SHARING INFORMATION IN RURAL COMMUNITIES THROUGH VOICE INTERACTION

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE
AND THE COMMITTEE ON GRADUATE STUDIES
OF STANFORD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Neil Patel
August 2011

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Scott Klemmer, Primary Adviser

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Terry Winograd

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Tapan Parikh

Approved for the Stanford University Committee on Graduate Studies.

Patricia J. Gumport, Vice Provost Graduate Education

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Abstract

Online communities enable people to participate in globally shared knowledge pools, but they are out of reach for poor and isolated communities around the world. Mobile phones have the potential to overcome the PCs accessibility, affordability, and familiarity barriers. However, most mobile information services limit rural populations to being passive knowledge consumers, not active producers. This dissertation explores the design and usage of voice-based social software for rural communities. We designed an application that allows small-scale farmers in India to share agricultural advice by posting, listening to, and replying to others' voice messages using any phone. It has served over 35,000 calls for over 4,000 callers since 2009.

This dissertation presents research guided by three questions for designing systems in this context: First, how do you design effective UIs for navigating audio content? Second, what community dynamics emerge? Third, how do you support sustained community engagement? Prior work has assumed that spoken input is most effective for technology novices with limited literacy. We tested this hypothesis in controlled and natural settings, instead finding that touchtone input was more effective and preferable. Next, we tested whether information was more influential when it came from high-status scientists compared to peer farmers. Contrary to stated preference, participants acted more upon the same information when it came from a peer. Based on these and other experiences from our fieldwork, we developed a generalized software platform for deploying voice-based social media combining call-in and and call-out features, and web-based moderation. Finally, we analyzed the impact of access costs, finding that paying for calls had a dramatic impact to usage overall, and peer-to-peer responding in particular. We present some preliminary experiments using financial incentives and motivational messaging to boost usage.

Acknowledgements

Thanks first and foremost to our field partner organizations: Jatan Trust, Development Support Center, PRADAN, and Digital Green. Sachin Oza, Archana Singh, and Rikin Gandhi were supportive of all of our research efforts. Special thanks to Kapil Shah, who was a mentor and collaborator from the beginning; and Paresh Dave, the "father of Avaaj Otalo." Thanks to Vijay Pratap Singh Aditya, Rohit Magotra, and ekgaon technologies for their mentorship and financial support during my first summer in India. Thanks to IRL's Spoken Web research group for their collaboration: Amit Nanavati, Nitendra Rajput, Sheetal Agarwal, and Anupam Jain, among others. Thank you to the team at Nokia Research Palo Alto for their ideas and support: Jofish Kaye, Tim Sohn, Agathe Battestini, and especially Tico Ballagas. Thanks to all of the excellent researchers and field staff that worked on our deployments and experiments in India: Deepti Chittamuru, Hiral Shah, Jigar Patel, Krishna Savani, Satyam Salil, and Manisha Sharma. Thanks to Steve Marmon and Akshay Kothari for their collaboration on our projects with farmers in California. I appreciate the mentorship of faculty at Stanford and UC Berkeley, including Scott Klemmer, Tapan Parikh, Terry Winograd, Dan Jurafsky, and Joshua Cohen. The HCI Research group at Stanford and the Pirates at UC Berkeley I-School were wonderful families to be a part of. Joel Brandt has always been very helpful to me and was a model Ph.D student to look up to. This research was financially supported by Nokia Research Palo Alto, Stanford School of Engineering, UC Berkeley School of Information, and IBM Research Labs, India.

Finally, thanks to Dad, Mom, Jay, and all of my family and friends in California and Ahmedabad for their love and support throughout the years. There are too many of you to name and not enough words to express my gratitude.

Dedication

To the farmers of Gujarat, for their love and inspiration.

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Chapter 1

Introduction

The Internet has enabled people from all over the globe to communicate and share information. Yet over two-thirds of the world's population remains disconnected from the Internet, and many of these people live in poor, remote areas in the developing world [13]. Access to relevant, timely information is critical for any individual or enterprise to make good decisions, including the world's poor. As information and communications technologies help improve livelihoods in the rest of the world, there is a risk of leaving low-income communities on the other side of a digital divide.

In response, development institutions, researchers, and enterprises are addressing the needs of the world's poor through appropriate information and communications technologies (ICTs). Collectively, the ICTs for development (ICT4D) movement creates technologies serving the world's poor according to their unique technical, social, cultural, and economic constraints. One of ICT4D research's foundational goals is to provide disconnected people with on-demand access to the global knowledge pool [54]. Low-income, rural communities typically rely on one-way broadcast media such as the radio, television, and written periodicals for their information [90]. These sources can be localized to a region or community, but still do not allow individuals to seek information on-demand. Local people may seek information from experts or others in their personal social network, but misinformation abounds and advice is fragmented across multiple sources. There are few comprehensive, on-demand sources for relevant, high-quality knowledge. This is precisely what the Internet provides for those who have access.

Often the most relevant information comes from others living in similar circumstances facing similar challenges. Low-income communities also lack digital platforms to communicate, share, organize, and collaborate with one another. Online communities have been around since the advent of the Internet [33]. Today, social media has exploded in popularity, dominating the total time spent online by Internet users in the West [86]. Online communities hold the potential for people to actively participate in knowledge sharing. Our field work has provided many examples of how local problems can effectively be dealt with by local solutions. This dissertation hypothesizes that equipping communities with transparent platforms to share, discuss, and debate could ultimately lead to more informed communities making better decisions.

Delivering local and global knowledge on-demand to remote communities requires a computing platform that is widely available, well-networked, and supports simple, language-adaptive interfaces for consuming and producing content. Fortuitously, just as the personal computer revolutionized information access and communication in the western world decades earlier, the mobile phone has emerged as the computing platform for the next billions of Internet users.

1.1 Mobile Phones

While broadband Internet penetration has crept forward slowly in emerging countries, mobile subscriptions are growing exponentially [13]. Mobiles combine several properties that make them ideal as a social information platform for low-income and marginal communities. They have achieved high penetration throughout the world, making them a familiar technology that does not require training, and creates potential for network effects. As of 2011, 80% of the world's population is within the range of GSM networks delivering both voice and data communications [144]. Mobiles are more affordable, and each new generation of handheld devices fall in cost even as capabilities increase toward traditional PCs. They are resilient to intermittent power and connectivity, have long battery lives, and can durably store a significant amount of data locally.

1.2 Voice

Mobile phones are increasingly capable of supporting various forms of content, including text, graphics, and video. However, audio remains compelling for an online platform targeting underserved, low-income communities. Audio works on any phone; cheap voice-centric phones are still used by the vast majority of the world's mobile users in the developing world [34, 30]. An audio-only interface is easily adaptable to any language; The 2001 Census reports 122 distinct languages and over 1,6000 dialects spoken in India [94]. Audio content can be consumed by people with little or no literacy skills. India has the largest illiterate population in the world, currently at 300 million.

In terms of usability, recording voice messages over the phone offers a low barrier to content creation; the user interaction is simply speaking into a phone. Text, the alternative to voice, presents several usability and hardware challenges. It is difficult to compose and read text with small screens and keyboards. It introduces language complexities including awkward key mappings and non-standard, expensive, and/or hard-to-find fonts. Last but not least, it does not accommodate low-literate or illiterate people.

1.3 Thesis Contributions

This thesis presents the design and usage of voice-based social media for rural information sharing. It is guided by three essential questions: First, how do you design effective UIs for navigating audio content? Second, what community dynamics emerge in the system? Third, how do you support sustained user engagement? Using the case study of an agricultural question and answer service for small farmers in Gujarat, India, we present the following contributions:

1. **Usage and social dynamics from a live field study**. Given needs and constraints of agricultural knowledge access outlined in Chapter 2, and prior literature related to voice social media in Chapter 3, we introduce Avaaj Otalo ("voice porch"). AO is a an interactive voice forum for small-scale farmers in India to post, browse, and respond to agricultural questions and answers. We launched AO in a seven-month pilot with 63 farmers across the state of Gujarat. System usage and participant feedback

provided strong evidence that the question and answer board provided a valuable informational resource and rich social space, and offered design lessons for voice-based social media.

2. **Touchtone navigation over speech**. A key design challenge for any voice UI is making navigation simple, accurate, and pleasant. A controlled experiment compared the relative effectiveness of speech to touchtone input on AO, finding that the rural participants completed more tasks using touchtone.

3. **Peer information more influential than scientists**. In AO's pilot, we observed the prominent role that identity and social status played in how farmers used the system and judged agricultural advice. We conducted a controlled experiment comparing AO users' likelihood of acting upon information based on its source. The results showed that opposite to stated preference, participants followed up on information more when it came from peer farmers, compared to university scientists.

4. **Implementation of a voice social media platform**. We present the implementation of Awaaz.De ("give your voice"), a software platform developed through years of experience deploying Avaaj Otalo and similar rural voice information services. Awaaz De's model is based on an "Internet for the few, mobiles for the many" access model. A large number of remote end-users communicate and share through voice messages over a mobile voice interface, and a small number of administrators with Internet access curate, route, broadcast, and respond to messages through a web interface.

5. **Access costs negatively impact usage; two experiments to increase it**. For any technology intervention, a key question is what factors keep people interested and engaged in the service. We examine the impact of access costs on Avaaj Otalos usage, finding that the transition from toll-free to paid phone access had a dramatic downward impact on call volume, and in particular the level of pro-social behavior on the system. We present experiments on incentivizing more access and contribution. Both had inconclusive results, but suggest directions for future study.

Chapter 2

Agriculture Extension: A Motivating Domain

Agriculture is the principle source of livelihood for 2 billion of the world's population [13]. Over 80% of the labor force in the world's low-income countries depends on agriculture [18]. In India alone, there are 600 million agrarian people. The majority of farmers in India are small-scale, working three acres of land [130] earning less than $2 per day [25].

Farmers have a diverse set of information needs. Based on our own field work and prior literature [16], they include learning soil preparation and improvement techniques, water conservation, choosing what crops to plant and in what combination, finding the best and most cost-effective seeds and fertilizer, pest and disease prevention and control, how to time planting, watering, and weeding to coincide with favorable weather patterns and to stave off pests, suggestions for value-added processing of harvest, and which markets to fetch the best prices. Agricultural knowledge and technologies have advanced rapidly in many of these areas, but better technology alone may not increase productivity. Knowledge from scientific institutions must be transferred to farmers and contextualized. Farmers must be fully informed about and costs and benefits of new technologies in order to make the most informed decisions about adopting them [41]. Recognizing disseminating good agricultural practice as a public good, many governments around the world have established agricultural extension programs [41].

2.1 Agricultural Extension

Agricultural extension programs disseminate information from the global knowledge base and local research institutions to farmers, assist in implementing new technologies, and educate farmers to improve their decision-making [7]. It is a form of continuing education for farmers. In the 1980s and 1990s, the World Bank championed the Training and Visit (T&V) extension approach, where trained field workers (traditionally, agricultural graduates) travel to assigned villages on a bi-weekly basis to disseminate new agricultural practices [14]. The World Bank promoted the technique in 50 developing countries around the world, including India. Eventually, the Bank's funding dried up and none of the countries mainstreamed Training and Visit into normal central or state government budgets [8]. Besides inability to sustain financially, Training and Visit extension is challenged by the logistical complexity of reaching all farmers with regular meetings, a lack of accountability to farmers, inability to recruit and continually train a qualified field staff, lack of political commitment, and weak measurement of impact. In a survey conducted by the International Food Policy Research Institute in India, only 6% of respondents reported having interacted with an extension officer [17].

Many aspects of the Training and Visit model remain in today's Indian extension programs. These include a strongly hierarchical structure, regularly scheduled field visits and trainings, and narrow focus on agriculture and specific crops. However, since the 90s, programs have evolved to address limitations of Training and Visit. A major trend has been decentralization [130]. Extension programs in India are primarily handled independently by Departments of Agriculture of each state. At the state level, the trend has been to build institutional capacity at the district, block, and village level. Agri-clinics and education centers at the village level offer intensive, broad-based training on a variety of topics [130]. Recognizing that public extension alone cannot meet the diverse information needs of all farmers [129], state Departments of Agriculture have partnered with local NGOs, agricultural universities, agribusiness companies, and community-based organizations to deliver comprehensive extension services [130].

Many states have taken steps to make agricultural extension more demand driven and accountable to farmers [17]. Extension programs have incorporated community members

closely into their programs. In several states, committees comprising farmers and other village officials evaluate the quality of extension delivery and approve new initiatives proposed by the state DoA. Farmers also participate directly in extension activities. In Rajasthan, a para-extension worker program hires and trains local community members to supplement the reach of the DoA officers [130]. Extension has been facilitated by local farmer clubs and interest groups, which generate demand internally for new knowledge or technology. The DoA provides financial incentives to maintain groups and funnels extension activity through them, expecting the members to propagate the advice. As agricultural extension has trended from top-down Training and Visit to decentralized, participatory approaches, some challenges remain. Information must be easily accessed and shared across fragmented groups and organizations. It must be aggregated for universal access, but also made locally relevant in terms of content and language. Finally, reaching all farmers in remote areas in person is often not practical or efficient. Many institutions around the world, including the Government are India, are looking to ICTs to address these and other challenges [98].

2.2 ICTs and Agricultural Extension

The Indian government has recognized that ICTs can play a critical role in increasing efficiency, comprehensiveness, and local participation in extension services [83]. In particular, ICTs can make it possible to access and document relevant local knowledge, facilitate exchange amongst a broad group of participants, and provide access to all available information [129]. In recent years, promising models of ICTs in extension have emerged. Notably, Digital Green uses locally-produced instructional videos for disseminating new practices. Videos prominently feature local progressive farmers who demonstrate the techniques, which researchers hypothesize has boosted practice adoption [45]. The common ground that farmers find with other farmers that "speak their language" translates to more proactive behavior. Others have delivered information over the Internet on websites tailored to local farmers' needs, in the local language [111, 113]. Radio remains a practical and effective means of agricultural information dissemination because of its familiarity, affordability, and the broadcasting capability. In one creative model, radio listeners call into

a live show with queries, and the radio jockey with Internet access types them into a search engine and relays the results live over the air [107].

Mobile phones have been utilized for a number of rural information projects in India [136, 73, 5, 87, 59, 46, 23] (for more complete lists, see [98] and [44]). Many of the services use synchronous or asynchronous voice communications to overcome the difficulty of composing and reading text messages [80]. LifeLines [73] 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. While having a human operator on the other line makes information requests with natural language possible, a downside is that they can only be made during office hours. In addition, Lifelines is not set up to allow people to contribute their own experiences and knowledge to the database for others to directly access. As discussed earlier, peer-to-peer information sharing provides common ground and an opportunity to learn from others facing similar problems. Many of the asynchronous voice solutions [59, 46, 23] face a similar problem: how to generate high quality content from local sources.

Chapter 3

Background Literature on Voice Social Media

3.1 Voice social media

In the early 1900s, rural Americans adapted the telephone network as a community gathering place. Rural phone companies broadcasted news and weather reports, churches conducted sermons over the phone, and individuals played music or read books to remote audiences [64]. The most popular innovation was the party line, in which groups of dozens or more individuals eavesdroped, or "rubbered", on phone calls intended for others. Far from an annoyance, party lines were a legitimate part of mainstream rural culture. It was an extension of the custom of "visiting" [64]. While some phone companies saw party lines as an abuse of their service and attempted to block them, other companies modified their systems to better support them. People derived social value and a shared context with their community by simply listening in.

A limitation of party lines was that discussions were ephemeral; there wasn't a way for people to catch up on the conversation later on. In the 1980s, chat lines became popular for single men and women to meet by recording voice messages on public voice chat rooms [137]. Later, researchers applied voice message boards for use in event coordination, question and answer, crowdsourced news, and civic engagement [114, 19]. They found that people will tolerate a relatively low-tech platform if it attracts a broader range

of participants, and that the voice medium offers a level of expressivity that text does not. Voice-based exchange raised the challenge of anonymity and privacy, and a voice-only interface was found to be difficult for novice users to form a mental model around [19]. Other applications have been deployed and studied in work environments [70, 3]. Thunderwire allowed office colleagues to communicate through an always-on, voice-only conference call. Participants developed a variety of communication norms to overcome the technically bare-bones medium and create a lively and active social space.

This dissertation extends knowledge of voice social media by applying it to a social, cultural, and economic context outside the scope of prior work. It's likely that some principles and insights from studying affluent, technology-savvy, educated, western users also apply to low-income, remote, uneducated, technology-novice rural Indians. On the other hand, people's social and cultural environment [78], socioeconomic status [54], and previous computer experience [52] affect what computing technology they access and how they appropriate it. As we strive to understand how to make technology usable and accessible for all people, we need to identify what principles do and do not generalize by testing their applicability in new contexts. For example, Avaaj Otalo's pilot participants adopted communication norms similar to those observed in Thunderwire and other online communities (Chapter 4). On the other hand, social status and identity played a more critical role than we had expected (Chapter 6).

3.2 Navigating Voice Interfaces

Users often find touchtone menu navigation systems frustrating because they are slow to use and constraining in their options. Designers and researchers have advocated moving away from touchtone menus toward a more natural, conversational interaction style [32, 146]. Spoken dialog systems should accept a range of input, including compound responses [47]. The flexibility of input leads to a more human-like interaction; users are willing to tolerate recognition errors if they feel the system is being responsive and cooperative [47, 71]. In one study, researchers found that participants who experienced the greatest recognition error rates (as high as 48%) gave some of the most glowing reviews of the system. The researchers concluded that error rate does not predict satisfaction because people cover a

wide range of expectations, and satisfaction is based on how well the system fulfills those expectations [146].

A number of spoken dialog systems for developing regions have employed a conversational approach. The designers have run into the challenge of bootstrapping a speech recognizer in one of the thousands of under-supported languages spoken in remote areas of the world. Modern speech recognition techniques require hundreds or even thousands of hours of speech data in the target language. Collecting and labeling the data is time-consuming and expensive, making it difficult to scale to multiple languages. Without the time and resources to bootstrap a large vocabulary, continuous speech recognizer, a common approach is to limit the recognition vocabulary to roughly 50 command words, which a user can give through single word input [105]. With single word input over a small vocabulary, much of the naturalness afforded by spoken input is lost.

Recognizing this, more recent work on voice UIs in developing regions have compared touchtone input to isolated-word speech. The results were mixed. In one case, isolated word had higher task completion rate, but no difference in preference [124]. In another, there was no difference in task completion, but touchtone was preferred [122]. Chapter 5 presents our study, which finds higher completion with touchtone, but with no difference in satisfaction. We discuss our results and possible explanations for the inconsistencies with the other studies.

3.2.1 How to browse all that audio?

Prior research has worked on ways to cope with browsing large amounts of audio content through both visual and voice-only interfaces. In the former, automatic speech recognition was applied to create transcripts helped users scan, search, and extract information from voicemails [143]. Even with recognition errors, the ability to scan visually made processing voicemails more efficient. Another project used metadata about threaded voice messages to visualize the chat space [148]. In the evaluation, people found visual indications of what a message was about more important than browsing metadata like a user's history or thread popularity.

In the voice-only domain, one strategy is to structure inputted voice content through

voice-based forms [121]. Other approaches had users annotate speech either during or after it was recorded [55]. In both cases, the unstructured nature of speech made it necessary for humans to supply extra time, effort or both to index the content for efficient retrieval. Other research attempts to make browsing audio faster automatically by compressing silence or speeding up the audio [132, 62], or skimming chunks based on acoustical signals [12]. In direct comparisons, researchers found that subjects find it easier to understand audio that was compressed based on semantic summarization compared to acoustic [132]. However, semantic techniques are only possible when speech-to-text is available in the target language. Chapter 7 presents an implementation of our voice social media platform that works absent of automatic speech recognition, and instead relies on a human to index incoming voice content.

3.3 Social dynamics in online Q&A systems

Online, virtual spaces where people communicate and exchange information grew along with the Internet in the 1980s and 90s. Early online communities included the Usenet [51] and the WELL [118], where people from around the world participated in thousands of hierarchically organized, public, text-based, threaded newsgroups. Since then, researchers have been studying online forums and question and answer systems by profiling users [133, 84, 145], identifying usage patterns [4, 2], modelling what motivates people to use and contribute to them [65, 35] and what keeps people coming back [27, 40]. As computing algorithms and devices have matured, researchers have studied how design elements such as reputation systems, game mechanics, and motivational feedback influence interaction within the virtual spaces [74, 116, 76].

Researchers studying the Usenet categorized the newsgroups, authors, and threads based on posting patterns and how they developed over time [133]. They identified several characteristic types of contributors, such as the Answer Person, the Questioner, and the Troll. Other studies of large-scale question and answer communities consistently find that a small number of core users comprise the majority of posting activity [84], most people consume content on the system without contributing (known as lurkers) [88], and “answer people” are often a small and distinct subgroup of the overall community [133]. Chapter 4

shows that the voice-based question and answer forum for rural Indian farmers exhibited some usage trends that were consistent to these findings (such as emergence of a core user group) and some that broke with them (such as distinct groups of questioners and answer people).

One of the most remarkable aspects of online forums is the amount of time, effort, and knowledge people contribute to anonymous strangers for free. How have these systems been able to overcome the free rider problem [139]? First, the production of digital public goods works under a different cost-benefit structure than their physical counterparts. The cost in time, money and effort to sign an online petition is lower than mailing in a letter. Even this small reduction in costs can have a relatively large impact on behavior [65]. Coordination costs for people to exchange information are lowered; time and physical location are no longer constraints, and digital information can be distributed anywhere in the world at near-zero cost. Producing digital goods is attractive because they are non-rival; any number of people can benefit without taking away from others. In addition, whereas physical public goods often take the collective effort of many, digital goods can be products of empowered individuals.

From open source software projects like Linux to successful Web 2.0 applications like Wikipedia and Stack Overflow, online communities can appeal to a variety of motivations [65, 125, 76]. Researchers have laid out a number of frameworks for understanding them [20, 147, 108, 65, 35]. Commonly, the frameworks list reciprocity, reputation or prestige, self-learning, efficacy (sense of accomplishment), community advancement, enjoyment in helping others, and social interaction. Some motivations such as community advancement are helped by organisation around shared interests. This makes it easier for members to empathize and lend support [118, 141]. The motivations are sometimes grouped into self-interest and group-interest [147], or extrinsic (brought on by external factors) and intrinsic (based on internally generated feelings) [108]. Other researchers have used social psychological principles to explain motivations, demonstrating increases in online contribution by highlighting the uniqueness of individual contribution, setting group or individual goals, providing social approval, and exposing individuals to cooperative behavior of others [27, 74]. Another body of work has studied the impact of financial incentives in online contribution. The results have been mixed: some studies show that quality [57, 50]

and quantity [58] can be bought, while other results show that there is at best a weak tie to either [61, 26, 58]. Chapter 8 builds upon this work by presenting two experiments attempting to increase usage and social interaction in two different voice question and answer systems through monetary and non-monetary motivations.

3.3.1 Identity in Online Communities

Identity is a foundational element of online communities closely related to motivation. Reciprocity, for example, rests on having a persistent online identity to associate past give and take to. Accumulating reputation similarly relies on an identity. In the virtual world, identity is decoupled from the physical body, so it can be ambiguous and deceiving [38]. The mediating interface defines how (and how much) identity is expressed. The spectrum ranges from attribution of real names on sites like Facebook [60] to predominantly anonymous membership as on 4chan.org [15]. Usenet members relied on cues from message posts, such as signatures and email addresses, to ascribe credibility and sniff out trolls [38]. Many online communities introduce some form of reputation system to foster trust among members. Reputation systems constrain members' present behavior because they expect that their future interactions are staked on it [116]. Reputation systems aggregate ratings (positive, negative, or both), comments, or other types of feedback to the user community [66]. Reputation may also be conveyed through indirect cues, such as an eBay seller conveying legitimacy by linking to their other physical or virtual storefront [66].

In most cases reputation systems are based solely on actions within the system, and do not incorporate an offline reputation. The idea is to provide a level playing field for any member of the online community to have an equal voice in the conversation [131]. While the egalitarian ethos of the Internet may be beneficial for collaborative work in some online communities, representing users' offline identity is useful in some situations, such as a doctor-patient discussion group or an advanced mathematics question and answer site [131]. Highly salient identity cues based on offline social and cultural factors can also seep into online communities. For example, racial identity has played a prominent role in online communities of Americans [142]. In India, social hierarchy is a deeply rooted

feature of society [39]. How does it impact Indians' social behavior online? Chapter 6 investigates that question in the context of information presented to farmers on Avaaj Otalo.

An information sources identity is one of many cues that people use to judge the strength, persuasiveness, or quality of a message. Depending on personal involvement, motivation, and capability, an individual may choose to *centrally* process the informational content, or rely on *peripheral* cues such as the source's authoritativeness, the length of the message, or whether it is a majority opinion [24]. Researchers have found that for information retrieval online, people assess credibility and quality much in the same way as from traditional media: a combination of assessing the source, the message, and the medium [140]. On the other hand, the lack of standardized quality controls and the sheer amount of information on the web lead to users to rely on a wider range of evidence to ascribe credibility [119].

Given needs and constraints of agricultural knowledge access outlined in Chapter 2, and prior insights related to voice social media from this chapter, we next introduce Avaaj Otalo ("voice porch"). We designed, developed, and deployed AO with local partners in Gujarat India to observe real-world usage of a voice-based social media service, and to spark further research questions on how best to design them.

Chapter 4

A Field Study of a Voice-based Question and Answer Service[1]

Figure 4.1: A farmer in Gujarat, India, accessing agricultural information through AVAAJ OTALO.

This chapter introduces *Avaaj Otalo* (literally, "voice porch"), an asynchronous voice question and answer service in Gujarat, India. Figure 4.1 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 [105, 123]. A few research efforts have sought to develop voice message forums, both for the developed world [115, 148] and for the developing world [22, 67]. To the best of our knowledge, only one early effort has ever been deployed or studied for an extended period [115]. In our case, exposure to Avaaj

[1]This chapter is adapted from [102]

Otalo provided users with their first experience with an online community of any sort.

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. Based on these findings, we discuss some design implications for social media tools serving agrarian communities in India and elsewhere.

4.1 System Background

4.1.1 Development Support Center and Extension through Radio

In 2008, we began working with Development Support Center (DSC), a non-profit rural development organization based in Gujarat, India. Since 1994, DSC has been developing and implementing programs to improve livelihoods among agricultural communities in the most drought-prone areas of the state. As is common across India, the majority of farmers in Gujarat are small-scale (less than five acres) and engage in dry-land (*i.e.*, non-irrigated) farming. DSC facilitates natural resource management initiatives in local communities for conserving water and engaging in ecologically friendly agricultural practices. They also perform extension activities for agricultural productivity enhancement.

Prior to our arrival, DSC had two extension activities. One was the distribution of a farming magazine, *Diva Dandee* ("Lighthouse", see Figure 4.2), which contains news articles on agriculture in Gujarat, information on government programs, farming education opportunities, and innovative techniques featuring farmers. Second, DSC broadcasts a weekly radio program throughout the state, called *Sajjata No Sang, Lave Kheti maa Rang* ("Bringing color to the farmlands"). The 15-minute long program airs every Thursday evening over All-India Radio, India's public radio station. The program has been on air since 2006, and regarded as one of Gujarat's most popular agriculture-related programs. Estimated average listenership is 500,000. DSC attributes the program's success to three main factors. First, it provides discussion of timely issues. Each week, the program producers develop a script based on the current stage in the growing season and any dynamic circumstances such as unseasonable rain or a pest breakout. The topics are finalized and the advice is vetted by an agricultural scientist.

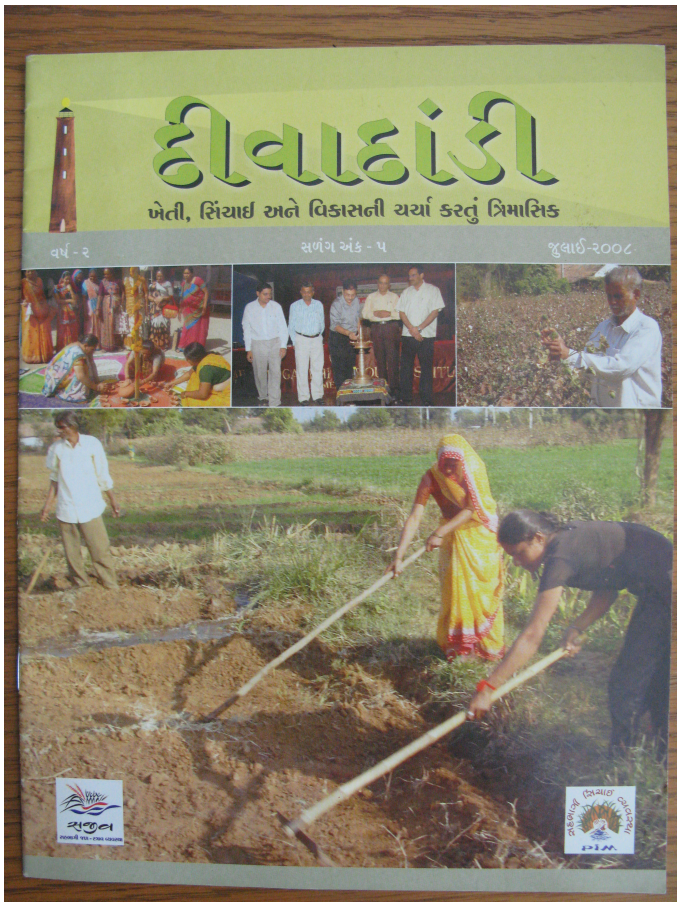

Figure 4.2: Cover of DSC's quarterly magazine, Diva Dandee

The second key element of the program is its "info-tainment" format. The content is performed as a scripted dialog between a re-occurring cast of characters, played by professional voice actors (see Figure 4.3). In every episode, there are agricultural experts and farmers, usually one male farmer and one female. The program consists of a lively back-and-forth between the experts and the farmers. The show avoids being preachy and condescending by using the farmer characters as a proxy for the listening audience. The female farmer is typically portrayed as progressive, far-sighted, and resourceful, while the male farmer is absent-minded and naive, asking the "dumb" questions. The conversation is light and humorous, balancing technical knowledge dissemination and entertainment.

Figure 4.3: A studio recording session of DSC's radio program

DSC also attributes the programs success to incorporating feedback and soliciting listener participation. This happens in two ways. First, farmers are featured in a program segment called *nuvo cheelo* ("new innovations"). The segment is a pre-recorded interview between a character on the show and an actual farmer discussing an innovative technique or solution to a problem. Anecdotally, DSC has found this segment to garner the most enthusiastic response from listeners. The second type of listener participation is phone calls and letters from listeners to DSC's offices. After each program airing on Thursday evenings, DSC opens their office phone lines for farmers to call in to give their reactions to the program, ask follow-up questions, and participate in trivia contests announced during the program. Farmers routinely take the opportunity to let DSC know what issues they are experiencing, and that feedback helps guide the next weeks script. In addition, farmers call the office and even the personal phone numbers of staffers throughout the week with their questions, comments, and experiences. During the most critical stages of the growing season, DSC receives over 100 phone calls and 40 hand-written letters every week.

In the Summer of 2008, we observed the radio program's success and listeners' enthusiasm in calling into DSC and giving feedback. There was a natural desire to "keep the conversation going" throughout the course of the week while the radio program was off the air. Farmers were using the content presented on the radio to spark new questions and discussions on other topics. We also saw that the volume of feedback was overwhelming the

Figure 4.4: DSC staff member deluged with farmer phone calls.

two-person DSC producer team, who received up to 30 calls per day from farmers throughout the state (see Figure 4.4). Many callers asked redundant questions, and often calls came outside of normal office hours. And finally, the popularity of the "new innovations" segment suggested that there was a demand for farmers to hear from other farmers.

We saw an opportunity to address several needs. The first was for DSC staffers to incorporate more listener feedback into the program directly and indirectly, and more efficiently respond to questions and suggestions. Being able to respond to redundant questions once for everyone would be valuable. Second, farmers needed information all the time, not just for 15 minutes a week during the radio broadcast. An easily accessible, on-demand information source would greatly enhance their ability to get relevant and timely advice. Finally, farmers were interested and enthusiastic to hear from other farmers like themselves.

4.1.2 Testing a Voice Interface in the Field

We administered questionnaires and focus group discussions with farmers, agricultural experts, DSC management and staff, and producers of the radio program to identify the right technology and features to address these needs. Based on the interviews, we identified a voice-based system accessible through mobile phones as the most appropriate technology choice. One of our collaborators coined the name Avaaj Otalo ("voice porch") for the service, in reference to the common area in front of many rural cottages where people gather

Figure 4.5: Testing voice interaction with farmers using flashcards.

to gossip and trade stories of the day. Most of the farmers had access to a phone, either their own or through a close relative or friend. We considered SMS, but found that most farmers did not compose or read text messages. In contrast, a flash card prototype indicated that most farmers could interact with an automated voice application (See Figure 4.5).

The flash card prototype also demonstrated the difficulty people had responding to conversational, open-ended prompts. A prompt such as, "Would you like to ask a question, listen to announcements, or listen to the radio program?" did not elicit as much desired input as: "To ask a question, say question; to hear announcements, say announcements; to listen to the radio program, say radio." Choosing explicit prompting, we considered two alternative input modalities for Avaaj Otalo: speech and touchtone. Chapter 5 shows the results of an experiment comparing the two.

4.1.3 Features

Wizard-of-Oz tests with farmers showed that they could quickly learn to use an interactive, menu-based voice interface. However, to avoid overwhelming first-time users, we wanted to limit the number of menu levels to get to content and functionality to one, and the number of menu options at any point to three. We included the following three features in the initial version of Avaaj Otalo, based on needs-finding with farmers and DSC:

- **Question and Answer Forum**. Users can 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 4.6 gives a sample interaction with AO to post a question.

- **Announcements Board**. This allows DSC to upload 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 contains all previously broadcast programs, starting with the most recent. Users browse 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 4.6: A sample interaction with AVAAJ OTALO.

4.1.4 Implementation

For the field study, Avaaj Otalo was implemented as a VoiceSite using IBM Research's Spoken Web platform [68]. 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, we observed a speech recognition accuracy of 94% in a largely quiet, indoor setting (see Chapter 5).

4.2 Pilot Deployment

After AO was implemented, we launched a pilot with 51 users scheduled to run for seven months[2]. 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.

4.2.1 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 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 was a school teacher and the other a businessman. All participants were male, due to the difficulty in recruiting female

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

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 replacements[3]. 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. They demonstrated system navigation and feature access through a 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 calls from pilot participants, who accessed the system through a toll free number.

4.2.2 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 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]Usage data includes these participants.

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.

4.3 Study Findings

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

4.3.1 Traffic Overview

Over the seven-month pilot, 6,975 calls were made to AO. The average call duration was approximately 5 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 4.7 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%.

4.3.2 Usability

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

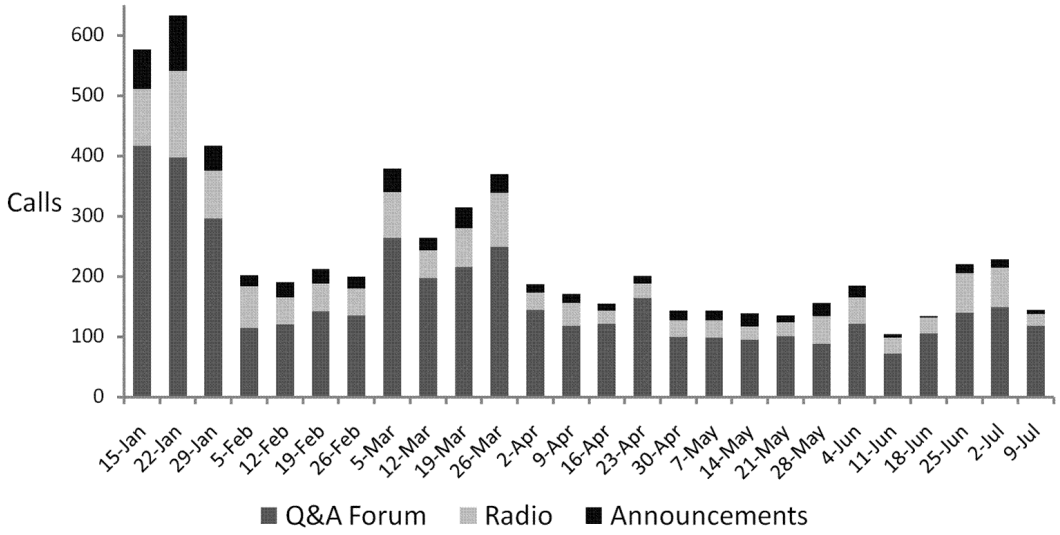

Figure 4.7: Number of calls to the three sections of AVAAJ OTALO, by week.

Errors

The average number of input errors (no match or no input) per call was .95, and the number of errors did not decrease significantly from the beginning to the end of the pilot. (see Figure 4.8). The number of question re-records and hang-ups before giving input to the initial prompt also did not decrease over time.

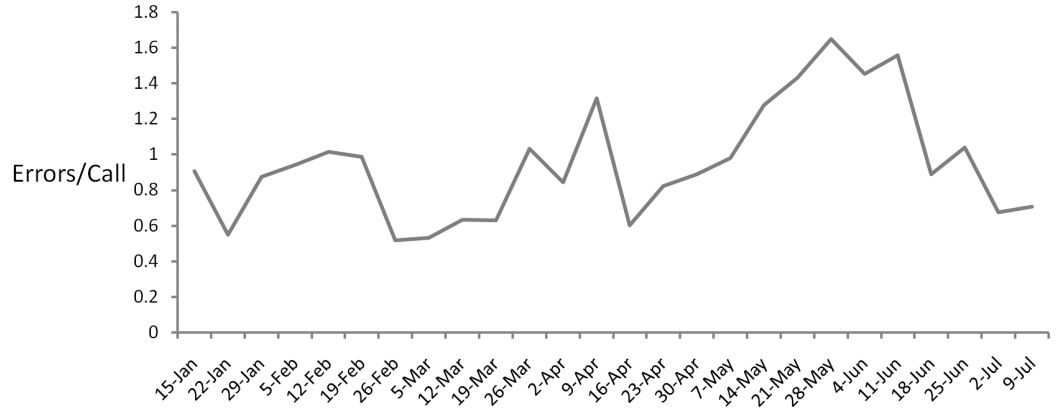

Figure 4.8: Number of input errors per call, by week.

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 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 because they weren't aware of the technical possibility.

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.

4.3.3 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 4.9 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 4.10 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

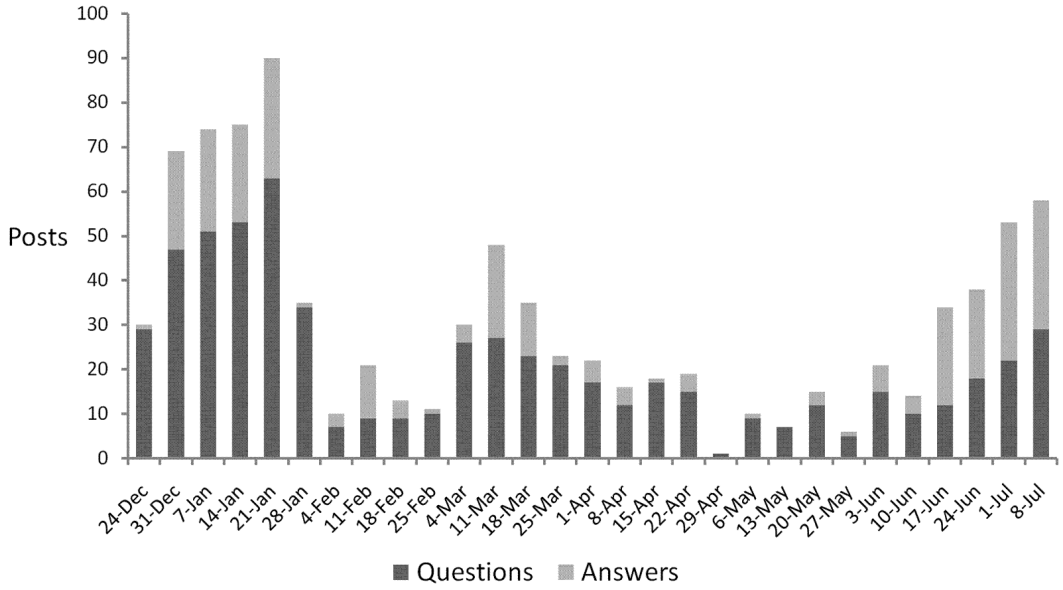

Figure 4.9: Number of questions and answers posted to AO, by week.

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 understand 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.

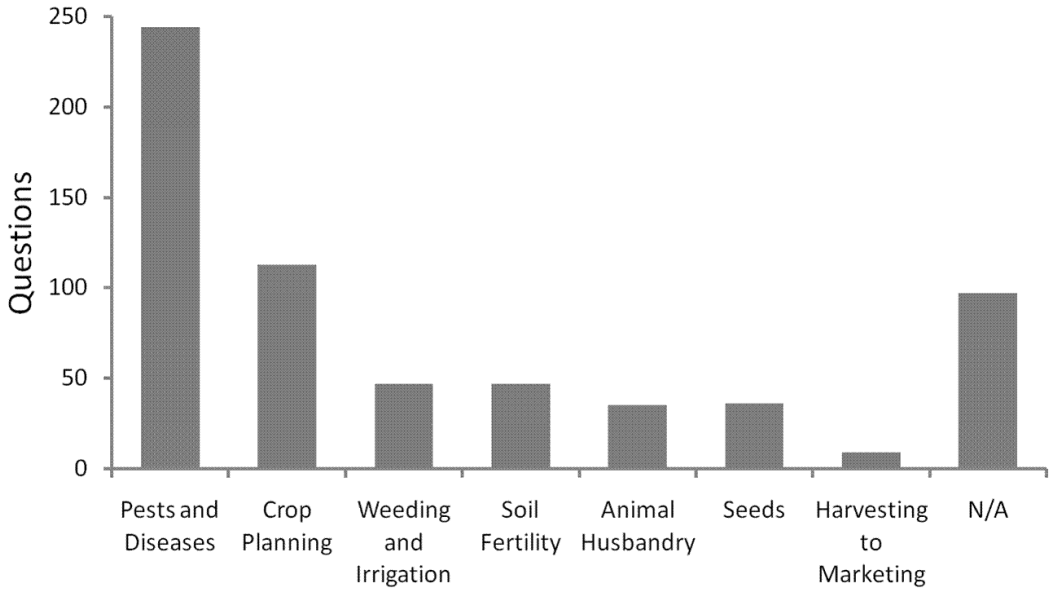

Figure 4.10: Number of questions posted to AO, by category.

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 questions, 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 4.9. 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.

4.3.4 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 taking care to post only accurate, novel, and relevant 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 intermediaries in some way, including 4 of the 6 most active users.

Social Status

AO users were often drawn to the intermediary 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.

4.3.5 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.

4.4 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.

4.4.1 Need for Structured and Open Spaces

One of the most striking findings from our study was the overwhelming stated 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.

Avaaj Otalo's design and social dynamic has parallels to Answer Garden, a research system for people within organizations to seek answers from higher-status "expert" members [2]. Answer Garden's goals strongly overlapped with Avaaj Otalo's: provide an interactive repository of expert answers, and alleviate the burden for experts in answering redundant questions. Answer Garden was also designed to relieve some social status issues around asking questions to experts. Users could post questions anonymously in order to avoid feeling intimidated or being perceived as incompetent, and be free to ask experts

without feeling obligated to reciprocate. For AO, these did not seem to be concerns. Farmers willingly identified themselves when seeking information from DSC's staff. Rather than fearing negative perceptions, farmers seemed to take pride in asking good questions, recognizing the value it had to other listeners. An interesting insight from Answer Garden's field studies was that the removal of the social barriers to asking experts led to a large proportion of answers that were not at the right level; experts provided too much or too little detail. By allowing social implications to play out, questions can channel to the appropriate expertise level. An open question and answer forum does just that; it gives peers an opportunity to respond, blurring the artificial distinction between "experts" and everyone else.

Many users desired more structure and transparency in the the service. 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. Based on these observations, a fourth 'Experiences' option was added to AO for people to share in an open-end way.

4.4.2 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 challenge here in leveraging social ties and trust relationships in online social spaces while not perpetuating existing stereotypes or inequalities that would deter participation. A similar challenge exists on Wikipedia, where people perceive those who edit the site as highly educated. This creates a participation barrier among those who feel they lack those skills or qualifications [9]. This challenge 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.

4.4.3 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 are convinced that

getting farmers to use and trust AO would have been a much greater challenge.

4.4.4 Financial Sustainability

As Avaaj Otalo transitioned from pilot to mainstream service, the first question raised was how it would be paid for. In the pilot, the service was available through a toll-free number, so that all airtime costs were borne by DSC. These airtime charges comprise the majority of AO's operational costs. In informal discussions, some participants indicated that they would be hesitant to use the service if it were not free. On the other hand, many farmers were calling DSC for advice at their own cost well before AO was offered. One pilot participant welcomed users paying for their own calls, saying it would discourage spurious or off-topic posts. After the pilot, DSC decided to transition the number from toll-free to local. Chapter 8 presents and discusses the impact of paid calling on AO's usage and social behavior.

4.5 Conclusion

This chapter presented the results from a field study of Avaaj Otalo. The 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. The forum provide access to timely and relevant agricultural advice while serving as a lively social space with the emergence of norms, persistent moderation, a variety of uses other than agricultural advice. Specific issues were raised: whether the user interface was easy and intuitive for navigation, and the role of social status and the strong preference for "expert" answers. In the following chapters, we examine these questions further.

Chapter 5

Comparing Speech and Touchtone Input[1]

5.1 Introduction

Speech interfaces have been identified for their potential to increase access to information services in developing countries like India, where 480 million illiterate people reside [135]. Earlier research has demonstrated that automatic speech recognition (ASR) is possible for languages and dialects with limited speech resources, such as many of those spoken in India [106]. However, with limited quantity and quality of hand-labeled speech data, acceptable error rates can only be obtained with a voice user interface (VUI) design that accepts a small number of distinct single word utterances at each node in the application (isolated word speech input). Isolated word interfaces can accept open-ended input, make it easier to remember what input to give [124]. However, for navigating voice menus with 3-5 options, touchtone may be faster, more accurate, and preferable in most situations.

This chapter presents a study comparing isolated word speech and touchtone input for navigating a voice interface for farmers in rural Gujarat, India. We conducted a controlled, between-subjects experiment with 45 participants, none of whom had any prior experience using an interactive voice response (IVR) system. The study compared task completion rate and user preference between the two input modalities and to correlate the results to users'

[1]This chapter is adapted from [101]

education levels and age. Touchtone outperformed speech in terms of task completion rate and learnability, and users reported significantly less difficulty providing input using touchtone.

Several studies have compared touchtone to various types of speech input systems with Western users [71, 37, 21]. One compared a touchtone interface to a fully functioning natural language system. User preference depended on the task being completed; touchtone was preferred for linear tasks (*i.e.*, listening to voicemails in the order received), while continuous word speech was preferred for non-linear tasks (*i.e.*, listening to voicemails from a specific acquaintance in random order) [71]. Another studying comparing touchtone to three different speech input systems and found that touchtone input was faster and more preferable than isolated word [37]. Touchtone was found faster because users could more easily "barge in" while the prompt was still playing, and didn't require the system to confirm input each time voice commands were given. Isolated word was reported less preferable to touchtone in this and another study [21] because having a spoken conversation while being constrained to single words or phrases is unnatural. This chapter presents results from an important user population outside the scope of these studies.

Two existing studies compared touchtone to isolated word speech input with low-literate, technology novices in the developing world. Figure 5.1 summarizes their results. In one, 20 female community health workers in Pakistan navigated a 3-level, 2-3 option per level voice menu using isolated word speech and touchtone [124]. There was a significantly higher task completion rate overall with speech input, though no difference in preference between the two modalities. Literate participants completed significantly more tasks than low-literacy participants overall. Participants commented that speaking was more familiar than dialing, although some found it challenging to "say the right thing" and speak single-word commands. In another study, 27 rural female caregivers in Botsana completed three-level navigation tasks with speech and touchtone [122]. No difference in task completion was found, though there was a preference for touchtone. The speech condition was likely helped by using Wizard-of-Oz interaction instead of an actual speech recognizer. In the first study, participants were given time to practice with the system and were coached by the researchers. In the second, participants were introduced to the system by watching a video tutorial. This study contributes results from mostly male participants who were not

	Technology	Literacy	Training	Result; User pref
IBM staff, U.S *[Lee and Lai, 2005]*	**Natural language** *~80% accuracy*	**High**	**None**	**Touchtone; prefer speech**
Hospital staff, Botswana *[Sharma et. al., 2009]*	**Wizard of Oz** *100% accuracy*	**Low**	**Yes**	**No sig. diff.; prefer touchtone**
Community health workers, Pakistan *[Sherwani et. al., 2009]*	**Cross-language transfer 93% accuracy**	**Low**	**Yes**	**Speech; no preference**
This study				
Farmers in India	**Cross-language transfer 94% accuracy**	**Low**	**None**	**Touchtone; no preference**

Figure 5.1: Results of studies comparing isolated word and touchtone from around the world.

given prior practice or a demonstration of the interface.

In other prior work, researchers designed a spoken dialog system in Tamil for farmers to access agricultural market information [106]. They achieved a 2% error rate with data from 15 speakers by restricting a bootstrapped speech recognizer's input vocabulary to 2-3 words per node. The tradeoff for more accuracy was low-perplexity menu navigation. This study used an isolated word interface using the *cross-language transfer* method, where an acoustic model trained in one language (in this case, English) is applied unmodified to a target language (Gujarati) using a transliterated vocabulary.

5.2 Prototype

We tested isolated word and touchtone versions of Avaaj Otalo. Prompts were recorded in a professional studio by one of the DSC radio program's popular female voice personalities. Barge-in input was disallowed for both treatments.

We built and deployed Avaaj Otalo using IBM Research India's WWTW [**?**] platform.

For speech recognition, Gujarati commands were converted to lexicons using the American English phoneme set. In the experiment, the system performed with a recognition accuracy of 94%. Although this is lower than Plauché's Tamil system [106] and industry standards (98% accuracy), the difference reflects the limitations of the cross-language transfer method for recognition in low-resource languages.

5.3 Method

We tested Avaaj Otalo with 45 participants recruited from ten districts throughout rural Gujarat. To participate, we only required that subjects be farmers by profession. We focused on recruiting small-scale farmers; the median farm size was 10 acres. All of the participants spoke Gujarati as their primary language, and none spoke English. The majority of participants (87%) reported never having used a PC.

The experiment used a between-subjects design to avoid a priming effect. Input modality was randomly assigned to each user to balance across age, education and gender.

Testing sessions were led by a DSC staff member who had experience communicating with the target user group. Participants were first introduced to the system and its features, and were assured that it was the system that was being tested, not them. Each participant completed three tasks with Avaaj Otalo corresponding to its three features. The first task was listening to announcements, which took exactly one navigational step. The second task was listening to an archived radio program, which took three steps. The final task, recording a question in the question and answer forum, took nine navigational steps. These steps were choosing to record, recording, confirming the recording, categorizing the recording by crop and topic, and recording one's name and location. The tasks were ordered by increasing number of steps for all participants.

If the system could not recognize user input, or if the user was silent, a follow-up prompt would ask the user to try again. If input was again not recognized, the system reverted to a series of yes-or-no prompts, offering each option serially. A failed task meant the user either navigated to a part of the application that was not called for by the task, or failed to get passed the yes-or-no prompts after several attempts with no sign of recovery.

We tested 38 participants in a quiet office, with only the DSC staffer and two researchers

as observers. Both conditions used a landline phone. Seven other participants, all women, were tested at their residences since they were unable to travel to the office. In the field, we mimicked the office environment by testing in a quiet room with only the researchers and one family member of the participant present. A landline phone was not available, so a mobile phone was used instead. Participants in the touchtone treatment used a headset so that the dialpad could remain in front of them (see figure 5.2).

Figure 5.2: Testing the DTMF interface with a participant at her home.

5.3.1 Capturing Data

We administered a pre-test questionnaire to collect demographics of the participants. The system logged task completion, errors, and call duration. During the test, two researchers noted points of difficulty, facial expressions, and comments by the participants during the call. To measure user satisfaction, ease of use, and learnability, we administered a post-test questionnaire with Likert scales.

5.4 Results

5.4.1 Performance Results

The overall task completion rate with DTMF was significantly higher than with speech (74% vs. 61%; $p < 0.05$). Figure 5.3 shows the breakdown by task, and according to age and education level. The third task, recording a question, consisted of three subtasks: categorizing the question, recording the question, and recording the participant's name and location. Categorization (task 3a) was the most difficult because it required traversing several levels, choosing one of nine crops, and one of six agricultural topics. For this subtask, touchtone users had a significantly higher completion rate than speech (the completion rates were also higher for 3b and 3c, but not significantly so).

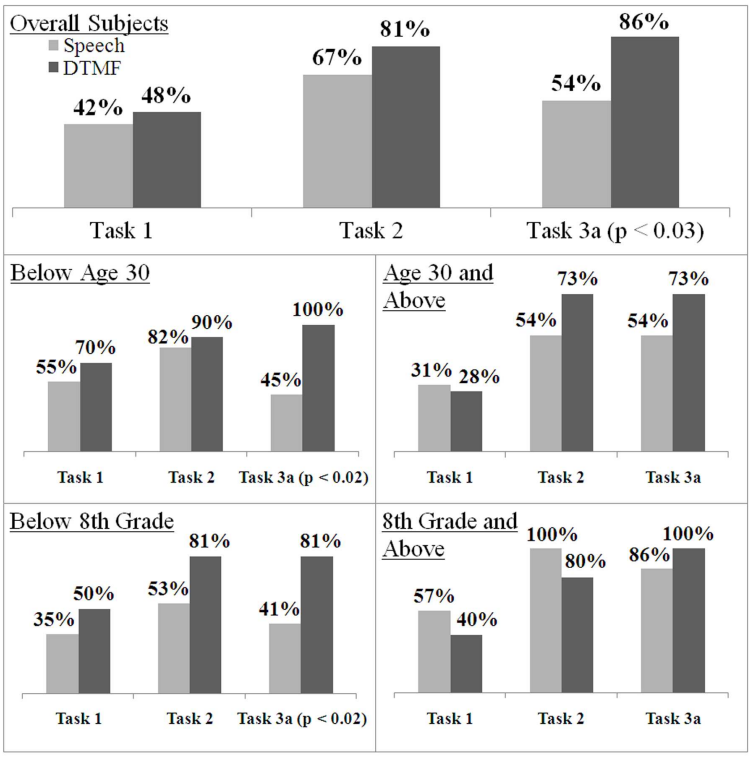

Figure 5.3: Task completion rates for speech (light gray) and touchtone (dark gray) versions. P-values are given where rate differences were significant.

	Task1	Task2	Task3
DTMF	48%	19%	29%
Speech	63%	42%	42%

Table 5.1: Percentage of users who reported each task as either "difficult" or "very difficult".

Participants using the touchtone interface also demonstrated a significantly greater performance improvement between the first and third task. We calculated the effect size using Cohen's d repeated measures analysis, corrected for correlated datasets [31]. DTMF users experienced a "large positive difference" (Cohen's d-value = 0.99) in completion rates between task 1 and 3. With speech the effect was a "small positive difference" (Cohen's d-value = 0.26).

Despite the difference in task completion rate, there was no significant difference in user satisfaction. In both groups, over 80% of users reported that they found it easy to access information from the system. Over 75% of both groups said they would "definitely" use such an application if it was made available.

5.4.2 User Perception of Difficulty

Table 5.1 displays the percentage of users who reported that a particular task was either "difficult" or "very difficult", based on a five-point Likert scale. Across all tasks, the percentage of such responses was 49% for speech and 30% for DTMF ($p < 0.05$). When specifically asked whether they faced any difficulty providing input to the system, 81% of DTMF users answered "no" or "definitely no", compared to 38% for speech users ($p < 0.01$).

5.5 Discussion

Touchtone input led to an higher task completion rate overall compared to isolated word input, confirming results from studies in the Western world [37, 71]. The result is consistent with prior UI design studies finding that semi-literate people's numerical literacy can be safely leveraged [97]. Our observations indicated two reasons why speech input's

task completion rate suffered. First, users expressed discomfort speaking single word commands, which was perceived as unnatural. "Talking to the computer" was an unfamiliar idea; touchtone users may have had an easier time forming a mental model of the system. The second reason was difficulty in recovering from errors made by either the system (recognition error) or the user (bad or no input). With speech input, the task completion rate was 42% when one or more recognition errors occurred, compared to 67% when no errors occurred ($p < 0.05$). Given that this interface is intended for low-literate, technology novices, it was notable that speech input had higher task completion only amongst the more educated participants.

Task completion and user preference results from this study conflict with the other two most similar studies from literature (see Figure 5.1). One of the key differences between those experiments and this one is the level of exposure participants received to the interface prior to attempting the tasks. To stay consistent with the common real-world scenario, this study gave participants no formal training with the system prior to beginning the tasks. In the other studies, training was given through hands-on use in one case, and a video tutorial in the other. Both gave participants more preparation in dealing with speech recognition errors and more comfort in giving single-word commands.

Findings from this study were later complemented by *in situ* results during the AO pilot. During the pilot, AO allowed users to choose between voice and touchtone for navigating menus. 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 4.6). Subsequent prompts presented menu options using the same mode. Figure 5.4 shows input mode selection in Avaaj Otalo over time. Touchtone was selected significantly more than voice in every week of the pilot period. 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. Unlike in the lab setting, the recognizer had to contend with noisy background environments.

Even if speech input gets easier to use with practice, it is critical that the interface accomodate novice users. It is not logistically or financially practical to train all potential users of the interface; instead, it should be easy to self-learn. No users expressed difficulty in understanding how to operate the system through touchtone input, including several

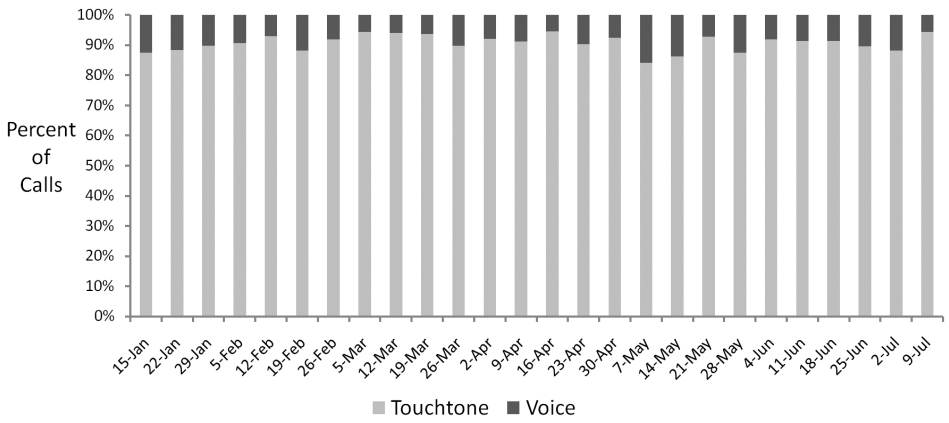

Figure 5.4: Input mode selection, by week.

fully illiterate participants. Though not mentioned by any study participant, one difficulty could be changing between touchtone and speech, which was required in the final task for recording the user's question and personal information. A difficulty across both modalities was navigating command-driven menus and knowing when to provide input. Every spoken prompt was followed by a beep to indicate that input was requested. The prompts did not explicitly mention the beep, and many users either gave input too early or not at all.

Difficulties notwithstanding, the participants' response to the application was unanimously enthusiastic. Many farmers said that the ability to access information at any time would have a significant impact on their farming practices. A few farmers singled out the ability to share their personal experiences with other farmers and with DSC staff as a key benefit of the system.

This study tested touchtone and speech with only low-perplexity navigation tasks. As shown in other studies [71], it is likely that speech input would be more amenable on Avaaj Otalo for more complex, random access tasks such as searching for specific content.

5.6 Conclusion

This chapter presented a controlled, between-subjects experiment comparing speech and touchtone input with a user community with limited education, familiarity with technology, and in a language with limited speech resources. Touchtone input had a higher task

completion rate and less reported difficulty. Next, we turn to investigate some of the social dynamics observed in AO's pilot deployment.

Chapter 6

Source of Information Effects: Role of Authority[1]

6.1 Introduction

Indian society has been noted for the prominent role that hierarchy plays in society [39], leading to a tendency to defer to authorities [120]. This deference effect has been demonstrated in a range of scenarios, from the workplace [128] to family life [72]. As broader segments of the population come online, many of them via mobile phones, this social dynamic could also play out online. In a new environment including information sources from all social strata, norms that place pressure to defer to authority figures may lead people to over-value authority sources at the expense of peer-sourced content.

India has also been characterized as a collectivist culture [138], which has a rich legacy of cooperation and sharing through peer networks. These values are also found within many online communities. Peers have been demonstrated to be a scalable, accessible, trusted and locally relevant source of knowledge [77]. Chapter 4 of this dissertation demonstrated that farmers who were provided access to a voice-based information forum for agriculture engaged in rich exchange, and found the information provided highly relevant. However, while farmers enjoyed hearing the questions and experiences of other farmers, most gave a *stated* preference for receiving advice directly from authorities.

[1]This work is in submission, done in collaboration with Krishna Savani, Scott Klemmer, and Tapan Parikh

Figure 6.1: In this experiment, tips from farmers (left) and scientists (right) were alternately sent to rural Indians through automated phone calls. After hearing the tip, subjects were presented the option to hear more information by calling a phone number. An experiment captured how many follow-up calls were induced by farmers versus scientists.

This chapter investigates how the authority of an information source affects the likelihood that farmers will follow up on the information. In a controlled experiment (see Figure 6.1), 305 users of Avaaj Otalo forum were called with seven farming tips recorded by two types of sources: peer farmers and scientists from local agricultural universities. To isolate the effect of the source's authority on participants' subsequent actions, the tip content itself was held identical across sources. After a brief introduction from the source, they heard a preview of the agricultural tip, and were told that they would be able to hear the conclusion of the tip recording if they hung up and dialed another number. Participants chose to call back and listen significantly more frequently when the tip was recorded by a peer farmer. Still, farmers continued to state in interviews before and after the experiment that they preferred receiving information from authorities. The stated preferences may have been biased by the fact that the interviewers were perceived as authorities, leading participants to provide a more socially desirable answer. These results suggest a demand for agriculture information from peers.

6.1.1 Authority in Indian Society

Some have described social hierarchy as a deep-rooted feature of Indian society [39, 11, 82]. Researchers have observed a "deference syndrome" in the Indian work environment, in which subordinates go against their own better judgement and struggle to express views

independent of their boss' [128]. While these observations could have come from any work environment, deferential behavior in India may be especially strong. One study of Indian and American college-age individuals found that Indians adjusted their choices in deference to authorities, even while the decisions went against personal preference, and even when the subject was told that the authority would never know about the decision; Americans, by contrast, did not [120]. In another context, researchers found that videos featuring local high-status or authoritative individuals can be highly effective for persuading healthy practices in villages [110, 99].

While hierarchy is influential, Indian society also has a strong culture of peer-to-peer exchange, rooted in a group orientation [138, 126]. The Honey Bee project has demonstrated that there is a significant supply of, and demand for, local knowledge and information to be shared amongst [56]. Digital Green found that including peer farmers in videos of new practices led to increased likelihood of adoption [45]. When compared to authorities, peers can more easily establish common ground because they "speak their language". A nation-wide survey by the International Food Policy Research Institute in 2005 found that "other progressive farmers" were the most popular source of information on agricultural technology. Traditional authority sources (agencies, technicians, NGOs) were at or near the bottom of the list [17].

6.1.2 Information Processing and Culture

Some information processing practices have been shown to vary by culture. For example, studies have found that people in different cultures pay attention [75] and incorporate [63] different contextual information. The elaboration likelihood model (ELM) was developed by social psychologists to explain how people process various cues while processing information [104]. The ELM differentiates between systematic information processing, forming attitudes based on the intrinsic strength, quality, or persuasiveness of the message; and heuristic processing, where they rely on heuristics like "authorities should be trusted", "long messages are valid messages", or "majority opinions are usually true" [24]. The ELM predicts that people will resort to heuristic processing in "low-involvement" situations, where they are not highly personally vested in the outcome.

The applicability of ELM can be influenced by cultural norms. An ELM experiment investigating the effects of race of information sources found that white American subjects were systematically processing messages in a low-involvement situation when the source of the information was black. In other words, where the ELM would predict that white participants would not pay attention to the content of the message in forming an opinion, they were doing so if and only if the source was black [142]. A follow-up experiment concluded that white participants were strongly motivated to attend to the black source to avoid being perceived as racist [142].

6.2 Experiment Design and Method

6.2.1 Background

In interviews and discussions after the AO pilot, 65% of participants expressed a preference for receiving answers exclusively from DSC staff and scientists. The remaining 35% of respondents wanted both authority and peer responses; none said they preferred information only from peers. Participants stated that DSC's experts had a greater breadth and depth of knowledge than peers, were more articulate, and that "scientific" knowledge is more reliable than "experiential" knowledge. The prevailing sentiment seemed to be that farmers were not reliable, or even capable of, contributing high quality responses:

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

After the pilot, DSC recruited staff members and scientists from local agricultural universities to participate as "expert" responders for the service. No farmers were targeted in this recruitment. In discussions with DSC staff, they indicated that staff and scientists would be best suited to provide high-quality, accurate advice. DSC's weekly radio program and quarterly newsletter already routinely profiled farmers, highlighting their innovations.

DSC's reluctance to include expert farmers as experts was largely based on logistical concerns, including the complexity of managing a larger and more distributed group of experts. But many DSC staff also shared farmers' lack of faith in farmer-provided advice.

6.2.2 Research Question and Hypothesis

Farmers' stated preference for information from authorities may be a reflection of underlying social norms favoring authorities. On the other hand, many farmers may also not have had prior access to a consistent, high-quality source of peer information. We wanted to determine whether rural Indian farmers would engage equally with information from their peers, if it could be provided with the same quality and consistency as information from experts. To do this, we designed a controlled experiment to answer the following research question:

Given the same informational message, are rural Indians more influenced by the information if it comes from an institutional authority figure, compared to a peer?

Prior field and experimental research [120, 102] suggested the following hypothesis:

Rural Indian farmers are more likely to act upon information presented by an authority than by a peer.

6.2.3 Participants

Participants were recruited from a pool of 1,014 phone numbers that had called Avaaj Otalo at least once during the prior nine months. Two paid assistants fluent in Gujarati and familiar with Avaaj Otalo recruited participants over the phone over a two week period. Participation in the experiment was introduced as as an opportunity to participate in a trial of a new service, Avaaj Otalo Margdharshan Seva (literally, "Avaaj Otalo's Direct Information Service").

Farmers were told that AO Margdharshan would provide them with recorded agricultural tips delivered via automated voice phone calls from the Avaaj Otalo phone number. Participants were told that the tips would come from farmers and scientists across the state associated with DSC. After hearing the description, farmers were asked if they wanted to subscribe, at no cost to them. If they agreed, basic demographic information was collected and their number was included in the trial. Recruitment was capped after reaching 305 confirmed participants.

N	305
Number of Districts	20 (of 26 in Gujarat)
Age	33 (mean), 30 (median)
Farm Size	10 acres (mean), 7 acres (median)
Education	8th Grade (median)
Grow Cotton?	60%
Other Crops	Peanut, millet, lentils, sesame, beans, corn, castor seed, cumin, mustard, tobacco, wheat, rice (of 26 grown in the state)
Keep Animals?	96%

Table 6.1: Subjects by demographics.

Basic information for these participants is shown in Table 6.1. Most participants were small or marginal farmers; all were male. Most of the districts and crops grown in the state were represented. 28 users participated in a pilot designed to validate our scripts, that the voice interface was usable and that the information provided was relevant. The analysis below is based on data from the remaining 277 users. After the study, DSC mailed all participants a booklet with all of the tips in full, along with supplemental farming-related articles and DVDs, as a thank-you gift.

6.2.4 Study Design

The experiment was conducted entirely over the phone. Each participant received 7 tips in the same order, and received an even spread of tips from each of the four sources (two

	Tip1	Tip2	Tip3	Tip4	Tip5	Tip6	Tip7
Grp1	S1	S2	P1	P2	S1	P1	S2
Grp2	S2	S1	P2	P1	S2	P2	S1
Grp3	P1	P2	S1	S2	P1	S1	P2
Grp4	P2	P1	S2	S1	P2	S2	P1

Table 6.2: Subjects were randomly assigned one of the four tip schedules specified above. The tips assigned all tips to all sources equally. The tips sources alternated between peer (P1,P2) and scientist (S1,S2) sources.

farmers and two scientists). Participants were randomly assigned to one of four tip schedules (see Table 6.2), counterbalancing tips and sources to achieve an equal number of every combination.

6.2.5 Study Materials

The phone calls for the experiment were executed over an ISDN primary rate interface (PRI) line connected to a commodity Unix server. PRI lines support up to 30 simultaneous calls, and a single line can map 90 distinct phone numbers. We recorded and assigned a distinct phone number to each tip-source combination (7 x 4 = 28), logging the identity of each inbound call to count the number of follow-ups.

The tips and the previews themselves were developed by agricultural staff members at DSC, and were reviewed for accuracy by outside scientists. The tips were designed to be factually accurate, clearly articulated, offer practical information and relevant for a wide range of farmers. It was also important that the tip content would be equally plausible coming from either a scientist or a farmer. To achieve this, DSC staff members recommended using "farmer-friendly language", which is colloquial, playful, and avoids technical jargon. Two tips dealt the cotton crop, which is grown by a large portion of Gujarati farmers. Two other tips dealt with animal husbandry, which is relevant to nearly all farmers, as most keep animals for home dairy consumption, manure, and/or labor. The other 4 tips discussed disease management, orchard promotion, drip irrigation, and soil testing. An appendix provides the original Gujarati and English translations of the tips.

We recorded two different speakers for each source type to mitigate individual effects. The scientists were both retired professors; one from soil science, the other from agronomy.

Both were in their 60s and had prior experience recording scripted agricultural messages for radio programs. The farmers were from two different districts in Gujarat. Both had attended DSC-organized events in the past. One was in his 50s, farmed 3 acres of land, and had been formally schooled to the 10th grade. The other was in his mid-20s, farmed 1 acre, and was also schooled until the 10th grade. The four selected individuals had no prior official designation within DSC, or within the Avaaj Otalo service. The tips were recorded in quiet office spaces, using a Macbook Pro's built-in microphone. We asked the sources to study and practice each tip carefully before recording to ensure a smooth delivery. We also asked them to internalize the message as if they had generated the tip themselves. The tips were re-recorded when a speaker misspoke, stuttered, or wasn't otherwise natural in his delivery.

6.2.6 Procedure

The original automated call provided background and motivation for a topic, but was limited to a problem statement or high-level description of a prescribed practice. To learn the full solution, including implementation details, participants could learn more information by calling the provided phone number. The AO Margdharshan "system" voice interface was similar to the Avaaj Otalo service participants had previously used. If the participant placed a return phone call at their own expense it provided a real-world measure of the participant's assessment of original messages value. While adoption of the advice would be the theoretical gold standard for influence, this approach allowed us to test our hypothesis within a reasonable timeframe and budget.

Figure 6.2 shows the structure of the automated phone calls used for the experiment. Each call begins with a welcome prompt reminding the user about the service and emphasizing that the tips come from scientists and farmers from across the state of Gujarat. The tip source then introduces himself. Farmers spoke their names and location: village, block, and district. Scientists spoke their name (preceded by the title "Doctor"), university affiliation, and introduced themselves as retired professors. Next, they recited the tip, ending with instructions on how to follow up for more information by calling the provided phone number. We marked the initial call as complete if it stayed connected to this point. After

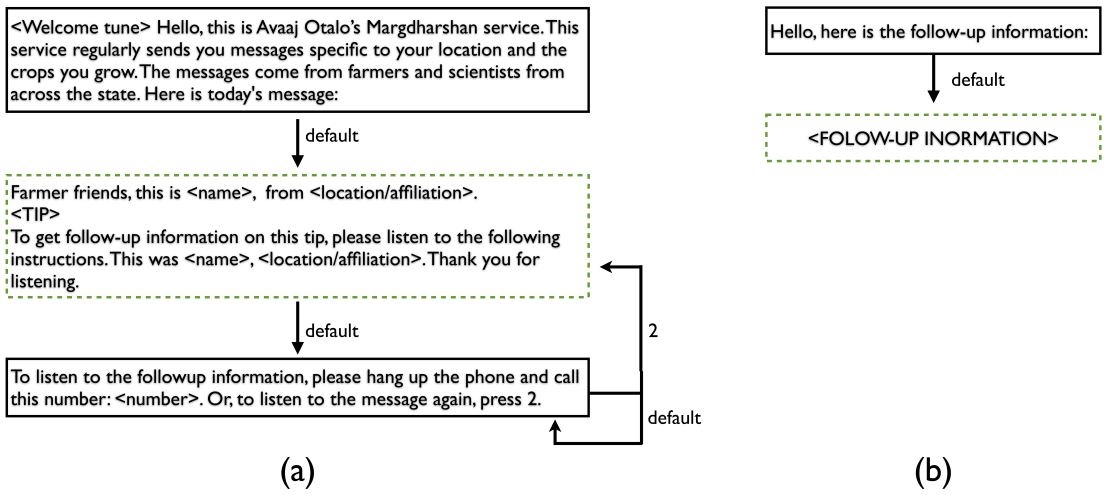

Figure 6.2: The prompt flows for the inbound tip (a) and outbound follow-up information (b) phone calls. The solid boxes contain prompts spoken by a voice representing the AO Margdharshan Seva tip service, and the dotted boxes are the voices of either the peer or authority source. The voice on a tip would be the same voice heard on the corresponding follow-up call.

that, the source re-stated their name to sign off. This repetition, along with limiting farmer introductions to simply name and location, was intended to create a strong authority manipulation. Finally, the system repeated the follow-up phone number and provided the option to listen to this message again. This prompt repeated automatically three times before the call self-terminated.

The seven tips were sent to subjects over the course of two weeks, with a new tip every two days. Twenty-eight participants were randomly selected to pilot the experiment. The pilot confirmed that most of the phone calls were indeed being received and completed, and that the follow-up rate was within an acceptable range for data analysis. Pilot participants also responded that that the tips were useful, credible, and that the callback procedure was convenient and affordable. Based on this satisfactory feedback, calls for the remaining 277 participants were scheduled. We began with an initial reminder call about AO Margdharshan, urging subjects to pick up the following calls from this number and listen to tips carefully. The seven tips were then delivered over a two-week period according to the assigned tip schedules.

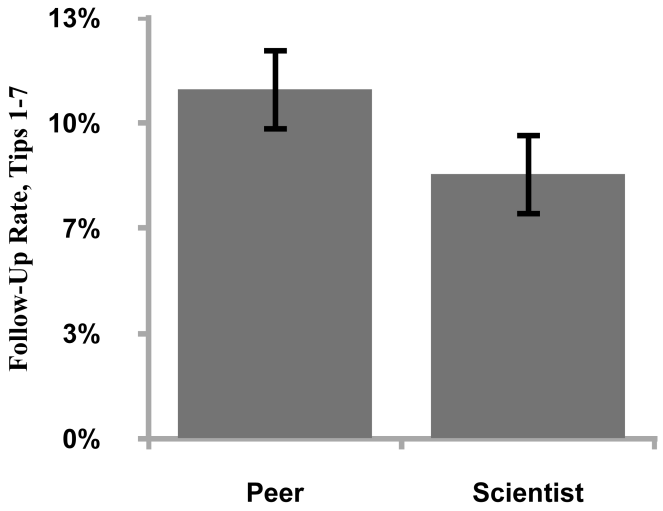

Figure 6.3: Aggregate follow-up rates by source for all tips

6.3 Results

Out of 1883 total attempts to contact the 277 participants, 1316 (70%) calls were successful, with the person who picked up listening to the full tip preview and instructions at least one time through. 72 out of 667 (10.8%) successful calls from a peer farmer source resulted in a follow-up. For the scientist-recorded tips, 53 out of 649 (8.2%) successful calls resulted in a follow-up. We analyzed the data using hierarchical linear modeling, treating tip calls as nested within participants. This analysis accounts for dependencies in response likelihood within each farmer (i.e., accounting for the fact that some farmers might be more likely to respond to any given tip than other farmers) while assessing the impact of the experimental manipulation on response likelihood [112]. A dummy variable indicating whether participants called back in response to the tip was the trial-level dependent measure; the source of the message was the trial-level predictor variable. There was a significant effect of source indicating that farmers were significantly more likely to call back after hearing a message from a peer than from a scientist (log odds = - .47, odds ratio = .64, z = 2.08, $p < 0.05$, see Figure 6.3). Follow-up logistic HLMs confirmed that the two peers elicited a similar rate of response (log odds = -.10, odds ratio = .90, z = 0.35, p = .73), as did the two scientists

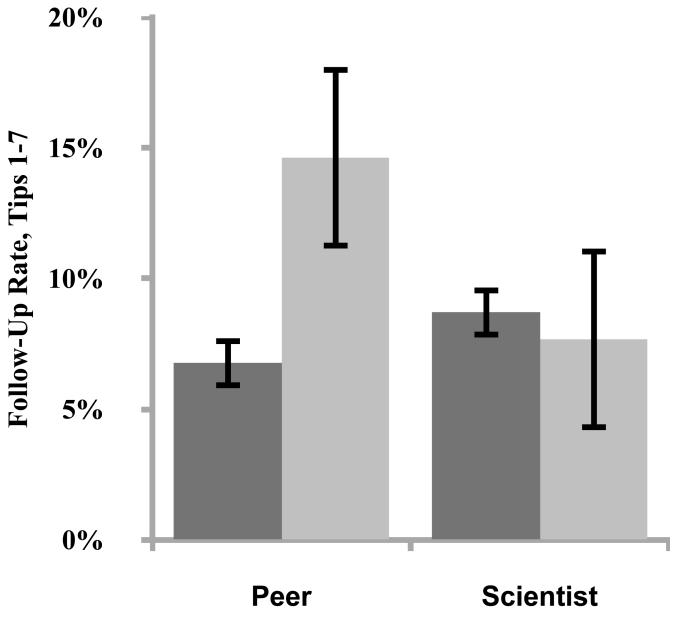

Figure 6.4: Follow-up rates for each source, split by level of education. More education participants followed up significantly more when tips came from peers.

(log odds = .34, odds ratio = 1.40, z = 1.04, p = .30).

6.3.1 Follow-ups by Age, Farm Size, and Education

Logistic HLMs also showed that participants' age did not predict their likelihood of calling back, nor did it influence the difference between the peer and expert conditions. The size of their farmland also did not predict their likelihood of calling back, nor did it influence the difference between the peer and scientist conditions. Farmers with more education (eighth grade education or higher) were significantly more likely to call back in response to the tip (log odds = .122, odds ratio = 1.13, z = 2.26, $p < 0.05$), and were marginally more responsive to peers than to scientists (log odds = -.115, odds ratio = 0.89, z = 1.75, p = 0.080). To explore this interaction further, we split the data by median education and found that whereas farmers with less then eight years of education were equally likely to respond to peers and scientists, farmers with more education were significantly more likely to respond to peers than to scientists (log odds = -.99, odds ratio = 0.37, z = 3.32, p = 0.001,

see Figure 6.4).

6.3.2 Post-Study Interviews

Starting one week from the end of the study, 34 randomly selected participants were interviewed over the phone using a semi-structured protocol. The interview was conducted in Gujarati by a native speaker. At two different points in this protocol, participants were asked to state whether they preferred to receive information from scientists or from peers. 42% explicitly stated a preference for scientists, 19% for farmers, and 39% said that either they have no preference, or that both are preferable. On the other hand, 26% of interviewees were able to recall some detail about the identity of at least one of the farmer sources (such as name or where they were from), compared to 13% recollection for the scientist sources. The sample was too small for these differences to be significant.

Those in favor of farmer information cited their practical knowledge and ability to speak from experience:

> I usually go by my experience and when farmers talk about their experiences I like that better. We have spent most our lives farming so naturally I would like information from farmers.

> Advice from farmers is important as they have local information. Different areas have different crops so local experience is important. Scientists have to discover or invent new things in order to give advice. Farmers have experiences every 10-15 days which they can talk about. Scientists take longer to do their experiments and get their results.

> [I prefer information from] farmers, because they are experienced. I can give you any information because I am experienced... without experience how can I give you advice? This is farming, anything can happen, whether it rains or floods is in the hands of God. Such situations can only be handled by an experienced person.

Several respondents said they preferred information from peer farmers because they spoke in a more understandable language (despite the tips being provided in the same colloquial language for both):

> Information given out by farmers is more clear. Scientists will not be able to explain clearly like ordinary farmers. Farmers talk in our language.

> When farmers give the message I feel that I can understand, but when scientists speak it is difficult as they speak differently. I like the farmers as they talk in a simple language. Maybe the information from the scientists is better but I can't understand their high-level language so whats the point of listening to them?

At the same time, farmers appreciated that information coming from scientists was backed by the latest facts and more rigorous experiments:

> I trust scientists and authorized people more as they are dependable. Farmers do trial and error which is not very dependable.

> I think scientists give better information. These days agriculture and farming have become a very scientific process.

A notable number of interviewees found information from both sources valuable. These participants added how the theoretical knowledge of scientists and practical, experience-based knowledge of farmers were complementary to one another:

> Both [provide good information], as scientists give information which they get from their lab experiments and farmers speak of their actual experience.

> [I value] both, as a farmer is also a type of scientist as he has real life experiences.

> I would prefer messages from those people who have tried it and done things practically. Scientists conduct experiments and get results and farmers also have actual experiences. So information from both of them will prove to be useful.

6.3.3 Enthusiasm for the Service

Interviews also provided other feedback about what participants liked and didnt like about the service, whether the tips were useful, and any other issues or concerns they faced. The service was generally received enthusiastically, with many reporting that the quality and practical usefulness of information provided was its best aspect.

> The information is very useful and was delivered in a timely manner. Animal rearing information was especially useful. When I got the first call I thought the service wouldn't be [very] useful but I changed my opinion as more information came through the subsequent calls.

For one illiterate participant, the service was useful enough to go to significant lengths to keep track of the various callback numbers:

> Yes, I had no problems listening to the message. In fact I have been waiting eagerly for these phone calls for many days. The service seems to have stopped since few days, why is that? I used to write the number on the phone and ask someone to type in the numbers as I am illiterate and cannot recognize letters. I sometimes assign a character to every phone number so that I recognize that it is from that particular person. In fact I saved [AO's] number that way when you had called me previously, so this time when you called I knew it was you. I store very few numbers so this system works.

The most common complaint from participants was that the full informational message was not provided in a single call, requiring them to use airtime for the follow-up call:

> The information in the message is not complete and we have to call the number which we get charged for. I have made several calls and I have lost fifty to sixty rupees credit in getting this information.

44% percent of interviewees mentioned that the cost of the outbound phone call factored into their decision of whether to follow-up. Several participants reported that they wanted to call back, but were either concerned about their airtime balance, or didnt keep any balance

at all, using their phone only for inbound calls. Few reported difficulty in recording the callback phone numbers, which was done either with pen and paper or by entering the number directly on the phone.

Some callers not included in the original recruitment were also calling the follow-up numbers (these callers are not included in the data analysis). These farmers who had gotten the numbers from a friend or relative who was a participant. Interviews also revealed that participants were using call recording facilities built into their phones to store the tips, later playing the tips for friends, family, or for themselves.

The enthusiastic response to AO Margdharshan Seva prompted DSC to retain it as a regular service after the study, with tips recorded mostly by staff members, and farmers permitted to record responses.

6.4 Discussion

This study's main finding is that the information source indeed *mattered* for farmers, albeit not in the expected manner. Farmers followed up significantly more frequently when presented the same information by peer farmers compared to authorities. In this section, we discuss our results, and provide some explanations for the discrepancy between farmers' behavior and stated preferences as collected from interviews.

6.4.1 Authorities in word, not in deed

Farmer responses during the interviews may have reflected some social desirability bias [42]. Farmers may have been answering based on what they believe to be the most socially acceptable answer, or that which reflects most positively on themselves. There could also have been a response bias — answering questions based on what the interviewee thinks the interviewer wants to hear [103]. Subjects likely viewed the researchers, who were conducting the interviews, as scientific authorities as well. On the other hand, the decision to follow up on on a tip was made away from any possible social sanctioning from authorities. Researchers have noted that social norms are situationally activated, particularly *injunctive norms* that guide behavior based on how one thinks others perceive their actions [29].

6.4.2 The Power of Peers

Agricultural extension programs in India focus on training agricultural scientists from universities to disseminate technologies and practices. This experiment showed that farmers acted upon information provided by peers more than the same information from scientists. This study corroborates prior work [102, 45, 56] suggesting that farmers should be more deeply integrated into the knowledge diffusion process for effective knowledge transfer in agriculture. A common sentiment expressed during our interviews was that experience-based knowledge from other farmers is a necessary complement to the recommendations of scientists. In recent years, India has experimented with more participatory approaches to extension, including working through local farmer groups, NGOs, and even enlisting local government (panchayat) officers as para-extension workers [130].

While farmers commonly exchange advice informally with friends and neighbors [17], this word-of-mouth can lead to misinformation. Relying on one's immediate friends, relatives and acquaintances limits the potential quality and breadth of information that can be obtained. We have directly observed farmers not knowing about knowledgeable and innovative farmers living just a few kilometers away, often farming the same crop. This study demonstrates that the demand for peer information can be greater than information from scientific authorities. Combining moderation or filtering to these rich peer-to-peer exchanges represents a "best of both worlds" scenario, ensuring quality while maintaining consistency, scale, diversity and breadth.

Most ICT4D projects are coordinated with local partners that are embedded in the target communities. It is common for ICT4D researchers to defer to the expertise of these local partners, particularly in matters related to local practices or culture. Throughout our partnership, DSC has relied on well-trained staff that they trust to answer questions and to provide content for Avaaj Otalo. While this approach has been successful in providing a useful and efficient service to farmers, our results indicate that together we may have under-estimated the demand for peer information exchange. We are now working with DSC to design ways for farmers to participate more effectively in responding to questions and content. This includes providing incentives and recognition, and by lowering the costs and other barriers, for farmers to participate.

6.4.3 Did the tip content inherently favor a source?

If the tips' content or linguistic structure was not believable for the speaker, then a participant may been motivated to call out of curiosity or incredulity ("does this farmer know what he's talking about?"). There was no evidence in the post-study interviews that the credulity of the tips' sources was in doubt. As an additional check, the tip content was independently rated by twenty Gujarati readers on Amazon's Mechanical Turk [6]. The Turkers were presented each tip's introduction in Gujarati script. The task first asked for a summary of the tip as a check to make sure it was understood. They were then asked to answer two questions for each tip:

1. Who is most likely to have given this tip: a scientist, or a farmer?
2. Who is more appropriate to provide the resolution information to this tip: a scientist, or a farmer?

For each each question, seven options were given. The first option was "A farmer is very likely/very much more appropriate to give this tip/resolution", and the seventh option was "A scientist was very likely/very much more appropriate...". The intermediate options substituted "moderately", "slightly", and "equally" as descriptors for likelihood and appropriateness. For the 15 surveys that provided reasonable summaries for the tips, no significant deviation was observed for either question when t-tests were applied comparing the mean and variance to the midpoint of the scale.

6.4.4 Limitations of the Study

Future study will investigate what feature of peer-sourced information yielded a higher follow-up rate. Farmers may have been more attracted by the familiarity of the accent, the novelty of the source, and/or out of a sense of camaraderie with fellow farmers. Participants may have been curious to hear from a farmer for advice they typically would hear from an outside expert.

Participants may also have been unclear about what would happen in the follow-up call, especially the first time they decided to follow up. The initial call did not explicitly state

that the follow-up call would deliver the conclusion, and that it would be another recorded message. Participants may have called back with the expectation that the tip would be delivered by a different person, or perhaps that they would be speaking with a live person. On the other hand, these uncertainties would have been resolved for any farmer that called back the first time. In post-study interviews, no participant indicated that such a confusion existed at any time, which was asked explicitly in several interviews.

Future research is required to generalize these results, as the Gujarati farmers may not be representative of all farmers. In particular, their perceptions of authorities and willingness to seek information may differ from farmers in India. These specific farmers, who were all connected to DSC in some manner as early adopters of Avaaj Otalo, may not even be representative of farmers in Gujarat. The way in which users interact with the message board is also likely to change and evolve over time, reflecting their experiences and learnings within and outside the system.

6.5 Conclusion

This chapter presented a controlled experiment testing the influence of authority on agricultural information dissemination to rural Indian farmers via a voice-based phone information service. Contrary to stated preferences, farmers followed-up significantly more to agricultural tips when they were delivered by peer farmers, as compared to when the same information was presented by agricultural scientists. This result demonstrates that there is a significant unmet demand for high-quality peer information for farmers in rural India; in some sense greater then that for information from established authorities.

Chapter 7

Implementation

7.1 Background

This chapter presents *Awaaz.De*, a software platform that leverages low-end mobile phones and opportunistic Internet access for aggregating, responding, and routing voice messages. This platform extends the prior technology used for Avaaj Otalo in a number of ways. First, Awaaz.De generalizes AO to support a customized set of voice message boards with configurable posting and browsing settings, and ability to create sub-forums around specific topics. Second, Awaaz.De complements the voice interface with a web-based administration interface. *Community managers*, often members of a local organization with Internet access, use the interface to moderate the message boards, annotate voice messages with author information and content tags, route messages to responders, and broadcast messages to reach wider audiences. The "Internet for a few, voice for the rest" model reflects the common scenario in rural information delivery. Finally, Awaaz.De integrates information-pull voice forums with information-push broadcast and surveys to reach broader audiences. In this chapter, we summarize Awaaz.De's architecture, concluding with future directions.

7.2 Example Awaaz.De usage scenario: Farmer Q&A

Babu farms cumin on three acres in a remote village in Gujarat, India. In the middle of the season he spots a green sucking pest attacking a section of his field. He picks up his mobile

phone and calls "Organic Farmers United", an information service for organic farming-related advice. Among the message board options, he chooses the question and answer board. He then selects the option to record a fresh message, and after the beep introduces himself and describes the problem. A couple hours later, Paresh, the community manager, logs into the web interface from his office in a nearby city. He listens and assigns the question to Kapil, an expert organic farmer in Baroda. In addition, he approves the question and places it at the top of the list of threads on the public Q&A message board. Kapil receives a phone call at between 6 and 7pm, the pre-specified time slot to receive pending messages. The automated call greets, plays Babu's question, and then asks to record a response or save the question for later. Kapil didn't need to look anything up, so he records straight away, prescribing Babu a homemade pesticide made from sugar water. As usual, the next morning Paresh checks the Q&A forum's inbox and finds Kapil's new response. Finding the answer satisfactory, he clicks to approve it. Immediately, Awaaz.De calls Babu and plays the response, then prompts for a follow-up question or comment to be sent back to Kapil, the responder. At the same time, other farmers are making their morning call to browse the Q&A forum. One farmer listens to the discussion on the sugar water remedy, and decides to chime in. He has tried the same technique, but found it unsatisfactory until he added neem oil to the spray. Paresh the community manager checks in on the thread a couple hours later. Concluding that it would be relevant to loop in a wider audience, he schedules a broadcast of the full thread to all cumin farmers in the area for later that day. It is this type of discussion, debate, and sharing of views that ultimately leads to greater success in the fields.

7.3 Design principles

Awaaz.De's design philosophy rests on three principles. First, make content easy to navigate and discover. Audio content is difficult to scan and must be consumed serially, so the system must index and curate the content to let users get to exactly the content that they want. For indexing audio, Awaaz.De keeps humans in the loop. Humans are more accurate than automated speech-to-text, and are cost-effective in certain labor markets [81]. Second, assume that users have no prior experience with computer interfaces. Our field

work has shown that most callers have little or no experience with an automated system, and it is not practical to train all potential callers beforehand. The voice UI should balance simplicity and functionality. Third, support interactive dialog. It should be social, giving opportunities for community members to give their voice and interact with others.

The Awaaz.De platform consists of two main components: a customizable IVR interface, and a web-based administration interface. We describe each in turn below.

7.4 Voice UI

Awaaz.Des voice UI is an automated interactive voice response (IVR), navigable purely with touchtone input. Figure 7.1 illustrates a standard call tree. An application designer defines a number of topical ("cumin") and/or purpose-based ("Q&A") message boards. Each board is presented as an option in the initial welcome prompt that a caller hears when she dials in. The designer configures each message board with a number of policy settings. A message board can be listen-only, post-only, or allow both listening and posting; it can be moderated or not; and it may allow callers to post responses to original threads or not.

7.4.1 Prompts

Awaaz.De applications use a set of 85 standard prompts. These prompts, such as "welcome.wav", "record.wav", and "nextmessage.wav" have fixed scripts and are played at fixed points in the application. Application designers translate each of the prompts from English to their target language and have them recorded by a voice talent. The prompts are then deployed to the Awaaz.De platform and played for the respective application.

7.4.2 Calling In

Awaaz.De assigns a unique phone number to each application. The phone line can be configured to be toll-free (arranged with the phone line operator), a regular local or long-distance number, or support missed calls or flashes, in which the line will ring until the caller hangs up, at which time the system will call the number back. These options allow

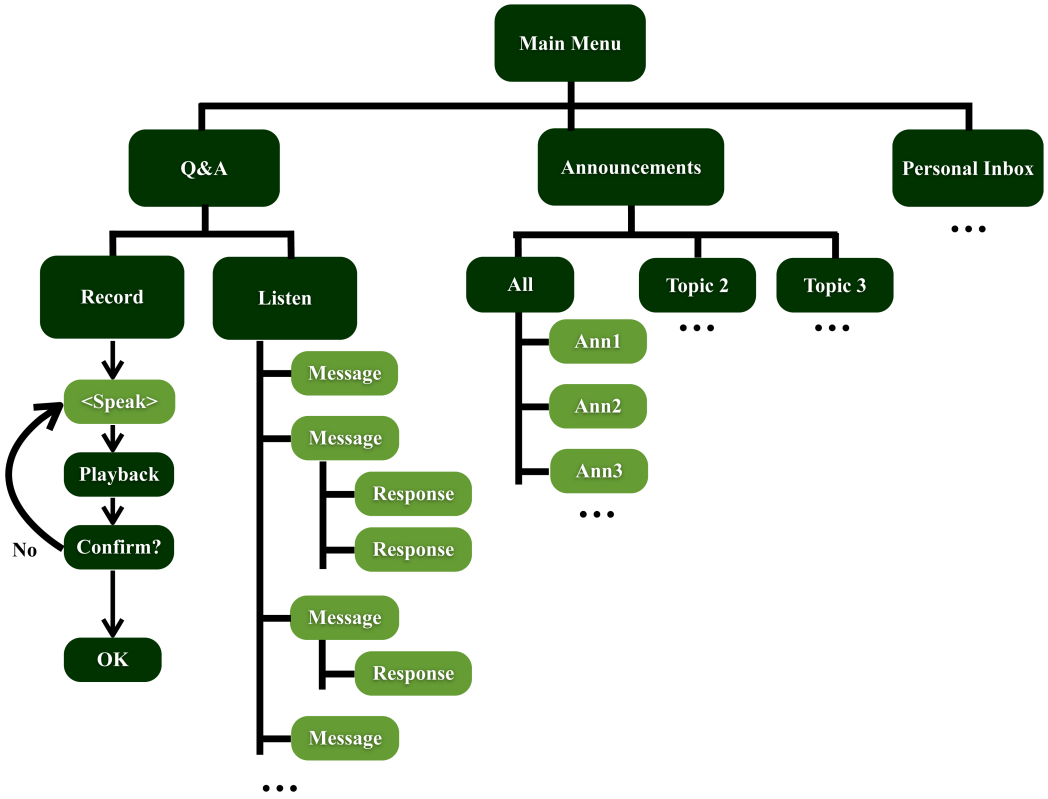

Figure 7.1: Example call tree. Dark boxes are system prompts, light boxes are user-generated content. From the welcome prompt, callers choose any available message board, or a board of personally authored messages. Within each message board, if allowed there is an option to record, and to listen to messages, one at a time. Messages may also be split into sub-forums by topic (tags).

the application designer to decide how much, if at all, she would like to charge for calls to the application.

7.4.3 Navigating a forum

Once a caller has chosen a forum, they are presented message record and listen options, depending on the forum's configuration. If the forum is configured to only have one of the options available, no menu options are given.

7.4.4 Recording a message

If the caller chooses to record, they are presented the dialog shown in Figure 7.1. First they are prompted to say their message after a beep. At that point the recording begins, and stays activated up to a maximum allowable message length, configured for each forum. The recording also terminates manually if the caller presses the hash ("#") key, or automatically after several seconds of silence at a system-defined silence threshold. The recorded message is then played back to the caller, and after the system prompts the caller to either confirm that the message was recorded satisfactorily, or to re-record the message. A message is saved by the application only after it has been confirmed.

7.4.5 Browsing a forum

If the caller selects to listen to messages in the forum, they are played messages one at a time, organized as threads. The default behavior is for the most recently posted thread to be at the top of the list, as in a last-in, first-out queue. A caller hears the first, original message in the forum's first thread, and is then prompted to listen to any responses that have been posted to that thread. If no input is given, the default behavior is to play the responses. After the entire thread has been played, the system prompts the caller to choose whether they would like to listen to the next thread, or record a response to the thread (if the forum has been configured to allow community responses). For simplicity, threads are at most one level deep; the caller can only record a response to the original message (for the rare exceptions, see the descriptions of routing and uploading with the admin interface). However, there can be an arbitrary number of responses in a thread. By default, the next thread is played.

Callers have advanced navigation controls within a forum. Through the touchtone keypad, the caller may skip to the next or previous message (within a thread), skip to the next or previous thread, pause play of the current message, or replay a message. At any point in the application, a caller can press '0' to return to the main menu. All commands in the application are available as *barge-in* commands. This allows experienced users to quickly navigate past familiar prompts. In a forum, an experienced caller can also quickly scroll

through threads with the skip thread command. These commands can be reviewed by selecting the option to hear "more instructions" when the caller first navigates to browse a forum.

7.4.6 Auxiliary lists and sub-forums

Besides forums, an application's main menu can include one of several auxiliary lists. The "personal inbox" option allows callers to listen to all threads initiated by the caller, starting from most recently posted. Another auxiliary list allows designated responders of the forum review pending, assigned messages (see the section on message routing for a complete description). Finally, administrators calling into the application get an additional option to listen to messages pending moderation (see the moderation section).

Forums can also be configured to have sub-forums that play messages filtered by particular category (see Figure 7.1 and the tagging section for more details). The sub-forums are presented as an additional sub-menu after choosing to browse messages in a forum. Listening to all messages unfiltered can be set as the first, last, or an omitted option.

7.5 Web-based Administration Interface

While most of the community interacts with the forums through the voice UI over telephony, moderation and over administrative tasks are done over the Internet (see Figure 7.2). These *community managers* can be staff members of organizations, government officers, or community people who can afford it. Community managers use the administration interface to set post ordering, add metadata and tag messages, route messages to specific community members for soliciting responses, upload externally produced content, deploy polls and surveys, and broadcast selected content. Below, we review the functionality in the admin interface, much of which evolved based on experience deploying voice forums with our partner organizations.

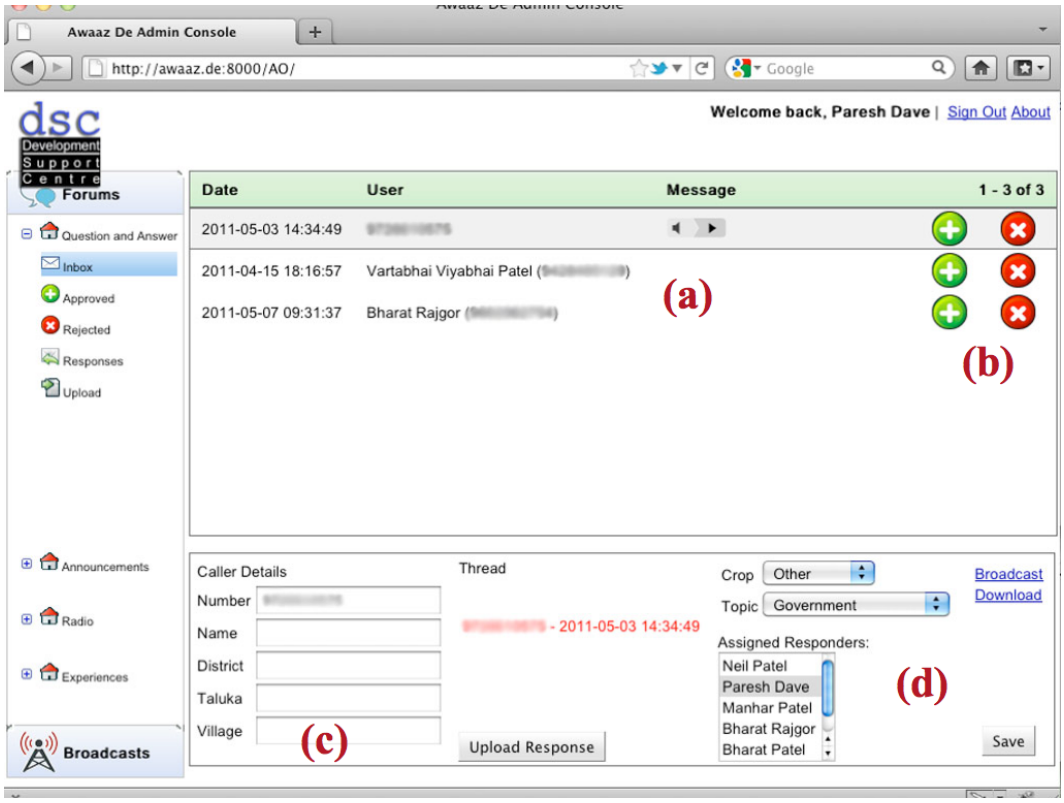

Figure 7.2: The web-based administration interface. The left panel displays a widget for each live message board. For each board, community managers (a) listen to messages, (b) moderate, (c) add caller details, and (d) categorize, assign, and broadcast.

7.5.1 Moderation

Having the ability to control what content callers could and could not access on the question and answer forum was among DSC's most vocal demands after Avaaj Otalo's pilot. The DSC staff felt that moderation was necessary to maintain a high level of quality and credibility for the service.

If a forum has been configured with moderation enabled, the web interface presents an inbox for that forum where newly posted messages or responses to messages are first dealt with. Next to each message in the inbox are green approve and red reject buttons. If a message is approved, callers who visit that forum will be able to listen to it, and respond if community responses are enabled. If a message is rejected, it is moved to the rejected folder where it can later be re-approved if necessary. Until then, the message is inaccessible

to the public, though the author of the message could review it in their personal inbox. For threads, only the approved responses are made available for listening. If the original post in a thread is rejected, all of the responses are automatically rejected as well. Once approved, a messages order in the forum can be adjusted by moving threads up or down. The prime real estate is the first and second slots in the forum; moderators can make certain content "sticky" by moving threads to the top.

In a moderated forum, all messages, whether new thread or response, whether from an assigned responder (see the routing section) or from a regular caller, must be approved by the community manager before going live. The one exception are messages authored by community managers themselves, whose phone numbers are flagged for special privileges. Messages from managers go live without approval. In addition, when managers call into the application, forum policy settings are overridden, allowing them to post or reply to any forum.

7.5.2 Adding metadata and tagging

The community manager begins by listening to the message, which is streamed through the browser. After listening to message, the manager may add details about the message, including the caller's name and location, if specified. In addition, the manager may categorize by selecting from pre-specified tags. Tags are forum-specific can be updated by the Awaaz.De administrator. For Avaaj Otalos question and answer forum, crop and topic tags were entered to categorize incoming agricultural questions and responses. Tagged messages populate the filtered subforums that the application designer can choose to create for any forum, based on the same tags.

7.5.3 Routing and Responding

After the pilot, DSC recruited internal staff members as well as outside scientists to function as experts for Avaaj Otalo's question and answer forum. These experts were expected to monitor the forum regularly and respond to questions that they felt qualified to answer. This was an unattractive proposition for the experts. They would have to remember to call into the system on a regular basis, navigate through the forum with their own time and

expense (the line was over a local phone number, so they would incur airtime charges to call in), and polling the forum was inefficient as there was no guarantee that there would be questions available that they were able to answer. None of the experts were being paid for their contributions by DSC. Instead, they were spending time and money from their own pockets to contribute.

The equation was backwards. The system should make it as convenient as possible for experts to respond to messages in the system. There main pain points should be reduced or eliminated: requiring people to remember to call in regularly, paying for the call, and sifting through the forum to find questions suitable to respond to. Awaaz.De addresses these issues through message routing. The community manager associates any number of responders with a forum. The manager or responders themselves specify tags that represent their expertise area, as well as a timetable for receiving regular phone calls from the system. Once this information is entered in, managers can assign each message to one or more responders. Awaaz De's routing algorithm searches for all responders associated with at least one of the messages tags. It then removes responders that have more pending messages than a configurable threshold (default is 10) and those that have already listened to the message above a threshold (default is 5). The community manager may short-circuit the routing algorithm by assigning messages manually. Once assigned, the system schedules a call to the responders registered phone number. In India, inbound calls are free to the receiver. Thus, the airtime charges associated with responding are shifted from the experts to the system itself.

Responders pre-specify times to receive calls to the Awaaz.De system administrator, who schedules a cron job. At the specified time, the job checks for pending messages and dispatches them accordingly. Timetables can be arbitrary, and they vary; some responders ask to be called during specific hours on certain days of the week, while others are available to receive calls hourly throughout the day. Automated prompts lead the responder through a list of their pending, assigned messages in the same way they would browse a public forum. After each message, the responder is prompted to record a response. They may also pass the message (removing it from their assigned queue), reserve the message (remove it from any other assigned experts queue for a few days), or refer the message to another person by specifying their phone number. After a threshold number of listens without response, a

message is automatically removed from a responder's queue. Calls are only made if there are messages pending for the responder.

Routing messages to experts is a mechanism designed to improve response time and make it convenient for key resource people in a community to contribute content. In 2011 to date, the average turn-around time for messages to receive their first response on Avaaj Otalo was 10.9 hours. It is independent of organic community responses that callers browsing the forum may make. In other words, an assigned and routed message may get multiple responses: one from the assigned expert, and one or more from anyone else who comes across the message in the public forum.

Responses to routed messages are independent of the approved or rejected status of a message. In other words, a community manager may deem a message unsuitable for public consumption and reject it, but may still assign the message to one or more responders. Messages with privacy concerns can be handled in this way.

Any message can be routed to a responder, including other responses. For example, a public response to a message in the forum may warrant its own response. This is one way in which a thread can become arbitrarily nested; if a response is assigned and responded to by an expert, it will be saved as a nested response. When the thread is played over the voice interface, it is flattened and the caller hears responses via pre-order traversal.

Responses need not be routed to an expert if the community manager can directly respond. This is especially true if a message seeks information that has already been given in a previous response for another caller. For this, managers can upload responses to any message from sound files stored on their local computer. Managers maintain a library of pre-recorded responses on their computer, which can include commonly made recording errors ("There was too much background noise in your recording, please re-record.") as well as responses to frequently asked questions (which can be downloaded from the interface to store locally). These can then be uploaded for speedy turn-around time. In the future, we can make it easier to mark duplicate messages or recycle responses through search of previous messages.

Audio content produced from outside sources can also be uploaded as original posts to forums. For example, Avaaj Otalos radio archive is a listen-only forum in which DSC periodically uploads the sound files from their weekly radio broadcast.

7.5.4 Alerts

There are many ways to alert a caller that a response has been approved for them to listen to. A text message (SMS) or even missed call could signal a user to call into the system to hear their awaiting unheard message. The default alert for Awaaz.De is to make a phone call in which the actual response is played. When the community manager approves a response, a phone call is immediately sent to the orignal message poster to hear the response. The automated response call plays a greeting, the poster's original message, and the new response. The poster then has the option to record a follow-up "response-to-the-response" to give comments, feedback, or ask a follow-up question. That response will be stored as a nested response to the original response, and go back to the community manager for approval to be set back to the original responder.

Response calls are sent to the poster of the most immediate parent message of the response. In other words, only the person who the response is directly intended for gets a call, not everyone who has participated in the thread. In addition to the initial callback upon approval of a response, backup calls are schedule an hour later and in the morning of the next day. If all of these calls are missed, the original message poster can still listen to their response through their personal inbox.

7.5.5 Broadcasts

Awaaz.De complements the information-pull model of voice forums with information-push broadcast functionality. Just as message routing makes it more cost and time-effective for experts to access questions that they can respond to, an information-push mechanism is convenient for community members to receive high-quality, targeted, and timely information from the system, navigation-free. Broadcasting is a way to surface the best and most relevant content from the forums for wider dissemination. Broadcasts are also ways to generate more interest in the system; community members can have a better understanding of the cost-benefit of calling the system if they are able to sample, for free, they type of content they will find in it.

Community managers can schedule any content from any forum for broadcast. Full threads are broadcasted as a unit. A manager begins by choosing the content to send, and

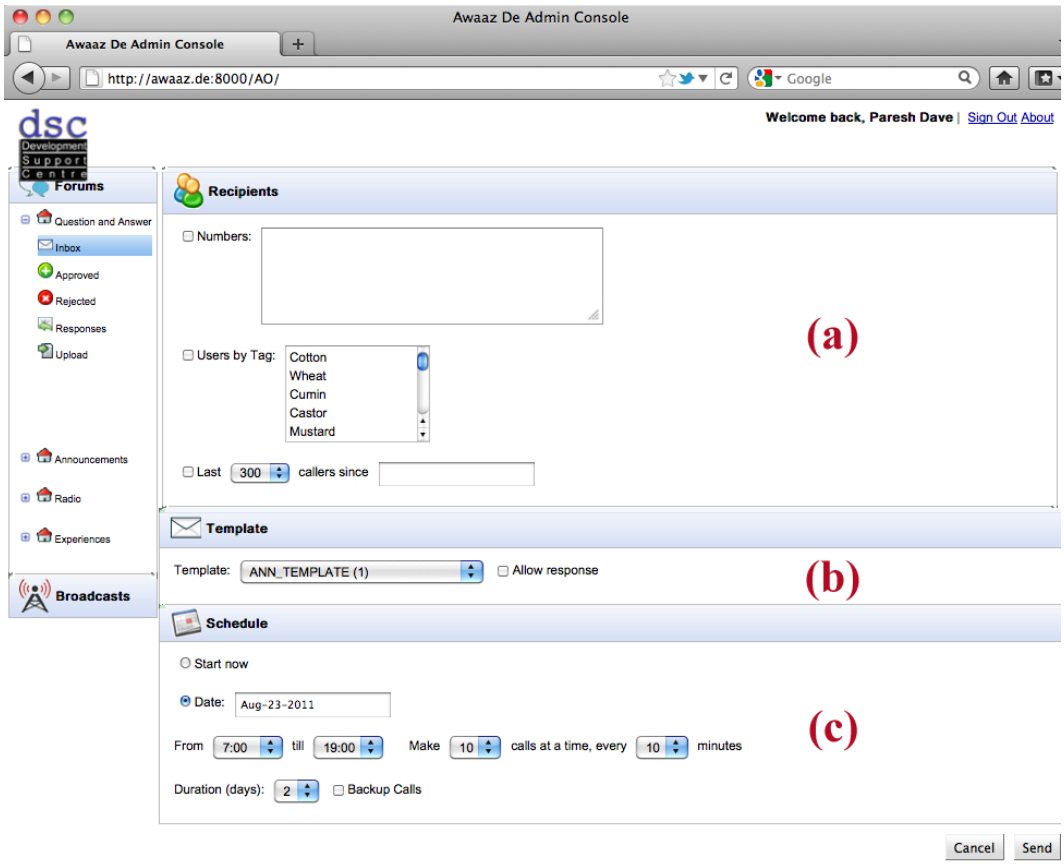

Figure 7.3: Interface for scheduling a broadcast. The three panels provide the manager to specify (a) recipients; (b) broadcast format via a template; and (c) the time the broadcast should be scheduled

then specifies the recipients (see Figure 7.3). The interface currently allows the manager to manually enter phone numbers (usually copy-and-pasted from a spreadsheet), or to gather phone numbers from any number of callers to the system since a specified date. Finally, for targeted narrow-casting, the manager can also choose to specify recipients by tag. Tags are associated to callers based on the messages they have posted. Managers can choose to specify recipients by any combination of these options; duplicates are automatically removed.

Next the manager chooses from among a number of pre-defined templates that structure the broadcast phone call. A can be any number and arrangement of prompts that play

before and after the content to be broadcasted. Application designers typically create different templates for different types of content, such as templates for questions and answers and announcements. Templates can include prompts that collect feedback from recipients, including ratings through touchtone input or open-ended recordings. An "allow responses" check box in the broadcast scheduling interface with which the manager can choose to insert a prompt soliciting recorded feedback immediately after the content is played.

The final step in scheduling a broadcast is specifying the timing of the calls to be sent. The start date specifies the day the calls will begin, and the start and end times specify the window of time in the day to limit the calls. In order to avoid clogging the shared inbound and outbound phone channel, the calls are spread out over time. Typically, we deploy applications over PRI lines (see below for details), which support 30 simultaneous channels. A typical rate of broadcast is 10 calls every 10 minutes. These parameters can be adjusted to speed up a broadcast at the expense of open channels for inbound calls. Based on the broadcast rate and number of recipients, the manager also specifies a broadcast duration, in days. The manager must specify a duration that will allow enough time for calls to be sent to every recipient at least once. Finally, managers can choose to schedule backup calls for the broadcast. Backup calls are made conditionally based on whether a previous call had been just picked up or listened to up to a certain prompt (configured in the template definition). Backup calls are scheduled in the remaining time between the last scheduled initial broadcast call, and the end of the broadcast period given by the broadcast duration. Currently, backup calls are not dynamic, in the sense that they are scheduled based on the success of earlier attempts. Instead, they are pre-scheduled at specific times in the broadcast time window.

Managers review previously scheduled broadcasts from the broadcast panel (see Figure 7.4. They can view details of the broadcast, including its start and end time, and number of recipients broken down by pending and completed calls. Managers can also cancel future broadcasts. If the broadcast template solicited recorded feedback, the manager can review the messages that were recorded, possibly uploading them to other forums based on the nature of the message (for *e.g.*, follow-up questions can be re-uploaded to the question and answer forum).

Using the same mechanism as broadcast templates, Awaaz.De also can also support

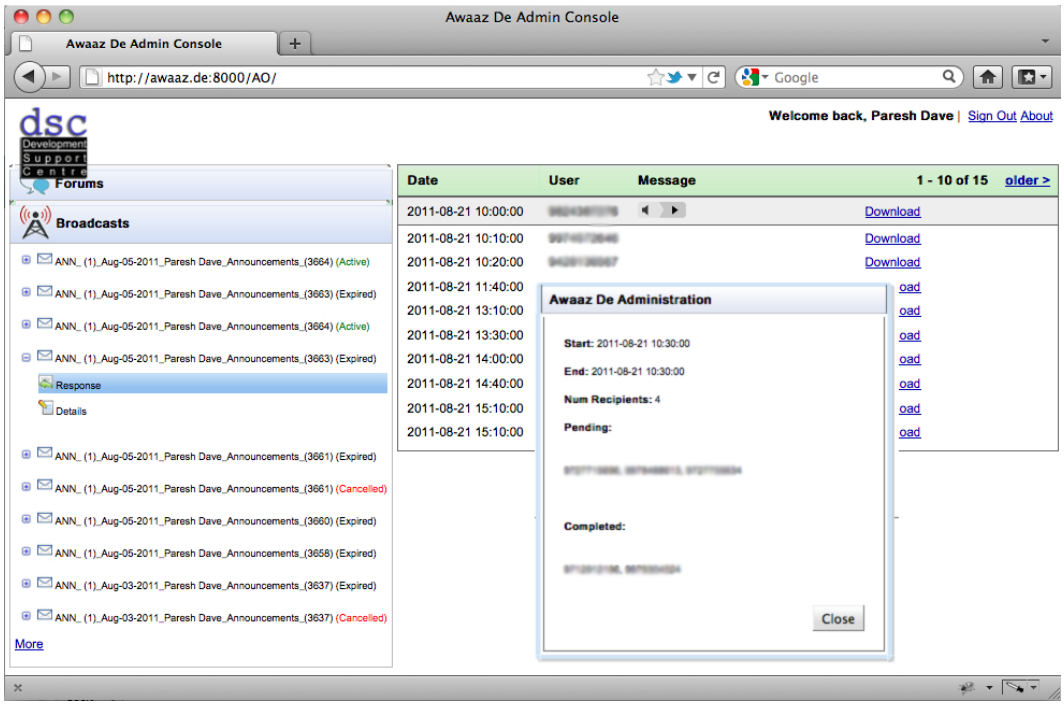

Figure 7.4: The broadcast review panel. The left panel has scheduled broadcasts and indicates whether the broadcast is active (calls pending in the future), expired, or cancelled. The details popup is in the foreground.

voice-based data collection through voice surveys. Through a programming environment, an application designer can create arbitrary surveys that can prompt recipients to respond to multiple choice prompts and/or record open-ended responses. Surveys can conditionally branch based on previous input. Results from these surveys can be reviewed through the administration interface, or presented as raw data in a spreadsheet.

7.6 Technology

The voice interface is implemented in the Lua scripting language as an application for FreeSWITCH [43]. FreeSWITCH interfaces with the network through a Primary Rate Interface (PRI) line supporting up to 30 simultaneous channels. The web interface is implemented with a Google Web Toolkit front-end, and Django back-end. The entire software stack can run on a basic commodity server with specialized PRI hardware, running Linux.

The code is open source and hosted at [10].

All interaction in the voice UI is captured in text logs. Each line in the log records a call session id, the phone number of the caller, the prompt being played or touchtone input being entered, and a granular timestamp. Complete call transcripts can be constructed based on session ids, and usage behavior can be mined based on tracking navigation over thousands of calls.

7.7 Discussion

Below we discuss Awaaz.De's social, and technical, and scalability challenges.

7.7.1 Community Managers

Community managers play a pivotal role in Awaaz.De applications. A community manager that diligently attends to people's messages and generally has a pulse on the needs of the community can significantly increase traffic. Success depends on training and incentivizing community managers. Some organizations co-opt paid staff who are doing similar projects within the organization; others hire a dedicated community manager. In either case, the manager must combine discipline to do somewhat mundane daily responsibilities and personal investment in building a satisfied and growing user community. Community managers are in a way similar to a radio jockey, and successful ones relish the opportunity to function as a communications hub.

Community managers exercise significant influence over the application. As the forum gatekeepers, they control what information is and is not publicly accessible, and through setting of post ordering managers dictate what content has primacy. Through the broadcast mechanism, they decide what deserves the attention of audiences. Organizations committed to delivering fair, balanced, relevant, empirically-backed knowledge leverage the community manager role to maintain a high level of quality. For example, DSC strips away spurious or redundant questions, and features the day's most frequently asked questions at the top of the forum and in regular broadcasts. Because human moderators are subjective,

the content and social dynamics in the system reflect an institution's biases. DSC, for example, is hesitant to designate a broader community of small farmers as expert responders, preferring instead to delegate to responsibility to staff members and a few trusted outside scientists. Other organizations will take a more open approach, even disabling moderation for some forums. Like Usenet, Awaaz.De only provides the technical interface to support social interaction; ultimately, people determine how it's used and for what purposes.

7.7.2 How does community management scale?

Awaaz.De relies on a person to manually act as a conduit for information flowing through the system. Message routing and broadcasting is initiated by the community manager; if a question comes in that has been responded to earlier, the community manager must search through the forums to find a response, or maintain a locally stored and indexed library of responses. As messages scale from tens to hundreds or more daily, this becomes an intractable task for a single person without mechanisms to quickly review and search audio. Community management can scale with a combination of speech-to-text, crowdsourcing, and machine learning technologies to automate indexing, moderation, searching, and routing of audio messages. We discuss some specific ideas in Chapter 9.

7.7.3 Why not use text?

Text-based information sharing has many advantages over audio. It is easier to browse, scan, and search. Composing messages incrementally and combining various sources can be done more readily with text than audio. However, there are usability and literacy barriers to using text. Composing text messages over the phone is cumbersome with small screens and buttons, and awkward mappings of buttons to characters. Many phones do not have local language bundles installed, and font packages in various languages are non-standard, expensive, and hard to acquire. Many rural people are not used to texting over their phone. In survey we conducted with 300 farmers in Gujarat, 25% reported reading an SMS message, and 15% reported having composed at least one SMS.

7.7.4 Who pays?

Airtime in India is cheap, but it is not free. Poor communities are highly price-sensitive, and the most common critical feedback from Avaaj Otalo users historically is that the service should be free. Chapter 8 shows that there is a significant drop in usage and social behavior in the forums (*i.e.*, browsing and responding to other people's messages) when Avaaj Otalo shifted from a toll-free to local phone number. On the other hand, covering full airtime charges (on top hardware and basic phone line rental costs) is often impractical for grassroots organizations struggling to operate under tight budgets. For Avaaj Otalo, DSC has struck a compromise with its user community: callers have to pay to call in and record their questions, but they receive the response (as well as broadcasts) for free. In this way, the two parties are meeting half-way.

Awaaz.De applications can generate revenue in a number of ways. Callers may be required to pay a monthly subscription fee, deducted from their prepaid airtime balance on a monthly basis. A variation on the subscription model is freemium [79], which has emerged on the Internet for various services, including online news sites like the New York Times [91]. Chapter 9 gives a more detailed discussion of these options and their tradeoffs.

7.8 Conclusion

This chapter presented Awaaz.De, a social platform for communities with limited Internet access. The platform follows a "Internet for the few, voice for the many" access model to reflect that most target users own low-end mobile phones and are most comfortable consuming and creating audio content. To cope with managing the voice message boards, Awaaz.De provides a web-based administration interface to moderate, annotate, and route messages. The platform provides considerable power to reach remote communities, but also challenges in delivering high-quality, relevant content that keeps people engaged. Besides the content itself, what other factors determine usage and engagement level? The next chapter examines this question.

Chapter 8

Sustaining Engagement with Incentives and Motivation[1]

Many online communities face challenges in sustaining interest and engagement over time. For low-income people, the financial cost to access a service can present a significant usage barrier. When Avaaj Otalo transitioned from being available over a toll-free number to a local phone number, the number of calls and the average duration of each call dropped dramatically (see Figures 8.1 and 8.2). The drop-off mostly came at the expense of browsing and responding to others' messages, the service's most social actions.

In addition to financial incentives, people are often motivated to participate in online communities for non-monetary reasons, such as self-learning, prestige, reciprocity, and community advancement [65].

This chapter presents two experiments that sought to increase the number of calls and message contributions to two different voice question and answer services using financial incentives and motivational messaging. In the first experiment, participants were offered free calls, free message recording, or free listening to and rating of messages. The freebies ended up resulting in less paid calling by participants, as they contented themselves with the access they were getting for free. In the second experiment, participants were given motivational messages that appealed to self and community, but there was no resulting difference in calling or message posting from the control group. In that experiment,

[1]This work was done in collaboration with Paresh Dave, Satyam Salil, Scott Klemmer, and Tapan Parikh

striving to make the motivational message concise in audio form may have dulled its persuasiveness. Taken together, these negative results imply that incentives and motivational messaging can be "too much" or "too little" to cause increases in usage and contribution to online communities. We conclude that follow-up attempts should provide more targeted rewards, and psychological motivations should be a part of the functionality, instead of explicit messages.

8.1 Study 1: Can freebies bring back social interaction?

When it comes to purchasing goods and services for low-income populations, pennies matter. Mobile airtime is no exception. In India, pre-paid airtime costs roughly one cent per minute [96], and average farming family income is $60 per month [25]. With over 300 minutes average usage per month [96], a typical rural Indian may spend over 5% of her total monthly income on mobile. Across all developing countries, the average spending per capita on ICTs is 17% of total income. By contrast, the average in wealthy countries is 1.5% [134].

Access costs have a direct effect on how much people go online [92], and in turn, how much people contribute time and content to online communities [65]. Even a small difference in access costs can translate to a huge behavioral change. Kollock gives the example of participating in a protest by mailing a letter (low cost) versus signing an online petition (near-zero cost). The same is intuitively true for producing and consuming community knowledge; unless the access costs are affordable for the world's poor, the gap between the digital haves and have-nots will continue to widen even as knowledge goods proliferate online [36].

8.1.1 Putting a Meter on Social Software

Avaaj Otalo was available over a toll-free number during its pilot period. There were 3,500 calls logged in the first month, which came to an average of two calls per farmer per day. Thereafter, calling settled into a lower but stable rate. Figure 8.1. A few months after the pilot concluded, AO re-launched with open access to any caller, and new features based on

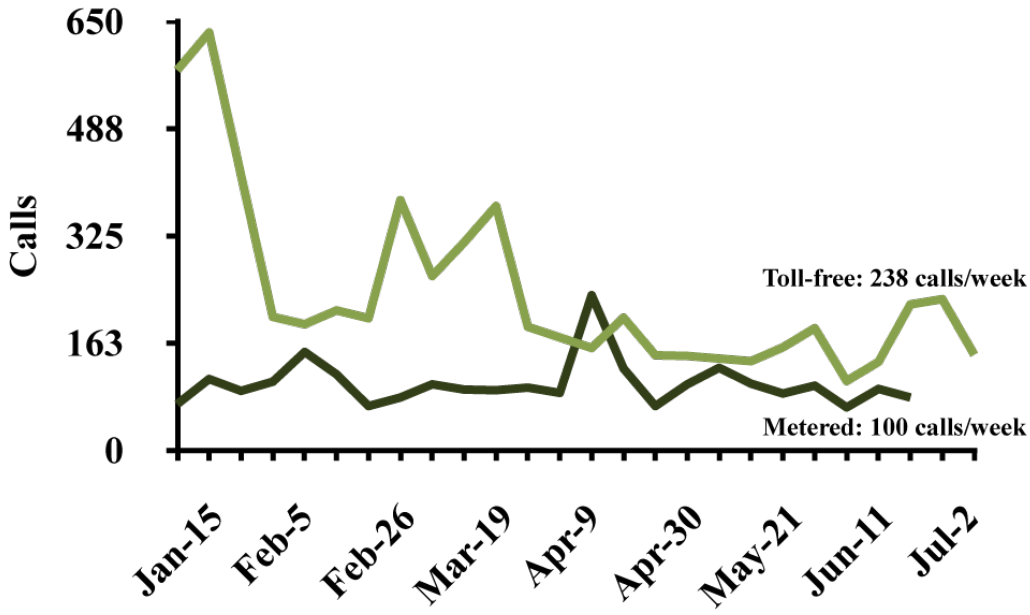

Figure 8.1: Calls to AO with toll-free (light green) and metered (dark green) lines. Toll-free calling was during Jan-July 2009, and the metered data shown is from the same months in 2011. The average calls per week was 238 with the metered line, and 100 calls per week with metered.

feedback from the pilot (see Chapter 7). Notably, the phone number to access AO changed from toll-free to a local number.

The decision to discontinue the toll-free number was budget-related. DSC could cover the line's flat monthly rental and some fixed amount of airtime for outbound message routing and broadcasts, but not an unrestricted amount of airtime. In addition, DSC was confident that farmers would still find value in calling in to get high-quality advice and responses to their specific questions. AO would send response calls, so the cost of a question and response round trip would be split between the caller and DSC.

The change from toll-free to metered access coincided with a significant drop in usage. Calling decreased from an average of 238 calls per week to 100 calls per week during the same time of year with the metered line (see Figure 8.1). This was in spite access to the

metered line being open for anyone to call, whereas the toll-free line was only available to a select group of 63 farmers who had access during the course of the pilot. The group of farmers in the pilot severely curtailed, if not completely ceased, their calling. Amongst the same cohort of pilot participants calling about 240 times per week during the farmers, it was down to 2 calls per week during the same time of year with the metered line.

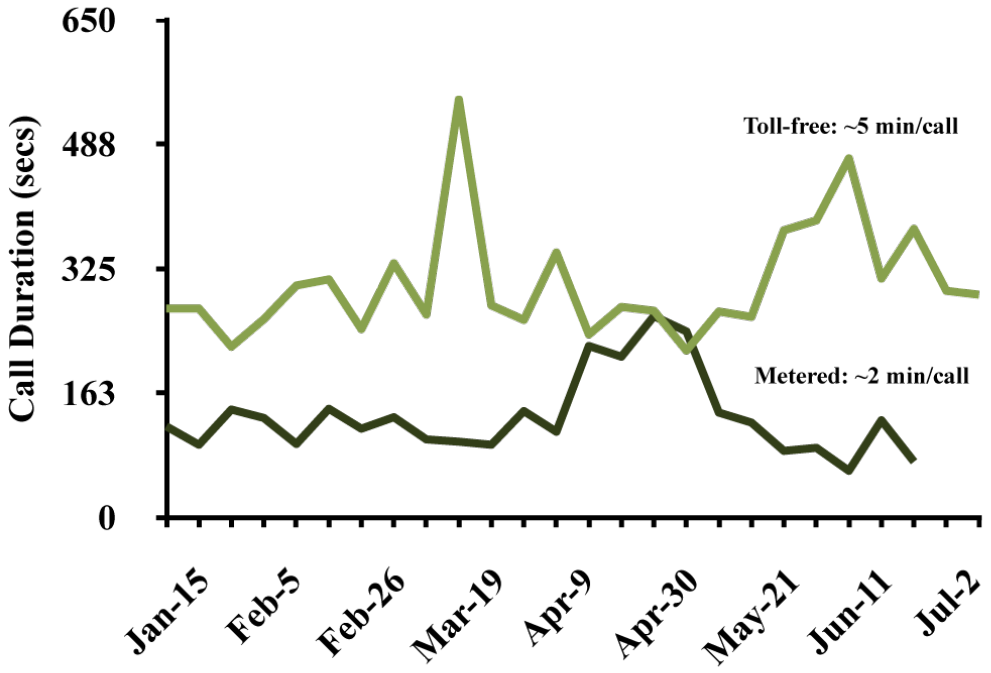

Figure 8.2: Average call duration on AO with toll-free (light green) and metered (dark green) lines over time. Duration is over 50% lower with metered access.

Not only did call volume change, but call *behavior* also changed. Since the line became metered, callers were spending less time on each call: duration dropped by over 50%, from 5:00 per call in 2009 to 2:18 in 2011 (see Figure 8.2). The shortened call durations left less time for the two most pro-social activities in the system: browsing the question and answer forum and recording responses to others' messages. Figure 8.3 shows the difference in lurking rates before and after the paid line, during the same time of year. Lurking was

calculated as the proportion of times callers chose to browse the forum out of the total times they chose to access the forum to either record or browse. Choosing to browse went from 88% of calls to 45%. Another indicator of lack of browsing was the number of messages listened to per call, on average. Figure 8.4 shows the the average dropped from 6.1 during the toll-free era, to 1.5 in the metered.

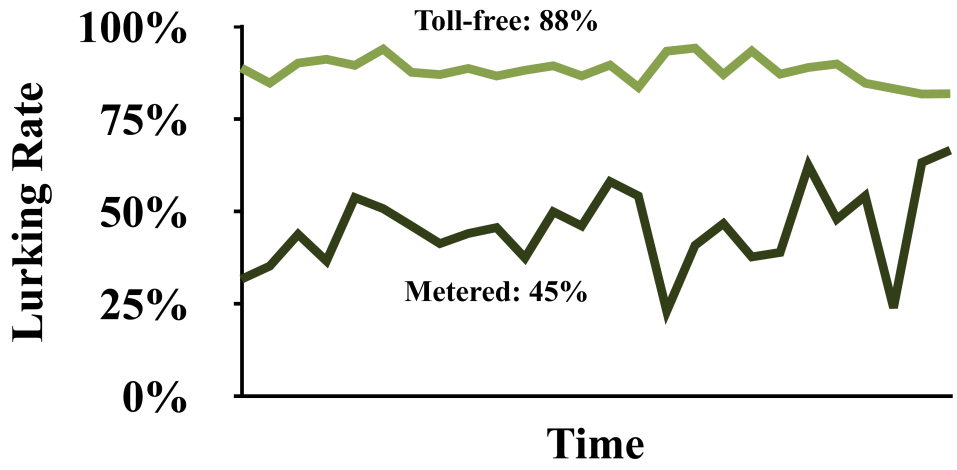

Figure 8.3: Lurking rate on AO with toll-free (2009) and metered (2011) phone numbers. Lurking was 50% lower with metered access

Browsing dropped, but so did responding. Originally envisioned as a platform for farmers to share knowledge with each other, peer responses went from 43% of total responses during the pilot phase, to 13% after the toll-free number was discontinued (see Figure 8.5). Responding is now a task dominated by the few chosen experts of DSC who are regularly assigned questions.

The lack of browsing for questions and answers also indicates a practical trade-off callers are making between immediacy of answers to their questions and the cost to procure them. Price sensitive callers are directly asking their questions without browsing the forum to check if their question has already been asked and answered. So in choosing on one hand to spend extra to potentially get an immediate answer, or on the other to record quickly and wait a couple days to get an answer, many farmers choose to wait and save a precious few

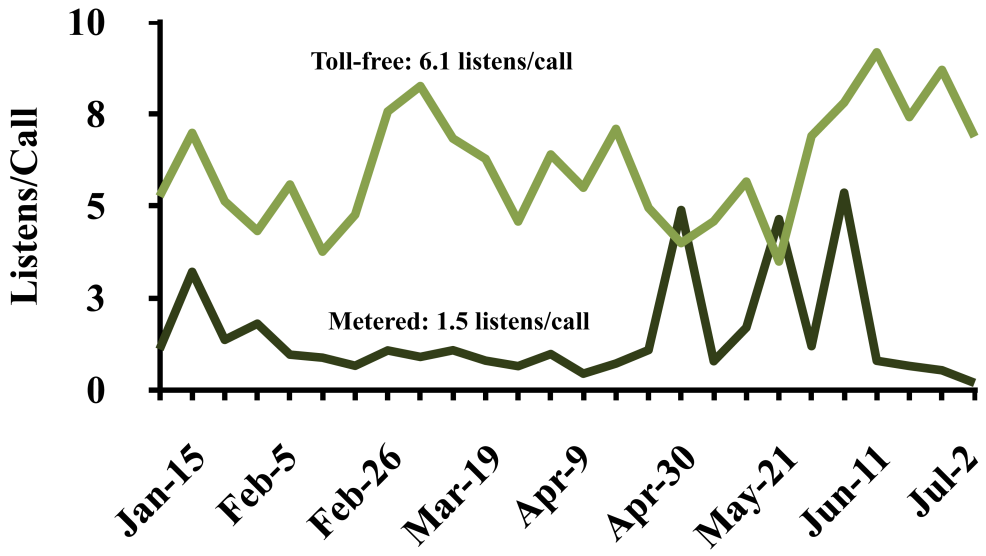

Figure 8.4: Number of message listens per call on AO with toll-free (2009 and metered (2011) lines.

cents. Furthermore, there is no way to know for sure that the information a caller is looking for is available in the forum.

The introduction of economic barriers to browsing had social implications: without exposure to the shared virtual space, callers are less inclined to perceive AO as an online community than an information service. Rather than an open forum for advice to be discussed, debated, and ultimately enriched by a more diverse set of voices, the system converges back to the one-way information flow the system was intended to relieve.

Another indicator of the paid line's negative effect on social interaction was the lack of a persistent user group. During the pilot, 10 of the pilot participants (roughly 16%) accounted for 80% of the calls to the system. This core user group posted the most questions and replies. Their regular presence in the system also led to participation as informal moderators of the forum, informing other callers on the proper way to frame a question, or rebuking callers who posted off-topic or otherwise spurious content. With the introduction of a paid line, however, the number of consistent users has dwindled. While roughly 65%

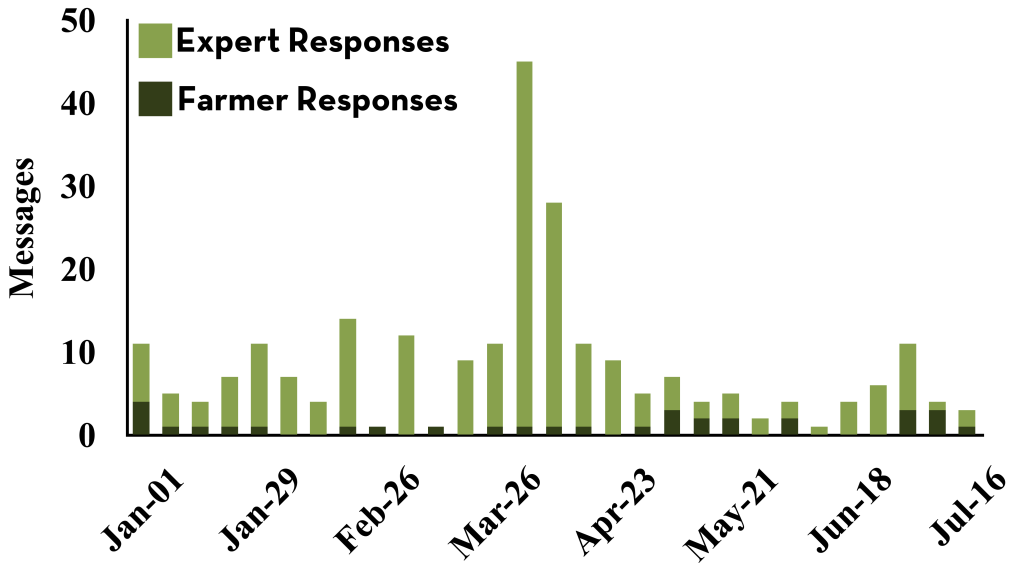

Figure 8.5: Recorded responses to questions in 2011. The light bar are responses from DSC's designated expert responders, and the dark bar are farmer responses.

of callers call back at least once, only 1% (7 out of 665) of callers called at least once every month over the first six months of 2011.

Clearly, access costs had a strong negative impact on pro-social activities in AO. The next questions were whether it was possible to bring back social interaction to the service, and how.

8.1.2 Incentivizing a social ecosystem with freebies

A well-known challenge for online communities is aligning incentives: ensuring that those who contribute to the system receive a benefit in return [49, 114]. Online communities sites on the web have applied a variety of approaches to incentivize usage and contribution, appealing to psychological motivations [74], gamification [77], and payments [26, 58]. Financial payments have concentrated on encouraging answers to questions, which is usually

regarded as the primary bottleneck for usage and engagement in Q&A systems [84]. Research on the efficacy of payments on Q&A systems have had mixed results: some studies show that quality [57, 50] and quantity [58] can be bought, while other results show that there is at best a weak tie to either [61, 26, 58].

Researchers and policy makers have debated the appropriateness of small "user fees" charged to poor communities for products or services such as healthcare or education as an alternative to pure charity. Proponents argue that charging a fee or performing cost-sharing ensures that products do not get into the hands of those who would waste them (screening effect), that paying for a good heightens the perceived value of the product and thereby increases its likelihood of legitimate use (commitment effect), that charging fees ensures that those in the most need will avail the product, that in the long term it avoids dependency or expectation of charity in the future, and that it is a sensible way to have a distribution program offset its own costs and overhead. A collection of several recent empirical studies has invalidated each of these claims [69]. The studies suggest that instead, charging small fees significantly reduces take-up of the products, do nothing to increase commitment and very little to screen out potential wasters, does not end up targeting the most in need, and does not affect future willingness to pay. One study shows that free access may even increase willingness to pay, after recipients and their neighbors experience real benefit from the product. A meta-analysis of these studies [69] identifies three criterion for when a product should be offered for free: when there are positive spillover effects to individual distribution (i.e. immunizations reduce the spread of diseases to the larger community), when a product or service is a preventative measure (which, due to present bias is less likely to be proactively consumed), or when a product is very cost-effective to distribute, relative to its benefits. In the case of DSCs question and answer forum, browsing and contributing to the forum can yield two positive spillover benefits to the larger community: greater knowledge diffusion through increased exposure to information, and more vetted, comprehensive information through participation in forum discussion.

Using freebies as a promotional strategy also provides the opportunity to expose a wider audience to the benefits and functionality of the service. This is the intuition behind free samples. After message broadcasting was made convenient to schedule for community managers (and after the mostly positive feedback of AO Margdharshan during the authority

experiment), DSC began regularly broadcasting messages from the announcement section to previous AO callers and other farmers in their contact directory. The announcement messages were recorded by one of DSC's senior staff members, and typically covered agriculture-related news of the week, discussions of current weather conditions, and advice pertaining to the specific period in the growing season. Over time, a trend emerged: broadcast calling correlated to more calling of the paid line. Figure 8.6 plots the outbound broadcast calls against inbound paid calls on the same day. Regression analysis shows a strong positive correlation between the outbound and inbound calls ($p < .05$). There was also a strong correlation between outbound calls on one day and inbound calls on the next.

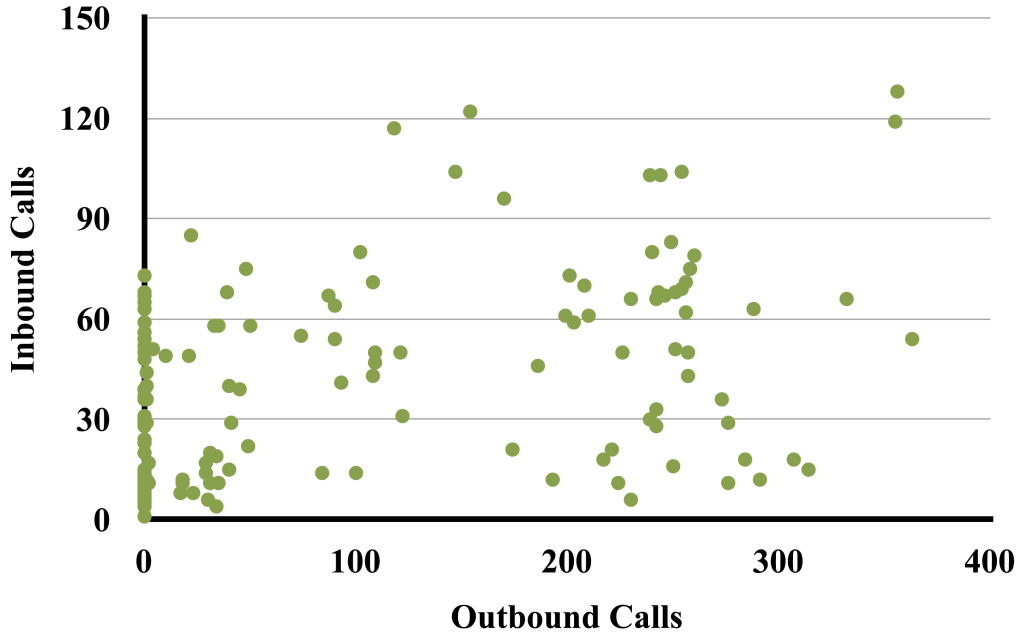

Figure 8.6: Outbound (broadcast) calls and inbound calls plotted for each day between February and July 2011 on AO. The concentration of points long the y-axis indicate days when no broadcast was scheduled. There is a strong correlation between outbound and inbound calls.

We hypothesized that providing the ability to contribute content for free would similarly have a positive impact on paid contribution in the future. If a farmer records a question, responds to another's, or perhaps takes a simpler action like rating content that they hear, the farmer is a participant in the online community. This may establish a commitment to

continue to participate [28]. Speech user interface researchers have noted the persuasive power of an interactive experience between users and the system [109]. Users may feel greater engagement with a system that carries on a conversation, as it feels more personal than a one-way information access experience [85].

8.1.3 Comparing different freebies: a controlled experiment

To test these ideas, we ran a controlled experiment on Avaaj Otalo, offering different groups of farmers different freebies to encourage usage and social interaction in a metered system. Our research question was:

> Can promotional freebies lead to increased usage and social interaction on voice based social media?

We tested two different freebies: free opportunities to record messages on AO, and free opportunities to listen to and rate content on AO. The latter was included as a lightweight way of engaging callers to make a commitment, albeit minor, to the system. These two freebies were restricted in that they were free offerings that were a subset of the full-featured service. We included free recording in order to encourage message posting; we chose to also include rating in order to test whether a lighter weight way to leave feedback could still drive increased participation. As a baseline, we compared them to a free call freebie, which gave participants a free session, off the meter, with AO. Compared to the free recording and free rating freebie, free calling is expensive because it gives callers an unrestricted amount of airtime. As a comparison point in the experiment, it represents the naive strategy: overcome access costs by eliminating them. We had two hypotheses:

> H1: Callers receiving free calls and free rating will increase the number of paid calls and time spent browsing the AO forum.

> H2: Callers receiving free recording will increase the number of paid calls, forum browsing, and message posting.

8.1.4 Participants

Participants were collected by extracting phone numbers from system usage logs from the three months prior to the experiment. Each was assigned to one of the three conditions shown in Figure 8.7. Assignment to each condition was random, but counterbalanced for the number of calls participants made in the three month period. There were 413 participants in all.

Condition	N	Attempts	Pickups	Freebie Prompts	Actions
CALL	138	1400	993	459	210
RECORD	137	1467	976	534	64
RATE	138	1372	929	495	303

Figure 8.7: Results by condition. Number of participants, number of calls, pickups, freebie prompts reached, and actions are given. For the CALL condition, an action was counted when the caller was transferred to their free session and took at least one navigational step before hanging up. For the other conditions, an action constituted availing the free offer (recording or inputting a rating).

8.1.5 Method

Participants received phone calls twice a week at roughly the same time each week over the course of five weeks. Each phone call followed a specific structure, illustrated in Figure 8.8. Participants who answered the call were greeted by the AO service, in the same voice as that from the prompts in AO's call-in line. The phone call was also originated from the same call-in number. After the greeting an informational message handpicked from the system was played. This spotlighted message was either an announcement posted to the

system by the DSC staff earlier, or a question and answer from the forum that was chosen by the staff to be spotlighted.

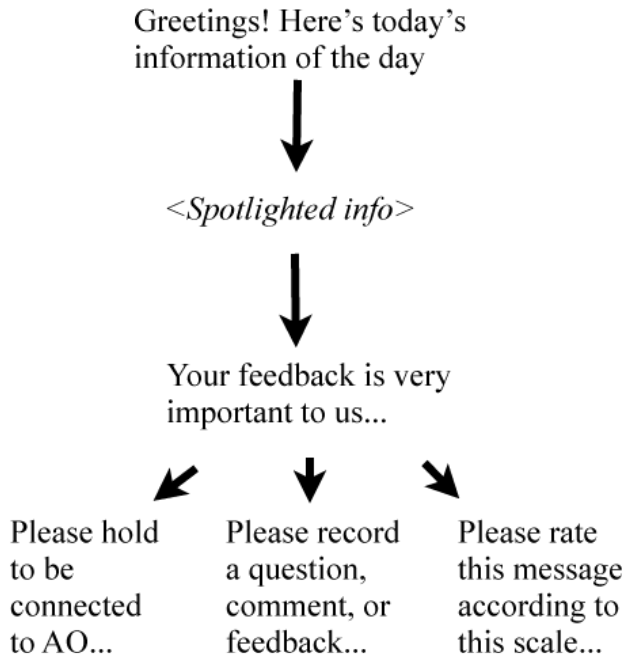

Figure 8.8: Structure of "freebie" calls. All broadcast calls played the same prompts and informational content, but varied in the final prompt which preceded the freebie offer

After hearing the content, a fifteen-second motivational message reminded the caller how important their participation and contributions are to AO. After that, the caller was presented with their freebie. Depending on their assigned condition, the caller was either prompted to record a comment, follow-up question, or other feedback, to rate the message they had just heard on a 3-point scale, or to remain on the line while their call was transferred to the call-in service for a free session. Full translations of these prompts are in Appendix B. This was a between-subjects experiment, so subjects received the same freebie throughout. For the rating condition, two different versions of a three-point scale where employed (randomly assigned, between-subjects). One scale asked to rate the message as "very good", "good", or "ok". The other gave the options "good", "ok", and "bad". The order of the options was fixed and mapped to the numbers 1, 2, and 3 on the dialpad.

We used two measurements of usage, as proxies for engagement. One was number

of paid, inbound calls made, and the other was amount of browsing, measured by both lurk rate and number of message listens per call. We also measured message posts (both through freebies and through inbound calls). Finally, we conducted phone interviews with 14 participants from the study across all conditions to help explain the quantitative results.

8.1.6 Results

Over four weeks, 4,239 phone calls were sent to 413 participants (see Figure 8.7). The percentage of times callers stayed on the call until the end (for the freebie offer) was 46% for the CALL condition, 55% for RECORD, and 53% for RATE. The lower survival rate of CALL calls was likely caused by a software glitch during the first week of the experiment that disconnected calls before the free session began. The glitch was discovered and fixed a week after the experiment began, but by that time participants may have anticipated the premature disconnection and hung up early.

For each condition, we recorded the number of times the freebie was availed, labeled as "actions" in Figure 8.7. A message recording or registered vote was considered an action in their respective conditions. For the free call condition, an action was counted if the caller took at least one navigational step in the call tree, by dialing a touchtone number.

Contrary to our expectation, paid calling during the experimental period *dropped* from the previous three months (see Figure 8.9). Participants in the CALL and RATE conditions made significantly fewer average calls per week. During those three months, broadcasts were still being sent, but at a lower frequency (once per week compared to twice per week during) and without the freebie offerings. Participants in the RECORD condition made fewer calls, but not significantly so. In post-study interviews, participants indicated that they called less because they were satisfied with the announcements and spotlighted question and answers being received through the regular broadcast calls. Rather than serving as a teaser to promote increased access of AO, broadcasts replaced paid calling that would have otherwise been made to get the same content.

The paid calls did not reflect any increase in pro-social behavior: both lurk rate and average number of message listens per call did not vary from the prior two months. The CALL condition's free sessions, however, showed a tremendous increase in average listens

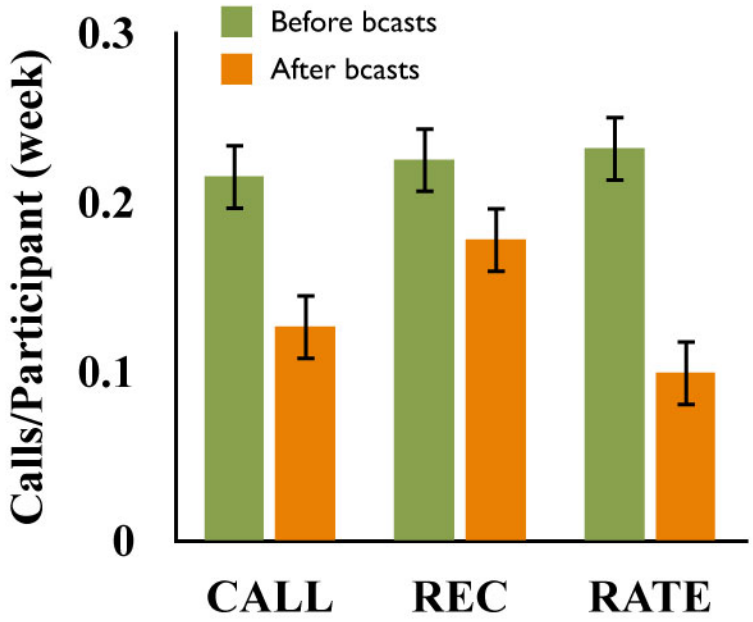

Figure 8.9: Comparing paid calling during the three months prior to the freebie (green), and the one month when freebies were offered (orange). CALL and RATE had significant reductions in number of calls, $p < .01$. The whiskers indicate standard error.

per call: 4.3 messages per call during the free calls, compared to 1.4 listens per call for paid calls in the prior two months.

Message Recording

Figure 8.10 shows average weekly message recordings in the two months prior to the freebies compared to the month they were offered. For the CALL and RECORD conditions, a significant increase in the number of messages was driven by the added free posting opportunities through the freebies. Comparing only paid message posts, all three conditions had significantly less posts during the experiment period compared to the prior two months.

Of the messages recorded through the RECORD freebie, 37% were comments expressing gratitude or praise, 44% were questions, and the remainder 15% were mis-recordings. A similar breakdown occurred for recordings from the CALL condition. A measure of message quality is the portion of messages that were approved by AO's moderator. Across

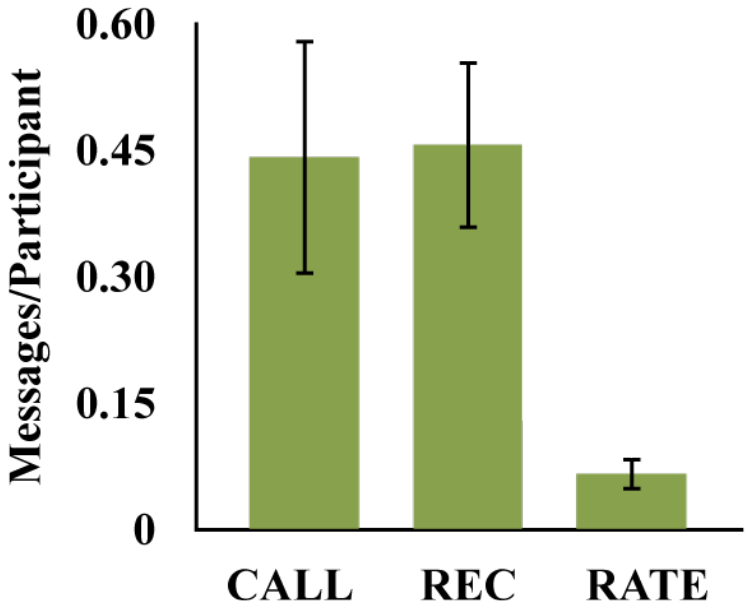

Figure 8.10: Messages recorded by condition. The average number per participant is .43 for CALL, .46 for REC, and .07 for RATE. The differences between CALL and RATE and REC and RATE are significant, $p < .01$

all conditions, the approval rate was 71% after controlling for mis-recorded messages. The approval rate for the two months prior was 74% (no statistical difference using chi-squared analysis).

Rating

One surprising finding from the experiment was that the number of rating attempts differed significantly between the two scale types. Participants who were given the very good-good-ok scale elected to rate messages nearly twice as much as those given the good-ok-bad scale (63% vs. 42% of the time, $p < .05$, t-stat=2.62, df=90). On both scales, people mostly rated messages as the top available rating. Average rating for the "very good..." scale was 1.18 (1 was for the high rating, 2 for the medium rating, 3 for the low), and median was 1, compared to 1.13 and 1 for the "good..." scale. One possible explanation for the difference in number of ratings is that people were more inclined to supply positive feedback than

neutral or negative. The "verygood" scale provided a more positive slant, with two positive options compared to one.

8.1.7 Discussion of Study 1

The results of this study did not confirm either of our hypotheses: the freebies did not lead to an increase in paid calling or posting to the system for any condition. To the contrary, paid calling decreased across all conditions. Instead of encouraging more calling, they replaced it. Participants felt satisfied with the amount of information they were now getting for free; there was not a need to pay to listen to more information. Future designs of financial incentives will fine-tune the timing of the offer to balance between push and pull information access. Another direction is combining financial incentives more tightly to desired behaviors, such as offering free airtime to ask a question, and offering double the airtime for an approved response or successful referral to anothers question.

Should the service be free?

As an information service provided by a non-profit organization providing a social good, the case can be made for the public sector to fund AO. In 2004, the Indian government started Kisan ("Farmer") Call Center, which is a toll-free phone line that farmers call to speak with a live extension officer [93]. The service lacks comprehensiveness and authority, as the officers are typically newly graduated students with limited practical experience. However, it is popular and actively competes for attention with AO because it is free.

Revenue models for an online service like AO include subscription and advertising through public-private partnerships. Subscription models have been used for other similar agricultural services in India. For example, Reuters Market Light offers SMS-based agricultural alerts for $1.50 per month [117]. It is unlikely, however, that these fees can sustain the service completely. Most mobile services that collect subscriptions do so through partnerships with mobile operators, which is not practical for smaller deployments.

8.2 Study 2: Can motivational messaging lead to more calling?

The online communities research has investigated what motivates users to participate and contribute. In general, motivations can be intrinsic (originating from the self) or extrinsic (based on an external system) [108]. Non-monetary motivations such as self-efficacy, altruism, reciprocity, commitment to the group, and feelings of prestige and gratitude can be activated through psychological messaging [27]. For example, researchers found that simple messaging to members of an online community about the uniqueness of their contribution, the benefit their contribution has to themselves and the broader community, and introducing usage-based goals leads to increased contribution [74].

Effective motivational messaging has the potential to amplify the effect of freebies as they were used in the prior experiment. In a study with another agricultural Q&A system in Madhya Pradesh, we sent freebie-style announcements with two variations of the same motivational message: one appealing to self-interest or individual goals, and one to group-interest or community goals. Our hypothesis was that both messages would produce an effect:

> Self-interest and group-interest motivational messages given regularly will lead to more calling and message posting than a control.

8.2.1 Method

The site for the experiment was Madhya Pradesh, where Digital Green [45] has deployed a voice service for members of DG's field staff to post agricultural questions and receive answers using their phones. The IVR application and the question and answer forum were implemented identically to AO; only the language of the prompts were different (Hindi instead of Gujarati). Instead of a paid line, DG's line is available over a toll-free number.

This experiment was set up analogously to Study 1. There were three conditions. The SELF group which received the self-interest motivational message, the GROUP condition that received group-interest, and the NONE condition which received no motivational message. There were 351 participants in all, randomly and spread roughly evenly between the

three conditions.

Twice a week, participants receive a message broadcast that, like in Study 1, played an informational message. After the message, the system played either the self-interest, group-interest, or no prompt. The translated messages are in Table 8.1. Originally containing more words of encouragement, the messages were pared down to 15 seconds from their original 45-second length to prevent listener fatigue. After the motivation, all participants were prompted to record an optional feedback message.

SELF	Your feedback is valuable to us. Providing your unique perspective and experience can reach the entire community, and earn you recognition with the entire community.
GROUP	Your feedback is valuable to us. Providing your unique perspective and experience can reach the entire community, and can help the entire community.

Table 8.1: Motivational messages used in Study 2. The recordings were about 18 seconds long each.

8.2.2 Results and Discussion

Figure 8.11 summarizes calls made and feedback messages recorded by condition over the 5-week experiment. There was no significant difference between the SELF, GROUP and control conditions. The main challenge was designing a strong but terse motivational message. The persuasiveness of the messages were likely diminished as they were shortened. While researchers have pointed out that the small amount of time, effort, and financial cost to contributing content to online communities can make even small psychological benefits lead to big behavior changes [65], this study was unsuccessful in taking this approach. One possible change in approach would be to appeal to known motivations in a way that is more closely tied to desired behaviors and functionality in the system. As noted in Chapter 6, identity and status play an important role in how people interact and relate to information in Avaaj Otalo. At the same time, researchers have known that reputation is a powerful motivator for participation in online communities [66]. One effective way question and answer services have been able to integrate a reputation system is through game mechanics,

where users rate each other's contributions to earn points and badges which allow one to earn merit and distinguish themselves by quality [77]. Future work will explore the design of an appropriate reputation system, and measure its impact using the same metrics from these experiments. One challenge will be making reputation measures expressive enough to attract people to participate, but simple enough to understand and represent through a pure voice interface.

Condition	N	Attempts	Pickups	Freebie Prompts	Actions
SELF	120	1625	934	268	25
GROUP	119	1584	921	227	16
NONE	120	1621	859	237	20

Figure 8.11: Results by condition. Number of participants, number of calls, pickups, freebie prompts reached, and actions are given. For all conditions, an action is defined as recording a message when prompted in the broadcast call.

8.3 Conclusion

This chapter presented two experiments to increase usage and message posting to voice based information systems in India. One experiment incentivized usage through free access, and found that access cannibalized the paid access to the system, rather than spur an increase. The other found the short 15-second motivational messages did not elicit an increase in calling or message recording, concluding that the messages were to short and/or infrequent to persuade participants. Taken together, these negative results illustrates the risk of doing"too much" or "too little" to elicit behavioral change in online communities.

Future work will search for the right balance.

Chapter 9

Conclusion and Future Work

9.1 Review of Contributions

In this section we summarize the contributions outlined in the introduction.

9.1.1 Design: Using touchtone navigation for a simple voice UI

The first stage of our work focused on developing a usable technology, given the needs and constraints of the user community. For many who call Avaaj Otalo, it is the first time they are interacting with an automated voice interface. We accounted for this by limiting the number of menus and options per menu within the application. The input modality for navigation should be comfortable and effective. Prior research and some intuition suggested that speech input would be most appropriate: voice interface design stresses the importance of a natural conversational dialog, and others designing voice interfaces for rural communities have assumed speech would be more comfortable for low-literate users. Our study comparing touchtone and speech input for navigating AO showed the opposite: touchtone input led to a higher task completion rate for navigation. Participants considered single-word speech input unnatural. In a follow-up field deployment, people voted through their calls: Over 90% of AO users during the pilot period chose to navigate with touchtone when given the choice.

9.1.2 Social Dynamics: A voice forum supports a rich social space

Taking Avaaj Otalo out of the lab and into the field was the most direct way to see how a voice social media application would be used by rural people. A seven-month pilot showed that AO's question and answer forum received a steady level of call traffic, supported active exchange between peers, was appropriated for a variety of uses besides agricultural question and answer, and engaged a core group of participants in active contribution and moderation of the forum. The response from pilot participants was overwhelmingly positive, and our local partner decided to keep the service as an ongoing project by allocating budget and dedicating staff members to administer it.

During the pilot, one of the most striking social dynamics was the role of identity and status in the forum. Participants made a point of identifying themselves before recording their message, and some reported how their association with the service was a source of credibility in their local community. People also stated a strong preference for outside authoritative sources of information compared to peer farmers. To test whether this preference affected how likely people were to act upon information, we ran an experiment that varied the source of informational messages, controlling for the informational content itself. Our results offered empirical evidence showing that the information source mattered, and that peer-sourced information led to significantly more follow-up action.

9.1.3 Internet for a few, voice for the many

This dissertation contributes a model for extending Internet-like services to contexts in which broadband-connected PCs are available to a minority of the population, but mobile phones are the more affordable and familiar computing platform. Awaaz.De is a software platform that allows a designer to create an IVR application consisting of customized message boards. Callers access the message boards and post new messages and participate in threaded discussions. Meanwhile, a community manager accesses Awaaz.De's web-based administration panel on a PC to review, annotate, tag, and moderate incoming messages. The manager can also set the ordering of messages in the forums, route messages to particular phone numbers for soliciting speedy responses, and broadcast select messages for wider dissemination.

9.1.4 Motivating and Incentivzing voice-based social media

Online communities rely on the consistent participation of its members to sustain a high quality public good. For AO, usage level is strongly tied to access costs. We contribute an analysis showing that AO's shift from a free to paid phone number coincided with collapse of the social ecosystem; once the line went paid, people effectively stopped browsing and responding on the forum. We experimented with two methods to encourage more usage and contribution: freebies and motivational messaging. Based on the inconclusive results, we suggest next iterations of both monetary and non-monetary incentives: pay-per-response and game mechanics through a reputation system.

9.2 Future Work

What are the key areas of improvement and open questions for voice-based social media? Below, we highlight some we've identified:

9.2.1 Searching and browsing audio

As the amount of voice content increases, community managers and end-users will require powerful, reliable, and intuitive search interfaces. For end-users, the holy grail is an interface that interprets natural language in real time and searches against indexed content, such as Google Voice Search for Mobiles [48]. Interpreting query input requires large vocabulary, continuous speech recognition. Speech technologies have come a long way, but high-quality recognition is currently unavailable for the majority of the world's languages and dialects. Traditional speech techniques require gathering hours of audio training data in the target language, hand-labeling it by trained linguists, and training a probabilistic model. The accuracy and robustness of the model is based on the amount of data and the variety of speakers. Collecting and labeling large amounts of speech data is a time consuming and expensive process; it constitutes the main barrier to having accurate speech recognition in all of the worlds languages.

Future work calls for developing cheap techniques for generating high-quality speech recognition for low-resource languages. Data collection is made scalable by the system

itself; the speech recognition improves as more voices are heard. For labeling and transcribing content, an emerging trend in speech research is leveraging online crowdsourcing platforms [89]. Using humans to manually tag and annotate voice data is already a part of the Awaaz De platform. More work is required to connect incoming voice content to larger pools of paid online transcribers, and provide controls for administrators to adjust quality and budget thresholds.

Community managers searching the indexed content to review or re-use content will be working from a screen, so standard search UI design applies [53]. However, designing an intuitive speech interface for end-users to give queries will be a challenging task. Our early experiments with speech input showed that novice users might have difficulty in formulating structured queries and recovering from recognition errors. We will have to experiment with various techniques for soliciting input to ensure that queries can be interpreted with high accuracy while not leading to excessive back-and-forth with the system.

9.2.2 Smart Phones

The number of subscribers to data services in India has increased from 30 million in 2007 to over 300 million in 2011 [95]. Increased demand is expected to accelerate development of next generation networks, cheaper data plans, and smartphones.

The trend toward cheaper mobile Internet and handheld devices will have an impact on the design of Awaaz.De. Richer and more interactive screens will aid in browsing, searching, and navigating voice message boards. One project visualized threaded voice content and various metadata with hierarchical representations, color, size, and shapes [148] (see Figure 9.1. With multimedia capabilities, Awaaz De can incorporate video, images, and text with voice content to support multimedia forums. For example, a farmer may record questions through video, capturing his diseased plants visually, and others have the flexibility to respond through video, voice, or text.

9.2.3 Learnability

Avaaj Otalo's full launch after the pilot period was not accompanied by any training of users. In lab studies and field visits, little training was required for novice users to catch

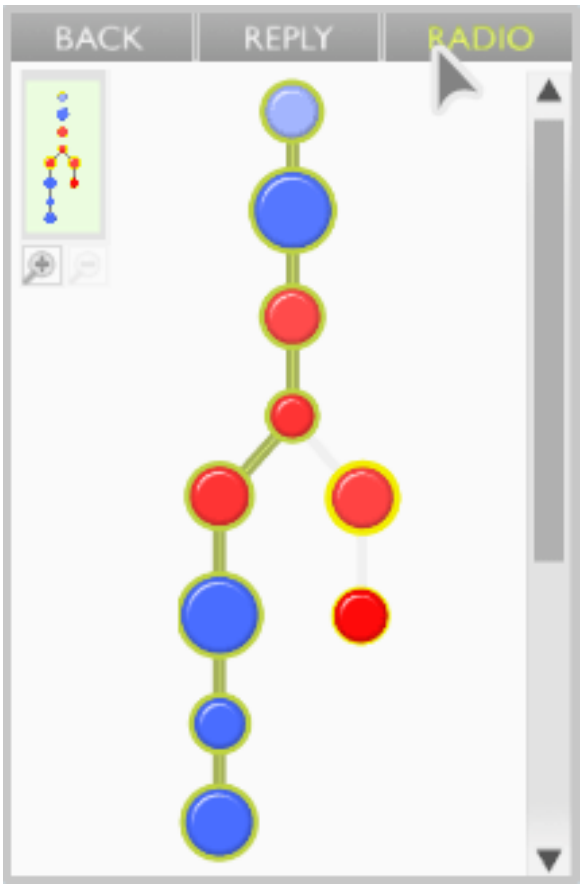

Figure 9.1: A screenshot of RadioActive's GUI

onto the system for navigating, browsing, and recording messages. In addition, it was common in field visits to see local people teaching each other. Still, there is evidence that many people who call the service are unclear or unable to use it. An analysis of recent call logs between January and July 2011 showed that roughly 40% of calls do not get passed the initial welcome prompt.

Future work should investigate the extent to which the automated voice UI can be understood and learned by untrained users. Identifying common reasons for hanging up without interacting with the system, and characteristics of callers that hang up would be valuable in designing training programs.

9.2.4 Voice social media for new domains

This dissertation applied voice-based social media in the domain of agriculture, for the purpose of question and answer, with one institutional partner. Future work should broaden out and apply the basic asynchronous voice message portal, routing, and broadcasting platform to other domains and use cases. This work partnered with organizations working in agriculture, education, labor transparency, and human rights. The tool has also been adapted to other uses besides question and answer, such as open-ended discussion and experience sharing, data collection, monitoring, customized market information access, product support, and voice-based classifieds.

Given the diversity of uses and languages that voice-based social media can support, Awaaz.De can branch into a number of applications. Currently it is being used by 8 organizations across 6 states in the domains of agriculture, education, labor transparency, and women's empowerment. Looking ahead, Awaaz.De can be made accessible to any institution, group or individual wishing to connect, organize, and collaborate through voice content over mobiles. Many rural people are thought-leaders, innovators, and local information hubs [100]. Future work should look to make voice social media simple and affordable to empower these "lead users" to manage localized knowledge bases.

9.2.5 Impact Analysis

The ultimate goal is to enable rural people to access the knowledge they need to be more informed decision-makers. Access to the system should translate to improvements in livelihood.

Currently, we are conducting a randomized controlled trial of Avaaj Otalo. In collaboration with developmental economists and policy researchers, we have designed a study in which treatment villages will be given free access to AO. In an alternative set of treatment villages, AO access will be combined with human extension worker visits. The trial will be conducted over the course of one year, covering a full growing cycle. During and after the trial, researchers will conduct surveys to measure farmer knowledge retention, decision-making, adoption of practices, changes in farm productivity, and income. In addition, we will measure network effects of AO: to what extent did knowledge from the system diffuse

to surrounding community members?

9.2.6 Awaaz.De

As this dissertation concludes, we are pleased that its work will carry on through Awaaz.De [1], a private company in India co-founded by the author. Ongoing hosting, maintenance, and technical support for deployments will be managed by Awaaz.De. The company will work on the future directions outlined in this chapter, and attempt to realize the full potential of voice-based social media for the people of India and beyond.

9.3 Closing Remarks

The best ICT4D work strikes a balance between practical solutions and scientific contribution. One goal is to a build system that is actually used and valuable to local institutions and communities. The other is generating evidence-based theories and generalizable knowledge. There is sometimes a tension between these goals, because doing what "works" from a practical standpoint may lead to a solution that is not technically novel or of limited theoretical value. For example, the author developed a simple software program to allow an NGO to certify small-scale organic farmers in India. Hundreds of farmers have been certified through the software and it continues to be used to date, but the software implementation itself was relatively trivial. However, pursuing immediate, practical solutions to problems in society need not sacrifice generating fundamental knowledge. One vivid example is Louis Pasteur's contributions to the field of microbiology; his experiments established basic theories upon which the field was founded while using the findings to develop pasteurization and other life-saving procedures still in use today. This dissertation strives for placement in Pasteur's quadrant [127], or "use-inspired basic research".

We deployed Avaaj Otalo, a live service that has delivered relevant, timely agricultural knowledge to thousands of farmers through tens of thousands of calls over two years. Early in the project, we faced a challenge in gaining the trust of our local partner despite uncertainty about the project's value and long-term sustainability. Later, we had to transfer ownership of the project to the local partner while transitioning from a pilot to mainstream

service under their management. This involved money and time commitments from the already resource-constrained partner. During this transition phase we also faced the logistical challenges of deploying a system with limited technical support and at times unreliable power and connectivity. As the project matured, the challenge shifted to convincing our partner of the value of research initiatives that further stretched their time and budget. While each of these steps were at times difficult, it was ultimately a deeply rewarding process.

This dissertation was a step toward enabling an Internet for the next five billion people on this planet. Starting out, I intended to connect poor, remote, and marginal people to the knowledge they needed to improve their own livelihoods. Over time, as I have come across so many remarkable and inspiring people in disconnected corners of the world, I have come to believe that the real service to humanity is connecting *us* to them. The global village is far from complete without the experiences, perspectives, and knowledge of all the world's people.

Appendix A

Agricultural Tips

All tips are listed below in translated English and original Gujarati, in the order they were given during the experiment described in Chapter 6. In the recorded versions, each tip's introduction began with "Farmer friends, this is this is <name> from <affiliation>." For scientists, their name was preceded by "Doctor". Farmers just stated their name. For affiliation, scientists gave university affiliation, farmers gave their home village. Each tip introduction ended with "This was <name> from <affiliation> speaking, thank you for listening". The conclusion portion of the tip was heard if the caller chose to follow up by calling a number specified in the introductory call.

A.1 Vaccinations

A.1.1 Introduction

Your animals are very much prone to several serious diseases like hemorragic septacimia and foot and mouth disease with varying frequency. Once the animal gets sick, there are so many troubles. You need to call the vet, you need to spend money on visits and medicines, it is very much time consuming for you and sometimes your agricultural activities get delayed. If the sickness is more serious, and the animal gets weakened, then it is a long-term damage. For milking animals like cow and buffalo, milk production will go down. If you want to save your animals from all these troubles and want to ensure health of animals,

the very simple and cheap way is timely vaccinations. To receive information on which vaccinations should be done for which disease, when, and where the service is available, listen to the following instructions.

પશુ બિમાર પડે એટલે કેટલી બધી તકલીફ! તાત્કાલિક દાક્તરને બોલાવવા પડે, દવા–વીઝીટનો ખર્ચ થાય, કામ ખોટી થાય. અરે! કેટલીકવાર પશુ કાયમ માટે નબળું થઈ જાય. દૂઝણું હોય તો દૂધ ઉત્પાદન ઘટી જાય! આ બધાથી બચીને ઢોરને તંદુરસ્ત રાખવા હોય તો સાદો અને સસ્તો ઉપાય છે, રસીકરણનો. દાક્તરની સલાહ મુજબ જે તે ઋતુ અને મહિના પ્રમાણે રસીકરણ કરાવી લેવાની અમારી સલાહ છે. કઈ ઋતુમાં ક્યા રોગો માટે રસીકરણ કરાવવું તેની વિગતો જાણવી હોય તો હવે પછીની સૂચના સાંભળો.

A.1.2 Conclusion

In Gujarat, we need to vaccinate the animals, especially for foot and mouth disease and HS. The germs of HS may cause the disease while the animal grazes on moist grasses, especially in July and August. The animal should be vaccinated for this disease in the month of April and May. But don't worry if you have missed it, you can do it even in this month. If your area has experienced this disease in previous years, better to vaccinate it every 6 months.

While the foot and mouth disease generally occurs in summer, and the vaccination should be done between October and December, better would be to vaccinate the animals at 6 month intervals. To protect the animal from bruselosis, heifers with four to nine months of age should be vaccinated once in a lifetime. Vaccination service is freely available from the state government. Please contact the nearest animal dispensary.

ગુજરાતમાં પશુને ખાસ કરીને ખરવા–મોવા અને ગળસૂંઢાની રસી મૂકાવવાની જરૂર છે.

ગળસૂંઢાના રોગના જંતુ જુલાઈ–ઓગષ્ટમાં ભેજવાળા ઘાસમાં રહીને ઢોરને રોગ કરે છે. તેની રસી એપ્રિલ–મે માસમાં દર વર્ષે અપાવવી જોઈએ. મોડું થયું હોય તો હજી પણ અપાવી શકાય. ગળસૂંઢો ઘર કરી ગયો હોય તેવા વિસ્તારમાં દર છ મહિને રસી અપાવવી જોઈએ.

ખરવા–મોવા રોગ ખાસ કરીને ઉનાળાની ઋતુમાં થાય છે. તેની રસી ઓક્ટોબરથી ડિસેમ્બર દરમ્યાન એકવાર અને માર્ચ–એપ્રિલમાં બીજીવાર આપી દેવી જોઈએ.

ચેપી ગર્ભપાત એટલે કે બ્રુસેલોસિસની રસી ૪ થી ૯ માસની ઉંમરની પાડી/વાછરડીને જીવનમાં એક જ વાર આપવી જોઈએ.

રસીકરણની સેવા સરકાર તરફથી વિનામૂલ્યે મળે છે. તે માટે નજીકના ઢોર દવાખાનાનો સંપર્ક કરવો.

A.2 Mealybug (cotton)

A.2.1 Introduction

Cotton is considered white gold. Cotton is a very precious and remunerative crop. Cotton crop encounters many pest and disease problems. And recently, mealybug are becoming very common problems. Even at the early stage of the crop, mealybugs do attack. They suck up the sap, leading to stunted growth. Once the plant is infested with mealybug, it remains weak for the whole season, which affects the production. To find out which pesticides should be applied, when, and at what dosage to protect your valuable crop from mealybug, listen to the following instructions.

કપાસ એટલે ધોળું સોનું. દરેકને એમ થાય કે ઓછા ખર્ચે ઝાઝો કપાસ કઈ રીતે ઊતરે! કપાસના પાકમાં રોગ–જીવાત ઉત્પાદન ઘટાડે છે અને ખર્ચ વધારી દે છે. છેલ્લાં કેટલાક વરસથી કપાસમાં મીલીબગનો ઉપદ્રવ વધી રહ્યો છે. કપાસ નાનો હોય ત્યારથી મીલીબગ લાગવા માંડે. મીલીબગ લાગે એટલે છોડનો વિકાસ રૂંધાઈ જાય. વધુ ઉપદ્રવ થાય તો છોડ સંપૂર્ણપણે સૂકાઈ જાય, ઉત્પાદન અને નફો ઘટે.

તમારી કપાસની બહુમૂલી ખેતીમાં મીલીબગનું નિયંત્રણ કઈ રીતે કરવું તેની વિગત જાણવી હોય તો હવે પછની સૂચના સાંભળો.

A.2.2 Conclusion

Controlling mealybug requires a integrated approach. If cultural practices like burning crop remains, deep plowing in the summer, crop rotation, mixed cropping, and cleaning borders and hedges are done on time, mealybug infestation can be avoided. But if mealybug has already caught your crop, then the easiest way is to remove the infested plants and place into some container, ensuring that they dont disperse elsewhere in the field, and burn them outside the field. But dont forget to spray the soil around the removed plant with methal perethione 2% powder. In the early stage of infestation, spraying neem oil with emulsifier-like soap at the weight of 70ml in 15 liters of water can be useful. One can also use bio-control agents like verticylium laykani at the rate of 70 grams or 15L water. Please ensure that spraying should be done while the climate is moist, preferably in the evening. As a last resort, one can use chemical pesticides as per the following dosage in 15L of water: Prephenophous 50 EC, 15 ml Quenalphous 20 EC, 30 ml Chlorpyryphous 20 EC, 30 ml

Spraying should be done for the whole plant including stand and also on the soil. Please add 15 grams of detergent in 15L of water while preparing the solution.

મીલીબગનું નિયંત્રણ કરવા ચારેબાજુથી પગલાં ભરવા પડે. જમીનની તૈયારી વખતે જૂના પાકના અવશેષો બાળવા, ઉનાળામાં ઊંડી ખેડ કરવી, પાકની ફેરબદલી, મિશ્રપાકનું આયોજન, યજમાન નિંદણનો નાશ કરવો, વાડ–શેઢા–પાળાની સફાઈ જેવી અનેક બાબતોનું વેળાસર ધ્યાન રાખ્યું હોય તો મીલીબગ ઓછા આવે. પણ હવે જો મીલીબગ આવી જ ગયા હોય તો...

સૌથી પહેલો ઉપાય, ઉપદ્રવવાળા છોડને ઉપાડીને, જમીન પર મીલીબગ ન પડે તે રીતે કોથળામાં ભરી, ખેતર બહાર લઈ જઈ, તાત્કાલિક બાળી નાંખવાનો છે. આવા છોડની આસપાસ મિથાઈલ પેરાથિઓન ૨% નો પાવડર છાંટવો. બીજું, ઉપદ્રવવાળા છૂટાછવાયા છોડ પર ૧૫ લિટરના પંપમાં ૭૦ મિ.લિ. લીંબોળીનું તેલ અથવા લીમડા આધારિત જંતુનાશક દવા છાંટવી. લીંબોળીનું તેલ સાબુ ઉમેરી ફાડીને વાપરવું.

જો જૈવિક નિયંત્રણ કરવું હોય તો, હવામાં ભેજનું પ્રમાણ વધારે હોય ત્યારે વર્ટીસિલિયમ લેકાની નામની ફુગનો પાવડર ૧૫ લિટરના પંપમાં ૭૦ ગ્રામ જેટલો ભેળવીને સાંજના સમયે છાંટવો.

ના છૂટકે રાસાયણિક જંતુનાશક છાંટવા હોય તો ૧૫ લિટરના પંપમાં પ્રોફેનોફોસ ૫૦ ઈસી: ૧૫ મિ.લિ. અથવા ક્વિનાલફોસ ૨૦ ઈસી: ૩૦ મિ.લિ. અથવા ક્લોરપાયરીફોસ ૨૦ ઈસી: ૩૦ મિ.લિ.માંથી કોઈપણ એક દવા થડ સમેતના આખા છોડ અને જમીન પર છાંટવી.

દવા બનાવતી વખતે ૧૫ લિટરના પંપમાં ૧૫ ગ્રામ (એટલે કે દિવાસળીના એક ખોખાં જેટલો)કપડાં ધોવાના પાવડર પંપમાં ભેળવી દેવો.

A.3 Pest prevention (egg stage)

A.3.1 Introduction

There are some ways to control insects at low cost, in a timely manner, and without much tension. One of them is controlling insects at egg stage. Destroying eggs ensures reduced population of insects. If you want to know how to control insects at egg stage, listen to the following instructions.

ખેતીમાં જીવાતોનું નિયંત્રણ ઓછા ખર્ચે, વેળાસર અને ઝાઝી ઝંઝટ વિના થાય, એવા કેટલાંક રસ્તામાંનો એક રસ્તો ઇંડાં અવસ્થાએ જ જીવાતનો નાશ કરી દેવાનો છે. ઇંડા નાશ પામે અથવા મૂકાય જ નહીં એટલે આપોઆપ જીવાતની સંખ્યા ઘટી જાય.

જીવાતોનો ઇંડા અવસ્થાએ નાશ કરવા બાબતે વધુ વિગત જાણવી હોય તો હવે પછીની સૂચના સાંભળો.

A.3.2 Conclusion

Insects like the caterpillar moth lays eggs in a bundle. Remove such infested leaves and burn them. Many of the eggs are parasitized by trichogramma wasp. The wasp lays eggs into the eggs of harmful insects. Using tricho card kills the eggs. One can also avoid egg-laying by using light and pheromone traps. Besides, planting marigold and castor as a trap crop and using neem-based pesticides leads to reduced insect population.

કેટલીક ફૂદી પાન પર જથ્થામાં ઇંડા મૂકે છે, આવા પાન તોડી લઈને લશ્કરી ઇયળની માદા ફૂદીએ મૂકેલ ઇંડાનો નાશ કરી શકાય.

ટ્રાઇકોગ્રામા ભમરી નુકસાનકારક જીવાતના ઇંડામાં પરજીવીકરણ કરે છે. ટ્રાઇકોકાર્ડ વાપરવાથી નુકસાનકારક જીવાતના ઇંડાનો નાશ થાય છે.

ખેતરને શેઢે પ્રકાશપિંજર અને ખેતરમાં સેક્સ ફેરોમેન ટ્રેપ ગોઠવીને માદા ફૂદીને ઇંડા મૂકતી અટકાવી શકાય.

આ ઉપરાંત ખેતરમાં ગલગોટા અને ખેતર ફરતે દિવેલા જેવા પિંજરપાકો ઉગાડીને તથા પાક ઉપર લીમડા આધારિત દવા છાંટી ઇંડાનો નાશ કરી શકાય છે.

A.4 Root rot and wilt (cotton)

A.4.1 Introduction

All farmers would wish to have a bumper cotton crop. If we can avoid loss of production due to reduced plant stand, we can harvest more profit. The plant stand can be maintained by avoiding soil borne diseases like wilt and root rot. There are some control measures for these diseases. And now is the right time to take these measures. To find out what are the steps to be taken, how and when, listen to the following instructions.

કપાસનો પાક સારો ઊતરે એવું દરેક ખેડૂત ઇચ્છે. જો આપણે રોગથી મરતા છોડવા અટકાવી શકીએ તો ઉત્પાદન અને નફો વધે. તે માટે સૂકારો અને મૂળખાઇ જેવા જમીનજન્ય રોગોનું નિયંત્રણ કરવું પડે. તે માટેના પગલાં ભરવાનો સમય પાકી ગયો છે. કપાસના પાકને સૂકારા અને મૂળખાઇથી બચાવવા નિયંત્રણના ક્યાં પગલાં ભરવા તેની વિગત જાણવી હોય તો હવે પછીની સૂચના સાંભળો.

A.4.2 Conclusion

If you find your plant getting suddenly wilted and the disease is spreading in a circular fashion, the diseased plant can be uprooted easily and the bark of the root appearing brown and can be removed easily, then it is considered that your plant is infected with root rot. While the same kind of disease is wilt, which may occur at any stage, but especially at the boll formation stage, in this case leaves become pale yellow and in severe infection the whole plant defoliates. To avoid both diseases, treat your seeds, rotate your crop, and apply enough of cowyard manure and cakes. Using tricoderma at the rate of 1.5KG in 60KG of farmyard manure while preparing the furrow is a good preventative measure. But if the field is infected with the disease, you should use 15 grams of bavistine (carbon dezime) in 15L of water around the infected plants.

કપાસના છોડ એકાએક ચીમળાઈને સૂકાઈ જાય, રોગ ગોળાકારમાં વધે, રોગિષ્ટ છોડ સહેલાઈથી ખેંચી કાઢી શકાય, મૂળની છાલ બદામી અને કથ્થાઈ રંગની જણાય અને એકદમ સહેલાઈથી ઊતરી જાય તો સમજવું કે કપાસને મૂળખાઈ રોગ લાગ્યો છે.

જ્યારે સૂકારાના રોગ કોઈપણ અવસ્થાએ પણ ખાસ કરીને જીડવા બેસે ત્યારે વધારે જોવા મળે છે. રોગિષ્ટ છોડનાં પાન ફીકાશ પડતાં પીળા રંગના થાય છે. વધુ આક્રમણ થાય તો છોડ ઠૂંઠો બની જાય છે.

આ બંને રોગને આવતા અટકાવવા બીજને કાર્બેન્ડાઝીમ અથવા ટ્રાઈકોડર્માની માવજત, પાકની ફેરબદલી, પૂરતું છાણિયું ખાતર અને ખોળ આપવા તથા ચાસમાં ૬૨ ૬૦ કિ.ગ્રા. છાણિયાં ખાતરે દોઢ કિલો ટ્રાઈકોડર્મા હરજીયાનમ નામની ફુગનો પાવડર આપવો. પણ જો હવે જો રોગ આવી જ ગયો હોય તો ૧૫ લિટરના પંપમાં ૧૫ ગ્રામ બાવિસ્ટીન (એટલે કે કાર્બેન્ડાઝીમ) દવા ભેળવી સૂકાતા છોડની ફરતે જમીનમાં રેડવું.

A.5 Orchard promotion

A.5.1 Introduction

Many farmers want to disengage from growing seasonal crops like cotton, millet, castor, moong, sesame. One one side, there is scarcity of labor and water, irregular electricity, requires organizing work daily. On the other side, encroachment of blue bulls and wild boars, infestation of new diseases and pests, and deterioration of ground-water quality leads to increase cost of production, tension, and mental stress. So, many farmers dream of having an orchard, or fruit crops. Managing orchards is less cumbersome, and once trees are grown, you can manage with less water too. To find out which government schemes and subsidies are available for orchard cultivation, listen to the following instructions.

હવે ઘણાં ખેડૂતો કપાસ, બાજરી, એરંડા, મગફળી, મગ, તલ જેવા સીઝનલ પાકોથી થાકતા જાય છે. એક તરફ મજૂરોની અછત, પાણી અને વીજળીની તંગી, ખારું થતું જતું પાણી, રોજ ઊઠીને કામો ગોઠવવાની ઝંઝટ. તે ઉપરાંત રોઝ અને ભૂંડનો ત્રાસ, નવા આવતા રોગ–જીવાત–ખેતી કરવી અઘરી પડે છે! એટલે ઘણાંને મન થાય છે કે હવે ફળઝાડની ખેતી શરૂ કરવી. બાગાયત હોય તો માથાકૂટ ઓછી! ફળઝાડની ખેતી હોય તો રોજિંદુ કામ ઘટે, ક્યારેક પાણી ઓછું હોય તોય ચલાવી લેવાય.

બાગાયત ખેતી કરવા કઈ કઈ સરકારી યોજનાઓ અને સબસીડી મળે છે તેની વિગત જાણવી હોય તો હવે પછીની સૂચના સાંભળો.

A.5.2 Conclusion

There are many schemes offered by the state governments horticultural department to promote orchard cultivation. Subsidies from Rs.2700 to Rs.24000 for new plantation of any fruit crop including mango, chikoo, lemon, guava, pomegranate, and ber, are available for all farmers in all districts. In another scheme, farmers from scheduled tribes can avail 50per plant to be plant in the back yard or in the borders. Apart from this, many schemes are available for plantation of orchard, processing, storage, and preservation of food crops, to conduct educational programs and tours, and organic demonstrations by the state government, national horticultural board, and APEDA. Please contact the deputy director for horticulture of your district and national horticultural board office located at Sardar Patel Market, Jamalpur, Ahmedabad with phone number <number>.

રાજ્ય સરકારના બાગાયત વિભાગ દ્વારા અનેક પ્રકારની સહાયક યોજનાઓ બહાર પાડવામાં આવી છે. તે મુજબ આંબા, ચીકુ, જામફળ, દાડમ, બોર સમેત તમામ બહુ વર્ષાયુ ફળપાકોના નવા વાવેતર માટે ૯,૦૦૦ રૂપિયા સુધીની તથા કેળ–પપૈયા જેવા વર્ષાયુ ફળપાકો માટે એકરદીઠ ૬,૦૦૦ રૂપિયા સુધીની સબસીડી તમામ જિલ્લાના તમામ ખેડૂતોને મળે છે.

બીજી એક યોજના હેઠળ અનુસૂચિત જાતિના અને આદિવાસી ખેડૂતોને ૫૦%ની રાહત કલમદીઠ આપવામાં આવે છે.

આ ઉપરાંત રાજ્ય સરકાર, નેશનલ હોર્ટિકલ્ચર બોર્ડ અને અપીડા દ્વારા ચાલતી વાવેતર, પ્રોસેસીંગ, સંગ્રહ, શૈક્ષણિક કાર્યક્રમો–પ્રવાસો–તાલીમ, નિદર્શન અને નિકાસ માટે ઘણી બધી યોજનાઓનો લાભ લેવા જેવો છે. વધુ વિગત માટે જે તે જિલ્લાના નાયબ બાગાયત નિયામકનો અને અમદાવાદમાં આંબાવાડી ખાતે આવેલ નેશનલ હોર્ટિકલ્ચર બોર્ડના કાર્યાલયે ફોન નં. ૦૭૯–૨૬૭૬૬૪૧૩ ઉપર સંપર્ક કરવો.

A.6 Soil test vs. university recommendations

A.6.1 Introduction

Many farmers are confused about recommendations of fertilizer dosage. The government recommends standard dosages of fertilizer for each crop. But others say that the dosage of fertilizer should be based on soil tests. So the confusion is whether to apply fertilizers as per government recommendation or as per soil test. To get a resolution to this confusion, listen to the following instructions.

ઘણાં ખેડૂતોને દરેક પાક માટે કરાયેલી રાસાયણિક ખાતરો આપવા વિશેની ભલામણો અંગે મૂંઝવણ છે. એક તરફ સરકારે દરેક પાક માટે ચોક્કસ પ્રમાણના ખાતરની ભલામણ કરી છે. તો વળી કેટલાક એમ કહે છે કે, ખાતરનું પ્રમાણ જમીનના પૃથક્કરણના અહેવાલને આધારે રાખવું જોઈએ. એટલે કે મૂંઝવણ એ છે કે, રાસાયણિક ખાતર સરકારી ભલામણ પ્રમાણે આપવું કે જમીનના ટેસ્ટના રિપોર્ટને આધારે?

તમારે આ મૂંઝવણનો જવાબ જોઈતો હોય તો હવે પછીની સૂચના સાંભળો.

A.6.2 Conclusion

It's easy to remove the confusion. Those farmers who apply chemical fertilizers without getting their soil tested should use the government recommendations. But those who have gotten their soil test should apply fertilizers as per recommendations in the mailed reports. In fact, while the report is made, government recommendations are taken into consideration and so it is more precise. So if you have tested your soil, go as per the report.

આ મૂંઝવણ દૂર કરવી સહેલી છે. જે ખેડૂતો જમીનનું પૃથક્કરણ કરાવ્યા વિના ખાતરો આપે છે, તેમણે સરકારી ભલામણ પ્રમાણે ડોઝ આપવો જોઈએ. પણ જમીનનો ટેસ્ટ રિપોર્ટ કઢાવી લેનાર ખેડૂતે તો રિપોર્ટના આધારે જ ડોઝ આપવો જોઈએ. જમીનના ટેસ્ટ રિપોર્ટમાં સરકારી ભલામણોનો વિચાર પણ કરીને વધારે ચોક્સાઈથી ડોઝ નક્કી કરેલો હોય છે. એટલે રિપોર્ટને આધારે ડોઝ આપવાની પદ્ધતિ વધારે ચોક્કસ છે અને તે પ્રમાણે જ ડોઝ આપવો જોઈએ. જો તમે જમીનનું પૃથક્કરણ ન કરાવ્યું હોય તો આવતા ઉનાળે પાક પૂરો થાય પછી કરાવી લેવાની અમારી સલાહ છે.

A.7 Unconventional animal feed

A.7.1 Introduction

The true farmer maintains his cattle like a family member. To maintain good health, you will to need to provide good nutrition. Generally we provide nutrition by supplying fodder and cattle feed which ensures health, strength, and productivity leading to healthy animals. But cattle feed is costly and generally need to be purchased from market while there are several nutritious wild plants around capable of providing nutrients at near-zero cost. If you would like to know the names of such plants and how to use them, listen to the following instructions.

સાચો ખેડૂત હંમેશા પોતાના પશુઓનું એવું ધ્યાન રાખે છે કે, જાણે તે ઘરના સભ્યો હોય! ઢોરને તાજુ-નરવું રાખવું હોય તો સારું પોષણ આપવું પડે. ઘાસચારો-ખાણદાણ પૂરતાં પ્રમાણમાં આપીએ તો ઢોરની તંદુરસ્તી, તાકાત અને ઉત્પાદન ક્ષમતા જળવાઈ રહે, બિમારી આવે નહીં. ખાણ-દાણ તો મોટેભાગે બજારમાંથી ખરીદવું પડે અને ખર્ચ થાય. પણ આપણી આસપાસની વનસ્પતિ અને ઝાડવામાંથી પણ પશુ માટેનો પોષક ખોરાક મળી રહે છે, જે વાપરવાથી કોઈ ખાસ ખર્ચ થતો નથી. તમારે આવા અપ્રચલિત ખોરાકની માહિતી જોઈતી હોય તો હવે પછીની સૂચના સાંભળો.

A.7.2 Conclusion

Low-cost, unconventional feed includes seeds of Umadhia, which contains 18% protein and could be fed up to 10% to milking animals and up to 15% to bullock. They should be used after cooking or boiling. The pods of gandho bowad and desi bowad are easily available which contains 30% protein and can be fed up to 15% to milking animals and 35% for bullocks. If you can find cake of Movada, you can feed it 1-1.5 kilogram per day to the milking animals. The flowers of Movada can also be fed up to 20%. Besides, pods of rain tree, tubers of banana, cake of jowad, salseed, or karanj, can also be given as a good source of nutrition.

ખર્ચ ઘટે તેવા પશુ આહાર તરીકે...

કુવાડિયાના બીજ ખવડાવી શકાય જેમાં ૧૮% પ્રોટીન હોય છે. બીજ બાફીને દૂધાળાં પશુને ૧૦% સુધી અને બળદને ૧૫% સુધી ખવરાવી શકાય.

બીજુ, ગાંડા અને દેશી બાવળની શીંગો બધે સહેલાઈથી મળી રહે છે. તેમાં ૧૩% પ્રોટીન હોય છે તે દૂઝણી ગાયોને ૧૫% સુધી અને બળદને ૪૫% સુધી ખવરાવી શકાય.

જો, મહુડાનો ખોળ મળે તો દૂઝણાને રોજનો એકથી દોઢ કિલો અને તેના ફૂલ ૨૦% સુધી ખવરાવી શકાય.

Appendix B

Broadcast call prompts

Table B.1 lists the prompts played in the broadcast calls described in Study 1 of Chapter 8. Figure B.1 displays the flow of the prompts in the call. Depending on the condition, different 'motivation_...' prompts and 'action_...' prompts would be played. For the CALL condition, the same motivational prompt for RECORD was used. For action_rate, the second variation had options 'useful', 'neutral', and 'not useful' in place of the options given below.

welcome	Hello, this is the new AO Margdharshan service. This service regularly brings you the latest, useful information from AO and then requests your valuable feedback. Here is today's news or announcement of the day...
motivation_record	Your feedback is valuable to DSC and Avaaj Otalo. You have your own unique perspective, and we want to hear it. Just as you benefited from this farmer's message, hundreds of others can benefit from your contribution. DSC selects the best messages for future DSC radio programs. We want to hear from you right now!
motivation_rate	Your feedback is valuable to DSC and Avaaj Otalo. You have your own unique perspective, and we want to hear it. Just as you benefited from this farmer's message, hundreds of others can benefit from your input. DSC selects the best messages for future DSC radio programs. We want to get your rating right now!

action_call	To be transferred to Avaaj Otalo for one free session, please stay on the line...
action_record	To record a feedback or comment about the information you heard, ask a question, or share your own experience. please record your message slowly and clearly after the beep. When you are finished, press '#'....
action_rate	How useful was this information to you? If very useful, press number 1. If useful, press number 2. If neutral, press number 3.
thanks_record	Thank you for your valuable contribution! If approved, your message will be on Avaaj Otalo for DSC and others to hear. When we receive replies to your message, Avaaj Otalo service will send you the messages by phone call. Till then, please call Avaaj Otalo at — to listen to yours and others' questions, answers, and experiences!
thanks_rate	Thank you for your valuable contribution! Your feedback will be useful in helping us bring you the most useful information. Please call Avaaj Otalo at — to listen to yours and others questions, answers, and experiences!

Table B.1: Prompts for broadcast calls

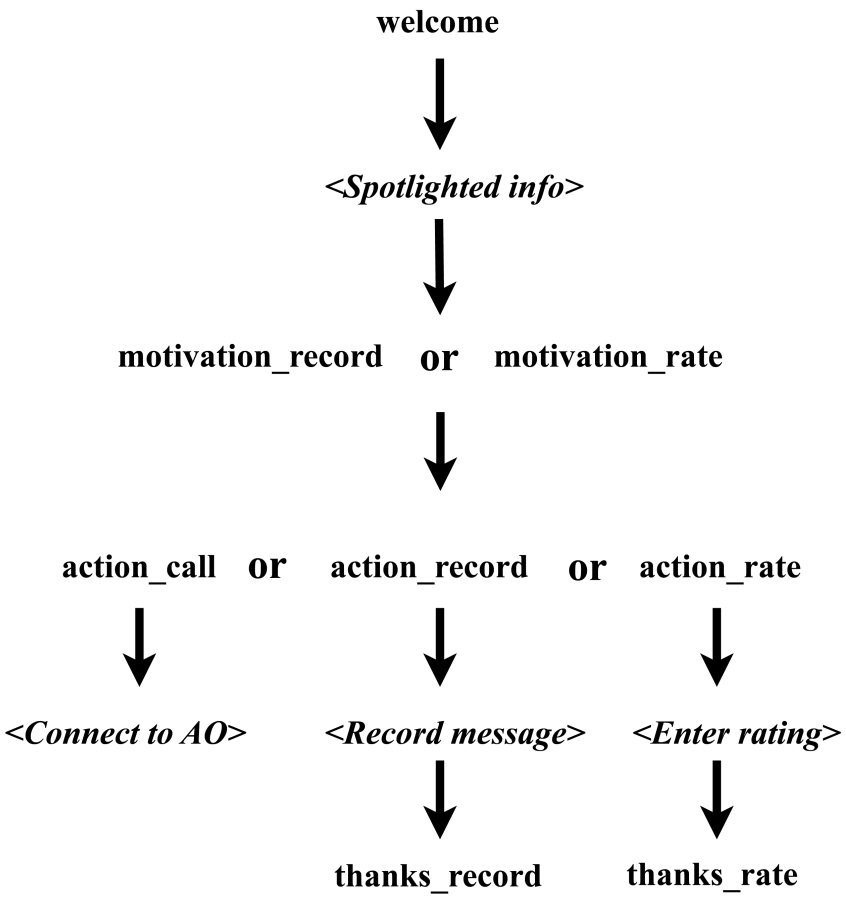

Figure B.1: Call flow for broadcast calls

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