

Avaaj Otalo — A Field Study of an Interactive Voice Forum for Small Farmers in Rural India

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ABSTRACT

In this paper we present the results of a field study of *Avaaj Otalo* (literally, “voice stoop”), an interactive voice application for small-scale farmers in Gujarat, India. Through usage data and interviews, we describe how 51 farmers used the system over a seven month pilot deployment. The most popular feature of *Avaaj Otalo* was a forum for asking questions and browsing others’ questions and responses on a range of agricultural topics. The forum developed into a lively social space with the emergence of norms, persistent moderation, and a desire for both structured interaction with institutionally sanctioned authorities and open discussion with peers. For all 51 users this was the first experience participating in an online community of any sort. In terms of usability, simple menu-based navigation was readily learned, with users preferring numeric input over speech. We conclude by discussing implications of our findings for designing voice-based social media serving rural communities in India and elsewhere.

Author Keywords

Voice user interface, social media, forum, India, rural development, agriculture, literacy, ICTD

ACM Classification Keywords

H.5.2 User Interfaces: Voice I/O User Interfaces; H.5.2 User Interfaces: Evaluation; H.1.2 User/Machine Systems: Human Factors

General Terms

Design, Human Factors

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Figure 1. A farmer in Gujarat, India, accessing agricultural information through AVAAJ OTALO.

INTRODUCTION

Agriculture provides a means of livelihood for over 50% of India’s population. Most of India’s farmers are small-scale; 78% of farms are five acres or less [23]. The Government of India invests heavily in its agricultural extension program, in which trained field officers help communities address common problems and learn about new farming techniques or technologies. However, this program has not lived up to its potential. In a survey conducted by the International Food Policy Research Institute, only 6% of respondents reported having interacted with an extension officer [3].

Information and communication technologies, or ICTs, have the potential to increase the reach of agricultural extension. Our work explores the use of a voice message forum to provide interactive, on-demand access to appropriate and timely agricultural knowledge. Voice is a natural and accessible medium for many small farmers, who often have limited formal education and already access knowledge through oral means, such as listening to the radio and conversations with agricultural experts and other farmers. Voice content can be accessed using low-cost mobile phones, which are being rapidly adopted by rural communities around the world.

Agricultural knowledge is highly time-sensitive and contextual. Information needs and appropriate responses vary with the growing season, year, geographic location, soil conditions, weather and for dealing with specific crops, diseases and pests. Even supposedly expert advice requires contextualization and local vetting. This often happens through farmers learning from the innovations and experiences of others. As a result, the tools for *content creation* must be as accessible as those for information access. An appropriately designed voice message forum could allow farmers to learn from best practices, the advice of experts, and the experiences of one another.

To explore this idea, we designed, implemented, deployed, and evaluated an asynchronous voice message forum called *Avaaj Otalo* (literally, “voice stoop”) in rural Gujarat, India. Figure 1 shows *Avaaj Otalo* in use. Prior research on voice-based user interfaces for the developing world has largely focused on providing access to static information resources [15, 21]. A few research efforts have sought to develop voice message forums, both for the developed world [18, 24] and for the developing world [4, 9]. To the best of our knowledge, only one early effort has ever been deployed or studied for an extended period [18]. In our case, exposure to *Avaaj Otalo* provided users with their first experience with an online community of any sort.

In this paper, we report on the results of a seven-month pilot deployment of *Avaaj Otalo* (AO), drawing from analysis of usage logs, posted content, and interviews with user and non-user farmers. The rest of this paper is organized as follows. In the next section, we describe related work. We then describe the design, features, and implementation of AO. The next section outlines the AO pilot deployment, followed by the results: how users interacted with AO, the content that was contributed, and social dynamics that emerged within and around the forum. Based on these findings, we discuss some design implications for social media tools serving agrarian communities in India and elsewhere. We conclude with directions for future work.

RELATED WORK

There are three main bodies of research related to this work — voice user interfaces for low-literacy populations, empirical studies of voice-based social media, and projects using voice as a medium to deliver information to small farmers.

Voice UIs for Low-literacy Populations

Most prior work on voice UIs for low-literacy populations has focused on practical approaches for speech recognition in under-supported languages [16, 21]. Other research has investigated interaction design issues, including the usability of menu hierarchies for phone-based navigation [12, 21] and evaluations of alternative modes of input, specifically comparing touchtone (DTMF) to speech [14, 20, 22].

Voice-based Social Media

There have been several empirical studies of voice-based social media in the developed world. Most of these have focused on *media spaces* that support synchronous or near-synchronous communications within groups, often in the workplace [1, 5]. Dourish et al. investigated use of continuous audio and video links to connect remote offices, concluding that it was not adequate to understand such spaces in terms of facilitating person-to-person communications, and that broader individual, interactional, communal and societal perspectives must also be considered [5]. Ackerman et al. studied office usage of a audio-only media space over a two month period, finding that audio was sufficient for creating a usable and useful social space [1].

Several researchers have proposed the use of *structured* voice messages for improving asynchronous voice communications [19]. HyperVoice first applied this idea to groups through an interactive voice response (IVR) toolkit for community discussion [17]. Subsequently, several researchers have designed voice-based forums, chat applications and wikis [8, 24] including for developing world contexts [4, 9]. To our knowledge none of these systems have actually been deployed or studied empirically.

One exception is IBM Research India’s Spoken Web project, which allows users to develop their own IVR sites using a simple speech-based interface [10]. In an early deployment, they found that a forum for posting advertisements for services quickly evolved into a general message board, and that locally-generated content was extremely popular, with users frequently listening to upwards of twenty messages at a time [2]. In this paper we expand upon this work, reporting on usage and social dynamics of a voice-based message board for agricultural advice serving small farmers.

Voice Information Services for Small Farmers

There have been a number of IVR systems deployed worldwide to connect farmers to timely and relevant knowledge (see [6] for a list). Most of these have focused on the provision of specific knowledge resources, such as weather information, market prices and government-related announcements. LifeLines [11] is a service with a mediated call center where human operators record questions, obtain answers from an appropriate expert, and then leave a voice message for the farmer to retrieve later.

SYSTEM BACKGROUND

Avaaj Otalo was designed in the summer of 2008 as a joint project of Development Support Center (DSC), an NGO in Ahmedabad, Gujarat, India, and IBM India Research Laboratory, based in New Delhi. It was conceived as an interactive, on-demand informational resource that would complement a weekly Gujarati radio program produced by DSC, called *Sajjata No Sang, Lave Kheti ma Rang* (“A program bringing color to



Figure 2. Testing IVR-style interaction with farmers using flashcards.

farming”). Launched in 2006, the radio program targeted small and marginal farmers. It quickly gained widespread popularity, reaching an estimated 500,000 listeners weekly within the first year.

Listener feedback was integrated into the radio program’s production process from its inception. Throughout the week, the program producer (a staff member at DSC) would receive phone calls from listeners relating their experiences following the advice, questions about new problems, or suggestions for topics to discuss. During the most critical stages of the growing season, DSC would receive over 100 phone calls and 40 hand-written letters every week. This feedback was reviewed when developing the next week’s program. Listeners reported finding the resulting topics highly relevant and timely.

Design Process

Avaaj Otalo was originally inspired by this feedback loop. The goal was to develop a system that DSC could use to effectively communicate with listeners, incorporate more listener feedback into the program (both directly and indirectly), and more efficiently respond to questions and suggestions. We designed Avaaj Otalo based on interviews with farmers, agricultural experts, DSC management and staff, producers of the radio program, and other relevant stakeholders. With farmers, we administered questionnaires and organized focus group discussions.

Features

Based on these interviews, we identified a voice-based system accessible through mobile phones as the most appropriate technology choice. Most of the farmers interviewed had access to a phone, either their own or through someone they knew. We considered an SMS-based approach, but found that most farmers did not compose or read text messages. In contrast, wizard-of-oz tests indicated that most farmers could interact with a simple IVR application (see Figure 2).

The following three features were included in the initial version of Avaaj Otalo.

- **Question and Answer Forum.** Users could choose to record a question, provide an answer, or browse the existing list of questions and answers. The list was replayed in order, starting with the most recently posted question. After recording a question, the farmer could call back later to check for responses. Browsing the list provided an opportunity to learn from the questions (and answers) of other farmers. The list itself had limited functionality: users could not search for or filter content, and it would play only up to two answers for each question (one from a DSC staffer and one from another farmer). Users were limited to 30 seconds for each question or answer they recorded. Figure 3 gives a sample interaction with AO to post a question.
- **Announcements Board.** This allowed DSC to broadcast announcements of general interest, including messages about agriculture, animal husbandry, relevant government programs, market prices, and weather.
- **Radio Archive.** Listeners frequently lamented missing episodes of the radio program. The radio archive contained all previously broadcast programs, starting with the most recent. Users browsed the archive by listening to 30 second summary recordings and then choosing to listen to the full 15 minute program, or continue browsing.

AO: Welcome to Avaaj Otalo! You can get to information by saying a single word, or by dialing the number. To ask a question, say 'question', or dial 1; to listen to announcements, say 'announcements', or dial 2; to listen to the radio program, say 'radio', or dial 3.

User: (*dials 1*)

AO: OK, you want to ask a question. To record your own question, press 1. To listen to the questions and answers of other farmer friends, press 2.

User: (*dials 1*)

AO: OK, you want to record a question. Please say your question slowly and clearly after the beep.

User: *How can I protect my cotton crop from mealy bugs?*

Figure 3. A sample interaction with AVAAJ OTALO.

Implementation

Avaaj Otalo was implemented as a VoiceSite using IBM Research’s Spoken Web platform [10]. Incoming calls from the public switched telephone network (PSTN) are routed to a Cisco Gateway through an ISDN connection. This connection can support up to 30 simultaneous calls. The gateway converts the signal to the Session Initiation Protocol (SIP) and forwards the request to a server running the Genesys Voice Platform (GVP), which interprets Voice XML generated by a Java application hosted on a Tomcat server. User input is forwarded by the GVP server to the speech recognition

engine, IBM's Websphere Voice Server (WVS). WVS is a large vocabulary, continuous speech recognizer trained on American English. For Gujarati speech recognition in AO, speech commands were converted to lexicons using the American English phoneme set. With this approach in a previous evaluation, we observed a speech recognition accuracy of 94% in a largely quiet, indoor setting [14].

PILOT DEPLOYMENT

After AO was implemented, we launched a pilot deployment with 51 users scheduled to run for seven months¹. The goal of the pilot was to obtain feedback about AO's functionality, gather data on typical usage patterns, and for DSC to gain experience interacting with farmers through the system.

Participants

The 51 pilot participants were selected from 4 districts across the state. Participants were chosen from a pool of farmers who had an existing relationship with DSC, either as frequent listeners and/or callers to the radio program, or through some other DSC activity. No more than one participant was chosen from a single village; DSC chose to spread the user base to cover a wide range of farmer backgrounds and experiences.

Of the initial 51 participants, all but two were farmers; one of the exceptions was a school teacher and the other a businessman. All participants were male, due to the difficulty in recruiting female farmers with their own mobile phone. Of the 45 users for whom we have demographic data, 19 had an eighth-grade education or less, 20 had completed some high school and 6 had completed college. The median age was 29, with a range of 18 to 60. The median land-holding was 10 acres, with a range of 0 to 60. All spoke Gujarati as their first language. None had significant prior experience with the Internet. Roughly three months into the pilot, 17 participants were removed due to non-usage. These non-users either lost interest in the system or had little interest to begin with. Twelve new participants were added as replacements². The decision to add new users was based on DSC's goals of maximizing system usage and feedback obtained through the pilot.

Participants were briefed on Avaaj Otalo's features during a meeting called by DSC prior to launch. System navigation and feature access was demonstrated through a simple role-playing exercise. Participants were encouraged to post questions that would be relevant for a wide audience, were based on current problems faced by themselves or their community, and were not already addressed in the radio program.

AO only accepted incoming calls from pilot participants, who accessed the system through a toll free number.

¹The usage data presented in this paper covers the period December 24th, 2008 through July 16th, 2009

²Usage data includes these participants.

Data Collection

We collected data about the pilot from three sources:

1. *Log of system navigation* — AO's logging system recorded every interaction between the system and caller (including prompts presented, options selected, and content listened to). Due to malfunctions with the logging system during the first 20 days, all log-based data presented in the paper begins after this time period.
2. *Transcription and manual coding of questions and answers* — Native Gujarati-speaking professionals with fluency in English transcribed farmers' recorded questions and responses. Technical terms and regionally specific vocabulary was translated by consultants experienced in agriculture and rural development.
3. *Interviews with Avaaj Otalo users and others in their communities* — Interviews were conducted in the homes of farmers over a one month-span. In all, 76 interviews were conducted, covering 36 pilot participants and 40 non-participants. The format was semi-structured. Prepared questions covered typical usage patterns, content quality, content organization, system navigation, feature preference, likes, dislikes, suggestions, and overall satisfaction.

STUDY FINDINGS

In this section we present the main findings from the pilot deployment.

Traffic Overview

Over the seven-month pilot, 6,975 calls were made to AO. The average call duration was approximately five minutes, remaining relatively steady throughout the pilot. Of the 63 individuals who were registered at some time, 45 (71%) called the system at least once. The system experienced three spikes in traffic: in January (fueled by enthusiasm for launch), in March (when 12 new participants were added), and in June (time for fall planting). Figure 4 shows a weekly breakdown of call traffic, by specific feature. The Q&A forum was by far the most popular feature, outnumbering announcement board and radio archive accesses combined in every week. Of the 36 AO users that were interviewed, 65% named it as the AO feature they liked the most (the remainder liked the radio archive). As is common in web forums, traffic on AO was dominated by a small number of highly active users. The 10 most frequent callers accounted for over 80% of overall calls, with the top 3 accounting for 60%.

Usability

In this section we discuss results related to the usability of the system.

Input Modality

AO allowed users to choose between voice commands and touchtone input (DTMF) for navigating menus.

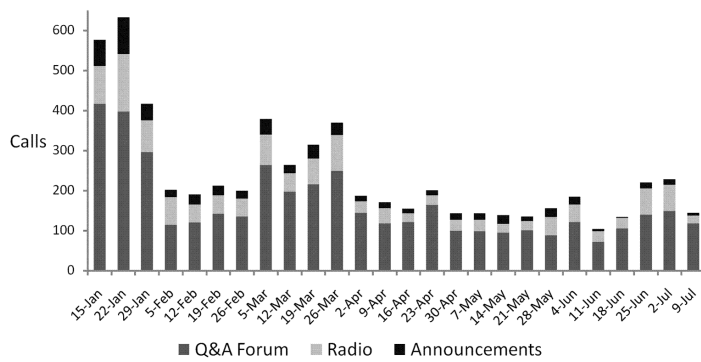


Figure 4. Number of calls to the three sections of AVAAJ OTALO, by week.

The welcome prompt asked the user to either say the given keyword or press the touchtone key corresponding to the option they wanted (see Figure 3). Subsequent prompts presented menu options using the same mode. Figure 6 shows input mode selection in Avaaj Otalo over time. Touchtone was selected significantly more than voice in every week of the pilot period. Of the 29 users who called AO more than ten times, 3 chose voice input in more than a third of their calls. User interviews had unanimous (100%) preference for touchtone navigation. Users found voice input more error prone. This could have been due to the low accuracy of the speech recognizer, which was trained on American English and often had to contend with noisy background environments.

Errors

We expected to see a decrease in user input errors over time. However, we found no evidence of a decrease. Figure 5 shows the average number of input errors (no match or no input) per call over the course of the pilot. There was also no evidence of a downward trend in the other user errors we examined, question re-records and early hang-ups (where the user heard some or all of the initial prompt but hung up before giving any input).

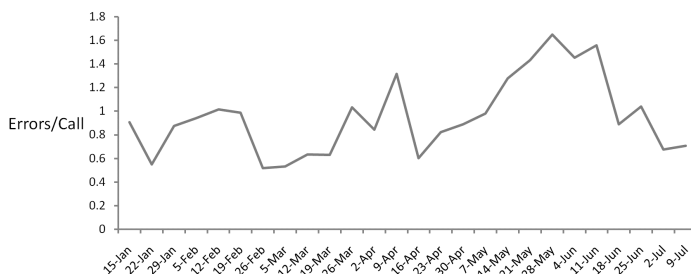


Figure 5. Number of input errors per call, by week.

Navigating the Forum

None of our interviewees identified menu navigation as a difficulty or source of dissatisfaction with the system. Avaaj Otalo did not provide the ability to search for specific content in the forum — users had to listen

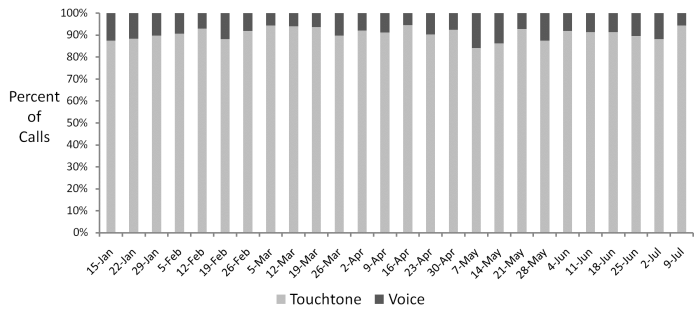


Figure 6. Input mode selection, by week.

to questions sequentially starting with most recently posted. Any answers would be played subsequent to the question, with no option to skip ahead to the next question. Surprisingly few interviewees complained about the lack of a search function, or the ability to filter questions by topic. This may have been simply because they didn't know of any alternative.

Some users requested that the system provide a mechanism to skip messages. This feature was initially left out to keep the prompting as simple possible. It was later added, but not announced to users. In retrospect, this was probably an oversight, as a skipping mechanism could have significantly improved the browsing experience.

Users were asked how they would prefer to have content on the forum organized: sorted by time (the current setup), by user, or categorized by topic (for example, according to specific crops). 85% of respondents preferred topic-wise categorization.

Forum Content and Usage

Out of AO's 6,795 calls, the Q&A forum was accessed 4,291 times, accounting for roughly 60% of total traffic. In those 4,291 calls, there were 1,138 attempts to record a question or answer. The rest, it can be assumed, was lurking activity. Below we discuss questions and answers in further detail.

Questions

Figure 7 shows the number of questions and responses posted to the forum over time. A total of 610 questions were posted. Users asked about a range of agricultural topics. Figure 8 shows a topic-wise breakdown of the questions that were asked. The most common were related to pests and diseases (39% of questions).

Farmers found tremendous value in listening to other farmers' questions. 77% of interviewees identified this as the main reason they liked the forum. Many were motivated to listen to as many as 25 questions and answers out of curiosity for what other farmers were asking.

Listening to questions from other farmers and the answers to these questions on AO helps me un-

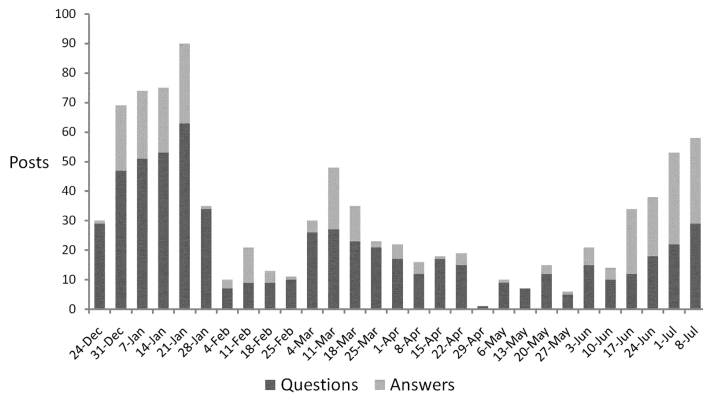


Figure 7. Number of questions and answers posted to AO, by week.

derstand my own problems [in agriculture] better. Often it helps me find solutions too. This is why my favorite feature is listening to other people's questions.

[By listening to other farmers' questions] I get new information about the new kinds of pests and diseases that are troubling crops and animals. I can be prepared for them. I can listen to other farmers' experiences and I benefit from this.

Yes, I have benefited [from listening to questions from other farmers]. One farmer had asked a question about how to deal with the hot wind that damages millet crop in this region. [The answer on AO] advised him to plant Rajka millet on the edges of the plot. I did that too and it saved my crop from being ruined. That was very useful.

Responses

Responses to questions on the forum came from other farmers or agricultural specialists at DSC who regularly monitored the forum. In total, 286 actual answers were recorded (not counting off-topic responses). 164 were provided by DSC staff, and 122 by AO users. When asked for their preference between receiving answers from DSC staff, farmers, or both, 65% of users said staff only and 35% said both. No interviewee said they would prefer responses only from other farmers.

[Only] when these other farmer's questions will be answered by an expert, then I will get to learn from [answers in AO]. Farmers don't know everything, right? What most of the farmers talk about is common knowledge to us. So I am interested in listening to what the experts say about the questions on AO.

One interviewee insisted that even informally trained but knowledgeable DSC staff are not sufficient for addressing their questions.

I want a real agricultural expert to answer my ques-

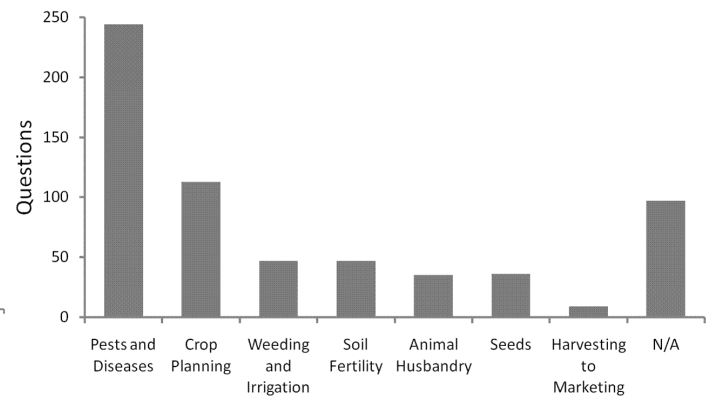


Figure 8. Number of questions posted to AO, by category.

tions, someone who is trained in such things. Then I shall be happy with AO.

Sixteen farmers (25%) contributed at least one response. Answers usually came from more active AO users. Eight of the top ten answering farmers were also among the top 15 in overall calls. Other farmers hesitated to respond because they did not want to take responsibility for answers that were incorrect or caused monetary loss. Many interviewees demonstrated a lack of confidence in their own knowledge, potentially attributable to their limited education and outside exposure:

I do not answer questions on AO because farmers cannot give proper answers to people's questions. Only an expert can do that. I know some answers but they are not *pukka* [authoritative] and there are *pukka* answers on AO, that is why I like AO. [A DSC staffer] gives accurate answers that work for [farmers] and so I prefer listening to him.

At one point a conflict developed between two users, one of whom was upset that his question was inaccurately responded to by the other. A third user sided with the question asker:

[Addressing the responder], you are my friend and it pains me to tell you this, but with regret I want to tell you to please stop posting answers, or else your number will be removed from Avaaj Otalo.

The responder defended himself by deferring to the authority of DSC.

[Addressing the asker], I have not responded to any of your questions; answers are actually given by DSC. Still if you feel that I directly give answers, you can check it. Also if you feel that I am guilty, then you can take necessary steps and deactivate my number.

DSC staff also had reservations about the quality of answers that other farmers could provide. As the NGO

hosting Avaaj Otalo, and under whose brand it was being offered, DSC wanted to ensure that only accurate, high quality information was provided. DSC was concerned that users of the forum would assume that advice from other farmers was endorsed by DSC, even if this was not the case.

Despite these reservations, DSC was curious about whether the user community could handle the responsibility of answering questions. Greater farmer involvement could dramatically reduce the burden on DSC staff and agricultural experts. To find out, the staff ceased answering questions in May (approximately 4 months after launch). The change was not officially announced to the user community. The effect can be seen in Figure 7. Both question and answer traffic dropped dramatically for the month. Users took notice, but did not respond by answering more questions themselves:

Hello. [name] speaking. I want to inform with regret, that recently asked questions are not being replied to in DSC's Avaaj Otalo. Monsoon is approaching soon, so monsoon farming will start. Cotton crop is about to be produced. Also farmers have questions related to controlling insects. To resolve them, I request to the DSC staff that they give answers at the earliest.

Farmers often learned from the questions of other farmers, and the answers that were provided. However, there were only a few isolated cases where farmers explicitly addressed their questions to other farmers. Users said they expected answers to come from DSC, and for farmers to offer their own testimonials to complement these with practical experience.

Social Dynamics

In this section we describe some of the social dynamics that emerged around AO, both within the virtual forum, and in the communities where AO was deployed.

Introductions

Over the course of the pilot, several communication norms emerged in Avaaj Otalo's forum. One was introducing oneself with name, location, and phone number before posting a question. Providing identification information was first suggested in the forum by a DSC staff member, and quickly adopted as a standard by forum members. This was significant given that users had only 30 seconds in which to concisely record their question or provide a response. Over 65% of questions included at least the name of the user in the recording. After a while, users complained when this norm was not followed.

The question you have asked is fine, but please provide your name, taluka, village, and district in detail so that this will benefit us and farmers will recognize you. Thanks.

Moderation

Another norm was refraining from posting inaccurate, redundant or spurious content. This was likely influenced by AO's linear message presentation style, as well as its inability to delete or skip messages. Once again, this norm was first introduced by a DSC staff member:

Farmer ladies and gentlemen, regarding Avaaj Otalo, I want to say two things. First, regarding the questions you ask. If they are already included in the [radio] program, we are not going to provide answers here. And second, basic information which is already given in our newsletter, will not be reproduced here. So please ask questions that are new and can be useful to all. Thanks.

Farmers themselves quickly picked up on this, and began self-moderating the forum.

Salute to farmers. I want to inform farmer friends that questions asked should be useful to all farmers. Film songs or jokes in between should not be posted. If the question asked is good, all farmer friends will also enjoy listening.

Occasionally, moderation posts took a more frustrated tone:

Hello. Earlier [another user] had [made recordings] like this. Are you making fun of DSC by asking such questions? Or are you asking for information useful to farming? You have not been given this number for such mischief or for passing time. You have been given the number to obtain quality and timely information from DSC. Why did you register your number if you wanted to do such mischief? In a short time, I will also complain to [DSC].

Intermediated Access

DSC encouraged pilot participants to share AO with others in their local community who were not registered participants. Over the course of the pilot, participants often asked questions, received answers, and played content for other users. Of the 36 interviewees, 12 reported functioning as information proxies in some way, including 4 of the 6 most active users.

Social Status

AO users were often drawn to the proxy role because of the social recognition they could gain in their communities. One user played forum and radio content in his storefront using a speaker phone he had specifically bought for AO.

I'm always the first one [in the village] to implement new methods and technology in agriculture. I have everything in terms of technology here. Everybody comes to see things at my place. Even Avaaj Otalo — I am the first one to get it in this place. So many experts and scientists are friends

with me and I tell them about AO. When they are here they ask to see it and I show them how AO works. They are impressed by how much modern technology and knowledge I have. It is a matter of pride for [my family].

In contrast, some who already had high social status through their knowledge, reputation or position in the community were concerned that this status was not represented within Avaaj Otalo. They suggested that this status be transferred to AO, otherwise those who posted frequently there could easily usurp them.

Why would I use such a system [like AO]? Everybody's answer has the same value no matter how correct or incorrect it is. I am already respected in my community as someone knowledgeable in agriculture and my answers on [AO] will be treated just like anyone else's off the street. How does AO benefit people like me? In fact it does not even recognize the knowledge and wisdom I have gathered over the years.

Core Users

The top ten most active users of AO accounted for 80% of overall traffic. This core group included farmers with limited education and economic resources (including land). Of the top three most active users, none had graduated past the 10th grade, and all lived in the most remote of the four districts covered in the pilot. These farmers were young (all under the age of 30) and tended to be more progressive and experimental in their agricultural practices. Lacking alternate sources of information, these farmers especially valued the connections and recognition afforded through AO.

Other Uses of Avaaj Otalo

The AO forum was intended for providing technical agricultural information, but users appropriated it for a variety of other purposes.

AO as Entertainment

The ability to listen to previous radio programs was praised by many participants. They enjoyed the flexibility to listen to missed programs, as well as re-listening at any time. One interviewee related how he would play the radio program for guests that would visit him, whether they were farmers or not. Another farmer listened to radio programs to help him stay awake at night while he irrigated his fields. The radio show was broadcast Thursday nights, and overall traffic on Avaaj Otalo from Friday through Sunday was 16% higher than during the rest of the week, driven by a 32% increase in radio archive accesses.

[I] mostly to listen to DSC's radio programs [on Avaaj Otalo] that I might have missed on Thursday, because I was traveling or didn't have the radio by me for some reason.

Some users took to recording poetry and songs on the forum. While some denounced the content as irrelevant in the forum, several interviewees said that songs were a welcome change of pace from the typical forum content. Many suggested that AO include separate spaces for sharing songs, jokes, and other light entertainment.

AO as Business Consulting

One Avaaj Otalo user ran a shop selling farming supplies as a means of supplementing his income as a farmer. Soon after AO was launched, he began posting questions to the forum asking for detailed comparisons of particular pesticides. Eventually, DSC staff discovered that he was using the responses to decide which pesticides to stock in his shop.

AO as Advertising

In another case, several users posted questions asking about how to deal with wild pigs that were destroying their crops at night. One user described a strobe light he had built to effectively scare the pigs away. After touting the contraption's effectiveness, he provided contact details for anyone interested in purchasing it. Shortly after, another user offered for sale a competing solution he had developed using a siren, claiming that it was a much cheaper approach.

DISCUSSION

In this section we discuss the implications of our findings for the design of voice-based social media targeting rural communities in developing regions.

Use Touchtone (Wisely)

Prior work for low-literacy populations has focused on the use of speech recognition, graphical icons and other ways of avoiding text. In our work we have consistently found that using numbers is intuitive, reliable, and accessible [13]. In Avaaj Otalo, for selecting from a small list of possible options, users have preferred and performed better using touchtone input as opposed to (admittedly, low-grade) speech recognition, reporting that voice input was more difficult to use and harder to understand conceptually [14]. Our in situ study confirms this preference, with most users opting for touchtone input.

Speech recognition is likely to still be a useful technology — for example, for searching for messages related to a particular crop or disease. In general, we advocate *appropriate* use of speech recognition, when and if it matches the requirements of the task — for example, in random-access tasks, when the space of potential responses is high (such as in a search interface).

Need for Structured and Open Spaces

One of the most striking findings from our study was the overwhelming preference for answers that came from institutionally credentialed “experts” over peer farmers. Partially, this could be due to the forum being closely

associated with an existing institution, namely DSC. Participants perceived the system more as a channel to engage with DSC than with peers. As such, many users desired more structure in the system. They wanted timely responses from DSC, and better mechanisms for representing identity and reputation within the system. Responding to a question also requires directness which implies authority about the problem being discussed. Farmers were uncomfortable claiming this level of authority, especially in the presence of DSC staff.

From DSC's perspective, greater control over answers is also desirable. DSC strives to maintain a positive reputation amongst its constituency, which includes providing only reliable agricultural information and advice. Within an open forum, they were concerned that users would interpret all information and advice as being approved by them. To prevent this misunderstanding, and the possibility of spreading misinformation, DSC recommended that they approve all content before it appears on the forum. This would also allow DSC to reduce redundant and spurious information, improving the farmers' browsing experience.

DSC staff believed that the most effective peer communication on the forum involved farmers sharing an experiment, innovation, or story about their farming, as opposed to answering a specific question. Users also appropriated the virtual space for a variety of purposes not directly associated with DSC — including for their entertainment, business and creative expression. In the next version of Avaaj Otalo we intend to experiment with approaches to content organization and presentation, including more special-purpose forums and personalization of content.

Leveraging Social Ties or Perpetuating Inequality?

External identity and reputation clearly played a very important role in the forum. Users naturally identified themselves before contributing to the forum, despite the valuable recording time it consumed. Farmers ascribed trust to credentialed authorities. Some even wanted their existing status reflected in the system before they would participate. DSC interpreted this as a ploy by farmers of high socioeconomic status to transfer this status to AO for exploitative purposes. DSC insisted that social status not be an identifiable characteristic within the forum.

There is a palpable tension here between leveraging social ties and trust relationships to create new online spaces, and perpetuating existing socioeconomic inequalities. This tension has been observed before in the transition to other online social spaces, but it is particularly acute in rural India, where such distinctions can be very rigid and have broad ramifications.

One solution could be to establish better mechanisms *within* the system for establishing personal identity and reputation. Many farmers themselves are experts in

various areas. However, the knowledge about who these experts are is not commonly available. In India, social networks can be fragmented even within villages, due to differences in caste and religion. By creating better mechanisms for identifying and recognizing experts on various topics, farmers could broaden their range of possible sources for advice and technical knowledge.

Complement Social Media with Traditional Media

Feedback from interviews indicated the important role that DSC's radio program played in the uptake of AO. The radio program has a reputation for providing relevant and trustworthy information over its 3-year history. It is also an entertaining and popular franchise. AO was positioned as a supplementary resource to the program, and consequently gained much of the benefit of its reputation. The heaviest users of AO were also regular listeners of the radio program. Without this previously engaged user base, source of high-quality audio content to seed the system, and mechanism for creating awareness, we speculate that getting farmers to use and trust AO would have been a much greater challenge.

Financial Sustainability

As Avaaj Otalo transitions from pilot project to formal service, questions of financial sustainability inevitably arise. In the pilot described in this paper, the service was available through a toll-free number, so that callers incurred no airtime costs, which were borne by DSC. These airtime charges comprised the majority of AO's operational costs. A simple solution would be to use a normal toll line, and to have callers pay for their own airtime. This change is likely to have a large impact on usage. In informal discussions, some farmers indicated that they would be hesitant to use the service if it were not free. On the other hand, many farmers already call DSC for advice at their own cost. One pilot participant welcomed users paying for their own calls, saying it would discourage spurious or off-topic posts. DSC has considered charging farmers for accessing Avaaj Otalo, which has worked for other agricultural question-answer services available elsewhere in India [11]. Another possibility is to generate revenue through selling advertising to companies who target rural markets. Finally, it could be argued that Avaaj Otalo increases agricultural productivity, while being much cheaper to provide than traditional extension, and so the government should subsidize some or all of the costs.

CONCLUSION AND FUTURE WORK

In this paper we have presented the results from an extended field study of Avaaj Otalo, a voice application for small farmers in rural India. Avaaj Otalo's most popular feature was a voice forum used to ask and respond to questions, and to browse others' questions and responses on a range of agricultural topics. For all of the participants in our study, this was their first experience with an online community of any sort. Not only did the forum provide access to timely and relevant agricultural advice, but it also became a lively social space with the

emergence of norms, persistent moderation, and a desire for structured interaction with accredited experts and open discussion with peers.

Our work has shown that voice can be a suitable medium for online communities in the rural developing world. This represents an early (but necessary) step in the development of appropriate social media tools for connecting these previously disconnected communities. A number of interesting research questions remain. How to make user-generated voice content easier to navigate and search is still an open problem. The tension between using existing social structures to bootstrap online social spaces, and the opportunity to alleviate existing inequalities, is another challenge that we will continue to face. We look forward to addressing these and other questions in the next version of Avaaaj Otolao.

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REFERENCES

1. M. S. Ackerman, B. Starr, D. Hindus, and S. D. Mainwaring. Hanging on the 'wire: a field study of an audio-only media space. *ACM Trans. Comput.-Hum. Interact.*, 4(1):39–66, 1997.
2. S. Agarwal, A. Kumar, A. Nanavati, and N. Rajput. Content creation and dissemination by-and-for users in rural areas. In *Proc. IEEE/ACM Int'l Conference on Information and Communication Technologies and Development*, April 2009.
3. R. Birner and J. R. Anderson. How to make agricultural extension demand-driven? Technical report, International Food Policy Research Institute, November 2007.
4. R. Cervantes and N. Sambasivan. VoiceList: user-driven telephone-based audio content. In *MobileHCI '08: Proceedings of the 10th international conference on Human computer interaction with mobile devices and services*, pages 499–500, New York, NY, USA, 2008. ACM.
5. P. Dourish, A. Adler, V. Bellotti, and A. Henderson. Your place or mine? Learning from long-term use of audio-video communication. *Comput. Supported Coop. Work*, 5(1):33–62, 1996.
6. M. Gakuru, K. Winters, and F. Stepman. Inventory of innovative farmer advisory services using ICTs. Technical report, The Forum for Agricultural Research in Africa, 2009.
7. R. J. Honicky, O. Bakr, M. Demmer, and E. Brewer. A message oriented phone system for low cost connectivity. In *Hot Topics in Networking 2007 (HOTNETS)*, 2007.
8. J. S. Kim. TattleTrail: An archiving voice chat system for mobile users over Internet protocol. Master's thesis, MIT, June 2002.
9. P. Kotkar, W. Thies, and S. Amarasinghe. An audio wiki for publishing user-generated content in the developing world. In *HCI for Community and International Development (Workshop at CHI 2008)*, Florence, Italy, Apr 2008.
10. A. Kumar, N. Rajput, D. Chakraborty, S. Agarwal, and A. Nanavati. WWTW: The World Wide Telecom Web. In *SIGCOMM Workshop on Networked Systems for Developing Regions*, Kyoto, Japan, August 2007.
11. Lifelines. <http://www.lifelines-india.net>.
12. I. Medhi, S. N. Gautama, and K. Toyama. A comparison of mobile money-transfer uis for non-literate and semi-literate users. In *CHI '09: Proceedings of the 27th international conference on Human factors in computing systems*, pages 1741–1750, New York, NY, USA, 2009. ACM.
13. T. S. Parikh, K. Ghosh, and A. Chavan. Design studies for a financial management system for micro-credit groups in rural India. In *CUU '03: Proceedings of the 2003 conference on Universal usability*, pages 15–22, New York, NY, USA, 2003. ACM Press.
14. N. Patel, S. Agarwal, N. Rajput, A. Nanavati, P. Dave, and T. S. Parikh. A comparative study of speech and dialed input voice interfaces in rural India. In *CHI '09: Proceedings of the 27th international conference on Human factors in computing systems*, pages 51–54, New York, NY, USA, 2009. ACM.
15. M. Plauché and U. Nallasamy. Speech interfaces for equitable access to information technology. *Inf. Technol. Int. Dev.*, 4(1):69–86, 2007.
16. M. Plauché, U. Nallasamy, J. Pal, C. Wooters, and D. Ramachandran. Speech recognition for illiterate access to information and technology. In *Proc. IEEE/ACM Int'l Conference on Information and Communication Technologies and Development*, May 2006.
17. P. Resnick. Phone-based CSCW: tools and trials. *ACM Trans. Inf. Syst.*, 11(4):401–424, 1993.
18. P. Resnick. The Boston peace and justice event hotline: a phone-based community bulletin board. In *CHI '94: Proceedings of the 12th international conference on Human factors in computing systems*, New York, NY, USA, 1994. ACM.
19. C. Schmandt and B. Arons. A conversational telephone messaging system. *Consumer Electronics, IEEE Transactions on*, CE-30(3):xxi–xxiv, Aug. 1984.
20. A. Sharma, M. Plauché, E. Barnard, and C. Kuun. HIV health information access using spoken dialogue systems: Touchtone vs. speech. In *Proc. IEEE/ACM Int'l Conference on Information and Communication Technologies and Development*, April 2009.
21. J. Sherwani, N. Ali, S. Mirza, A. Fatma, Y. Memon, M. Karim, R. Tongia, and R. Rosenfeld. Healthline: Speech-based access to health information by low-literate users. In *Proc. IEEE/ACM Int'l Conference on Information and Communication Technologies and Development*, December 2007.
22. J. Sherwani, S. Palijo, S. Mirza, T. Ahmed, N. Ali, and R. Rosenfeld. Speech vs. touch-tone: Telephony interfaces for information access by low literate users. In *Proc. IEEE/ACM Int'l Conference on Information and Communication Technologies and Development*, April 2009.
23. R. Sulaiman V. Innovations in agricultural extension in india. Technical report, Food and Agriculture Organization of the United Nations, 2003.
24. A. Zinman. RadioActive: Enabling large-scale asynchronous audio discussions on mobile devices. Master's thesis, MIT, August 2006.