KrishiPustak: A Social Networking System for Low-Literate Farmers

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ABSTRACT

With the wide penetration of mobile internet, social networking (SN) systems are becoming increasingly popular in the developing world. However, most SN sites are text heavy, and are therefore unusable by low-literate populations. Here we ask what would an SN application for low-literate users look like and how would it be used? We designed and deployed *KrishiPustak*, an audio-visual SN mobile application for low-literate farming populations in rural India. Over a four month deployment, 306 farmers registered through the phones of eight agricultural mediators making 514 posts and 180 replies. We conducted interviews with farmers and mediators and analyzed the content to understand system usage and to drive iterative design. The context of mediated use and agricultural framing had a powerful impact on system understanding (what it was for) and usage. Overall, *KrishiPustak* was useful and usable, but none-the-less we identify a number of design recommendations for similar SN systems.

Author Keywords
Social media; ICTD; low-literate; HCI4D; India

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI):

INTRODUCTION

As of 2014 there were 6.9 billion mobile phone accounts in the world and 78% of the subscribers lived in developing countries [18]. Beyond facilitating communication, mobile phones have transformed the way we send money, manage our health, check market prices, engage with government, manage emergency response, and many other things. Along with the wide penetration of mobile phones, mobile internet is becoming increasingly affordable. For example in India, Aircel's 'pocket internet' offers 25 Megabytes for USD 0.083, valid for one day [2]. Studies conducted among low-income youth in slum communities in India found that they were accessing social networking (SN) sites such as

Figure 1: Farmer using *KrishiPustak* with the help of a mediator

Facebook and Orkut within the first month of mobile internet usage [47].

Currently there are a number of popular SN sites that offer users an online presence: Facebook, Twitter, Orkut, Google+, Pinterest, Instagram, etc. However, most of these sites rely heavily on text, and are therefore unusable by low-literate populations. This led us to ask: Is it possible to have a social networking system for low-literate users? Is the notion useful or interesting? What would the application look like? How would it be used? How would content be shared and viewed?

Other obstacles to the use of SN systems by low-income populations include the cost of devices and network activity, and digital literacy. While the cost of mobile devices and connectivity is decreasing, smartphones capable of running non-textual apps usable by low-literate communities are still out of the reach of most very low-income people. To meet constraints in literacy and the availability of devices, a common work-around we see is for non-literate or poor members of a community to seek help from someone who has access to technology and is more digitally-literate [52] (see Fig. 1). This mediated use of technology can amplify its

use to many people in the community who would otherwise not be able to use it. So, in addition to the above questions related to the design of an SN application for low-literacy, we wanted to know if we could design the system to work through a human mediator.

To answer these questions, we designed, deployed, and evaluated *KrishiPustak*, an audio-visual SN mobile application that we distributed to low-literate farming communities in a rural area near Mysore, India. We followed a multistage process that included: design and deployment, user testing and discussion, redesign and deployment, and follow-up user testing. *KrishiPustak* was deployed on Nokia Lumia 820 phones via eight agriculture extension workers serving as mediators. Over a period of four months, mediators registered 306 farmers who made 514 posts and 180 replies. We conducted two rounds of user evaluations, including interviews with mediators and farmers as well as an analysis of the content of posts. In this paper, we describe the design and evolution of the system, as well as how *KrishiPustak* was used by farmers. In particular, we found that the context of mediated use within the agricultural setting strongly influenced how farmers described and used the system. Many posts had a professional theme, including pictures of cows and agricultural fields. Other posts related to families, local grievances, and aspirational content, but since usage of the device was gated by a mediator who was affiliated with an agricultural organization, the propensity for farming related posts is perhaps unsurprising. Results also suggest that the system could be enhanced by the addition of third party content, and UI features for encouraging and maintaining conversations.

Overall, there are two main contributions of our paper. First, we design and develop *KrishiPustak*, an audio-visual SN mobile application, and demonstrate through a four months pilot deployment that the interface worked for our target users. Low-literate farmers were able to post and comment on the application through mediated use. Secondly, our study shows potential use cases and demand for SN systems for low-literate users in rural settings.

RELATED WORK
There are three areas of related literature that are particularly relevant for our purposes: UX for social networking, UIs for low-literate users, and intermediated technology use in low-income contexts.

Social networking user experience
With some notable exceptions [12, 58, 59], most research in the use of SN systems is with populations in North America and Europe. Previous work in this area attempted to find a formal definition, describing SN systems as networked communication platforms in which participants 1) have uniquely identifiable profiles that consist of user-supplied content, content provided by other users, and/or system-provided data; 2) can publicly articulate connections that can be viewed and traversed by others; and 3) can consume,

produce, and/or interact with streams of user generated content provided by their connections on the site [9].

A number of related studies have investigated why people use SN sites like MySpace and Facebook (e.g. [5] [25] [56]). Research suggests that Facebook use is motivated by two primary needs: (1) the need to belong and (2) the need for self-presentation [35]. People get on to and use social networking sites for social connection, shared identities, content, social investigation, SN surfing, and status updating [19]. Users' motivations, use and perceptions may change over time [24]. Research into social media use, particularly MySpace, in rural life found differences between rural and urban users. Rural users had far fewer friends online, and those friends lived much closer to home. Rural users also have substantially different gender distributions and use privacy features more heavily [12]. Other research focuses specifically on SN systems on the mobile phone [e.g. 13]. Of relevance here is the research developing Facebook clients to enable offline access by prefetching content [60].

SN systems have also been used in a more instrumental way to achieve some particular end. For example, food sharing communities to prevent food wastage [11], organizing political demonstrations in Palestine [57] or as rich educational aids in Nepal [43].

Research in the use of SN within developing countries is still sparse, mainly examining how existing social networks are used. Two studies of low-income youth in slum communities in India found that within the first month of mobile internet usage, these youth get onto SN sites such as Facebook and Orkut. They argue that SN sites are instrumental in helping young people to transgress social identity and expand social connections and life chances [47, 48]. Another study discusses the usage of Facebook in Kenya where social media participation is growing, but describes how limits in technical infrastructure and uneven access put constraints on use. They show that high costs associated with using the internet, limited access to computers and smartphones, and unreliable electricity hinder online participation [59]. In another study, researchers found that to overcome the costs associated with internet use, young adults in informal settlements in Kenya consolidated diverse online activities to support income generation, e.g., looking for employment, marketing themselves, and seeking remittances from friends and family abroad [58].

To our knowledge, our study is the first to design, develop, deploy and evaluate a new (prototype) SN system for low-literate, resource constrained users in the developing world.

UIs for low-literate users
Research in the design of UIs for users with little or no education is a growing body of work. Early work in this area recognized the value of imagery and advocated the extensive use of graphics to overcome users' inability to read text [14, 17, 29, 36]. Work in "Text-Free UIs" established that static, hand-drawn representations are better understood than

photographs or abstract iconography. But with deeper interaction and an increase in the specificity of information represented, more photorealism can be helpful [32]. Among other features, some authors note that numbers can be acceptable as many low-literate people can read and understand numerical digits. Researchers have also recognized the value of combining voice feedback with graphical imagery [29, 36, 37, 44]. Krishi Mitra [50] is a prototype UI for low-literate rural farmers to access market information without having to go through a middle man. Like our system, it is virtually text-free, with audio-visual cues for navigation. As it is an information access system, however, it has a rather different purpose and functionality, e.g. it does not enable content creation and sharing between farmers.

Beyond navigation and content consumption, one interaction issue for UI's for low literate users is how to manage access. Various studies have investigated how passwords might be implemented for such users. Relevant to our work, previous research shows that both pictorial and numeric passwords can be difficult for low-literate users [22, 45]. Indeed, to our knowledge an optimal solution has not yet been found, and this remains an important area of research.

One body of research on interfaces for low literate users looks at voice as an interaction modality because it is a natural means of expression well-suited to input, and avoids some of the issues related to non-literacy. [1, 8, 23, 34, 40, 49, 53]. Particularly relevant for our context are a Q&A forum for small-scale farmers [40] and a citizen journalism portal for rural users [34]. Researchers have examined the tradeoffs between IVRs (spoken menu output with DTMF/keypad input navigation) and spoken dialogue systems (SDS) (spoken menu output with speech input navigation) and have reached varying conclusions regarding the benefits of typed versus spoken inputs [15,54]. There is also research that identifies design principles for voice-based virtual communities [38]. However, speech input is technically challenging to implement [33] and challenges in voice UIs include threading content, indexing, searching, and browsing. To overcome some of these difficulties, the VideoKheti system combined speech input, graphics, audio output, and touch to address farmers' information needs. However, the addition of speech input did not provide much assistance over a graphical touch system with audio output for low-literate farmers [6].

Finally there is work that explores the suitability of menu-based navigation for low-literate users [20, 21]. Researchers have compared linear, hierarchical and cross-linked navigation [4], and linear, and hierarchical navigation with varying depths [30, 31] and have found that users perform better with linear structures where items are listed as a flat array on one or more pages.

Research in the area of UIs for low-literate users have spanned multiple application domains, including agriculture, citizen journalism, health data collection and dissemination, job information, video search, mobile banking, microfinance, map navigation, video communication and so on. However, to our knowledge there has been no previous work in SN for low-literate users.

Technology and intermediation in low-income contexts

As noted in the introduction, *intermediation* is a common work-around in low-income areas to meet constraints in literacy and the availability of technology. Non-literate or poor members of a community will seek help from individuals in the community who either have access to technology (e.g., ownership) or are more digitally-literate (e.g., a friend or relative who can read or knows how to use a device) [52]. In their study of technology usage and mobile media sharing in low-income communities in India, Sambasivan and Smyth analyze shared social norms and practices, flows of information and materials, and the creative processes that underlie existing information access through a human infrastructure. They argue that technological interventions will be more effective if they take into consideration the underlying infrastructures such as intermediation that are embedded in communities [51].

Some notable projects which rely heavily on human infrastructure include: DakNet (human transport networks - busses, motorcycles, ox carts) [42]; MOSES (Groups of kiosk users) [55]; Digital Green (farmers and villagers in close-knit communities) [10]; data entry accuracy using forms, SMS, and voice (Human data entry operations) [41]; and rural mobile health (community health workers and patients) [27, 46].

BACKGROUND, CONTEXT AND TIMELINE

We partnered with two non-profit organizations to deploy *KrishiPustak*: Digital Green (DG) and Bharatiya Agri Industries Foundation (BAIF). DG shares agriculture extension information with small and marginal farmers across villages in India, Ethiopia and Ghana. DG screens videos of farmers demonstrating best practices in farming and animal husbandry relevant for the local context and in the local dialect of that region. Videos typically feature a local progressive farmer explaining and demonstrating an agriculture-related technique. Videos are screened to groups of 15-20 rural farmers by a local mediator [7, 10]. DG primarily works with other organizations to meet the specific needs of farmers in a given area, and BAIF is one of these [3]. BAIF focuses on development intervention programs in animal husbandry and agriculture with 4.5 million poor families and has field operations across 60,000 villages in India. We chose their operations in Mysore district, Karnataka, as the location for our pilot because of close proximity to where we are based and a long partnership with DG. This operation employs field extension staff who work closely with the target farming communities, including the screening of DG videos. All the field extension staff are male. Eight field extension officers from BAIF (henceforth known as 'mediators') at Hunsur in Mysore participated in our study as technology aides to the low-literate farming population. They were pre-selected by BAIF to participate in

our study as reliable mediators who had been with the organization for some time. Each of the mediators was given a Nokia Lumia 820 mobile phone with the *KrishiPustak* application installed. They were to register low-literate farmers and help them use the application throughout the pilot study. The villages that mediators worked with were all within about 100 km of Hunsur.

Target Communities
The eight mediators in our study were on-call para-veterinary workers who conducted artificial insemination of domestic cattle. They lived in the same or neighboring villages as the farmer families they worked with. All mediators were male, 23-33 years old, and their education level was between Grade 10 and 12. Household expenditure per year was between USD 500 – 3300. Fluent in local languages such as Kannada and Tamil, they did not speak English, but could understand and read short phrases and used the English alphabet for transliteration of local languages. Each of them used a Nokia X201/202 phone given to them by BAIF for coordinating activities in the field. They used the phones for receiving and making calls, texting in transliterated Kannada, taking pictures, listening to music, watching videos (purchased offline at local mobile shops) and using Facebook. Of the eight mediators, six had Facebook accounts. Most of them had opened their accounts on the PC at the BAIF office, with the help of office staff, thereafter they used Facebook on their mobiles. Most posts and comments to Facebook were made in transliterated Kannada.

The role of the (literate) mediators was to provide technology intermediation – that is access to the technology, support, encouragement and on-the-spot training - to the low-literate farmers who were the end-users of *KrishiPustak*. The eight mediators were asked to register end users who met the

following criteria: a) Low levels of formal education (less than Grade 5); b) Little or no experience with mobile phone uses beyond voice calls; and c) No existing SN accounts. For their facilitation of the project, mediators received remuneration in the form of phone talk time. We viewed this as essential as we were asking them to spend time and effort on our project. End users (farmers) did not receive any remuneration; we were explicitly interested in understanding whether farmers would understand the value proposition and take to the use of the system without any economic incentive.

Design constraints
A number of user and system constraints had to be taken into account to design an SN system for low-literate farmers in rural India. 1) End use was mediated. 2) The system was designed for use in settings with intermittent and low-bandwidth internet connectivity. While video content might have provided the system with greater richness, bandwidth limitations made this difficult so only audio and static images were shared. 3) Since the user group was low-literate, audio-visual rather than textual content was used. 4) We wanted to keep the barriers for use low, so we chose to have no password for login. 5) To encourage broader use and critical mass, there were no 'friends'; instead everyone on the network would be connected to everyone else. While this mirrors village life (where everyone knows everyone else), this is an important difference with other popular SN systems where users can publicly articulate connections [9].

Timeline
We followed a multistage design process which consisted of the design and development of a first version of the prototype application. This was deployed for two months from December 2013 to February 2014. This was followed by a round of user testing and interviews in mid-February, which led to the design of prototype version 2. After another four weeks of deployment another round of user testing and interviews were conducted.

PROTOTYPE DESIGN (VERSION 1)

User Interface
We drew inspiration from guidelines for 'Text-Free UIs' [26, 28, 29] and designed an audio-visual application to allow multiple users to create photo or audio posts through their own accounts on a shared smartphone. Users could reply to posts using photos or audio as well. There was no text in the UI, though numerals were used to denote the number of replies to a post. Since there were no 'friends,' anybody who registered on the system could view content from and reply on the posts of all other users. Below we provide some detail of the first version of the *KrishiPustak* application.

Start page
The *KrishiPustak* start page was intended to be used primarily by mediators for managing the accounts of farmers they were working with (see Fig. 2). It comprised a list of user accounts registered on that phone, a button to add a new user ('+' symbol on the top right corner), and an option to synchronize the content on the phone with the server. User
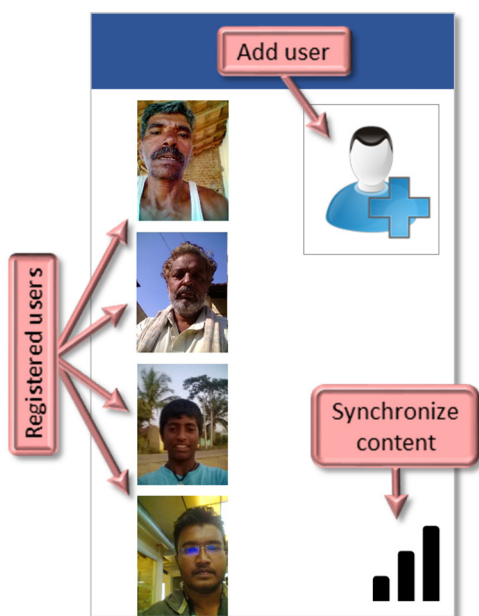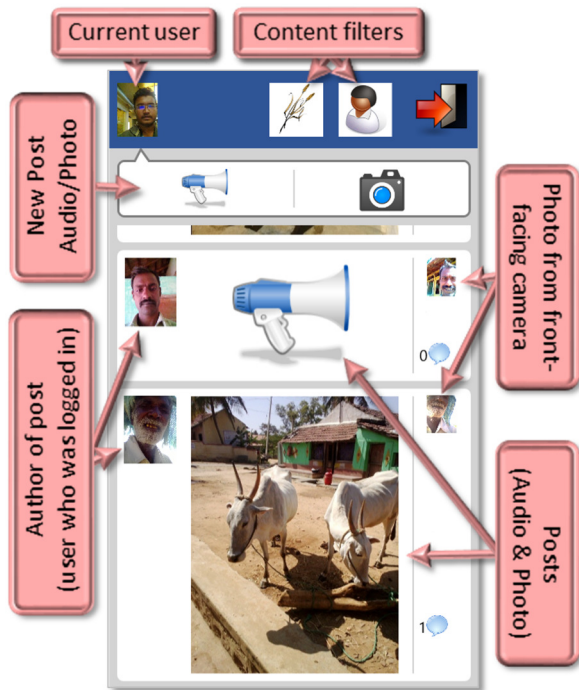

Figure 2: Start page for mediators to select or add users and synchronize content.

Figure 3: Version 1 consolidated posts page (home page).

accounts were displayed as a list of their profile photographs - clicking on any photo would 'log in' as that user with no authentication. When a mediator wanted to add a new user, they would be sent to a page to record a brief audio message and create a profile photo. The vertical bars on the bottom right corner were used by mediators to synchronize content with the server when internet connectivity was available.

Consolidated posts page
This was the primary "home page" for farmers, where they could view all the posts made on the system (see Fig. 3). The page was divided into three components: a header, a row to make new posts, and a content pane for existing posts. The header consisted of four images: left-most was the user who was currently logged in; on the far right was a 'log out' button; and in between were images of an *agriculture* filter and a *personal* filter. Tapping on these filter buttons would filter posts in the content pane for these categories.

The row to make new posts had a *loudspeaker* button to record an audio post and a *camera* button to make a photo post. Tapping either button directed the user to a page for creating the new post. Before confirming the photo or audio post, the user had to pick a filter: *agriculture* or *personal*. Selecting a category at the time of posting helped other users to filter relevant content on the consolidated posts page.

Similar to other popular SN sites, synchronized posts were displayed on an infinite scroll page and were temporally ordered with the most recent at the top. Each individual post contained three pieces of information. 1) A picture of the author of the post. Tapping on this picture navigated the user to a profile page where he/she could view all the posts made by that author and listen to the recording that they made when

they signed up. 2) The actual post content—a rendered photo or an image of a loudspeaker for an audio post. Clicking on the loudspeaker/picture post would send the user to a detailed post view. 3) On the right of the post content was an image of the person who actually made the post, taken from the front-facing camera upon posting. We included this image for two reasons: First, we were interested in how often posts were actually made by mediators (on behalf of users) vs. farmers themselves. Second, because we had no authentication it was relatively easy to accidentally make a post from someone else's account. In this case, the image of the poster would be different from the 'logged-in' user.

Detailed post view page
When users selected a post of interest by tapping on it, they were taken to a page dedicated to that post. This page included the posts' contents (a photo or loudspeaker image played by tapping), all the related replies in an infinite scroll layout, and buttons (*camera* and *loudspeaker*) for posting a reply to that post. Individual replies had the same structure as posts in the consolidated posts page (with some indentation between the post and its replies), including a photo of the reply author taken by the front-facing camera.

System backend
Due to intermittent connectivity and limited bandwidth in rural India, we designed our application to enable seamless offline interactions. Whenever any new content was created during user registration, posting, or replying, an entry was created into a local database and the associated files (audio clips/images) were stored locally. Then, a background process polled for internet connectivity and incrementally synchronized the local content with a database in the cloud. The background process alternated between uploading and downloading content, each in small atomic units to maximize usage of short bursts of connectivity. In addition, in case of problems with the background process there was also a manual option to synchronize content on the start page.

The cloud database was implemented as an Azure Mobile Service, while the local database used SQLite. The actual images and audio recordings were stored outside of the database and hosted on a server using PHP.

DEPLOYMENT AND EVALUATION (VERSION 1)

Training session 1
The deployment of *KrishiPustak* was initiated by a one-day training session attended by eight mediators, one researcher and a Kannada translator. *KrishiPustak* was introduced as a way by which low-literate farmers could connect with each other, similar to Facebook but using photos and audio. The Facebook analogy was used because six of the eight mediators had Facebook accounts, and the others had heard of, but not used, Facebook. The training included a three-hour demonstration of *KrishiPustak* in groups of four mediators, followed by individual practice for one hour each. The translator called each mediator twice a week for the first eight weeks after the training session to encourage them to use the system.

Data collection
We conducted face-to-face interviews with all eight mediators and eleven farmers after two months of deployment. Criteria for recruiting the eleven farmers was they should have used the *KrishiPustak* application at least once and were representative of the *KrishiPustak* user pool across age and gender. Eight of the farmers were male and three female (in keeping with the ratio of male/female clientele of the mediators). They were between 21-71 years of age. The mean age was 44.6 yrs and median was 43 yrs. The mean years of schooling was 1.5. Verbal informed consent was collected before recording the interviews. Respondents could refuse to be interviewed but no one did. All mediator and farmer interviews were conducted in Kannada. They were asked about their experiences while using *KrishiPustak*. All interviews were transcribed and translated into English for analysis; mediator and farmer comments are denoted by M* and F* respectively in the results. To complement the interview data, we also analyzed the content posted on the system.

User testing, version 1
During the almost two months of deployment of version 1, eight mediators registered a total of 256 farmers. We did not collect user metadata or demographics (e.g., age and gender) beyond that required to join the system (photo and introductory statement). Farmers made 374 new posts and 97 replies on the *KrishiPustak* application during the two months. Whilst *KrishiPustak* received a fair amount of use, user testing identified a number of design problems that significantly impacted how the system was used.

Photo information was not enough
To conserve bandwidth, any new post was either a photo or an audio recording. However, it became clear that stand-alone photo posts were not enough to explain what people wanted to share. For example, two of the interviewed farmers had posted pictures of roads they wanted the local government to repair. They wished to say something along with the photo about the inconvenience caused to them due to the road condition, so they created a reply to that effect. Indeed, 40% of 'replies' to posts were created by the authors of the post, and many of these were audio supplements or descriptions of a photo. For instance a farmer had taken a photograph of some boys doing stretching exercises outside a hut. The same farmer had added an audio reply saying "There is a college here. So they do exercises. They do it well."

Difficulty in threading
Users could not reply to a post from the home page. Rather, they had to click on the post to open the detailed post view and reply to it from there. We found this was not intuitive: in testing, when asked to reply to a post, nine of the eleven farmers and six of the eight mediators made a new post instead. This was borne out in our data analysis which showed that many *new* audio posts seemed to be replies to prior photo posts, though it was not always clear which ones. For example, all the following were new audio posts that clearly referred to *some* photo on the page: "Shankar, *this* cow is now pregnant. Give her good food and rear it well. Safeguard it so that it yields lot of milk."; "*This* sheep is very nice."; "*That* man is not looking nice in the photo". This could well be why the total number of replies was so much lower than new posts (97 replies to 374 posts).

PROTOTYPE DESIGN (VERSION 2)

User Interface revisions
Based on the findings from version 1, we made a number of changes to the prototype ranging from small visual revisions to basic changes in how users replied to posts. Some of these changes can be seen in the revised consolidated posts page in Figure 4.

Annotating photos and improving replies
Since users wanted to annotate their photo posts with an audio explanation, we added the option to record an audio message along with new photo posts.

We also improved the reply mechanism, enabling users to reply to a post directly from the consolidated page without going to the detailed post view. For photo posts, we provided an overlay including *camera* and *microphone* icons for replies (see Fig. 4). For audio posts, these icons were provided below the *loudspeaker* icon. This design scheme was kept consistent on the detailed post view page.

Adding an animal husbandry tag
Our server data revealed that a large number of posts (~44%) were related to cattle. A number of farmers also wanted to see more posts of livestock and some wanted them prioritized (to appear at the top). Based on this, we added a
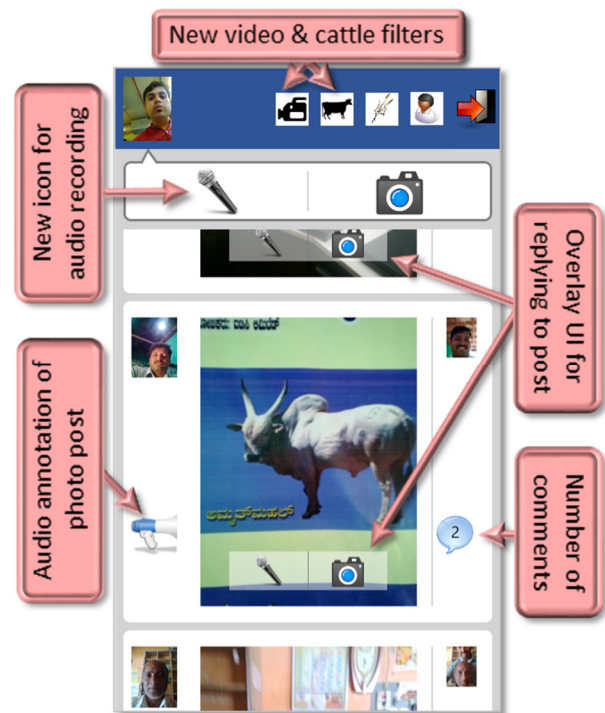

Figure 4: Version 2 consolidated posts page (home page).

new filter—an animal husbandry tag—to help segregate relevant content. The icon used was a cow - the most frequently posted animal. When making new posts, users now chose from three filters instead of two.

Seeding curated external content
As discussed below, our interviews indicated that there was a desire for content beyond user-generated material. While a wide range of content was mentioned (from images of Gods to music), many users were keen to see more agricultural information, particularly related to animal husbandry. Since one of the goals of our partner organizations was to improve information sharing among farmers, we wanted to explore how people would perceive external, curated content.

While it would have been nice to allow users to download a variety of videos, bandwidth constraints made this very difficult. Therefore, to gauge users' reception of external content, we embedded a single Digital Green video into the application. Among 26 DG videos for the state of Karnataka, we picked one related to cattle mulching and included it on all of the mediators' phones. To provide easy access to the video from the consolidated page, we added a video tag on the title bar. Tapping on it directed users to the video page. Here they could play the video and reply to it just like they could for any other post.

DEPLOYMENT AND EVALUATION (VERSION 2)

Training session 2
The deployment of version 2 was initiated by a one-day training session. Eight mediators, one researcher, and a Kannada translator attended the session. The training included a thirty-minute individual session with the new version of *KrishiPustak* (the mediators were given the phones so they could explore the revised application without any prompts from us), followed by a group demo with all the eight mediators and a one-hour practice session in groups of two so the mediators could help each other with the new version.

Data collection
Three weeks after the deployment of *KrishiPustak* version 2, we conducted face-to-face interviews in Kannada with two of the eight mediators (M1 and M5) and two farmers who did not take part in the previous user testing. One of the farmers was male (35 yrs) and the other female (33 yrs). Both the farmers had less than two years of schooling. As before, informed verbal consent was collected and respondents could refuse to be interviewed but none did. The mediators and farmers were asked about their experiences using *KrishiPustak* and all interviews were transcribed and translated into English. As before we also analyzed the content posted on the system.

User testing, version 2
During the three weeks of deployment of prototype version 2 between the end of February and March 25th, 2014, the eight mediators registered a total of 50 additional farmers. We observed 140 posts and 83 replies on the *KrishiPustak*

application. Overall, from a combination of the interview data and data coming from direct systems use, we found that the revisions to the application appeared to be beneficial to mediators and farmers.

Video page receives traffic
The DG video that we introduced received 22 replies from farmers. These included audio replies as well as picture replies (such as photographs of cows). Interviews with F1, F2 and M5 revealed that they found having the video both interesting and relevant for their needs. M5 and F2 requested that more videos be added to the system. However, according to M1, three farmers he had registered said that the dialect of the video needed to be more localized (the video was produced in a different region in Karnataka). M5's farmers had questions about whether they could avail loans to practice what was shown in the video.

Replying to posts becomes easier
During the training the mediators reported that the new reply design was much easier to use because it allowed direct association with the post a user was replying to and would save time as it could be done from the consolidated page. This was borne out by our data which showed that the ratio of replies to posts increased by 127%.

FINDINGS RELATED TO THE OVERALL SYSTEM
In this section we discuss more general findings related to the overall implementation and deployment of *KrishiPustak* across both versions.

Number and topics of posts
Over a period of four months, mediators registered 306 farmers who made 514 posts and 180 replies. Approximately 70% of all posts were picture posts and 30% audio posts. About 30% of the posts were tagged as *agriculture* and 70% as *personal*. However, in browsing the photos, it was clear that many of the photos tagged as *personal* were related to farming and cattle rearing. We tried to classify the content of a random subset of photos tagged as *personal* and found that about 50% of them were of livestock or other agriculture. This may suggest a misunderstanding of what the tags were for or were intended to represent, or it may just indicate the pervasive nature of agriculture in farmers' lives.

We did a further analysis of the subjects of all photo posts. We found that 44% of the photo posts were pictures of cows and other livestock, 18% were of fields and countryside, 14% were of village fairs, 13% were people, and 11% were of home exteriors. Of the audio posts, 26% were self-introductions, 16% were songs, and 14% were about local grievances that local authorities needed to fix. The remaining 44% of the posts were unclassifiable; they were unclear, repeated or blank recordings.

Posting from others' accounts
By examining the photos taken from the front-facing camera when posts were made, we found that 30% of the posts were made by someone other than the person who was logged in. Of these posts, about 30% show that the mediator was the

one physically making the post (i.e., about 10% of all posts actually have the mediator captured from the front camera while making the post). It's not clear who made the remainder of these—it is possible these were other users who were incorrectly logged-in, or just unidentifiable camera shots. This is one of the consequences of not having passwords for log-in (and mediated use, where many users were accessing the system from the same device). However, it did not seem to be too consequential for our system, since we have the photo which showed who had actually posted. It is an open question as to whether passwords might need to be implemented at a later date.

Reasons and rationales for use
The mediation by trusted agriculture workers was a major factor in uptake and usage of the system and it was clearly influential in how users understood what the system was for. There was an overwhelming proportion of agricultural or farming related posts, rather than what might typically be considered 'social' posts. This is perhaps unsurprising, given that the users were farmers and the mediators para-veterinaries who interacted with the farmers for professional purposes. We take up this point below, but first examine how mediators and users understood the system.

The mediators
Mediators largely ascribed professional rationales for the use of *KrishiPustak*—typically information sharing from one farmer to another on farming best practice. For example, M4 said "I do put together people with the same problems and show the posts, e.g., a cow that had miscarriages. I show the posts mutually. I tell them listen to the information from the man himself." This was a recurrent theme, likely to have arisen because the researchers were initially introduced to them by their association with DG. For M4 this even extended to his rationale for who he signed up to the system "a good farmer […] one who can answer well, not one who digresses from the question." Only one mediator described the system as being like Facebook for low-literate users, despite that being how it was presented in the training. However, at least three other mediators, described features which might be considered SN features: to find friends or to see posts from other people whilst "sitting in this place only". Interestingly, one of the mediators, who had actually registered 35 end users admitted that he could not tell the farmers what the system was for as he did not know himself. That end users were willing to sign up to the system even so demonstrates just how important the mediators were in the uptake of the system.

The end users
Farmers were asked about their reasons for joining and their understanding of what the system was for. Reasons for joining often included direct reference to the mediator, for example, "[M3] called me and said let's do this and I agreed" (F6); "This is good for you. People like you will help. [M2] said so" (F4), "[M1] said that it is good for me, he did the account for me, it must be good" (F8). Three of the farmers described the system as being for sharing farming

information with others. For example, one farmer described the system as being "To show other people. The cows were given such facilities, my cow's photo has reached others", another as "You take these and show to people in other countries and tell about how to tend cows." This is consistent with the mediators' accounts of the value of the system being for sharing farming best practice.

A couple of farmers had trouble articulating what the system was for. A number of users gave accounts which included the idea that using the system would confer some benefit on them, as illustrated by F4 and F8 above. Given this idea of some sort of good, the famers typically constructed rationales about the system according to the concerns which impact their lives. For example, F8 said "others like officials can see only through such phones. It is good if a few people see. Officials may take action about our difficulties"; (F2) "[the photo] goes to a bank because I want to take a loan" "My house is broken, can I post my house? I want a house for my cow". Two of the female farmers we interviewed had posted pictures of the poor condition of the road near their house, in the hope that officials would see it and fix it.

What users post and why
We were initially surprised by how few obviously personal posts there were (e.g., photos of family and social events). When asked why they did not post family pictures, it was clear that users' perceptions of what the system was for played a part. Whilst 13% of posts were family or friends, most users said they did not know they could make such posts. On being told this option was open to them, some farmers specifically said they would not want to as they are concerned about privacy or misuse of the pictures. However, others were keen to do so: F2 said he would like to put up family photos and F9 said "I do not know that I can post [pictures of family] henceforth I shall do if the phone is given to me". This last comment, "if the phone is given to me" hints at how the mediated nature of use has a practical impact on what is and isn't posted. That is, since the mediators visit the farmers for work purposes, it is not clear how easy it would be to take photos of family during these visits or if the family would be doing something 'post-worthy' at that time.

The strong farming theme underlying *KrishiPustak* use was also seen when farmers were asked what else they would like to post or see from others. Comments included "Coconut tree, tomato, all good crops so that others see and follow the same what we have done" (F5); F8, a land owning farmer, said "I am interested in posting crops like turmeric, coconut because I grow them"; and F7, an agricultural day labourer interviewed at the same time, agreed "I am also interested in doing these but I do not have land of my own." However, some farmers could see a more social side to the system. F5 said he "would like to post our temple fair, our village play" and F9 could envisage social benefits to the system: as well as wanting to post family pictures, he said, "I joined the system as I have not travelled. Maybe I will come to know about other places". Other users said they would like to see

pictures of Hindu Gods and Goddesses (this was common), film stars, peacocks, rivers, or listen to religious songs.

Incentivization of mediators crucial
The mediators said that they had different motivations for joining the system, such as ownership of an expensive phone, respect within the community, helping broadcast information from one farmer to another and finding ways to help the farmers. However, the remuneration we provided with talk-time was an important driving force for their activity. From the time we deployed the system up until the first round of interviews, we charged the mediators' personal phones (Nokia X201/202) with currency once every 2-3 weeks. We ranked mediators in order of number of farmers registered and number of posts and replies received and then distributed talk time in a decreasing rank order. The person with the most activity received the highest amount of talk time while the person with the least activity received the lowest. During the interviews, five of the eight mediators asked for talk time recharges to be done once a week. In fact, whenever the translator called the mediators to encourage use during the deployment, mediators enquired about the next talk-time recharge and whether it could be done early.

Robustness of the System and Hardware
Despite being a prototype, the system was robust and worked well throughout the deployment with no major crashes or issues. However, some minor issues started surfacing when the amount of content increased substantially. From the mediators' perspective, there were some concerns about the robustness of the hardware in the field; one speaker broke, one screen cracked and M4 was afraid of losing or dropping the handset.

DISCUSSION AND RECOMMENDATIONS
When we deployed *KrishiPustak*, our aim was to provide low-literate users with the richness of a modern SN system. In this section we examine how this played out in practice, covering three key topics: the preponderance of professional posts, social relations on the system and the limitations of user-created content.

Context of use: mediation
The notion of mediation is central to our system. This design was based on earlier findings about technology use by low-literate users [10, 27, 46]. Trust in, and respect for the mediators was central to farmers' decision to sign up. However, mediation had both practical and conceptual impacts on system use.

Practically the system was not *to-hand* for the users. It was only available to them when they saw the mediator, typically during professional visits. Indeed, based on analyzing the authors of the posts we also found that around 10% of the posts were actually made by the mediators from the farmer's accounts. Naturally, this impacted what kinds of content users posted—for example, personal and social photos were less likely, simply because of when and where the farmers have access to the technology. It would be interesting to examine if using different people as mediators, for example people at the center of a social hub such as a village shop, might impact use differently.

To compound this, the mediators largely ascribed professional rationales to the usage of the system typically for information sharing to spread good practice. It is likely that this stems from the context of the study: they are para-vets, largely interacting with their end users on professional business. Furthermore, the association of the researchers with a farming information dissemination project (DG) is likely to have influenced the mediators' understandings of the systems. This would have had an influence on how the system was explained to and used by the farmers.

Context of use: Farming communities
Technology use is always situated, that is, influenced by and embedded in a wider ecosystem. In this case, that of small subsistence farming communities. This is reflected in the kinds of posts that were made and desired (here a strong agricultural theme) and in the rationales which were constructed as to what *KrishiPustak* was.

In the light of limited information on what the system might actually be, the farmers constructed accounts of what it could be for. There was a repeated idea that some good would come (to them) from using the system, often related to problems they actually faced—whether a loan was required or a road needed fixing. Their accounts were typically *practical*, that is the system must be *for something*, i.e., have some practical use, even if they did not always articulate what that might be. If we can take a step back from our own grounded understanding of social and professional networking systems, the *idea* of a SN system, is a pretty nebulous one (indeed the extensive research into *why* people use SN system might remind us of this [5, 25]). Furthermore, as discussed in the literature, it is not uncommon for SN systems to be put to practical use, so it is perhaps not surprising to that farmers ascribe such uses to the technology.

Having said this, in their actual and desired use of the system, we can see many of the regular features of an SN system, albeit with a strong agricultural bias. Indeed, given the overwhelming proportion of apparently agricultural and animal posts, one might ask whether *KrishiPustak* was in practice used as a *social* networking system, or might it be better conceived of as a *professional* networking system? Both farmers and mediators describe the system as being useful for spreading information on farming best practice and their wish list of posts included many agricultural themes. Nonetheless, the social side of the system still shows through in existing usage. Some posts were visibly (or audibly) social—village fairs, people posts, and songs. In addition, whilst farmers did want to see more farming-related content, they also expressed a desire to see more village events, religious imagery, film stars, and so on.

Around 70% of the posts were tagged as personal, although to our (non-farmer) eyes more than half of these were

pictures of farming or cattle rearing. It is quite possible that for these farmers, the distinction between "personal" and "agriculture" is simply irrelevant because agricultural concerns pervade their lives. Whilst there are clearly professional elements to the system use (such as sharing farming best practices), these users are predominantly from agricultural communities and clearly have a passion for their work; they are interested in posts related to agriculture and nature more generally. To illustrate, favorite posts included animals they admired (well fed, well-tended), a nature scene (good perspective), and a fruit tree (small but with many fruits).

Social relationships

To try and understand how much *KrishiPustak* could be said to be a social *network*, we analyzed the cross-replying network graph of users [16]. The graph was made on the basis of replies made by people. A directed edge was drawn between the person replying and the person whose post he/she was replying to. A dense graph would have shown a lot of cross activity, and a large number of bi-directional edges would have pointed to developing relations between people. However, our graph was quite sparse, with little evidence of individual relationships (see Fig. 5). Of all the replies there was only one instance when two users had replied on each other's (separate) posts. However, the picture is more nuanced than that, as many people did comment on other users' posts (whether using the 'reply' channel which occurred more in version 2 or by creating new posts in version 1). Furthermore there were a number of 'conversations,' where multiple people interacted around a post. That is, they posted audio replies comprising a conversation. For instance, in an audio reply to a photo post of a cow, two people converse: "1st person: What is your name? 2nd person: Subramanya 1st: How many cows do you have? 2nd: – 4 1st: How much milk do you supply to the diary? 2nd: 2 litres." Such instances for replies as well as posts are

Created with NodeXL (http://nodexl.codeplex.com)
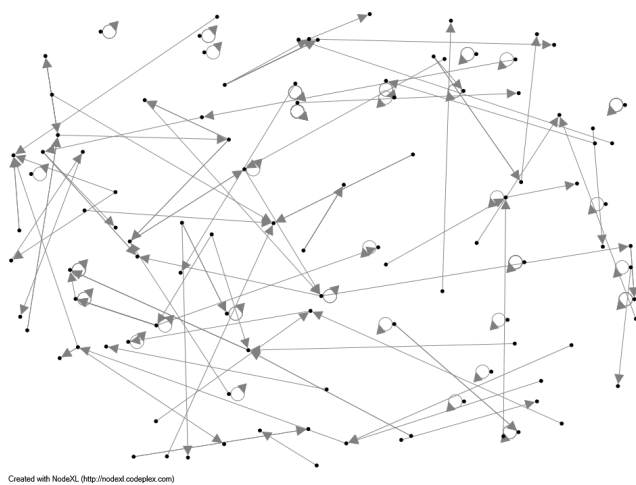
Figure 5: Graph analyzing cross-replying among users (represented as nodes). A directed edge represents one user commenting on another (or the same) post. Note that there are no bidirectional edges.

common: almost 9% of the total posts and replies are conversations. Whilst these are not bidirectional relationships in the conventional sense, i.e., two people who reply to each other's posts, they definitely point to community interactions while using the application.

External or third-party content

User-created content is only one part of what users share on SN systems like Facebook; users frequently share content available on the Web, such as videos, music, political commentaries, etc. Indeed, a study of users in Indian slums showed that one way to manage language barriers (such as limited literacy in English) was to post content containing English slogans or text [47]. Whilst we are not suggesting our users would want to post content in English, this research, combined with the ready acceptance of the DG video and farmers' desire to see pictures of Gods and film stars and so on, does suggest that the system might be enhanced by the addition of third party content. How this could be best done is an interesting question given the constraints we must design for: the mediated nature of the interaction (users only have access to the phone for limited time, typically during a visit for other work-related purposes); the users' low-literacy (how would they search for and identify relevant content); and the limited internet access in the villages. However, it is not impossible. One could imagine banks of content that could be created (perhaps with local language verbal tagging, etc.). Then, mediators or other curators might seed this content, and a well-designed speech-based search could be used to locate resources where internet is present and so on. However it is done, third party content is likely to be an important part of any SN system for low-literate users.

CONCLUSIONS AND FUTURE WORK

In this research we designed, developed, deployed and evaluated *KrishiPustak*, an SN system for low-literate farmers in rural India. The system was deployed on Nokia Lumia 820 phones that were provided to eight agriculture extension workers of a non-profit organization. These workers acted as human mediators to provide access and help farmers use the system. *KrishiPustak* allowed farmers to make posts and replies using audio-visual content. Over a period of four months, 306 farmers registered on the system and made 514 posts and 180 replies. We conducted interviews with farmers and mediators and performed an analysis of posts to understand how the system was used and to drive iterative design. We found that the context of mediated use and the agricultural framing had a powerful impact on how the system was used. Mediators largely described the system as being for sharing agricultural information and farming best practices, and most posts reflected this. However, despite a strong professional bent, other uses also showed through, with posts related to families, local grievances, and aspirational content. This suggests that even if the concept of SN is not immediately obvious to such an audience, there is real potential for such uses to come through.

As the application scales up, we may want to investigate other ways that users can manage posts that they view. In our version there was no friends' lists, but this might be something to explore in the future. For example, everyone in the village might be automatically connected, but then users may be able manage their connections by adding or removing them. With scale, we may also want to experiment with user-friendly graphical or numerical passwords, to help manage privacy.

In future work it would be interesting to see how an audio-visual SN system plays out in other low-literate contexts, particularly if it expanded beyond the confines of single usage to see whether and how more social uses might emerge. For example, mediators might be local shop owners, health workers or others who have substantial contact with people from the area. Another interesting line of work could be to explore non-mediated use: what does usage of *KrishiPustak* look like when farmers use their own devices?

ACKNOWLEDGMENTS

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