Real Mobiles: Kenyan and Zambian Smallholder Farmers' Current Attitudes Towards Mobile Phones

Susan P. Wyche
Michigan State University
Department of Media and Information
East Lansing, MI, United States
spwyche@msu.edu

Melissa Densmore
University of Cape Town
Department of Computer Science
Cape Town, South Africa
mdensmore@cs.uct.ac.za

Brian Samuel Geyer
Michigan State University
Department of Anthropology
East Lansing, MI, United States
geyerbri@msu.edu

ABSTRACT
What are rural farmers in sub-Saharan Africa's current attitudes towards their mobile phones? We draw from qualitative studies of smallholder farmers in Kenya and Zambia to answer this question. A review of ongoing efforts to develop mobile phone services for farmers paired with critiques of the "colonial impulse" embedded in future-oriented visions of technology use guided our study. Our findings suggest there is a mismatch between the design of mobile phone applications targeting rural farmers and our participants' perceptions and usage of their devices. We also discovered several understudied barriers that hinder adoption of mobile services: the influx of counterfeit and substandard mobile phones, distrust of the content being delivered via SMS and reservations about the spiritual and health consequences of interacting with handsets. We use these findings to encourage ICTD researchers and practitioners to reexamine the mobile phone. Specifically, we suggest developing interventions that teach farmers how to better use the devices and present recommendations for improving existing mobile phones.

General Terms
Design, Human Factors

Keywords
Human-Computer Interaction (HCI); mobile phones; agriculture; rural; sub-Saharan Africa; qualitative research, postcolonial computing

1. INTRODUCTION
Most people in sub-Saharan Africa are farmers with small pieces of land, large families, and poor crop yields. Their primary occupation is growing food, but many do not grow enough to feed their families or to sell at markets. Widespread mobile phone ownership among this social group means that for the first time there is a realistic opportunity to provide them with pertinent information that could help them grow more crops and sell them for more money. Yet, despite the expanding body of academic and applied research on mobile phones, the ICTD community still knows little about this largest segment of mobile phone users and their evolving attitudes towards these devices: How do they actually use, or not use, their phones to access agricultural information? What types of handsets do they own? What problems do they face when using them? What can farmers' experiences tell us about how to improve the design of mobile phones? There is value in deepening the community's understanding of farmers' mobile phone use patterns, so that scholars, practitioners and funding agencies can better anticipate how phone-based technologies will be adopted or disregarded.

The purpose of this paper is to provide this understanding. We studied mobile phones, and their use and non-use, among nearly 200 farmers living in rural Kenya and Zambia. The qualitative case studies, covering two regions in each country, highlight similarities and some differences in how smallholder farmers interact with their handsets. Our findings suggest that mobile phones are reaching everyone, but farmers do not widely perceive them as tools that support their agriculture practices. The influx of counterfeit and sub-standard or "China-make" models pose new burdens to farmers, and access to useful agricultural information is inhibited by an overflow of misinformation delivered via SMS. Questions about the spiritual and health consequences of interacting the devices also shaped our participants' interactions with their phones.

We use these findings to raise questions about the future-oriented nature of some ICTD projects and to encourage researchers and practitioners to improve upon what they built yesterday. In other words, building and evaluating novel mobile phone applications renders invisible the complications smallholder farmers encounter when using their existing handsets. Our findings suggest opportunities to create interventions that teach farmers how to operate their mobile phones and highlight improvements that need to be made to current information and communication technologies. More broadly, we demonstrate the value in non-needs-based studies of mobile phone use and argue that substantial rethinking of these technologies and the socio-cultural issues surrounding their use is necessary if they are to support smallholder farmers' agricultural practices.

2. Related Work

2.1 Prototype Systems for Farmers
The explosive growth of mobile phone ownership throughout the developing world has motivated academic researchers, technology companies, entrepreneurs, governments and NGOs to both design and evaluate mobile applications that target smallholder farmers. Notable projects from the ICTD and Human-Computer Interaction (HCI) literatures include Avaaj Otalo, an interactive voice-based service that provides best agricultural practice information to farmers in rural India [41]. VideoKheti also supports knowledge sharing among farmers by allowing them to watch agricultural extension video on mobile devices [14]. KrishiPustak is another

ICTD '15, May 15–18, 2010, Singapore, Singapore.

http://dx.doi.org/10.1145/2737856.2738013

prototype application developed to support social networking and information exchange among rural farmers [32].

Studies examining the design and evaluation of these and other prototype systems are valuable because they demonstrate potential ways that new technologies may improve rural farmers' lives. However, these studies are less useful for revealing the antecedent conditions necessary for adoption of these services. In other words, asking farmers to interact with a sample system that is unavailable to broader segments of the population provides little insight into how these applications might be adopted and typically used, especially outside of the study region. These prior studies all take place with farmers living in India, where infrastructural factors, such as access to electricity and road conditions, tend to be more favorable than in rural regions in sub-Saharan Africa [27]. Applications such as VideoKheti are also developed for farmers who have access to smartphones that are capable of screening videos. While these models are becoming increasingly common in sub-Saharan Africa's urban and peri-urban areas, rural farmers still tend to own basic and non-Internet enabled handsets [13].

Our investigations of mobile phone use in rural Kenya and Zambia broaden the ICTD community's geographical and comparative understanding of farmers' mobile phone usage practices. This knowledge is useful for raising questions about the external validity of prior studies and highlights dissimilarities among smallholder farmers in different developing regions.

2.2 Commercially Available Services

There have been few attempts to develop prototype mobile applications for smallholder farmers in rural Africa; however, commercially available services that target this population abound. These applications are primarily short message service (SMS) based services. This platform supports sending and receiving brief (160 characters or less) messages that communicate timely and simple information such as weather forecasts or market prices. Using SMS to send content also requires significantly less bandwidth than a voice call, making this platform not only less expensive than calling, but also capable of delivering information to mobile phone owners in areas where network connectivity is limited. Interoperability also drives use of SMS. Mobile devices spanning the oldest and most basic handsets to the latest smartphones are all capable of receiving text messages [25]. Here we provide a brief overview of two popular varieties of commercially available SMS services targeting smallholder farmers in sub-Saharan Africa: Farmer advisory and information services and Market Information Services (MIS).[1]

2.2.1 Farmer advisory and information services

SMS-based services provide pertinent information to farmers so they can better assess and manage risk related to, for example, managing livestock, weather conditions and diseases outbreaks [16]. What follows are examples of representative advisory and information services for farmers.

iCow is USAID-funded application available to dairy farmers in Kenya that sends registered users texts about their animals' estrous cycles and useful advice such as tips about cow breeding and nutrition [6]. Also available in Kenya is an application supported by the country's Plant Health and Inspectorate Service (KEPHIS) that offers planting advice. After sending a request to a "short code" or an abbreviated number that is used as an "address" for text messages, farmers receive an SMS with information about the recommended maize varieties to plant in specific regions.

Other mobile services send texts with climate information or disease alerts to farmers. There are dedicated weather services, such as the government-run Radio and Internet for the Communication of Hydro-Meteorological Information (RANET) project in Zambia. The developers of this application collect weather data from farmers, then disseminate the information about extreme weather events and climate change to them [35]. M-Kilimo is a "farmer helpline" that also sends customers weekly weather forecasts in Swahili [24]. Other mobile applications typically combine weather information with other content, such as market pricing information; Esoko and the defunct Nokia Life Tools project are examples [16]. Other SMS applications such as, The Digital Early Warning Network (DEWN) in Tanzania, disseminate advice about how to control disease outbreaks to farmers [39]. These services may benefit some farmers by providing them with pertinent information; but there are few systematic studies examining their use or non-use.

2.2.2 Market Information Systems

Market information systems (MIS) are another popular type of SMS service developed for smallholder farmers in sub-Saharan Africa and other developing regions. MIS are typically mobile applications that disseminate market price data to farmers. They were created to address information asymmetries between the farmers and traders, who had traditionally been able to take advantage of farmers' lack of knowledge about the market value of their produce [16]. Popular examples of MIS include Reuters Market Lite (RML), Esoko (formerly known as TradeNet), M-Farm, Kenyan Agricultural Commodities Exchange (KACE), and Lima Links in Zambia [44].

There are virtually no systematic usage studies of farmer advisory and information services, but there is a growing body of literature devoted to evaluating the impact MIS have on farmers' livelihoods, and findings from these studies are mixed [38]. Fafchamps and Minten studied whether the distribution of "agricultural information through mobile phones generates important economic benefits" in rural India, and found access to pricing information did not significantly improve farmers' ability to negotiate with buyers or receive more money for their crops [18]. Likewise, Camacho and Conover asked if text messages with detailed weather and price information improve smallholder farmers' welfare and found that receiving price information via text message did not increase Colombian farmers' profits [10].

Although these studies do not find that MIS positively impact farmers' ability to make more money selling their crops, results from other investigations suggest economic benefits do come from the use of these systems. In their impact evaluation of Esoko in Ghana, Nyarko and his colleagues ask "Can MIS help farmers get higher prices for their production?" [40]. They found that farmers using the MIS sold their yams at 11% higher prices than those without this service. Results from these studies are promising and suggest there can be benefits to delivering rural farmers pricing information via SMS. Yet, these findings do not explain the low adoption of MIS in in sub-Saharan Africa or investigate farmers' mobile phone usage (or non-usage) practices [13]. Earlier studies of MIS were also predominately carried out within the disciplinary tradition of economics and lack a qualitative understanding of farmers' existing mobile phone practices [9]. These evaluations typically involve controlled study

[1] For a more comprehensive review of these services see: [16,20,25].

groups comprised of people already using the services under study, or researchers training participants how to use the systems prior to the evaluation. Although these studies are useful for understanding mobile phones and the circulation of information in markets, underlying their implementation appear to be assumptions that farmers rely on their handsets for obtaining pricing information.

It is this lack of research detailing what activities farmers use and do not use their handsets for that is consistently described as a limitation of these studies [16]. Donovan writes that a consequence of this gap in knowledge is the continued development of mobile interventions that fail to gain traction with smallholder farmers because their existing practices are incompletely understood. Rather than developing a new system or evaluating an existing one, we build upon prior qualitative investigations of sub-Saharan Africa's rural residents by investigating their current mobile phone usage patterns [34,37,46].

2.3 Computing's "Colonial Impulse"

This decision to investigate farmers' existing mobile phone usage patterns was influenced by Dourish and Mainwaring's recently raised concerns about the "colonial impulse" embedded in Western software developers' efforts to build mobile phone applications that target long-standing international development problems without fully understanding peoples' experiences with the devices [17]. Drawing from familiar debates within the international development literature, including the shortcomings that accompany framing countries as "developed" and "developing," these scholars argue that software developers' future-oriented focus on what they might "build tomorrow" blinds them to them to their ongoing responsibilities for what they "built yesterday." They argue that technology researchers typically imagine themselves as being responsible for building computational systems that populations around the world will use in the future. This orientation comes at the high price of turning their attention away from social groups' contemporary experiences with existing technologies, such as the mobile phone.

Dourish and Mainwaring offer researchers and practitioners alternative strategies to conducting needs assessments studies that results in prototype systems, including "engag[ing] with people on their own terms." For us, implementing this strategy meant qualitatively studying farmers' and their current conditions in order to think more broadly and more realistically about the contexts where these mobile phones and the services they support are used.

3. Research Context: Rural Kenya and Zambia

Kenya has a population of 43 million, while Zambia has an estimated 14.5 million residents. The largest segments of both countries' populations live in rural areas where they are few employment opportunities other than small-scale agriculture [19]. The majority of agriculture production in both countries remains subsistence, or farming activities that form a livelihood strategy where the main output is consumed directly and where only a minor proportion of output is sold [7]. In Zambia it is estimated that 80% of the country's population makes a living through subsistence farming and in Kenya roughly 75% of the country's population falls into this category [2]. Maize is the dominant crop in both countries and other popular outputs include sorghum, beans, and sweet potatoes [42].

Large populations of smallholder farmers paired with relatively high mobile phone ownership in both countries influenced our decision to conduct fieldwork there. Roughly 71% of each country's population are mobile phone subscribers, a rate that is higher than the African average of 65% [13].

4. Study: Methods, Sites and Participants

The evidence from multiple cases is considered more compelling and robust compared to findings from a single case [48]. While there have been some large-scale, typically quantitative, studies comparing how public access venues (e.g., libraries and cyber cafés) are used in different developing countries [23] qualitative investigations of mobile phone use that are conducted in two African countries are few. Studies likes ours are useful for providing rich contextual details about the similarities and differences in mobile phone use on a continent where the economic, social and infrastructural conditions vary between (and within) regions and countries.

The first author has been studying mobile phones in East and Southern Africa since 2007. Data collection for the findings presented here took place in Kenya during a two-week period in May 2013. The second study occurred in Zambia over a similar time period in October 2013. NGO employees and in-country contacts helped us identify comparable field sites in both countries. Our research took place in rural places located approximately 30-60 kilometers from the nearest urban and peri-urban areas. Subsistence farming was the primary livelihood activity in all of the sites visited and the size of farmers' plots typically ranged from 0.25 to 2 acres. We looked for participants who owned mobile phones to participate in our study. Of course, a limitation of this sampling approach is that we excluded farmers without a device from participating. However, we rarely encountered farmers who could not participate because they did not have a handset. This observation offers further evidence suggesting that ownership of a mobile phone and the communication it enables are critical to rural householders in Africa.

The primary research methods employed in both locations were group interviews, one-on-one interviews and observations. Local research assistants helped us gain access to groups of farmers and establish trust with them during sessions. These collaborators also moderated discussions in the language(s) participants felt most comfortable speaking (Swahili in Kenya; Nyanja and Bemba in Central Province, Zambia and Chitonga in Southern Province, Zambia). Each group discussion consisted of around six participants and ended after each member had answered our questions: this typically required 1 to 1.5 hours. When possible we interviewed men and women in separate focus groups in order to ensure that women's perspectives were heard.

The sessions resembled focus groups because we asked farmers about their perceptions, opinions and attitudes towards information and communication technologies. However, the meetings also differed from this formal method, because they happened with little planning and at locations that were immediately available. For instance, interviews took place in farmers' front yards or anywhere else where extra chairs and benches were available for people to sit in. Participants called friends interested in participating, so some interviewees trickled in after sessions started. This approach allowed us to conduct several interviews with a range of farmers during our limited time in the field. In total, we interacted with nearly 200 smallholder farmers, with an approximately equal gender balance (see Table 1). To show appreciation to those who assisted us with our study, everyone who attended a group discussion received a scratch card with roughly $1 worth of mobile phone airtime.

Country	Province	Field Sites	Participants
Kenya	Nyanza	Homa Bay, Kabondo	32 (17 men; 15 women)
	Western	Mumias, Kakichuma, Chwele	44 (27 men; 17)
		Total	76 (44 men; 32 women)
Zambia	Central	Chapu, Chisamba, Chongwe and Chanyanya	78 (43 men; 35 women)
	Southern	Mukuni	39 (22 men; 17 women)
		Total	117 (65 men; 52 women)
		TOTAL	**193 (109 men; 84 women)**

Table 1

Similar interview protocols were used in both studies, and they contained open-ended questions about the benefits and drawbacks surrounding mobile phone ownership, including questions about the costs associated with having a handset and about what farmers typically used them for. An important component of each session was documenting participants' phones. Farmers were asked to show us their devices and we digitally photographed them to record their make, model and condition. We also asked participants to show us the batteries embedded in their phones and to tell us about the contents of the message "inbox" in their handsets.

In both studies, data analysis began in the field to ensure that a sufficient quantity and quality of information was gathered. This initial analysis included writing field notes after interviews and the primary researcher and her research assistants discussing common themes emerging in the data. Analysis continued once the transcription and translation to English of the digitally recorded interviews was complete. An inductive and iterative approach using open coding guided this phase of our analysis. This approach consists of carefully reading and re-reading transcribed interviews and field notes, coding participants' responses and allowing new themes, issues and questions to emerge during the process [22].

After the first and third authors analyzed transcripts and drew tentative conclusions, the data were discussed with the second author, who has over ten years of experience living, working, and studying technology use and non-use in developing countries. Her feedback was then incorporated into the analysis. Once this process was completed, the authors reread the related literature and formulated research findings presented here.

5. Findings

Findings from our case studies add to a growing body of more nuanced research on mobile phones, by describing rural farmers' contemporary attitudes toward the devices. We begin by describing the counterfeit and substandard mobile phones that the majority of our participants had. The recent influx of these inexpensive, poor quality, yet desirable, devices in rural areas appears to have resulted in a widespread perception among farmers that newer mobile phones are not as good as older handsets. Next, in spite of the fact that most of the services developed for smallholder farmers in rural Africa rely on the SMS platform, we present evidence that further demonstrates the limited use of this service among farmers. Although farmers rarely send SMS, nearly all of those interviewed received text messages including many unsolicited messages from advertisers. This barrage of advertisement and scam messages appeared to create a belief among famers that phones were a source of unreliable information. Broader misconceptions related to the possible health–related side effects and rumors about Satan contacting people using mobile phones also affected farmers' perceptions of the devices.

Throughout our analysis we describe how our findings suggest a mismatch exists between the design of mobile phone applications targeting rural farmers and our participants' perceptions of their devices. We also highlight some differences between our Kenyan and Zambian participants, but our findings largely speak to the commonalities in both groups' experiences with their mobile phones.

5.1 Substandard and Counterfeit Handsets

The majority of the farmers interviewed owned substandard and counterfeit mobile phones, rather than original Nokia 1100 models reported in prior studies of rural farmers in Uganda [29]. Two-thirds of the Zambian farmers and slightly more than half of our participants in Kenya used these lower-quality devices. Farmers' experiences with what Kenyans referred to as "China-makes" and Zambians called "gongá" (a colloquial term used throughout the country to describe anything that is fake) contributed to a widespread perception that mobile phone quality has deteriorated since their introduction into rural areas.

Discussions among participants suggest that these sub-standard phones, that mostly come from China but are also manufactured in other countries, such as India, represent a second wave of handsets. Farmers in both countries repeatedly told us:

> *Chinese phones are very bad. I don't know what happened. A long time ago, phones used to be strong, but the ones these days have got problems*.

A number of Kenyan farmers added that they missed the original Nokia 1100 (and closely related 1101 and 1108) handset models, because they were "hearty" and "could still deliver a message after being dropped." Unfortunately these original models have become difficult to find since they were discontinued in 2005 [3]. The newer substandard phones and counterfeit Nokia models tended to stop working after falling onto the ground could rarely be fixed by mobile phone repairers, and had other problems that stemmed from their low quality internal components.

There is a deficiency of research on this on these devices despite their growing presence in sub-Saharan Africa. A 2012 report from Kenya's Communications Commission estimates that more than 3 million of the estimated 30.4 million handsets in the country are sub-standard or counterfeit [1], a percentage that is significantly lower than among those we interviewed. We do know that African traders travel to China to buy new, used and copies of mobile phones that their fellow Africans can afford [28,30]. These phones with names such as OKING, G-Tide and Donod enter the continent via major shipping ports in Dar es Salaam and Mombasa. During our fieldwork we observed traders selling these handsets in small stands, shops or out of car trunks in the market towns close to our study sites.

Although farmers in Kenya and Zambia universally criticized these phones because of their tendency to break after short periods of time, they continued to buy them. In particular, it was often inexperienced consumers and women who had bought these handsets assuming them to be genuine, only to find their investment to be unusable. Andre, a young farmer living outside of Chapu in Central Zambia who owned a counterfeit smartphone,

told us why he and others continued to buy these substandard phones:

Chinese phones are not durable but they are cheap. Cheap things are always expensive, you can buy about five Chinese phones in a year, but when you buy a durable phone, it can last for a very long time.

In both countries the substandard phones cost the equivalent of $12 to $15, which is less than an original handset, such as the Nokia 1100 or Samsung GT models that sell for $20 or more. Unfortunately, as Andre explains, the life expectancy of these phones is dismal compared to original models. This realization prompted many participants to tell us "cheap is expensive." Although counterfeit handsets appear to be affordable, they break easily and over time it would be more cost-effective to invest in a single original model, rather than "about five Chinese phones."

Affordability was not the only factor that attracted farmers to these devices. Counterfeit and substandard mobile phones are fashionable and have desirable features, or attributes missing from most basic original handsets. Notable features include dual, and sometimes quad, SIM-card slots. Owning multiple SIM cards enabled the farmers to increase network coverage and to take advantage of pricing plans that favor in-network calls [25]. A less noted but equally valued feature of counterfeit phones is the large piezo speaker that some farmers enjoyed because it allowed them to listen to the radio embedded in most of their phones. A low-quality camera and memory card slot were additional features common to China-makes that are missing from the higher quality, affordable, and basic Nokia and Samsung models.

Most counterfeit phones are also stylish and come in bright pink, red and blue colors. Some models have embossments that make them shine, or "bling." Others models feature the Apple logo and are embossed with "iPhone," although to the Western observer these handsets are clearly not versions of the famous smartphone. These design features contrast with the matte and muted black and grey colors common in Nokia and Samsung's basic models.

Although the sleek design and affordable prices appealed to most farmers in our study, in addition to their poor quality there were other drawbacks to owning one of these phones. Counterfeit phones come with counterfeit batteries. Similar to the handsets, distinguishing these artifacts from the original ones is difficult. Fake batteries often feature a holographic sticker that resembles those Nokia places on batteries to distinguish them from bogus ones. Farmers in both countries repeatedly complained about these batteries because at best they could hold a charge for three days while the worst batteries required daily charging; an original battery, on the other hand, could maintain a charge for one week. The prevalence of these substandard batteries exacerbates an established problem in the ICTD literature: an inability for rural residents to maintain a charged mobile phone battery in environments where access to electricity is scarce or non-existent [46,47].

Because maintaining a charged battery was difficult, farmers tended to keep their phones turned off to "preserve the charge." Yet, implicit in the design of services that deliver farmers time-sensitive information via SMS are assumptions that their handsets are always on so they can immediately obtain a price, be reminded to weed their crops or receive immediate updates about impending thunderstorms. We discovered that it is more likely for farmers to keep their handsets turned off, in order to save the battery charge. It was also common for farmers to not always have their phones in their immediate possession. When we asked to see farmers' phones during our interviews, many told us they had left their

Figure 1: Typical Counterfeit Nokia Phone purchased by the first author in Kenya.

devices at a mobile phone charging kiosk—sometimes 10 kilometers away from their home—to be charged. Other farmers had phones stored away at home, but they were broken China-makes they hoped could one day be fixed. These factors dramatically reduce the likelihood that farmers will receive time sensitive information delivered to them soon enough for it to be useful.

Other problems related to operating these counterfeit phones emerged. The phones we observed had vastly different and inconsistent user interfaces that confused novice phone users in both countries. The placement of common menu items and protocols for sending text messages differ from handset to handset. The icons depicted on the menus varied, as did the language used on the interfaces. For example, Kenyan farmers complained, telling us, "all the phones do not use the same English." Some interfaces used the term "delete" and others used "erase" on the menus. Farmers who once owned and knew how to operate an original Nokia 1100 phone struggled to learn how to use new devices, particularly features such as SMS, with their unfamiliar interfaces, words and icons. These Kenyan farmers added that another benefit of the early Nokia models was the big and bold lettering used on the handsets' interfaces.

The reported growth of phone ownership in rural areas on the African continent is phenomenal. Findings from our study corroborate this: farmers own phones. However, the current influx of substandard and counterfeit phones may mean these handsets are not viable tools for disseminating time sensitive information via SMS. Also these ubiquitous handsets are not the high-quality, long-lasting and easy to use devices farmers prefer.

5.2 SMS and Receiving (Mis)information

Findings from research conducted in rural Kenya suggest "the SMS habit is not yet deep seated in East Africa" [12]. Given the possibilities associated with using SMS to deliver farmers pertinent information and the recent questions raised about its

effectiveness, we asked participants about their use of SMS. Our findings provide additional evidence suggesting that SMS is rarely used among Kenya's rural farmers and that usage is also fairly limited among Zambia's farmers.

Farmers in both studies, especially women, tended to laugh when we asked them if they sent text messages, telling us it was a feature they did not use because they did not know how to compose a message on their basic handsets. Texting is difficult enough to use with English, much less for Swahili, Nyanja, Bemba, and Tonga, languages characterized by long words and imprecise spellings. In contrast to perception and prior research [31], it is not illiteracy per se that was the primary barrier to using text messaging. In Kenya, and to a lesser degree in Zambia, basic reading and writing is found among most people under 50 (most of those who own phones) [4,36]. However, although sending a text message typically costs less than calling, farmers overwhelmingly preferred voice communication because of its immediacy and assurance that the message was received [15]. When sending a text message the receiver may be "silent" or never respond. A young farmer living near Bungoma, Kenya, explains:

You can send, but someone can just be silent, so it just makes you want to talk.

Farmers in both countries told us another reason recipients may not receive an SMS is because the "inbox" on their phones is full. Although most farmers rarely sent text messages, that did not preclude them from receiving them. It was common to see tiny envelopes blinking on their handsets' screens, indicating there was insufficient memory in the mobile phone to accommodate a new message. We looked at the message inbox and saw dozens of texts with content farmers told us was of little use to them. Rather than containing information about weather, crop prices or best agricultural practice, messages were typically advertisements—written in English—from Safaricom, Airtel, or MTN or content from services that farmers had, often unknowingly, subscribed to. For instance, we asked Zambian farmers to show us their mobile phones' inbox (Figure 2, left). The image in Figure 2 (center) illustrates what we saw on more of a quarter of them. MTN subscribers' boxes were filled with messages from "551," and inboxes of those who used Airtel handsets with messages from "5512." These messages touted services ranging from access to sports scores and news updates to offers for learning to speak French. For example:

Yesterday I received a message, which said here is an opportunity to learn French and it's free. But when I followed up, I discovered that they wanted to be deducting airtime from my phone, that's when I gave up because I do not have money to do such a subscription.

This farmer's reaction to such messages was typical. On the one hand participants he was intrigued by the service and the information they provided. On the other hand the cost of the receiving the information, typically K 0.2 ($0.01), was prohibitive for customers who all maintained meager amounts of airtime on their phones. Unfortunately, the majority of the Zambian farmers receiving these messages did not realize that responding to them subscribed them to the services. Complaints about lost airtime, or "talktime," were frequent, and most attributed that loss to these programs. Refrains similar to this one were common:

I don't like messages that make our accounts to be deducted, like you had talktime and all of a sudden you just discover that talktime has been deducted because of football news.

Services that allowed consumers to replace their handsets' ringtones with a popular song were a notorious example of this problem. In Zambia, Airtel's version is named "Hello Tunes," and MTN offers an identical service called "Caller Tunez" that has the additional feature of allowing callers to hear the song while waiting for the phone to be answered.

What I don't like is the subscription on Caller Tunez, the one calling me is the one enjoying the music while they wait for me to pick up their calls but I am the one to pay for it. I don't know how to unsubscribe.

Marjorie, like more than half of the women in Zambia who discussed their interactions with this service complained about not knowing "how to unsubscribe." Details about how to unsubscribe were typically included at the end of an SMS, or the last few lines that inexperienced users who are unfamiliar with scrolling to the bottom of a message may miss [31]. Consequently these farmers continued to receive text messages with information many could not read and cost money.

Kenyan farmers' inboxes were not overflowing with advertisements from similar services at the time of our study. This result may suggest that the country's largest network provider, Safaricom, does not target them, however inboxes void of advertisements did not mean they were immune to receiving confusing information via SMS. Typically one Kenyan farmer in each of group discussion described receiving a scam message related to the country's popular mobile money transfer system, M-Pesa (Figure 2, right). Awareness of these scams emerged from word of mouth and bad luck stories of friends and family members beings duped by them. Speaking from the perspective of farmers who had received these messages, Jacob explains:

I had a very serious problem somebody I don't know sends a message that I have received 2,500 (Kenyan Schillings) from so and so. I was surprised reading the message that I have received money. Within a minute, he is calling again that 'sorry I have send some money to your phone which is wrong number so please return the money to me.

Articles in Kenya's most influential newspaper, the *Daily Nation,* frequently feature stories about victims of this and similar money transfer scams that result in well-intentioned individuals giving away their money to strangers (e.g., [45]). Widespread use of mobile money does not yet exist and none of the Zambian farmers reported receiving similar messages. Drawing on research in Ghana, Burrell examined the way in which Internet users attempt to secure access to resources through misrepresentation of themselves [8]. Similar to the Internet, SMS may, like the Internet, be becoming increasingly prevalent as a way take advantage of people.

Confusion, paired with misunderstandings and lost money, prompted negative reactions from farmers like Martin, who told us he no longer thought "nicely" about the mobile phones:

I don't think nicely of phones as they take all the money I put in them.

His mobile phone had recently stopped working and he had no intention of purchasing a new one because his prior handset became a financial burden, or took "all the money."

5.2.1 Using Mobile Agricultural Services

In both countries, rural farmers rarely used their mobile phones to access agricultural information and few had used the commercially available services that target them. Roughly a dozen of the 193 farmers encountered reported using their mobile phone

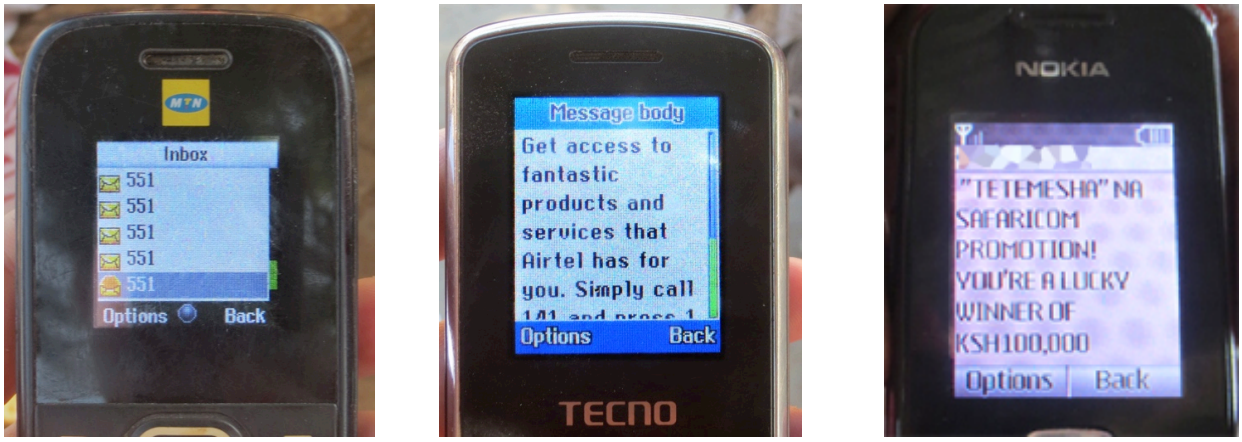

Figure 2: Zambian farmer's mobile phone inbox (left); Advertisement from Airtel-Zambia (center); Scam message sent to Kenyan farmer (right)

to access agricultural information, specifically market prices. Outside of Homa Bay, Kenya, we met a handful of farmers who told us they received market information from the Kenya Agricultural Commodity Exchange (KACE), but these messages were infrequent. Charles explains:

You cannot use it [KACE] regularly when you produce once in awhile, maybe once in a season. You will only use it at that particular time. You don't need to know about the market when you don't have the goods. We only produce once in awhile, not consistent.

His comments suggest farmers may benefit from the information provided by market information services. However, as Charles and the other farmers in his group noted, they needed the service "once in awhile" and only if they had excess crops to sell. Participants in this group added that infrequent use of the service resulted in them forgetting how to access it. Accessing KACE is also complicated: rather than prominently featuring the service on a handsets' menu the MIS is deeply embedded in phones. The placement of service prompted a Kenyan farmer to tell us:

It takes step one, step two, step three, step 24, then you get the information you need.

He was referring to the multiple menus and time-consuming SMS replies required to eventually obtain the requested market price information. This farmer later asked us why the information could not be placed on his phone's menu, or be made more readily and easily accessible.

None of the Zambian farmers in our study had acquired agricultural information on their mobile phones or used the services available to them, such as Lima Links. Answers to our questions about using their handsets to access weather, pricing of crops, or best agricultural practices information were "no," and typically accompanied by confused stares and responses similar to the following:

These [mobile phones] don't show information; they are just for communication and music. We don't use our phones for any agricultural programs. I only learn about these things through people who come the way you have come. I get to learn more about it from different radio programs.

Prior studies of rural Ugandan farmers suggest that obtaining agriculture information is the most valued feature of mobile phones [29]. Findings from our studies tell us that this may not be the case in Kenya and Zambia where our participants relied on friends, local traders and radio programs, instead of their phones, to learn about agricultural information. Multi-country studies across Africa consistently show that mobile phones are used primarily to maintain individuals' social networks via voice calls; this was also the case in Kenya and Zambia, where "communication" was described as the most common use of the phone [34,36,37]. Infrequently is this communication related to agriculture; instead farmers were sending "greetings," organizing meetings, or passing along information about a birth or death.

5.3 Questions and Concerns about Mobile Phones: Supernatural Forces and Cancer

Usability barriers continue to hinder adoption and use of SMS-based mobile phone services and applications. Here we describe additional, less understood barriers to use that stem from rumors and questions about the devices. Kenyan farmers told us that they turn their phones off at night to "preserve the charge;" this is unsurprising given the limited access to electricity. Zambian farmers engaged in similar practices for similar reasons, but also told us they keep their handsets off at night to prevent "Satan's agents" from contacting them. The following quote is representative of what participants told us:

Myself and other people fear to have their phones on at night just in case. We switch them off so we won't receive a phone call from Satan's agents.

Anthropologists have provided us with excellent scholarship on the persistence of religious beliefs, particularly those related to Charismatic Pentecostalism, and practices in contemporary Africa [33,43]. They write that this form of Christianity continues to grow throughout the continent—including in Zambia and Kenya—and that, in contrast to some other forms of Christianity, Pentecostals routinely receive miracles from the Holy Spirit and have ecstatic experience such as speaking in tongues [26]. They also note that an "obsession with demonology is one of the most salient features of the new Pentecostalism churches" [33].

Based on her fieldwork in Ghana, Meyers concludes that such fearful reactions such as these are "stimulated by the book of Revelation—that the end of the world has come near and that Satan is trying to prevent people from following God and being saved" [33]. She adds that there are widespread beliefs that Satan can appropriate all sorts of commodities to achieve this goal. Findings from our research suggest this includes mobile phones. To prevent Satan from using the devices to contact them, some Zambian farmers choose to turn them off at night. While there were no instances of Kenyan farmers telling us they shut off for

phones for this reason, they too, were concerned about technology's possible ties to demonic forces. For example:

In the Bible we have this number they call 6-6-6 it is a very familiar number to those who have read the Bible and they say this number is so much related to mobile services…in the Bible, people are warned having it marked on their forehead, but some have gone so far and said, that mobile phone, they have the marking.

His remark was in reference to the infamous mark of the devil presented in the Bible and concerns about the number sequence appearing in mobile phone numbers. Numerophobia, or a fear of numbers, has been documented in Nigeria where urban consumers are routinely encouraged to avoid phones call from numbers ending with 333, 666 and 999 [5]. We see that concerns about numbers and their ties to digital technologies also shape rural farmers' attitudes towards their mobile phones. An appreciation of, and deeper understanding of, such matters, is crucial for technology developers and researchers from the scientific and technological North who are developing mobile applications and services for rural African farmers.

5.3.1 Questions about Mobile Phones and Health

In both countries, additional questions and concerns centered on misunderstandings regarding the impact mobile phones may have on their owners' physical well being. Women wondered if storing their mobile phones in their bras would cause breast cancer and everyone asked about the side effects that may accompany holding a handset close to one's head. The following quote captures this concern voiced by Kenyan and Zambian farmers:

There is a belief, that when you use a phone most of the time, for days at a time, the phone will negatively affect your body, we hear.

These worries extended beyond the phones. Kenyan and Zambian farmers asked about the consequences of the grey material embedded in the lottery-style scratch cards, purchased to add additional airtime to their phones, becoming embedded underneath their fingernails.

These cards, when you scratch with your fingers, I am told it affects your skin, the material covering it is a virus?

Farmers heard these stories on the radio or learned about them from friends and family living in urban areas. Understanding how such perceptions affect non-use of mobile phones in developing regions is uncharted terrain in the ICTD community.

6. Discussion: Improving Upon What We Built Yesterday

Dourish and Mainwaring argue that asking, "What might we build tomorrow?" blinds software developers and researchers to their ongoing responsibilities for what they built yesterday [17]. Findings from our qualitative studies of Kenyan and Zambian smallholder farmers suggest that software developers, in addition to NGOs, technology companies and funding agencies, should consider turning their attention away from future-oriented activities such as developing novel mobile phone applications. Instead, there are opportunities to improve upon the usage and design of mobile phones, devices that have been present in some parts of rural Africa for more than a decade. Here we outline two potential ways to achieve this goal: educational interventions and redesigning the phone.

6.1 Educational Interventions

Mobile phone applications and services are benefitting some farmers in the developing world, but not yet those in rural Kenya and Zambia. If these technologies are to succeed here, farmers must recognize that like the garden hoe, the mobile phone, and the information it can provide, is a tool that can support their agricultural practices. Our findings, particularly those related to performing basic mobile phone operations such as deleting unwanted text messages and unsubscribing from SMS services, even understanding the drawbacks of purchasing a counterfeit phone, suggest opportunities for developing educational interventions. We must teach farmers how to use mobile phones and that the devices can provide them with useful information.

The Digital Green project is an example of creatively using video to educate rural farmers about best agricultural practices, and we imagine extending this approach to deepening rural farmers' understanding of mobiles phones and their capabilities [21]. In this project, video segments are produced in a participatory production process in villages using pocket video cameras and shown locally with small, mobile projectors. The video's agricultural content could be supplemented with information about how to navigate different mobile phone interfaces and perform basic operations. A key part of the Digital Green approach includes having both local participants and experts relate the information to viewers. Doctors and church leaders from the local communities could take on a similar role in mobile phone videos, disseminating findings from the latest research about the health consequences of using mobile phones and answering questions about Satan contacting people via the mobile phone. Training has to happen more than once to ensure farmers remember what they were taught, including how to access services after periods of non-use. Another benefit of this approach is that is could also be used to teach farmers about the availability of these services. Limited knowledge of their existence undoubtedly limits their use among smallholder farmers.

As mobile phones in rural Africa evolve from communication tools to service delivery platforms, education must accompany the introduction of new services and applications. Programs also must approach technological literacy as a complex social and cultural practice that includes not just teaching farmers technical skills, but addressing rumors surrounding these new technologies and take into account differences between men's and women's skill levels

6.2 Redesigning Mobile Phones: Improved Handsets and Graphical Interfaces

Rather than developing more applications and services for farmers, there is an opportunity to build better phones or at least continue to manufacture ones that farmers preferred using, such as the Nokia 1100 handset. The best-designed applications are unusable if the mobile handsets supporting them are not designed for rural Africa. Microsoft's recent introduction of the Nokia 215 handset that reportedly features a battery that will sustain a charge for one-month is promising, but the $29 price may make it out of reach for farmers looking for handsets that cost $10-$12 [11]. Technology developers may consider collaborating with the manufacturers of "China-makes" to create durable phones designed for long-term use in rural Africa that sell for a price rural farmers can afford. These phones should also appeal to farmers' aesthetic sensibilities and include the features they want, similar to the way China-makes currently do.

The physical design of mobile phones needs to improve and so do their graphical interfaces. Rather than being deeply embedding

them in mobile phones, the services farmers most need should be accessible with one or two pushes of a button. Confusing metaphors based on prior experience with computers (e.g. floppy disk for save, paperclip for attachment) should be replaced with symbols and icons farmers understand. Icons that support improved battery management, by indicating which features drain the most power, as well as consistent interfaces designs, would also be an improvement to current handsets. We encourage software developers to imagine mobile phones that allow farmers to personalize their mobile phone's interface, giving them the power to decide what features and services they want to be readily accessible. Enthusiasm for smartphones should be tempered by awareness that these consume more energy than basic phones. Rural farmers may also find also find these devices that typically have complicated interfaces and unfamiliar features difficult to use. Phones with fewer rather than more features, that have simplified menus and large display fonts may be preferred.

Efforts to develop features that might help farmers distinguish relevant content from scams are also necessary. In addition to efforts in training, we should also consider design features to support understanding of security and privacy. Farmers are all too susceptible to viruses and scams that might lead to identity theft, or loss of airtime or money. Ultimately, these design elements need to work in conjunction with the previously mentioned education efforts to help rural farmers self-filter good content from bad, and to manage their handsets so that that their phones become useful tools rather than burdensome devices. More broadly, the ICTD community must work more closely with smallholder farmers in Africa to better understand the types of applications and services they envision and supporting their agriculture practices.

7. Future Research and Conclusion

Our findings based on rural farmers' current usage practices suggest their perceptions of their phones are still evolving, and so too must the ICTD's research community's understanding of how mobiles phones are used, and not used, in rural sub-Saharan Africa. Future research should focus on how rural farmers learn how to use their phones and the role religion plays in shaping mobile phone use. Our findings are based on two short-term studies or capture only a "snapshot" of life in the rural areas visited. Longer-term efforts to investigate how different social, economic and infrastructural differences on the African continent shape use are also necessary.

While many popular and academic narratives on the impact of mobile telephony for Africa's smallholder farmers depict a positive outlook in which technology will bring sustained benefits to this largest segment of the continents' population as ownership increases, parallel developments complicate these storylines. Old problems persist, such as misunderstandings about sending SMS and the challenges of maintaining charged handset batteries. New problems have also emerged, including counterfeit phones, SMS scams, and broader misconceptions about mobile phones. Considered together, our findings suggest reexamining the mobile phone itself. Rather than developing (and funding the development) of new mobile phone applications, the researchers, software developers and funding agencies should work towards creating interventions aimed improving these existing devices and fostering greater understanding of their use.

8. ACKNOWLEDGMENTS

Thank you to all of the farmers who shared their knowledge with us. Special thanks to our research assistants and collaborators, Nightingale Simiyu, Willis Okumu, Dominic Nangea, Ben Kazule, Majory Kalima, "HarryB" and Charles Steinfield. The Kenyan study was made possible by the generous support of the American people through the United States Agency for International Development (USAID). A gift from Facebook Inc. supported the fieldwork in Zambia. Susan and Melissa are grateful that Paul Aoki introduced them to each other.

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