# Krishi Kontho: An Agricultural Information Service in Bangladesh

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**ABSTRACT**
In this paper, we present *Krishi Kontho* (literally, "agricultural voices"), which is an agricultural information service that utilises pre-recorded voice messages, and SMS, that are pushed to smallholder farmers mobile phones at intervals carefully choreographed with the life cycles of their crops. We present the design of the service, and we present the result of an eleven-month field trial in rural Bangladesh. Findings indicate that this type of service, that synchronises messages with cultivation practice, may improve crop yields while reducing the use of agricultural inputs such as fertiliser and pesticides. We find that the farmers in the field trial deemed the service to be of value to them in regard to improving their agricultural practices. We conclude by discussing our findings and their implications for the design of agricultural information services, including the challenge of designing for specific temporalities, or rhythms of practice, in rural Bangladesh and elsewhere.

**AUTHOR KEYWORDS**
HCI4D; ICT4D; Agricultural Information Service; Temporality; Crop Cycles; Voice; Mobile; Bangladesh.

**ACM CLASSIFICATION KEYWORDS**
H.5.2. Information interfaces and presentation (e.g., HCI).

**INTRODUCTION**
In many developing regions, agriculture is crucial to the economy and the food security of the people [1, 2, 32]. In Bangladesh, which is our focus, agriculture forms the base of the economy, and it is the primary source of the country's food security, it employs 48% of the workforce, and accounts for 19% of the gross domestic product [16]. The government of Bangladesh has invested heavily in its agricultural extension program, in which trained field officers support rural communities with training on farming techniques and technologies. Although there are almost 14,000 government field extension officers in Bangladesh, tasked with informing farmers on agricultural practices, it is not adequate as each agent has to assist more than 2,000 farming families [16].

Previous HCI research has focused on understanding the temporality of practice [12, 8, 10, 23, 25, 37], and designing for temporal coordination [3, 27]. In addition, previous research on agricultural information services includes work on voice forums [32], rural information portals [14], and rural radio [7, 24]. However, one challenge with voice forums, rural information portals and to some extent rural radio is the temporal delivery of information to the farmers. As indicated, the nature of the agricultural production entails that farmers need information on a variety of topics, at a variety of stages, including seeding, preparing and sowing, growing, harvesting, packing and storing, and selling [13, 26]. Farmers have different types of information needs during each stage [18]. Arguably, online voice forums, rural information portals, and rural radio may lack a tight coupling between the temporally given information needs of the individual farmers and the content of the information provided to them. The information to the farmers, then, must be delivered in a rhythm that corresponds to the temporality of the farmers' cultivation practices.

To explore this idea, we designed, implemented, deployed and evaluated an agricultural information service called *Krishi Kontho* (literally, "agricultural voices") in rural Bangladesh. The service utilises pre-recorded voice messages, and SMS, that are pushed to the farmers' mobile phones at intervals carefully choreographed with the life cycles of their crops. This paper, then, delivers an example of how one may address the core HCI challenge of designing for the temporality of practice. The paper demonstrates that simple (voice and SMS) technology (albeit in a complex setting) may benefit smallholder farmers in the Global South as advice is synchronised with the rhythms of their agricultural practices.

The paper is structured as follows: First, we will consider related work. Secondly, we will present the design of the Krishi Kontho agricultural information service. Third, we will present findings from an eleven-month field trial of the service. Fourth, we will discuss the implication of the findings. Lastly, a conclusion is provided.

## RELATED WORK

In this section, we will relate to previous research on temporality in HCI as well as the body of literature on agricultural information services and voice-based ICT interventions. We will attempt to bring these streams of research together in this section. We will start with the HCI literature on temporality and subsequently turn to the research on ICT interventions in the Global South.

Time and designing for the temporality of practice is a topic that is pervasive in HCI. Building on organisational scholarship about the formation and regulation of temporal order in organisations [22, 33, 34], HCI researchers have introduced the concept of *rhythms* to describe various temporal orders integral to practice. Much of this research has highlighted the plurality of rhythms in workplace settings and the considerable effort it may take to bring this multiplicity into practical alignment [5, 20, 28, 37, 39]. For example, Reddy and Dourish [37], detail both large-scale and finer grained temporal rhythms of practice. Relatedly, Møller and Bjørn [27], highlight the notion of being *in due time,* which refers to an activity being completed in a timely manner allowing for subsequent activities to be shaped in an orderly fashion. Furthermore, Bardram [3] focuses on *temporal coordination* understood as the temporal aspect of cooperative work to inform the design of a tool for synchronising distributed work. Bardram links successful coordination to artifacts stating that "… a temporal artifact such as the clock or the calendar can be turned into a temporal coordination artifact, mediating the temporal coordination, when shared within a collaborating community of practice [3, p.164]. Notably, for an artifact, computational or otherwise, to work as a coordination tool in practice calls for a (shared) sense of temporality, or rhythm, among the practitioners involved. We may interject that in our case the sense of temporal order, the rhythm inscribed in the Krishi Kontho service, stems from the crop cycles of the agricultural practices (we will elaborate on this point below).

Turning to the literature on ICT interventions in the Global South we find that several agricultural information services have targeted developing regions, including voice forums [32], rural information portals [14], and rural radio [7]. Since textual literacy is a significant issue in developing countries, especially in rural areas, several information systems for rural communities are speech-based. Studies pertaining to voice forums, based on interactive voice response, show that users can use voice-based systems, irrespective of their literacy levels [18, 35, 40]. Related to our work is, for example, a system called Avaaj Otalo, which is an interactive voice application for smallholder farmers in Gujarat, India. Avaaj Otalo allowed farmers to connect to a question and answer forum to record questions, provide answers, or browse an existing list of questions and answers [32]. This and other forum-type applications focused on user-generated content, to be produced, curated, and searched by the end-users themselves [e.g. 40].

Agricultural information services based on text and video, rather than voice, have also been deployed on the Internet for the benefit of farmers in developing regions [1]. One example is The Farmers Portal provided by the Department of Agriculture, Government of India [14]. The vision

of the portal, which is at the time of writing available to the public in a Beta version, is to provide Indian farmers with "all relevant information on specific subjects around his village/block/district or state. This information will be delivered in the form of text, SMS, email and audio/video in the language he or she understands.", as described in the portals 'about' section [14]. The scope of this particular agricultural portal, then, is broad. It will potentially cover crop management, extension activities such as farm schools, post-harvest advice, risk management, disease management, animal husbandry, and more. Often portals of this kind may be accessed by the farmers through information kiosks [21]. Information kiosks in this context refer to ICT enabled services: shared computers in rural kiosks. Kiosks are often to be used by members of income groups who cannot afford to own a computer, but who needs access to agricultural information services and other Internet resources [18, 21].

In addition, radio is a well-established way to provide information in rural areas, including information on agriculture. That is, radio is used extensively in developing countries to promote changes in farming practices to improve agricultural production [29]. While other technologies like television are found in the homes of affluent farmers, transistor radios running on batteries are affordable for the poorer segments of the population. Furthermore, radio does not require textual literacy, and an increasing shift to local radio program production and broadcasting is removing language and dialect barriers. As a result, radio has become a medium of communication and dissemination of information, as well as for training and education, for broad segments of rural communities pertaining to agricultural subjects [30].

However, voice forums and rural information portals may leave it up to the farmers to navigate the forums or portals and find the information they need for themselves by themselves. Arguably, if for example a voice forum or an information portal is very complex and full of different types of information it may be a challenge for the farmers to navigate such services and find precisely what they need when they need it [2, 18]. Moreover, a further challenge with voice forums, rural information portals and to some extent rural radio is the temporal delivery of information to the farmers. The nature of the farming suggests that smallholders need information on a variety of subjects, in a variety of phases, including seeding, preparing and sowing, growing, harvesting, packing and storing, and selling [13, 26]. Farmers have different types of information requirements during each step, ranging from weather forecasts, pest attacks, fertiliser, improved cultivation practices, pest and disease management and finally prices. Arguably, voice forums, rural information portals, and rural radio may lack sufficient coordination between the crops cycles of the individual farmers on the one hand and on the other hand the content of the information available to him or her.

In sum, rather than having farmers with low-literacy levels seek out information for themselves, an information service could ideally provide the information to them in a manner synchronised with the rhythms of their agricultural practice. To address this challenge, we as mentioned designed, implemented, deployed and evaluated an agricultural information service called *Krishi Kontho* (literally, "agricultural voices") in rural Bangladesh. Will turn to this service now.

#### KRISHI KONTHO DESIGN

The agricultural information service Krishi Kontho was made in a collaboration between the international NGO Christian Aid, the technical partner mPower, the local NGO Gana Unnayan Kendra (GUK), as well as local farmers in the area of the field trial. While it was the role of Christian Aid to provide funding for the project from its international network, it was the role of mPower, GUK, and selected farmers in the GUK area of operation to develop the service. This was done in a highly collaborative manner where mPower facilitated the design process, and GUK staff and local farmers joined as co-designers. Briefly put, the design process took approximately six months and included field trips and design workshops in addition to more technical activities and tests.

As indicated, it is a voice-based agricultural information service, although it also utilises SMS

messages, and is accessible to the farmers via (low-end) mobile phones. A key aspect of the service is that it delivered the messages in a temporal order to fit each stage of the crop cycle. That is, the participating farmers received thirty automated voice messages on their mobile phones, during the production cycle of maize and chilli, which was their main crops. Each message was a 30-59 second audio recommendation on various practices about each stage of crop cultivation, such as soil preparation, seeding, fertilisation, irrigation, pest and disease control, harvesting, drying, storage and more. The voice format was chosen to mitigate the low literacy rates in rural Bangladesh. In Bangladesh, 36% of adults are illiterate, among residents in the rural areas the number is 52% [4]. In addition to voice some technical information, such as pesticide and fertilisation dosages, was also sent using SMS. The idea is that if a farmer, for example, cannot remember the precise fertiliser dosage from having heard a voice call – he or she can always show the SMS with this information to someone literate such as children in the household of school age.

Mobile phone-based interventions can potentially provide poor farmers with information and knowledge that in turn may help them improve their farming practices and their livelihoods [2, 18]. The high potential for sharing agricultural information via mobile phones is related to the high penetration rate of mobile phones in developing countries (this can be seen in contrast to the low penetration rate of, e.g. personal computers in these regions) [1]. In Bangladesh, while the mobile phone penetration rate is 77,9%, the mobile broadband penetration is just 17,8 %. Mobile phones are still primarily used for voice calls. Households with fixed (wired) internet access at home are 13,8 %, and fixed high-speed broadband penetration in the home is 2 % of households. There is still, then, limited availability of Internet-enabled devices and bandwidth in Bangladesh, especially in rural areas [19]. Therefore, mobile phone-based solutions made sense.

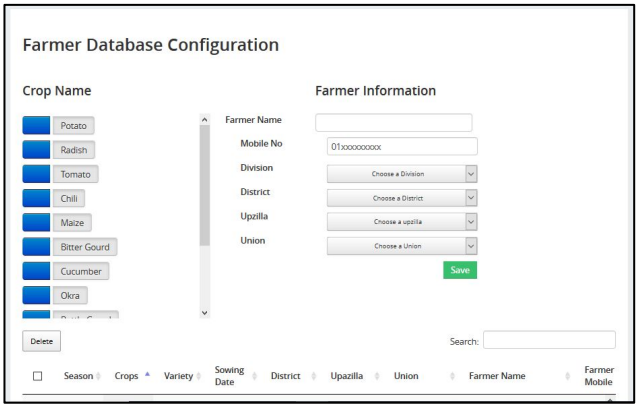


**Figure 1. The farmers where registered in a database as part of the initiation of the field trial. Important data included name, phones number, crops, sowing dates, and location.**

Crudely put, the service worked in the following manner. First, the field manager collected basic information on the individual farmers, such as their names, phone numbers, crop types, and plantation dates. Second, the field manager entered this information into the Krishi Kontho system (see figure 1). Third, the agro-manager configured and added the messages to be sent to the farmers phones. Fourth, the service automatically called the farmers and delivered the recorded voice messages to the farmers at set times and intervals. As mentioned, the voice message was accompanied by SMS that replicated the technical specifics of the voice messages for later use.

*Content*

A key activity in the design phase of Krishi Kontho was to author the initial voice-messages that were to be pushed to the mobile phones of the farmers. This was done in collaborative workshops with representatives of all project partners and with the participation the intended beneficiaries, i.e., the farmers themselves. The task was to design a set of voice-recommendations pertaining to each of the crops, namely maize and chilli, that was to guide the farmers throughout the crop cycles. After their authoring, the messages were recorded by a professional voice actor in a studio and were later uploaded to the service where they were disseminated according to schedule.

Particular emphasis was taken to tailoring messages so they were pertinent to specific stages of popular crops, namely, chilli and maize. To validate their content mPower – the technical

partner - organized validation workshop with agricultural experts.

Content, then, were related to the different stages of the crop management of chilli and maize including seed selection, seedbed preparation, heat stress, cold stress advice, and more. Some examples of the voice message content are given below:

*১. মধ্য আশ্বিন থেকে মধ্য কার্তিক (অক্টোবর - নভেম্বর) মাস পর্যন্ত ভুট্টার বীজ বপনের উত্তম সময়।*

*You may plant Maize now as October to November is the best time to plant Maize.*

*২. ভুট্টার জমিতে জোঁ থাকা অবস্থায়, (৩/৪) বার চাষ দেওয়ার পর মই দিয়ে মাটি ঝুর ঝুরে করতে হবে এবং আগাছা ও আর্বজনা পরিষ্কার করে নিতে হবে।*

*If you plant Chili directly in the field, without seeding bags, then two and half kilos of seeds will be appropriate for 33 decimals[1] of land.*

*৪. মরিচের জাব পোকা দমনের জন্য হলুদ রং এর ফাঁদ ব্যবহার করা, গুড়া সাবান (৫গ্রাম/লি) পানিতে মিশিয়ে ভালভাবে স্প্রে করা, অথবা ইমিডাকো রপ্রিড গ্রুপের ঔষধ নির্দিষ্ট মাত্রায় ব্যবহার করা।*

*You can spray detergent to control the pest 'Green Peach Aphid' in your chilli plants. Use 5 grams per litre of water and spray evenly and lightly.*

The messages above, then, are examples of the voice messages that the farmers received during the field trial of the service.

Having accounted for the design, we will now turn to focus on the field trial of the service.

#### THE FIELD TRIAL

To gain experience with the service, and to provide input for further development, the service was put through an eleven-months field trial. The total number of farmers *actively* taking part in the trial was one hundred, hereof eighty women and twenty men. The field trial started May 2016 and ended March 2017.

During the field trial, each of the one hundred farmers received thirty voice messages and accompanying SMS messages on the management of maize and chilli. The messages were scheduled to be sent in the afternoon and evening as the farmers usually stay at home at this time and thus are available to hear the messages.

The operational cost of sending one voice message to a farmer was 1.00 BDT (0.01 USD), and 0.25 BDT (0.003 USD) per SMS message. Both this operational cost and the initial development cost was taken on by the project partner Christian Aid. No cost was passed on to the farmers

#### The deployment area

The Krishi Kontho service was put to its field trial in the area of Upazila Fulchari. To give an impression of the area and the people in it, we may start by saying that ninety percent of the geographical area of Fulchari Upazila, is comprised of what is known as Chars. These islands are comprised of sediments naturally occurring from the gradual accretion of silt and sand in the main rivers that runs through the area. The villagers and farmers taking part in the field trial live on such Char islands. A Char island may have a lifespan of for example ten years or so. It emerges out of the river, so to speak, only to be submerged by the river again some years later. In the interval, these numerous Char islands are used for residence and farmland by thousands of farming communities. This ecological and geographical situation leads to unstable settlement patterns for the farmers, with frequent loss of farmland. In fact, the people of the Chars in the Fulchari Upazila area are effectively landless due

[1] A decimal is a unit of area in Bangladesh approximately equal to 1/100 acre or 40.46 m².

to either never having owned land or having lost their Char land to flooding. In the years 2016 - 2017, the area was repeatedly flooded and the Chars shifted as a result of heavy rain in India and China brimming the Brahmaputra River with water on a massive scale and carrying it downstream through Bangladesh.

In the area, smallholder farmers are prone to take advice from people who are not experts. As mentioned, although there are almost 14,000 government field extension officers in Bangladesh, tasked with informing farmers on agricultural practices, it is not adequate as each agent has to assist more than 2,000 farming families [16]. Consequently, farmers often have to rely on advice from sellers of inputs such as fertiliser and pesticides, whom may be prone to oversell and give poor advice. In addition, female farmers are often led out of public field extension programs due to gender barriers, as female farmers may not be permitted to interact freely with male governmental field extension officers for reasons of tradition and culture. Note that eighty percent of the users of Krishi Kontho were women. Furthermore, the agricultural advice farmers can get through traditional media is very generic, and not customised to fit their specific needs let alone match the crop cycles that the farmers are engaged with. Therefore, there is in this area arguably a need for a service along the lines of Krishi Kontho.

In preparation for the trial, the project partners lead a campaign to make farmers in the area aware of the field trial and the opportunity offered, namely, to use the service free of charge. This effort was rewarded with support on the part of the farmers in the area, and it was relatively straight-forward to recruit the participants needed for the field trial. As the farmers joined the field trial, they had their name registered along with their phone number, crop types, and seeding dates to enable the delivery of the right set of messages to them at the right time. This data was, in turn, entered into the Krishi Kontho database (see figure 1).

Before we move on to describe the findings of the trial, we will pause to consider the methods by which data on the trial was generated.

**Methods for generating data on the field trial**

**Figure 2. Focus group in progress on the farmers' experience of using the service.**

As part of the Krishi Kontho field trial, we gathered data through a mixed method approach spanning quantitative and qualitative analysis.

Before the start of the field trial, we created a baseline of the previous year's crop yields, production costs, and pest and insect infestation. The purpose of the baseline was to enable a comparison between the situation before the field trial and the situation at the end of the trial. The baseline acted as the foundation of a quantitative impact assessment. The data for the baseline was generated through several data generation instruments, including a survey and public record data. The local NGO administered the survey to the farmers in the area taking part in the trial. The field data collection team included five GUK field facilitators that know the area and were familiar to the farmers. At the end of the field trial, data on the same parameters of crop yields, production costs, and pest and insect infestation were generated, using similar data generation instruments as before.

In addition to the intervention group of one hundred farmers, we also randomly selected another one hundred chilli and maize farmers from the same area. These 'control group' farmers were not sent any voice messages or SMS messages, rather they followed their usual practices of information seeking such as for example consulting local input retailers for advice. The rationale behind this approach was to enable a

comparison between farmers that had actively used the service and a similar group that had not done so. The two groups of farmers in the trial, then, were created by an approach of simple randomisation. That is, two hundred farmers were recruited randomly from a larger pool of volunteers, out of the two hundred farmers, one hundred were randomly designated 'intervention group', and the remainder were designated 'control group'. In this manner we attempted, by simple randomisation, to guard against selection bias as far as practically possible, while introducing a comparative element to the quantitative part of the field trial.

In terms of qualitative inquiry, we conducted three focus groups with the beneficiaries of the service shortly after the end of the field trial (see figure 2). The participations in the focus groups where randomly selected among the farmers of the intervention group. Of the one hundred farmers actively taking part in the trial we managed to include twenty-nine in the three focus groups. The focus groups had the participation of eight to ten farmers on each occasion, and they lasted for about ninety minutes each. In this manner, we spoke to more than a quarter of the individual farmers actively involved in the trial. Focus groups may be said to provide a way of including a relatively large group of informants, allow for conversation among peers, and facilitate a rage of communication processes [41]. In our focus groups, we experienced a range of communicative processes including, storytelling, joking, debating, boasting, teasing, and the negotiation of consensus.

The focus groups were conducted in the farmers villages to make them as comfortable as possible with the situation, and they were conducted in the local language of Bangla. We facilitated a discussion among the farmers on a range of topics including their "user experience", the "impact of the service on farming practices", the "impact on their livelihoods", and we further encouraged a discussion of future scenarios, including "how the service might be improved", and "what one might be willing to pay for such as service if anything". We presented the topics to the focus groups in everyday language and encouraged the farmers to give examples that might illustrate their points. In addition, we made room for discussion of topics brought forward by the farmers themselves such as "the inadequacy of the government agricultural extension service", and "the hardship of life in a flood-prone area". All focus groups were audio recorded, transcribed, and in turn translated into English. After the third focus group we experienced data saturation, i.e. we were roughly getting the same answers, and therefore we did not organise a fourth focus group.

In addition, we also conducted four semi-structured one-to-one interviews in order to get the perspective of some of the NGO staff and managers involved. We interviewed two field managers and two agro managers. These interviews mainly provided us with a contextual understanding of the situation in the area and the role of the NGO. The interviews with the field managers and agro managers were conducted in English. Lastly, we also conducted two one-to-one interviews with female farmers to further probe the value of the service to the farmers.

Our analysis of the qualitative data, i.e. from the focus groups and the one-to-one interviews, took a broadly practice-oriented perspective [9, 11, 38, 42] with inspiration from ethnomethodology [15, 36]. Practice studies, in our perspective, explicate how participants organise their practice and emphasise how technologies and artifacts may become an integral part of a practice. The authors read through and discussed the data in various analytical session in person and on Skype. The data was organised into themes as topics emerged from the analytical sessions. A concerted effort was made to have the themes, and in turn, the findings emerge from the data itself.

#### The findings of the field trial

In this section, we present the main findings of the field trial. We will start with the quantitative inquiry (see table 1) before moving on to the qualitative one.

| Farmers | Crop | Yield compared to the previous year | Production cost compared to the previous year |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Intervention group | Chili | Up 14% | Down 4 % |
| | Maize | Up 10% | Down 8 % |
| Control group | Chili | Up 9,5 % | No change |
| | Maize | Up 4 % | No change |

**Table 1. Summary of quantitative inquiry**

On average, we found a twelve percent increase in crop yields. The production of maize and chilli had increased compared to the previous year. The average chilli production of the intervention group was 864 kg pr. acre, compared to 755 kg pr. acre the previous year. Among farmers in the area *not* actively taking part in the Krishi Kontho field trial, the annual chilli yield was 827 kg pr. acre. Year on year increase in production, then, was fourteen percent for chilli (109 kg pr. acre) for the beneficiaries of the Krishi Kontho project. In comparison, the year on year increase in production was nine and a half percent for chilli (72 kg pr. acre) among farmers in the 'control group'. Judging from the fact that both the beneficiaries of the project as well as non-beneficiaries had increased chilli crop yields, some of the overall year-on-year increase in production can be explained by more favourable climate conditions the year of the field trial, compared to the previous year. Having said that, the beneficiaries did have the largest yield increase for chilli compared to the non-beneficiaries. This picture repeats itself in relation to the other crop of the field trial, namely, maize. The average maize production of the farmers using Krishi Kontho was 3,798 kg per acre compared to 3,444 kg per acre the previous year. That is a ten percent increase or 354 kg per acre from the previous year. Among farmers in the 'control group' maize production was increased by four percent. Of the farmers in the intervention group, eighty-five percent were able to increase their production of maize and chilli.

This increase in production yields compared to previous years, and compared to the farmers not using the service, is all the more significant if one also takes into consideration the reduction in production cost that was associated with it. The overall decrease in production cost was on average eleven percent for both crops, respectively four percent for chill and eighteen percent for maize. That is, the previous year the production cost of an acre of chilli had been 45,753 BDT (USD 566), in the year of the field trial the production cost of an acre of chilli was 45,000 DBT (USD 558) for the participating farmers, a reduction in production cost pr. acre of 753 BDT (9,3 USD). For an acre of maize, the production cost had previously been 40,905 BDT (507 USD). During the field trial, however, the production cost fell to 38,475 BDT (476 USD), that is a reduction per acre of 2430 BDT (30 USD). Cost reduction is as important to the farmers' livelihood as is the increase in crop yields.

The reduction in production cost was mainly a consequence of a more modest use of fertiliser and pesticides, which in turn benefits the natural environment, the work environment, and the quality of the crops produced. Associated with the farmers' use of Krishi Kontho, then, was smaller doses of fertiliser and pesticides, the dosage was kept lower due to well-timed use. That is, the timing and rhythm of fertilisation and application of pesticides, dictated by the tempo and content of the voice messages, had an impact on production cost. In addition, irrigation cost was reduced, also due to well-timed and moderate use. Also, pest and insect infestation was lessened compared to the plight of the farmers in the non-intervention group.

In sum, we may say that the use of the service correlates with increased crop yields and a decrease in the use of fertilisers and pesticides. The quantitative data analysis, then, points to the potential of this kind of service to improve the livelihoods of smallholder farmers. Note that the limitation of the quantitative findings presented above is that the data was generated through one eleven-month field trial, in a limited area with two crops, rather than through multiple trials or more extended trials.

#### Value and experience offered to the farmers

Our qualitative inquiry, our focus groups and interviews, reveals that many users attributed value to their interactions with Krishi Kontho. The users saw the service as a source of information, an alternative to the advice of input sellers and the overextended public agricultural extension agents.

This sentiment was often strongest among female farmers:

*We thank you for the messages. They helped us a lot. Thank you.*

(Female farmer, Fulchari Upazila, Gaibandha)

Women farmers used Krishi Kontho to build their farming skills, build social capital, and share information. Independent of male extension agents and male input sellers. After getting the voice messages, they would share the information with other farmers in their village who did not have access to the service. This would help their neighbours, and it would build the social capital of the female farmers sharing the information with others including men in the village. This would elevate their status in the village to the point where those *not* taking part in the field trial would become "jealous" of those holding the information. Having access to Krishi Kontho, then, was seen as valuable:

*We got the messages and were fortunate, and some of the others became a little jealous. But of course, we shared the messages with them - all they had to do was ask.*

(Female farmer, Fulchari Upazila, Gaibandha)

Farmers without access to the service, then, wanted that access as well. In addition to the social value of using and sharing information from Krishi Kontho, the farmers appreciated the more tangible rewards. One farmer reported that in the season where he used the service his maize yields moved from 800 kg to 1,400 kg. And for chili, his yields were up from 320 kg to 480 kg. This particular farmer especially appreciated the detailed seeding advice of the service:

*I know what kind of chili seeds to plant, how close and how many. I know that now from the messages […] This harvest was 480 kilos, much better than the previous harvest.*

(Male, farmer, Fulchari Upazila, Gaibandha)

To get advice and recommendations, the farmers had previously called the public extension officer on the phone, but this had been very time-consuming. For example, in the case of plant diseases and pest, they previously had to take the affected plant to the extension officer in town. However, this was rarely done. The public extension officer was often too busy to come to their village. The service of Krishi Kontho somewhat alleviated this kind of predicament in the sense that the service also provided voice-messages with recommendations on plant diseases and pests in relation to the crops included in the field trial, namely, maize and chilli. However, what the service did not do was to provide for two-way interaction between farmer and agricultural expert (we will discuss this limitation in further detail below). Furthermore, the service only advised on maize and chili, other crops farmed by the villagers in the area such as wheat, jute and chickpeas were not advised on. This made the farmers ask for recommendations in concerning these crops. On the one hand, this speaks to the limitation of the field trial service; on the other hand, it speaks to the future potential of this kind of service in the sense that it is a clear indication that the concept of Krishi Kontho was appreciated by the farmers - as they wanted "more of the same" in relation to other crops. As one farmer put it:

*You send us messages on maize and chili. We are very thankful for that. But we have other crops as well. I farm with my wife. So, it would be great if you could provide us messages on wheat and chickpeas also. And we also used to grow jute before the flooding. Can you also give us messages on jute?*

(Male farmer, Fulchari Upazila, Gaibandha)

The farmers in the area lost much or their land due to land and river erosion in recent years. They live, as mentioned, on the slit islands (Chars) and none of them has television or electricity. There are some houses with solar panels, but those are few, they are the homes of the *comparatively* affluent families. This is partly where the phones are charged. Farmers in the area almost all have mobile phones of the feature phone variety with a price tag of about 10 USD. Smartphones beginning at 75 USD, however, are beyond their reach. This is partly why a service such as Krishi Kontho based on voice-messages sendable to any kind of phone resonates with this community of farmers. Sometimes the farmers hear agricultural radio programs on their phones, many of the phones have an FM receiver. One farmer said:

> *Sometimes we listen to Krishi Dibanishi [an agricultural program – in English "Day and Night Agriculture"]. And we understand what is said. It is interesting. But it is not always what we need to hear. We would rather have messages on what we need to hear.*
>
> (Female farmer, Fulchari Upazila, Gaibandha)

This response opens up the topic of the temporal delivery of information. Many users appreciated the rhythm of message delivery via Krishi Kontho, where information, as mentioned, was delivered in step with the crop cycles of maize and chilli, synchronised with the sowing dates of the farmers for each of these crops. One of the most applauded features of Krishi Kontho was the synchronisation of the message delivery with the temporal order of farming. Our findings support that this part of the service worked out well in practice; the farmers taking part in the field trial valued the temporal delivery of the messages that helped structure their cultivation practices:

> *The messages came when needed and gave us an idea of how to take care of our fields. Sometimes we already knew some of what the messages said, for example how to spray for insects, but we did not know exactly when it was the best time to do it.* (Female farmer, Fulchari Upazila Gaibandha)

Services like Krishi Kontho may provide a tight coupling, then, between the temporally given information needs of the individual farmers and the content of the information provided to them - without requiring the farmers to search for information. The farmers may know some of the advice already, for example how to spread fertiliser, but may still benefit from receiving the messages as they also pertain to *when* it is best done. Furthermore, the very appearance of the messages on the phones can serve as reminders.

The advice and the timing of the delivery of the advice is relevant in slightly different ways to different farmers. That is, Krishi Kontho provided its services to farmers in different households with slightly diverse levels of farming experience. While for example in one household farming would employ all of working age and be the main activity, in another household the woman might farm only for subsistence (rather than selling) while her husband work in town driving a motor-rickshaw. That is, some farmers have more experience with, and knowledge of, farming than others. Crudely put, three kinds of farmers may have benefitted from the service. First, those that needed to know both how and when to do something. Second, those that already knew how but needed to know when (and vice versa). Third, those that just needed to be reminded to do something. In this manner, the farmers may be said to pair their knowledge and experience with the advice offered by the service each in their way. This raises the question of how to further personalise the service to fit the knowledge profile of the individual farmers better.

Furthermore, the farmers sought more information not only on additional crops, but also on adverse weather such as flooding, and market prices. When asked how the service could be improved, the farmers called for warnings of the water masses coming down the Brahmaputra River during

monsoon, often flooding their fields and invading their homes. To them flood warning is a priority:

*We have left our villages so often to take refuge in government shelters, while our houses and fields are under water. It does not make sense to plant, fertilise and spray for insects only to have the crops flooded before harvest.*

(Female farmer, Fulchari Upazila Gaibandha)

Effective flood warning was not an integral part of Krishi Kontho during the field trial, and there is a clear potential to improve the service in this respect. Also considering the very vulnerable situation of the farmers on the Char islands.

Furthermore, there was an information need that was not disaster or cultivation related, and that was the wish for market information. The present situation of the farmers is that they sell at the local market in the nearest small town, and there is no practical alternative to this market and the group of wholesale buyers there. This means that the farmers are in a weak situation, without adequate alternative markets, there is no real competition in relation to the price-setting of their produce. Some collusion on prices, on the part of the wholesale buyers, have been a problem according to the farmers. With this in mind, it is understandable that local farmers would like to be informed on the crop prices at several nearby markets and towns on a timely and regular basis to be able to compare prices. However, one of the challenges of this is that wholesale buyers in neighbouring markets are not known or familiar. As one farmer put it:

*How do we know that a buyer [in another town] will actually pay the prices he claims he will pay? Once we have travelled there with our harvest, he might change his mind and offer another price. How do we know?*

(Female farmer, Fulchari Upazila, Gaibandha)

This reservation towards trusting (partial) strangers' springs from previous experience. Many farmers just go to their local market where they might not be offered the best prices because they have a relationship with the buyers there and trust that buyers will pay them the said price and on time. This trust issue, however, did not temper most farmers' wish for market information (but it does complicate the practical delivery of trustworthy market information as we will discuss below).

Furthermore, there is the issue of the financial sustainability of Krishi Kontho. During the field trial of Krishi Kontho, the farmers used the service free of charge. As mentioned, the operating cost of the service was BDT 1 (0.012 USD) per voice message sent to the farmers, in addition to that were the operating costs of the ICT infrastructure, not to mention the cost of designing and deploying the system. Asked if they would be willing to pay for this service in the future, most farmers gave somewhat evasive answers. There was no real appetite among the farmers to pay for what had previously been free:

*We need to understand first how you are going to charge us for the messages before we can [fully] answer you. What amount for what information? I need to know – and if I find a message to be useful, I might pay for it, but I cannot guarantee that the others will.*

(Female farmer, Fulchari Upazila, Gaibandha)

This attitude of caution and restraint when it comes to giving out cash is quite understandable considering the farmers' precarious and unpredictable situation on the Char islands. Farmers find it hard to accurately plan for the future when so much is contingent on the climate and the level of flooding. Saving some cash is one of the few safeguards the farmers have against natural disaster.

## DISCUSSION

In this section, we discuss the implications of our findings for the future design of agricultural information services in developing regions.

### The value of voice-based services and synchronised message delivery

One of the most lauded features of Krishi Kontho was the synchronisation of the message delivery with the temporality of farming. Each message, as mentioned, was delivered on the mobile phones in step with the crop cycles. It was the intention that farmers should have the information they needed at the moment they needed it. Our findings support that this part of the service worked out well in practice; the farmers who took part in the field trial valued the temporal delivery of the messages, which helped structure their cultivation practices. This finding is in line with the HCI literature on the temporality of practice, reviewed above, which underscore the significance of designing for the rhythms of practice [3, 27, 37]. In our case, the rhythms were those of maize and chili cultivation, rather than those of for example hospital work as considered by Bardram [3], Møller and Bjørn [27]as well as Reddy and Dourish [37]. As indicated, services like Krishi Kontho may provide a tight coupling between the temporally given information needs of the individual farmers and the content of the information provided to them - without requiring the farmers to search for information. As mentioned, voice forums as well as rural information portals it to the farmers to navigate the forums or portals and find the information they need by themselves. As indicated, if for example a voice forum or an information portal is very complex and full of diverse types of information it may be a challenge for the farmers to navigate such a service. Having said that, one may note that the expert-oriented and highly-structured approach of Krishi Kontho do not afford two-way interaction between farmers and agricultural experts, or between peers for that matter - as a voice-forum or rural portal might have done [14, 32]. Furthermore, the Krishi Kontho approach may struggle to add information in the same high tempo as those information services that take advantage of user-generated content. For Krishi Kontho voice messages, for example, had to be pre-recorded by a voice actor adding to the production and running cost of the service.

There seems to be a distinction, then, between the affordances of for example voice forums and agricultural information portals with (1) peer-generated, peer-curated, searchable content, with supports for peer interaction [32], and (2) the affordance of a service such as Krishi Kontho that relied on messages authored and selected by experts to be delivered at set intervals and in a tempo to corresponds to the users' non-digital practices. Generally speaking, one approach is not better than the other. However, one might say that each approach has different affordances and hence delivers value to the users in different ways. Voice forums have had significant usage in developing regions [see e.g. 32, 40], and we may cautiously say that the approach of Krishi Kontho seems to add value to agricultural practice as well in the form of better crop yields, less expenditure, and new knowledge of farming. But the approaches differ. Arguably, the two approached may be seen as complementary, rather than mutually exclusive. That is, smallholder farmers in developing regions may ideally be serviced by both the likes of Krishi Kontho as well as, for example, voice-forums relying on mass user-generated content.

### The need for additional information on adverse weather and markets

One of the striking findings of our study was the need for more information on adverse weather. Prior work on information services in developing regions has also emphasised the climate dimension [2, 18, 31]. Climate change affects the lives of farmers in very concrete and often negative ways, with flooding in for example Bangladesh [17] or drought in for example Ethiopia [6]. In general, we advocate that agricultural information services in exposed developing regions include early warnings of adverse weather. Regular news broadcasts, on FM radio for example, may not deliver this information in a timely manner and may deliver it without a focus on potential issues for crop cultivation. Hence, the need for systematic farming related information on weather, especially on upcoming adverse weather conditions.

Market prices is another example of information sought after by the farmers in our case. Providing

market information for several local markets in developing regions may sound straightforward on the face of it. However, when one introduces conditions of ambivalence, contingencies, and lack of trust, then reliable market information delivery becomes more of an issue. For example, how is a service provider to guarantee that the prices quoted via an information service actually will be honoured on the ground, so to speak, on the market when it is time for the transaction? Keep in mind the trust issues mentioned above. One can imagine that it only takes a few bad or inaccurate price quotes that do not live up to what was promised, to erode confidence in an agricultural information service. As far as we can see, useful market information requires the commitment of not only the farmers but also of the wholesale buyers in the area. This theme remains to be explored further.

#### The financial sustainability of agricultural information services in developing regions

As agricultural information services such as Krishi Kontho aim to move from field trial to established service, questions of the financial sustainability inevitably arise. As mentioned, during the field trial the service was provided to the farmers free of charge, and the participating 100 farmers freely shared the information with non-participating farmers, spreading the recommendations to other villagers. At first sight, it might seem like a simple solution to let each farmer pay his or her share of the operating cost of the service: Krishi Kontho might, for example, works as a subscription service, or charges might be levied on the delivery of each voice message, there are a few complications to consider. First of all, some farmers, as described above, indicated that they would be hesitant to use the service if it was not free. Second, through informal discussion, it emerged that if the service was not free, farmers might adopt the approach of one person formally paying for the service and then informally sharing the information with the rest of the community. One way to counter this might be to do subscriptions per village, rather than per person. Another solution to the issue of financial sustainability is to look elsewhere for the operation cost. For example, sellers of agricultural equipment, or providers of inputs such as fertilisers or seeds, might be convinced to bear the cost. A sort of sponsored advertisement. This and other business models remains to be explored. The issue of financial sustainability remains an issue for many types of service aiming to move from field trial to more established service in developing regions [2].

## CONCLUSION

In this paper we have present Krishi Kontho, which is an agricultural information service that sends voice messages, and SMS, to farmers, in order to provide them with agricultural knowledge, which is in step with the life cycles of their crops. In addition to presenting the design of the agricultural information service we also reported from an eleven-month field trial and found that the service may improve crop yields while reducing production cost. Furthermore, the farmers valued the service and were able to pair their knowledge of farming with the advice offered by the service. The service addressed the challenge of limited literacy by providing advice in the form of voice messages, rather than for example only text.

One challenge associated with Krishi Kontho and services like it, especially in developing regions, is the question of financially sustainable. This is an open issue. Also open for further research is the integration of weather and market information, and the question of how to further personalise the service to better fit the knowledge profile of the individual farmers.

In sum, the paper has addressed the core HCI problem of designing for the temporality of practice. It has done so by providing an example, Krishi Kontho, made to deliver agricultural advice to low-literacy rural communities in the Global South in accord with the rhythms of their crop cultivation practices.

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