 INTRODUCTION

In this paper we report on the development and evaluation of an IVR system which was designed after conducting user research on the farmers of Central Punjab, Pakistan. Agriculture, in Pakistan, accounts for almost 25% of GDP involving 43% of the country's workforce [2]. However, there is a 40% gap in per acre yield when it is compared to its neighboring countries i.e. India, Srilanka while this breach widens to 100% if compared to the developed world [1]. Dearth of information available to the farmers has been a major contributing factor in growing the per acre yield divide between Pakistan and other countries. Literature [8] has strongly endorsed the value of ICT intervention in improving the welfare and prosperity of the rural workers. It is therefore imperative that agriculture in Pakistan needs effective ICT intervention to ensure sustainability and better growth rates to improve livelihoods as well as its GDP.

This paper extends the previous work conducted in the similar context [4], where researchers studied the use of a touch screen kiosk system to deliver agro-information to farmers. Despite some positive findings, the biggest drawback of the Kiosk system is its high deployment and maintenance costs. For a more sustainable and accessible solution, an IVR (Interactive-Voice-Response) system has been proposed and tested with 31 farmers. Literature supports mobile based solutions which have been reasonably successful when compared to other modes of ICT interventions. Awaaj Otalo [5] and LifeLines Agriculture [11] were two voice based social forums in India which enabled rural farmers to receive advice and feedback to their queries either from experts or from their peers. Polly, a viral phone game used to disseminate job positions, [7] is another successful project of how mobile has been used to deliver information to a range of low literate to literate users. Given the increasing mobile penetration in the rural areas (47%) and the availability of low-cost mobile phones, a mobile based solution is a sustainable and convenient solution. Punjab Agriculture helpline and Telenor Pakistan have recently deployed IVR systems for the agricultural fraternity.

In this study, we propose an IVR system for the illiterate or semi-literate farmers and test whether such a system could be used to effectively deliver agro-information. The paper has therefore two goals: first, to assess the usability of mobile phones and an IVR system in the rural context. And second, to evaluate the acceptability of such a medium as an information source for the farmers.

The IVR presents relevant information about weather, fertilizers, best farming practices etc. The content being provided in the IVR system is according to the feedback and priority, discovered in the user research phase. We will thereafter present the findings, recommendations and limitations of the user testing phase.

2 USER RESEARCH (UR)

2.1 Purpose/UR Goals

The goal of the user research phase was multifold. Multiple factors contribute to the rural and agricultural life chain and it is

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important to investigate all the factors to propose a robust solution. Primary objective was to find out the information needs of the farmers and secondly to assess how much ICT is in place and used by this community. Is the information received by these mechanisms trusted by the farmers? Why are the farmers hesitant to use any of such services? The concept of ICT is still novel within the rural context and therefore cultural and social norms play a vital role in understanding how effective any ICT system would be.

2.2 UR Process/Procedure

Punjab having the largest and most diverse cultivatable land in Pakistan was our selected area for user research. Twenty male farmers were voluntarily interviewed in Sangla Hill, a mini-town near Faisalabad, Central Punjab. Each participant had a farming experience of at least five years and was a key stakeholder who could take farming decisions on his land. The farmers' ages ranged from 25 to 65 years and among participants some were semi or completely illiterate. The interviews were conducted in farms and homes where they felt comfortable. We asked open ended questions in order to engage the users in discussions and to capture wide range of relevant issues [9].

2.3 UR Results

All interviews were recorded and notes were taken during semi-structured interviews and informal discussions. Following are the major user research issues and findings of the interviews.

- Weather Uncertainty
- Unreliable Pesticides, Fertilizers and Seeds information
- Unawareness regarding Pests and their early symptoms
- Irrigation and Canal Planning
- Helpline issues
- Current information sources and technological awareness

The interviews indicated that weather uncertainty is an impactful factor to reduce their crop production and farmers had to face heavy losses in the past due to weather uncertainty. Few participants, who faced huge loss in wheat production few years back, mentioned that *"Rain and storm are harmful for wheat crop at the time of harvesting. Around 25 percent production is reduced even in case of ordinary rain or storm. Loss depends on the intensity of storm and rain."* So for farmers, it is very important to have weather forecast updates available in order to plan their farming activities accordingly.

Secondly, unreliable pesticides, seeds and fertilizers information is a major pain point for farmers. Fake sprays, ineffective fertilizers and poor quality seeds do not only minimize their crop production but also have a very adverse effect on fertility of the land. Moreover, due to traditional practices farmers are still unaware of techniques to mitigate pest attacks and to even detect these attacks at an early stage. As a result, they have to invest heavily on pesticides at a later stage and are unfortunately often misled by the retailers. This leads to substantial crop reduction or low quality crop and hence lower profits.

Due to salty nature of ground water in the region of central Punjab, farmers cannot rely on ground water resources i.e. tube wells. As a result irrigation is highly dependent on canal system. However canals all over Pakistan are closed every year for one or more months without any proper schedule and there is no definitive source which notifies farmers about each year's plan. It has also been reported by Pakistan Council of Research in Water Resources (PCRWR) that farmers over consume water [6] which results in waterlogging and degradation of soil. It is therefore extremely important to not only provide the irrigation schedule but also real time updates regarding the amount of water that must be irrigated.

The current information sources are mainly peers, retailers, radio or television. Radio and television provide limited agro-information whereas retailers arguably have prejudice towards profit margins. As has been the case elsewhere, such as China [12], peers seem to be the greatest source of agro-information. Few agricultural helplines, such as Punjab Government helpline (IVR) and Telenor *Khushaal Zamindaar* helpline (IVR+SMS, un-paid), are now present to aid farming community but they are still far from being widely used. According to our user group three farmers had heard about whereas only one person had subscribed to the Telenor's helpline. The subscriber acknowledged that he received text messages from the helpline but did not call himself to retrieve information. He seemed to be satisfied with the quota and the content of information provided. The impassiveness appeared to be a result of a relatively traditional mindset. During interviews, we also called on the Punjab government's helpline but the IVR system seemed to have some design flaws such as English language option appearing before Punjabi, the local language, and even when the farmers were able to navigate through, the helpline agents were unable to answer the farmers' queries due to the unavailability of agricultural experts. The farmers were uncomfortable while talking to female agents as a result of their urban accent but also possibly as a consequence of patriarchal culture in the rural areas.

3 SYSTEM DESIGN AND DEVELOPMENT

Multiple problems highlighted by farmers during user research phase were later narrowed down to the most critical issues that affect the crops. Four of the most critical issues i.e. Weather uncertainty, Pesticides information, Fertilizers information and Irrigation scheduling were addressed. As per literature [3, 5, 7, 10, 13] two major solutions have been used in developing countries for addressing problems of their low-literate community i.e. Kiosk and Voice/SMS platforms.

Although kiosks have a strong visual and audio impact, they are costly to deploy and sustain. It is nearly impossible to deploy these systems without any government support. On the other hand, IVR systems have audio limitation and hence limited amount of information can be put up. However, IVR is a low cost solution with its accessibility to every mobile phone user. Smartphone application was another option but considering that smartphone owners are still scare in the rural community this was not an appropriate option. An independent SMS system was also reviewed [13] and found out to have issues with ease of use such as inputting long strings into phones as well as low literacy rate. SMS's can certainly be employed alongside the IVR to complement the service to improve information retention. Consequently, an IVR system was decided as the suitable fit. Asterisk VOIP (Voice over Internet Protocol) server is used as a platform to implement IVR system. MySQL server was used for data storage and data log maintenance. SIP (Session Initiation Protocol) protocol was used for telephony communication between the asterisk server and clients (users).

The system is designed so that the landing prompt asks for language selection i.e. option 1 for Punjabi, and option 2 for Urdu. Punjabi being the native language in the region was given preference over Urdu. After language selection, system prompts for 4 options at main menu; 1 for weather forecast, 2 for pesticides information, 3 for fertilizer information and option 4 for canal schedule. The menu was designed according to the feedback attained during the user research phase. Every option has further sub menus to disseminate relevant information to farmers. All of the informational prompts were collected from the Punjab Agricultural Department.

Maximum hierarchy of the IVR system is 4 levels (pesticides flow) and all other information flows have a maximum depth of 3 levels. Similarly, maximum width of the system stretches to 4 options (main menu) while most of the other sub-menus have a maximum width of 2 options. There are two types of prompts in the IVR: first, navigational prompt (requiring an input from the user) and second, informational prompt (leaf node with the required information). On average, prompt length is around 15 seconds whereas maximum length is 30 seconds. At any sub-menu the user has the option to navigate back to the previous menu or to end the call. The IVR has been designed to repeat the current level prompt if no-input is received following a 3 second delay after the prompt completes or in case of wrong input. Prompt repetition will occur thrice before the call is automatically disconnected.

4 SYSTEM EVALUATION

4.1 Evaluation Goals

The main objectives behind IVR testing was to,

- asses the reaction of farmers towards mobile and IVR
- determine whether illiterate, semi-literate and literate users are able to use the IVR and its usability issues

4.2 Procedure-cultural and Experimental Setup

We evaluated the IVR system in Sangla Hill, where the initial user research was conducted. Thirty-one male users participated in the evaluation. Twenty-one users owned a mobile phone out of which six were smart phone users and four of these had used internet to some extent. The remaining farmers had access to phones through someone in their household. Our user group age varied from 20 to 70 years. All users spoke Punjabi, understood numeric but only fourteen farmers could read Urdu.

The testing was conducted in farms as well as *bhethaks*, sitting areas where farmers socialize after days' work. Each user was briefly rundown about the IVR's functionalities, given a basic demo and then asked to complete a certain task i.e. find the information for rice's pests and navigate back to the main menu. Each user was given 2-3 tasks to carry out. Although the interviews were video recorded, the tasks were not timed as the general easiness to use and repetition of prompts to complete a certain task was registered. Afterwards feedback and suggestions were noted during an informal session with them in order to get more in-depth feedback.

4.3 Evaluation Findings

Testing results showed that, in general, farmers were interested in the system because they recognized the retrieved information as valuable to their farming practices. Some of the participants inquired about the helplines number so that they could call from their own mobile phones. *(P#4)* states *"Please write your helpline number on a paper and give it to me. I will call on the helpline when required"*. This was representative of the IVR being acknowledged as an agro-information source. Existing mobile owners were confident of using the IVR on their own and were relatively successful in interpreting and using the system. Infrequent mobile users (10 out of 31) could be further divided into two groups; six users outperformed their counterparts whereas the remaining four farmers had problems using a mobile phone and asked the interviewee to press the buttons on his behalf.

System Acceptability and Task Completion

Almost 15 out of 31 farmers were comfortably able to complete their tasks without any prompt repetition. Among these 15 users, three had used Telenor's IVR system and had better information retrieval times than the rest. Ten, of the remaining sixteen, users were able to complete their tasks but with prompt repetitions with at least two users repeating the prompt thrice. This repetition, when inquired upon afterwards, was mostly a casual confirmation; the user had listened to and understood the prompt the first time yet he wanted to confirm his selection after the repetition.

During the second repeat the user would quickly press the correct selection before the prompt completed affirming his stance for casual confirmation. Six remaining farmers, who were amongst the infrequent mobile users, said they did not understand the prompt the first time. They seemed to be confused understanding how the IVR worked and therefore required repetition to understand prompt. Three of these users were unable to complete their tasks. It is also interesting to find that most of these repetitions occurred on the main menu prompt, which prompted about weather, pesticides, fertilizers and water scheduling. This prompt had four possible options which possibly confused the user. By the time the users heard the fourth option they possibly had forgotten the first three and had to repeat the whole menu again. In general, majority of the farmers were able to complete their respective tasks which was a positive indication towards system usability.

During informal sessions, some of the users commented on the pesticides/fertilizers acknowledging that this was the first time they learned about newer pesticides and fertilizers information and their official prices. They complained about the local retailers who would sell them ineffective and expensive sprays. They appreciated such information as they would now know what exactly to purchase and at what cost.

Understanding of Navigational/Informational Prompts

Although only three farmers had prior experience of calling into an IVR system, other farmers were still successful to comprehend navigational and informational prompts. They were able to understand how an IVR system works; after initially telling them about the repetition functionality of a prompt, they would themselves wait for the prompt to repeat if they were unable to understand it the first time and selected the option in the next attempt. Some users would wait for the prompt to end before

pressing the button while others would press immediately after hearing the option of their choice. We asked users during semi-structured interviews regarding understanding of navigational prompts and the users suggested that the IVR instructions were very clear and each prompt repetition helped them complete their tasks. There were a couple of instances where the user had pressed the wrong option, unintentionally, while pressing two buttons at the same time. On both the occasions they were able to navigate back to the upper level menu. *(P#2)* commented *"Do I have to listen to the entire prompt or can I move back into the previous menu at any time?"*

Informational prompts, which contained the actual information, were also understood by the users. *"Informational prompts are easily understandable and voice quality is good" (P#10)*. A few participants indicated that the 7 day weather forecast was too long and should be shortened. After retrieving pesticides and fertilizers information, a number of farmers requested us to write down the name and price of the pesticide mentioned in the prompt. The pesticides/fertilizers sub-menu prompts were also repeated a number of times primarily as the farmers wanted to listen carefully to the names and prices. This reflected upon the importance of having a text message following a user's IVR use. Information retention is a drawback of an IVR that can be resolved by delivering a text message to the user.

Users Involvement and Suggestions

Despite receiving an encouraging response during the user testing phase regarding the usability of an IVR system, it was observed that some users were not as keen as others to use such a system in the future. Some of the participants, most of whom were older and infrequent mobile users, gave a cold response and seemed uninterested. This seemed partially as a consequence of technology intimidation and more as a result of the farmer being rigid towards traditional practices and disinclined towards adopting newer practices. When *Ishaq* (mobile user, 50 years old, had knowledge about Telenor's helpline, able to use our IVR) was asked whether he has changed his farming practices on the recommendation of agricultural extension workers over time; he answered in affirmative. He was then inquired about not using Telenor's helpline, despite him acknowledging its benefits, upon which his response was *"I have been farming for over 40 years, what I should even ask about? (from the helpline)"*.

It was noticed that in spite of farmers admitting the benefits of using such a helpline, they still do not use the service. This perception seems to be common among a lot of older farmers and it is therefore important to address this thought-process. This is possibly due to their traditional mindset and as a result of technology intimidation. This may not be an irrational behavior on their part as their agro-information source has almost always been generational or through peers and incorporation of any ICT project needs to work around this behavior. Such behavior has also been viewed in China [12] amongst other countries.

However, younger and literate farmers on the other hand were more receptive and involved. They valued newer information and asked about when they could call into the IVR from their phones. They suggested modifications to the system and recommended various add-ons. Seed information, soil based fertilizer information, pesticides/fertilizers information regarding more crops, bank loan schemes and land ownership processes were some of the recommendations.

Almost unanimously, farmers demanded government intervention to support them in various domains i.e. quality, price, availability and regulation of seeds, higher procurement rates, etc. This demand shows that any solo effort at the private sector alone will be insufficient. They link any such intervention with the general improvement in their lifestyle as a result of improved income, which is highly dependent on government support.

6 DISCUSSION AND CONCLUSION

In this research, we have presented an IVR application that disseminates real time and credible agricultural information for the farmers of central Punjab. Due to high cellular penetration in rural locations more farmers than before are using mobile phones. Results showed that such a system can be operated by the farmers and can be viable solution to provide agricultural information. However, it is important that such a solution is only sustainable when farmers perceive that the system will be installed on a long-term basis, is actually supported by the Government and brings clear financial benefits.

Our results also highlight the challenges that Pakistani farmers in particular and illiterate people in general face and the way they appreciate technology is common in the sub-continent. This finding fosters interesting prospects for using existing best practices in the Pakistani context and coming up with new solutions and guidelines, which could be adopted at a much broader level. There are certain limitations to our work such as the small deployment time, limited number of testers and no impact analysis. Impact analysis would possibly reveal a detailed examination of the user traffic, their calling and information extraction trends, drop off rates and usability issues among other valuable information. It will be important to find out whether the farmers trust the IVR's advice and act on it.

In future, we plan to extend this project by deploying and incorporating new features based on user's suggestions and other relevant findings. It is important to study the results of impact analysis to determine the success of such a solution in long-term and we plan to do it in the next round. An agricultural based IVR could be a good starting point to empower Pakistan's farming community and this could possibly turn into a more power tool such as to educate the rural community.

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