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Alliance Bioversity & CIAT

Error 404, farmer not found:
why agricultural information services must consider how smallholders use their phones

Key message

Numerous barriers hinder mobile information services in delivering information effectively to smallholder farmers. Many of these barriers can be explained by farmers' habits in using their phones. Therefore, carefully considering how exactly farmers use their phones in specific local context is crucial to mitigate behavior-related barriers. We describe 18 potential behavioral barriers that should be checked before implementing mobile information services for smallholder agriculture.

The power of agricultural information in every farmer's pocket – in theory

Mobile phones are now nearly ubiquitous in low- and middle-income countries (LMICs). Rural people, including smallholder farmers, are increasingly connected. This development has raised strong interest by governments, NGOs, and private sector companies: under the broad term 'digital agriculture', countless digital services targeting smallholder farmers have been deployed across LMICs. In recent years, more advanced 'smart farming' solutions for on-farm decision support receive growing attention. Notwithstanding, most farmer-facing digital services continue to be mobile information services (Ayim et al., 2022; Chandra & Collis, 2021; Miine et al., 2023; Porciello et al., 2022). In these, agriculture-related information is channeled to farmers with the aim of influencing their decisions. Common examples include agronomic advice, market information, or climate forecasts and weather alerts – sent to farmers' palms and pockets.

Mobile agri-services: proven benefits, but low adoption

Ample evidence underscores that usage of digital information services can improve farmers' yields, income, and overall resilience (Beanstalk AgTech, 2023; Fabregas et al., 2019; Porciello et al., 2022). This said, the enormous adoption gaps may seem surprising: although most smallholder farmers in LMICs now have access to mobile phones, mobile information services have not become mainstream practice anywhere. It is estimated that only about 10 % of the roughly 500 million smallholder farmers in LMICs are active users of at least one digital service for agriculture (Beanstalk AgTech, 2023). Many farmers, once registered, do not become active users (CTA, 2019). What is holding back farmers from seizing the opportunities that come with mobile information services?

Low rates of adoption are often explained by mismatches between the design of digital services and farming reality. For example, mobile information services may not deliver the kind of information farmers require, in the right format, at the right time, in a trustworthy manner (Coggins et al., 2022). Such services are perceived as irrelevant by farmers. But even when contents are well-tailored, there can be technical constraints to accessing them. Smallholder farmers in LMICs often maintain cheap (non-smart) feature phones that cannot be used to load apps, consult websites, or engage with chatbots (Wyche et al., 2019). Where farmers do own smartphones, their use in agriculture can be hampered by the high cost of mobile data or inadequate infrastructure in many rural areas (Mehrabi et al., 2021).

Why is it so difficult to effectively reach farmers on their mobile phones?

Research on digital agriculture in LMICs has paid much attention to determinants of adoption that relate to infrastructure (e.g., is there mobile network on farms?), technology (e.g., do farmers own smartphones?), and human capacity (e.g., are farmers generally literate?). Yet little systematic emphasis has been placed on studying technology-related behavior: how do farmers usually engage with mobile phones? Through ethnographic case studies in Kenya and Zambia, Susan Wyche and colleagues have explored how resource-poor populations use their phones, how they think of them, and what challenges they experience (Wyche, 2017; Wyche & Steinfield, 2016; Wyche et al., 2015; Wyche et al., 2019). These studies highlight many aspects of phone users' attitudes, experiences, and resulting skills that affect the effectiveness of mobile information services. For example, small screens, worn-out keypads, and the complexity of entering text on 12-key feature phones make messaging cumbersome – furthering a strong preference for voice communication. Another relevant example relates to phone sharing among household members, which may affect how farmers can or cannot engage with digital agriculture services (e.g., Aiken et al., 2022; Blumenstock & Eagle, 2012; Wesolowski et al., 2012).

Avoiding failure requires understanding farmers' habits around mobile phones

Researchers and practitioners who shape the digital transformation of smallholder agriculture need to better understand mobile phone-related behaviors and attitudes in their target communities. Such understanding can help with anticipating, assessing, and mitigating unexpectedly low engagement with mobile agri-services. In this document, we take stock of the diverse behavioral challenges that can affect the functioning of mobile information services. Building on and adding to the research by Wyche and others, we compile challenges observed while implementing mobile agro-climate information services for smallholder farmers in sub-Saharan Africa, Latin America, and South-East Asia (see Table 1 for an overview of projects). These experiences are anecdotal in nature and not exhaustive. Nevertheless, they should provide an overview of the diversity of challenges that may require attention in digital agriculture. Farmers' behaviors towards mobile technology are heterogeneous; the observed challenges are context-specific, subject to cultural experiences, and may be temporary. This said, we hope this broad overview helps to guide pre-design user research by digital agriculture initiatives, aiding to diminish design-reality mismatches in the future.

Table 1: Overview of study cases

Project / service name	Period of implementation	Country or region of implementation	Technology	Type of information	Reference
AKILIMO	2015–2022	Nigeria, Tanzania, Ghana	Mobile app, SMS, WhatsApp, IVR, USSD	Agronomic advice	https://akilimo.org
FENALCHECK	2017–2018	Colombia	IVR	Agronomic advice	Kropff et al. (2021)
WEFOCOS	2018–2022	Vietnam	Smartphone app	Agronomic advice, climate information	Nguyen et al. (2023)
Agro-climatic Bulletins	2018–2024	Vietnam	Zalo (Vietnamese WhatsApp alternative)	Agronomic advice, climate information	Alliance of Bioversity & CIAT et al. (2022)
Ushauri	2019	Tanzania, Kenya	IVR hotline	Agronomic advice	Ortiz-Crespo et al. (2020)
Melisa	2021–2022	Colombia	Chatbot	Agronomic advice, climate information	https://alliancebioversityciat.org/tools-innovations/melisa-chatbot
Croppie	Since 2021	Colombia	Mobile app, chatbot	Coffee yield estimation, agronomic advice	https://croppie.org
5Q	2022–2023	Thailand	IVR	Monitoring of farmers' agricultural practices	Eitzinger (2021)
Diet Quality Questionnaire	2022–2024	Rwanda	USSD	Crowdsourcing dietary data	Manners et al. (2022)
Diet Quality Questionnaire	2023	Guatemala	IVR, WhatsApp	Crowdsourcing dietary data	Manners et al. (2023)
Waterpoint monitoring system	2024	Ethiopia	Mobile app, SMS	Climate information	https://et.waterpointsmonitoring.net
Sprout use platform	2024	Kenya, Nigeria	SMS	Agronomic advice	Simiyu et al. (2024)

Behavioral challenges

Case 1: Why does information not reach farmers?

1. **Farmers are reluctant to take calls from unknown numbers.** Widespread use of phone calls to commit fraud and scams or to disseminate unsolicited advertisements has led some farmers to become cautious about unexpected calls. Based on earlier experiences with fraudulent (or plain annoying) calls, these farmers ignore any incoming calls from unknown or suppressed phone numbers. Mobile information services that employ push-calls to farmers – for example, to send automated voice messages with weather alerts or daily market prices – may need to ensure calls come from a consistent number that is saved in farmers' contacts. In our experience in Thailand, this was the most prominent reason for farmers not answering IVR (Interactive Voice Response) calls.

2. **Farmers ignore SMS or delete them right away.** Massive campaigns of promotional SMS (Short Message Service) are a common marketing strategy in many LMICs. Messages can be sent by the SIM holder's own mobile network operator (e.g., offers on airtime discounts), other businesses, or criminal scammers. In most cases, these SMS are perceived as spam by farmers, who have grown used to ignoring SMS or deleting them without paying much attention.

3. **Farmers switch off the phone to preserve battery.** With many rural areas only weakly connected to power grids, consistent access to electricity can be challenging for smallholder farmers. In some cases, phones can only be charged at designated village shops that have a power outlet, or in town. In response, some farmers keep their phones switched off during significant shares of time. This may mean that SMS or calls may fail to reach farmers even when they carry the phone with them and are within network coverage. This is a particular challenge for agricultural information that is time sensitive, such as weather alerts, agronomic reminders, or market information.

4. **Farmers frequently change SIM, turning their registration with the information service obsolete.** Many mobile network operators in LMICs offer discounts or free airtime packages on registering a new SIM card. In result, some farmers frequently register a new SIM, which costs them less than maintaining an existing one and forgoing the 'new client' bonuses. In addition to phones getting lost or stolen, this phenomenon contributes to a high turnover of mobile phone numbers. The numbers originally registered with an agricultural information service are quickly outdated, and more and more farmers become unreachable.

5. **Farmers share mobile phones with other household members.** Mobile phones are sometimes treated as general household items that are shared among family members, including spouses, siblings, or children. While there is often one person considered the actual owner, phones may be used by multiple individuals on a regular basis. Farmers sometimes deliberately leave the phone at home when they leave to work on the farm (where there might be no network signal anyway). As a result, it is hard to ensure that calls and messages reach the intended addressee. For mobile-based crowdsourcing projects, this also raises concerns about data accuracy. Sending messages and calls during evening hours, when most household members are at home, can be a promising strategy (Eitzinger et al., 2019).

6. **Farmers are reluctant or unable to install new smartphone apps.** While feature phones are nearing ubiquity, smartphone adoption is increasing, too. Growing numbers of smallholder farmers in LMICs own inexpensive 'entry level' smartphones. As these phones typically come with limited storage space, farmers can be reluctant or unable to install new agriculture-related apps due to lack of storage. This was a frequent observation in our project targeting coffee farmers in Vietnam.

7. **Farmers buy cheap data bundles that do not cover image uploads.** Some mobile network operators in LMICs offer inexpensive data bundles that provide unlimited access to text in Facebook and WhatsApp. These offers primarily target owners of internet-enabled feature phones, but are also purchased by smartphone users. They do not allow image up- and download even within WhatsApp or Facebook, which limits opportunities for chatbots that provide illustrative images or offer image interpretation (e.g., for yield estimation with *Croppie* in Colombia).

8. **Farmers switch off mobile data to preserve their data plan.** Having paid for costly data bundles, smartphone users sometimes actively protect their prepaid data volume from being depleted by incoming images and videos or background app updates. By switching off mobile data connectivity unless it is actively needed, farmers can delay data-heavy downloads until they reach public Wi-Fi access points, for example, at agricultural training centers. In turn, messages sent through messenger apps, including chatbots, can be delivered with significant delays.

9. **Farmers are reluctant to read long text.** While many farmers are literate, not all are used to reading long text. Especially when text messages are not in farmers' native language, reading extensive messages can be tiring, resulting in farmers losing attention halfway through. Obviously, there is no universal threshold for 'long' text. In an experience involving USSD (Unstructured Supplementary Service Data) in Rwanda, many targeted farmers did not scroll beyond the first screen shown on their feature phone – on many basic handsets, this length equals less than half an SMS. Failure to scroll and read messages that extend beyond one screen is also reported by Medhi et al. (2011) and Wyche et al. (2015).

10. **Farmers cannot read text messages due to poor eyesight.** Farmers' widespread preference of voice communication over receiving messages is well documented. Common explanations relate to limited literacy or insufficient phone operating skills (see previous point). Another reason is frequent poor eyesight among farmers. While impaired vision can be caused by aging, excessive exposure to sunlight, or use of dim fuel-based lighting at home, smallholder farmers' socio-economic conditions rarely allow for adequate corrective eyewear (Mills, 2016; Sherwin et al., 2008). This challenges any information service that involves SMS, USSD, or chatbots, or sends example images.

11 **Farmers are reluctant to send SMS.** Some mobile information services require farmers to send requests via SMS to trigger a response, for example, weather forecasts or up-to-date market information (a prominent example is *Esoko*). Many farmers, however, find it difficult to send SMS. Reasons include limited literacy, but also the cognitive effort of texting due to small keys, cracked screens, and the complexity of entering 26 different characters using just nine keypad pushbuttons.

12 **Farmers are reluctant to invest in learning to use new technologies.** Many farmers in low- and middle-income countries have relatively limited digital skills and experiences. This can cause errors and confusion while using unfamiliar channels, such as SMS, IVR, chatbots, or mobile apps, contributing to disadoption of mobile information services. Anything can be learned, in theory. But without immediate observable benefits, farmers have little incentive to invest significant effort into overcoming the difficulty of interacting with new technologies. This can be true even when technologies are familiar in principle: deploying the *Melisa* chatbot in Colombia, we observed the difficulty experienced by smartphone-owning farmers in initiating a conversation with a virtual counterpart. Designers of mobile information services may need to minimize, as much as possible, requirements for learning, and prioritize the technologies farmers already use intuitively.

Case 2: Information reaches farmers. Why is it not accessible when needed?

13 **Farmers do not carry their phones to the farm.** Mobile phones are frequently shared among members of rural households. In some cases, this means the phone predominantly stays with household members at home (see point 5 above). In consequence, farmers are not able to access the phone while on farm or during trips to agro-vet shops in town, which is when they might most need agronomic advice, weather forecasts, or information on agricultural inputs.

14 **Farmers delete SMS to free phone memory.** Due to limited storage space on farmers' devices, SMS are frequently deleted to allow new messages to come in (and to remove the flashing 'envelope' icon on screen). This implies, however, that messages with potentially relevant agricultural information are easily deleted, as well. In Kenya, we have observed farmers who saved SMS with useful agricultural information for later reference, but then accidentally deleted them. Proper timing of messages seems crucial: sending messages shortly before the information is required not only helps to avoid the message being forgotten. It also reduces the risk of the message getting swept out and thus inaccessible.

Case 3: Information reaches farmers and is accessible when needed. Why is it not acted upon?

15 **Farmers hesitate to trust unfamiliar voices.** In response to low levels of literacy, many mobile information services emphasize voice-based channels, including IVR, voice messages, or push-calls. Many farmers, however, hesitate to rely on advice provided by a voice they are not personally familiar with. Use of local language, local dialect, and farmer jargon is important for fostering trust in information contents. In an experience from Colombia, we found that a firm and confident voice – irrespective of the speaker's gender – was crucial for making farmers trust the messages.

16 **Farmers frequently change SIM, making it difficult to customize the information service.** Incentivized by mobile network operators, some farmers regularly register new SIM cards (see point 4 above). The resulting rapid turnover of mobile numbers, however, makes it challenging to personalize information to the individual user. Some mobile information services customize messages according to data associated with the farmer's registered number, for example, their location, farm size, or primary crops. Some chatbots analyze earlier interactions to tailor information to the farmer, for example, regarding their individual interests or challenges. Lack of such personalization may result in information perceived as less relevant, less understandable, or less trustworthy, and therefore not practical.

17 **Farmers are unfamiliar with scientific terminology.** Farmers tend to refer to many agricultural concepts using different terms than those used by the scientific community. Many agricultural extension agents master the skill of conveying scientific findings using local farmers' terms. Mobile information services need to apply this skill, too. In some cases, however, there are no clear 'farmer jargon' substitutes: In Vietnam, advisory messages about chemical plant protection recommended active ingredients, rather than commercial trade names of pesticides. Farmers, however, had difficulties understanding and remembering those terms. The need to speak farmers' language also extends to the language register employed. In Kenya, overly comprehensive messages perceived as long-winded deterred some farmers from reading them altogether.

18 **Farmers are unfamiliar with scientific forms of communication.** Like any other social group, smallholder farmers should be addressed using the language and cognitive concepts they are familiar with. It is not uncommon to find mobile information services targeting farmers with bar or line charts, for example, about crop yield responses to different fertilizer rates. Many farmers can make little sense of such diagrams. It may seem less obvious that significant numbers of smallholder farmers are also unfamiliar with maps (e.g., weather forecasts), percentages (e.g., relative yield differences), or the principle of probability (e.g., likelihood of drought). In our experience, many farmers are indeed interested in outputs of academic research if they are provided in short, affirmative, familiar formats.

Behavioral barriers can be addressed and mitigated

Digital agriculture solutions may be effective in one smallholder farming context, but turn out to fail elsewhere. How farmers use mobile phones is diverse, and their attitudes, experiences, and skills vary both between and within societies and communities. In practice, this diversity makes it challenging to create effective mobile information services, as many usage barriers may show up unexpectedly. However, that diversity also implies that virtually any farmer can be reached, one way or another: every phone user's individual habits and preferences are potential entry points for agricultural information. With adequate efforts, it may be possible to overcome or mitigate many of the barriers described in this document. Some opportunities are outlined below.

In-depth user research. An important strategy for mitigating barriers consists in applying extensive *User Research* before taking any decisions on design and implementation. Because of the heterogeneity in farmers' digital experiences, localized solutions are needed. To come up with suitable solutions, it is crucial to obtain a detailed understanding of how target farmers engage with mobile phones. Thorough user research – including observing diverse farmers using their phones – helps reduce the risk of overlooking widespread behavioral barriers. This document may highlight relevant aspects to scrutinize during such efforts. After exploratory user research, strongly involving the target group in all steps of the design process is vital: exploring ideas and testing early-stage prototypes with expected future users helps adapt the design to local realities, avoiding mismatches with typical mobile phone usage (Müller et al., 2024; Steinke et al., 2022).

Diversifying the user experience. Mobile information services must ensure to provide accurate information that farmers find relevant and useful. What channels are used to deliver that information needs to be considered undogmatically. Due to farmers' diverse technological capacities and preferences, it is challenging to design a solution that corresponds to everyone's lived experiences. Successful digital agriculture services have established multiple parallel channels to make the same information available, sometimes at different levels of detail. An information service can offer agro-climatic information through text and voice formats, through push messages and on-demand services, via online and offline technologies, and of course, in multiple languages. Provided budget is available for setting up diverse channels, the more channels are available to deliver information, the more likely the farming population will be reached effectively at scale.

Continuous iteration. First attempts rarely succeed, so in creating effective agricultural information services, learning from failure is normal and imperative. Building solutions based on user research, then testing them under real life conditions allows identifying what really works and what does not. The trick is to quickly follow up on these insights with design improvements. By staying in touch with farmers – including users and non-users – owners of mobile information services can continuously collect insights on farmers' experiences and potential usage barriers. Once the mobile information service is launched, continuous, agile iteration can help to increasingly match target users' mobile phone-related preferences and habits (Goedde et al., 2021; Shepherd et al., 2020). Iterations may involve periodic usability tests or A/B testing of different digital interfaces to rapidly observe challenges that may need to be addressed.

Integrating non-digital last mile communication. Despite the promise of the digital revolution, some individuals remain hard to reach through digital channels. Not every rural farmer owns a mobile phone, and penetration is unlikely to reach 100 % anytime soon in some segments of society, such as low-literate women and elderly farmers. Linking up with analogue disseminators can help: highly respected farmers or religious leaders can be systematically engaged to spread relevant information, orally or through demonstrations on farm. Last-mile information dissemination can also be incentivized more directly. For example, YOMA (https://yoma.world) is an online community where NGOs offer rural youth real-life tasks in exchange for virtual tokens they can redeem for goods (such as mobile airtime) or services (such as online education courses).

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