Research Article

Mobile Phones and Rural Livelihoods: Diffusion, Uses, and Perceived Impacts Among Farmers in Rural Uganda

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Abstract

To successfully use mobile phones to aid development efforts, understanding the impact of the social structure on mobile phone adoption, uses, perceived impacts, and reinvention of uses is invaluable. Interviews were conducted with 90 mobile phone-owning holders of small- to medium-sized farms—50 women and 40 men—actively involved in agricultural development-based farm groups in Kamuli District, Uganda. Respondents indicated use of the mobile phone for coordinating access to agricultural inputs, market information, to monitor financial transactions, and to consult with agricultural experts. Over time, the number and variety of agricultural uses increased among all users, indicating that adoption occurs for a few key purposes, but that uses will be added or reinvented to fit changing needs. This study identified a number of unique uses, including storing local market trends in the calendar, using the speakerphone function for group consultation with agricultural experts, and taking photos of agricultural demonstrations.

Introduction

The benefits accruing from the widespread adoption of information and communication technologies (ICTs) in developing countries include increasing people's knowledge of market information; improving the coordination of transportation, especially during emergencies; and enhancing the effectiveness of development activities (Saunders, Warford, & Wellenius, 1994). The international donor community has rallied efforts toward "bridging the digital divide" between the "haves" and the "have-nots" to help maximize the impact of ICTs on the Millennium Development Goals outlined by the United Nations (infoDev, 2010). How much, exactly, developing societies gain from improvements in access to information through ICTs is not yet clear (Jensen, 2007). Researchers argue that ICTs may help to achieve development objectives in their roles as *complementary* tools that assist in the effectiveness of outreach programs (Donner, 2008; McNamara, 2003). Indeed, McNamara (ibid.) further cautions that ICTs have the ability to *enable* change, though not necessarily to *create* change. That is, ICTs are not goals in and of themselves.

Hosman stresses the importance of conceptualizing the utility of ICTs in relation to the social structure, and that "merely providing technology does not automatically create a need for it, nor does it foster a culture of use or attempt to comprehend the underlying issues and challenges most efficiently addressed with the aid of technology" (2010, p. 50). Under-

standing people's livelihoods, their motivations behind adoption, and their perceived relative advantage derived from ICTs is vital in understanding the adaptability of these technologies to social, cultural, and economic practices (Kaba, Diallo, Plaisent, Bernard, & N'Da, 2006; Michiels & Van Crowder, 2001). To achieve successful implementation of ICTs in development efforts, it is critical to understand both the impact of the social structure on how technology is adopted and used, and who derives the greatest benefit from its use.

Mobile Phones in Uganda

Uganda, as well as many other African countries, faces unique challenges that stress the government structure and development agencies. Uganda is ranked 156 out of 179 countries in the United Nations Human Development Index, indicating that life expectancy, education, purchasing power, and income are extremely low (UNDP, 2008). Uganda has a population of approximately 32 million and an HIV prevalence rate of 5.4% among individuals between the ages of 15 to 49 (World Bank, 2008a). Over one-fourth of the population (31%) lives below the poverty line, and 45% of children under the age of five are malnourished (ibid.). The agricultural sector is critically important in developing economies, and in Uganda, over 80% of the workforce is employed in a field related to agriculture (CIA, 2009). Determining and studying how ICTs are being used to advance development goals of the agriculture sector of low-income countries is of the utmost importance (Jensen, 2007).

In Uganda, the number of mobile phone subscribers increased from 776,200 to over 8.5 million from 2004 to 2008 (UCC, 2008). This rapid growth can be attributed, in part, to a 1996 Uganda Communications Commission (UCC) telecommunications policy that outlined objectives to provide universal access, particularly in rural, underserved areas, by opening the telecommunications sector to private investment (UCC, 2005, p. 21). As a result of increased competition, several mobile telecommunications service providers, including Celtel and MTN Uganda, Ltd. were established, resulting in increased construction of mobile telecommunications towers, particularly in rural areas (ibid., p. 22). Given the rapid growth of, and the increased access to, mobile telecommunications, particularly among the rural poor, it is important to determine how mobile telephony may be used to support sustainable livelihood initiatives.

Mobile Phones for Agriculture Development in Kamuli District, Uganda

The Kamuli District of Uganda has an approximate population of 707,000 people, with a land area of approximately 1,700 square miles, and it is considered to be among the poorest districts in the country (UDS, 2006). Over 80% of the working-age population is engaged in subsistence agriculture (Kamuli District Local Government, 2008, p. 6). Volunteer Efforts for Development Concerns (VEDCO), an agriculture development-based nongovernmental organization, has been working in Kamuli District, Uganda, since 2004 to "support collaborative training and development activities that strengthen the capabilities of rural people to: improve agriculture and natural resource management practices; build assets; diversify income sources; and achieve food security, nutrition and health" (CSRL, 2008). As of 2008, approximately 800 households (1,023 farmers) were working with VEDCO in the Kamuli District, and 70% of these farmers were women (D. Masinde, personal communication, June 20, 2011).[1]

VEDCO tries to achieve its development goals by forming farm groups and training community leaders, namely rural development extensionists (RDEs) and community nutrition and health workers (CNHWs). Members of VEDCO farm groups and VEDCO staff choose the individuals who will serve as farm group leaders. Since the leaders serve as exemplars, those who hold higher social status in terms of education and wealth tend to be nominated into leadership positions (ibid.). RDEs are trained in agricultural techniques, including farm planning and management, post-harvest handling, and marketing skills, while CNHWs are trained in nutrition and health extension, including management of malnutrition in children, nutritional management in the context of HIV/AIDS, and crop and livestock production (Mazur, Sseguya, Masinde, Bbemba, & Babirye, 2006). Both RDEs and CNHWs are instructed to train members of farmers' groups and the broader community (ibid.).

According to a study conducted by VEDCO,

1. Dorothy Masinde is the associate director for field operations in the Kamuli District for the Center for Sustainable Rural Livelihoods, Iowa State University.

approximately 42% of 306 rural farming households in the Kamuli District own a mobile phone (CSRL, 2009). At the time of this study, VEDCO had not explicitly outlined objectives to use mobile phones to aid its efforts. However, in 2010, VEDCO included goals to collect and distribute market information via SMS in its five-year strategic plan (VEDCO, 2010). In addition, VEDCO has established a goal to distribute approximately two SMS messages per month on additional topics covering disease outbreaks, HIV/AIDS management tips, gender issues, climate-related updates, updates on farmer trainings and meetings, and agricultural and health-related extension (H. Kizito, personal communication, June 20, 2011).[2]

Analyzing the uses of mobile phones among farmers actively involved in agriculture extension-based farm groups provides further understanding of the role of mobile phones as complementary tools for development. Avgerou (2010) emphasizes understanding the social structure underlying the context-specific application of ICTs. Understanding the use of mobile phones to aid in development requires an adequate knowledge of the current uses and perceived impacts of mobile phones, as well as an assessment of the opportunities and barriers reinforced by the local social structure. Our research study addresses social influences, including gender and leadership status, on the use of ICTs as complementary tools to enable, empower, and enhance agricultural development initiatives.

This study presents the general patterns of the following: 1) adoption practices, including the perceived relative advantages that lead to adoption; 2) general patterns of agricultural uses of mobile phones; 3) perceived impacts of mobile phone uses; and 4) the reinvention of mobile phone uses to fit changing needs. Within each of these areas, general results for all group members are presented first, followed by gender and leadership differences.

Literature Review

Numerous studies have documented the capability of mobile phones to aid in the achievement of development objectives (see Donner, 2006; Hudson, 2006; Saunders et al., 1994). The following section highlights some of the research that has focused on the uses of mobile phones for agricultural development in developing countries.

A 2007 study of animal health workers and farmers in two districts in Kenya documented the use of the mobile phone for the identification and management of livestock diseases, and for coordinating greater attendance and participation in organization meetings (FARM-Africa, 2007). Farmers indicated that mobile phones reduced their transportation costs by enabling them to gain remote access to agricultural information and group support (ibid.). Furthermore, a 2009 study of the adoption of mobile phones by dairy farmers in rural Uganda highlighted the ability of mobile phones to provide information advantage and encourage greater efficiency. Karamagi and Nalumansi (2009) found that many dairy farmers in the Bugerere District in central Uganda were travelling approximately 75 miles to the main market in the capital, Kampala. Blindly searching for buyers at the market often left the farmers with thousands of liters of unsold milk, which would inevitably spoil and become worthless. However, after the adoption of mobile phones, the farmers began using them to connect to FoodNet, a service that supplies up-to-date price information for agricultural commodities, as well as contact details for interested buyers via SMS.

Local social norms and values are likely to influence the productive use of mobile phones. Studying the gender differences in mobile phone uses in rural Uganda, Scott, McKemyey, and Batchelor (2004) found that many women were not using mobile phones because of the cost of making a phone call and their lack of knowledge of how to use the device. Scott et al. found that men were more likely than women to use mobile phones for business purposes, and that women were more likely to use mobile phones for kinship maintenance. A 2010 study on the use of mobile phones to aid agricultural development in southwestern Uganda revealed that, while women used the phone less than men, they were more likely to use the mobile phone to access agricultural information (Masuki et al., 2010). However, men were still more likely than women to use the mobile phone for business purposes, such as accessing market information.

2. Henry Kizito is the executive director of VEDCO.

Theoretical Framework

There are two theory-building areas to which we hope this research will contribute. The first theoretical dimension is the information and communication technologies for development (ICTD) perspective. In addition, diffusion theory is used. This study uses a combination of ICTD and diffusion theory to understand mobile phone adoption in a holistic manner. In doing so, the presented findings provide insight into why individuals within resource-constrained environments adopt mobile phones, and what barriers and opportunities appear in the diffusion process.

Information and Communication Technologies for Development (ICTD)

Researchers studying ICTD often argue that ICTs have the potential to aid in rural development and poverty reduction (Donner, 2008; Duncombe & Heeks, 2002; Hudson, 2006; Saunders et al., 1994). Past investigations of the perceived attributes of mobile phones within developing countries have focused on their ability to encourage efficient and informed action, leading to greater productivity over current practice (Hudson, 2006; Saunders et al., 1994). Researchers (Albu & Scott, 2001; McNamara, 2003) stress that mobile telephony can be an asset for development by enabling the rural poor to respond more efficiently to external economic opportunities or threats through an increase in access to information.

Scholars argue that mobile phones improve the productivity of individuals and organizations within resource-constrained environments due to increased *efficiency, effectiveness,* and *reach* (Burrell, 2008; Hudson, 2006; Saunders et al., 1994). Research has expanded the efficient and productive uses of the mobile phone to include the following: 1) obtaining information advantage for sound decision making (e.g., dissemination and retrieval of market information, especially for buying and selling); 2) conducting a coordination function (e.g., coordination of transportation, especially during emergencies); and 3) networking and taking advantage of social capital (e.g., agricultural specialists and veterinarians can readily exchange information to improve crop yields and livestock production) (Hudson, 1997; Saunders et al., 1994).

Hudson (2006) documents three overarching communication functions of the mobile phone within an organization: 1) provision of information to solve problems through consultation, remote diagnosis, and information sharing; 2) coordination of information to increase efficiency in carrying out the organization's work, including emergency assistance, monitoring, and training; and 3) strengthening group solidarity.

Diffusion Theory

The diffusion of innovations approach, as outlined by Rogers (2003), was used to expand understanding of reasons for adoption, usage patterns, and communication objectives that are and can be met by the mobile phone in a developing country. This includes how and why an innovation is adopted, and especially the unique reinvention of an innovation to fit the changing needs of the individual (ibid., pp. 180–187). Understanding an innovation's perceived attributes—and especially the perceived relative advantage, the compatibility, and the reinvention of an innovation to fit local circumstances—will uncover uses capable of dealing with a greater spectrum of needs (ibid.).

Like all technological devices, mobile phones may have a differential impact on people and societies. While much has been written on the global digital divide between rich and poor countries, considerably less is known about the local digital divide within poor countries (Jensen, 2007, p. 881). Rural women, due to low levels of education, high rates of illiteracy, and lack of assets (such as credit and agricultural inputs), constitute the majority of the world's poorest (FAO, 2009). These factors may delay the capabilities of women to use mobile phones for agricultural purposes. Additionally, earlier adopters of innovations tend to be leaders and have more heterogeneous networks (Rogers, 2003, p. 288). Since farm group leaders are considered community leaders and are regularly trained by VEDCO staff, they may adopt productive uses of mobile phones earlier than nonleaders in farm groups.

Methodology

Our study uses a combination of qualitative and quantitative analysis. Primarily, this study employs qualitative analysis; however, quantitative analysis is also used when possible to identify potential impacts of gender and leadership status on adoption practices, uses, and perceived impacts of mobile

phones. Semi-structured in-depth interviews were conducted to gain a more nuanced, qualitative understanding. Semi-structured in-depth interviews are guided by a predetermined theme and questions; however, flexibility in the order or form of questions is encouraged to reveal deeper insight into respondents' experiences (Kvale & Brinkmann, 2009).

The quantitative aspects of the study were uncovered from the interviews, using thematic analysis. Thematic analysis involves the identification of themes from qualitative data that "at minimum describe and organize the possible observations and at maximum interpret aspects of the phenomenon" (Boyatzis, 1998, p. 4). The researchers used themes identified in prior ICTD research to guide analysis. All interviews were read multiple times, both to identify appropriate thematic coding, and to uncover new or unique themes not identified in prior research. It was hoped that a combination of qualitative and quantitative analysis would reveal with greater detail the different needs and motivations of users of mobile telephony in the developing world. Given the nature of VEDCO's outreach structure (i.e., farm group structure), those who are actively involved in VEDCO farm groups may have an advantage in learning agricultural uses for the mobile phone over other community members. Interviews were conducted through an interpreter conversant in both the local dialect and English. This research received Iowa State University Institutional Review Board approval, and consent from participants was obtained prior to the interview. The research was conducted June–July 2009.

VEDCO provided the researchers with a list of 306 farmers who owned mobile phones and were working with VEDCO in the Kamuli District. Not all eligible people on the list were contacted. Through assistance from VEDCO, deliberate efforts were made to select and reach individuals evenly spread throughout the Kamuli District. In instances when a potential interviewee could not be reached, the next possible interviewee closest in proximity was chosen.

Semi-structured in-depth interviews were conducted individually with 90 VEDCO farmers. A nearly equal number of women (n=50) and men (n=40) were interviewed. The median age of respondents was 39.5 years. Out of the 90 respondents, 31 were leaders of VEDCO farm groups. The median age of leaders (44 years) was higher than that of nonleaders (39 years). Respondents had, on average, reached year seven of primary school (i.e., the final year of primary education). On average, farm group leaders had completed eight years of schooling (i.e., through the first year of senior school), whereas nonleaders had completed seven. As of 2009, Uganda's gross national income per capita was approximately US$500 per year (United Nations, 2011). VEDCO farmers in the Kamuli District have a monthly income of approximately US$61 per month, or US$732 per year (H. Kizito, personal communication, June 20, 2011). Since the value provided is a mean, it may be inflated due to high-income outliers. One male farm group leader was unable to finish the interview in its entirety. For questions unanswered by this respondent, an adjusted sample size was used for data analysis.

Results and Discussion

Results shed light on the reasons for mobile phone adoption, agricultural uses, and perceived impacts of uses among holders of small- to medium-sized farms working with VEDCO in Kamuli District, Uganda.

Mobile Phone Adoption

In 2009, over half of the respondents (54%) had adopted the mobile phone within the last two years. Another 36% had owned a mobile phone for three to five years, while 10% had owned one for six to 10 years (see Figure 1). The majority of respondents interviewed owned the Global System for Mobile Communications-enabled (GSM) Nokia 1100 series mobile phone with built-in flashlight. None of the households interviewed had electricity. Mobile phone batteries were charged at a cost of 500 Ugandan shillings (approximately US$0.20) every three to four days at a battery-charging kiosk in the nearest town (D. Masinde, personal communication, April 19, 2010). All respondents paid for mobile phone services through the "prepay" model, in which a scratch card is purchased in varying price increments and loaded onto the mobile phone as mobile phone credits.

Influence of Gender and Leadership Status on Mobile Phone Adoption

An analysis of the time of mobile phone adoption revealed slight differences between genders. On average, mobile phone ownership (in years) among

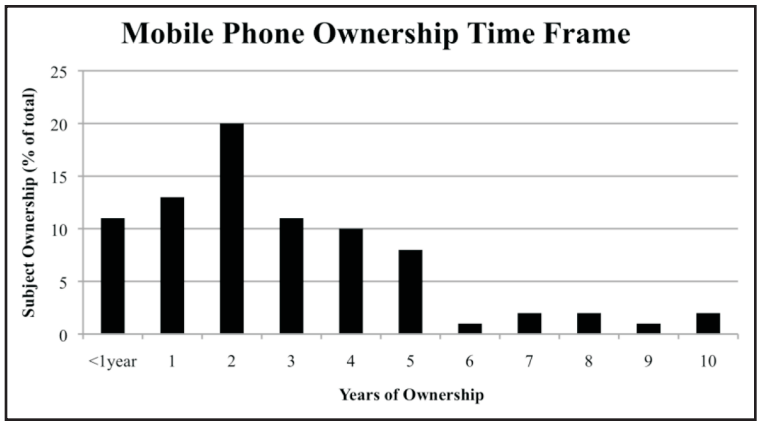

Figure 1. Distribution of Years of Mobile Phone Ownership.

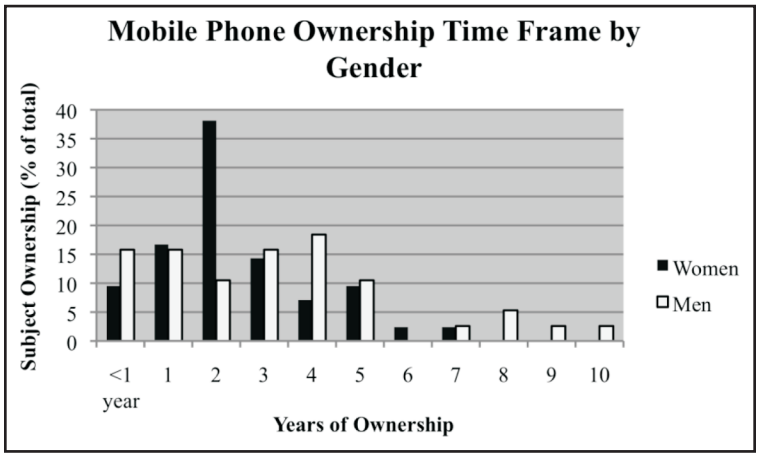

Figure 2. Distribution of Years of Mobile Phone Ownership by Gender.

women ($M = 2.4$ years, $SD = 1.6$) is more recent than among men ($M = 3.3$ years, $SD = 2.5$), $t(78) = -1.92$, $p = 0.059$. Over half of the women surveyed (64%) had adopted their mobile phones after 2006 (see Figure 2).

The reason why over half of the women adopted mobile phones between 2007 to 2009 is unclear. Rural women have a primary unpaid responsibility for all household duties, and they are likely to expend any additional income on child education fees and family food needs (FAO, 2009, p. 6). In the last two years, mobile phone handsets have declined in price to approximately 40,000 Ugandan shillings (approximately US$19; Burrell, 2008). Perhaps the decrease in cost has made the mobile phone more accessible to rural women. While it was speculated that farm group leaders would be earlier adopters due to their roles as liaisons with VEDCO, on average, mobile phone ownership (in years) among farm group leaders ($M = 2.59$ years, $SD = 2.4$) did not differ significantly from nonleaders ($M = 2.91$ years, $SD = 1.7$), $t(77) = 0.672$, $p = 0.504$.

Perceived Relative Advantages

Questions regarding the perceived relative advantages that led to mobile phone adoption were specifically asked during interviews. Perceived relative advantages included both the maintenance of kinship networks and agricultural purposes, including the abilities to access financial information, and to efficiently coordinate meetings and consult with agriculture extension agents or farm group members. Overall, 27% of respondents indicated that adoption and initial use were solely for kinship maintenance. Another 47% cited both kinship maintenance and agricultural purposes, and the remaining 26% indicated that adoption was exclusively for agricultural purposes.

Overall, findings suggest that mobile phones are being adopted for agricultural purposes, such as accessing market information, increasing job opportunities, gaining agriculture advice, and saving valuable time and money through increased consultation and coordination. Table 1 provides the occurrence rates of individuals who adopted for: 1) solely kinship maintenance, 2) both kinship maintenance and agricultural purposes, and 3) solely agricultural purposes.

Influence of Gender and Leadership Status on Perceived Relative Advantages

Overall, genders differed in initial use categories of the mobile phone, X^2 (2, N = 89) = 12.47, $p < 0.01$. Table 1 shows that more women (36%) than men (15%) adopted the mobile phone solely

Table 1. Frequency of Initial Use Categories That Influenced Mobile Phone Adoption.

Initial Use Categories	Adopter Characteristics									
	Gender				Leadership Status					
	Female		Male		Leaders		Non-Leaders		Total Respondents	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Kinship maintenance (only)	18	36.0	6	15.4	5	16.1	19	32.8	24	26.7
Kinship maintenance and Agricultural-based purposes	26	52.0	16	41.0	14	45.2	28	48.3	42	46.7
Agricultural-based purposes (only)	6	12.0	17	43.6	12	38.7	11	18.9	23	25.6
	50	100.0	39	100.0	31	100.0	58	100.0	89	100.0

for kinship maintenance, and that more men (44%) than women (12%) adopted solely for agricultural purposes. Surprisingly, women (52%) were slightly more likely than men (41%) to adopt the mobile phone for both kinship maintenance and agricultural purposes. While management of kinship networks is most important to women, the finding that they are adopting for agricultural purposes indicates ability to identify uses pertinent to their agricultural needs.

Overall, leaders and nonleaders did not differ in initial use categories of the mobile phone, X^2 $(2, N = 89) = 4.39$, $p > 0.05$ (see Table 1). More leaders (39%) than nonleaders (19%) adopted the mobile phone solely for agricultural-based purposes. Due to their contact with VEDCO, farm group leaders may have received knowledge of agricultural uses of mobile phones first.

Agricultural Uses of Mobile Phones

The agricultural uses of mobile phones were sorted into five use themes described in previous research on the use of telephony in resource-constrained environments (Burrell, 2008; Hudson, 2006). The following themes were used as a guide to categorize responses: 1) coordinating access to agricultural inputs, 2) accessing market information, 3) seeking agriculture emergency assistance, 4) monitoring financial transactions, and 5) consulting with expert advice. Table 2 provides illustrative examples and the percentage of respondents who used each of the five agricultural use themes.

The majority of respondents (87%) use mobile phones for coordinating access to agricultural inputs, including agricultural training, seeds, livestock, and pesticides from local dealers, governmental and nongovernmental agriculture extension agents, and community members. For example, in the past, an individual would have paid to travel to a seed dealer, only to find that all seeds had been sold. Now, the farmer is able to call ahead, determine availability, coordinate a meeting time, and agree on a price before expending time, energy, and money on travel. Coordinating access to agricultural inputs was likely found to be the leading agricultural use of mobile phones, due to the direct impact that access to inputs has on livelihood stability, productivity, and profitability.

The second most frequently cited agricultural use of the mobile phone, indicated by 70% of respondents, was accessing market information. Accessing market information includes using the mobile phone to contact local farmer associations and buyers, as well as buyers, friends, or family in other geographic areas who have access to different markets. For example, a male respondent stated, "I call [a buyer in] Kampala in order to get the fair market price for charcoal so as to not have a financial loss."

Approximately 57% of respondents indicated use of their mobile phone for agriculture emergency assistance. Uses for agriculture emergency assistance include contacting a veterinarian or agriculture extension agent when livestock are ill or crops are diseased or pest-stricken. One of the most frequently observed agriculture emergency assistance functions was contacting a veterinarian to treat sick livestock. Respondents indicated that calling a veterinarian, rather than travelling to consult face-to-face, quickened communication, eliminated the expense incurred from travelling, and resulted in earlier detection and treatment of illness in livestock. For example, a male respondent stated, "Due to my ability to call the veterinarian, I am able to quickly and correctly treat my animals and keep them healthy for breeding."

Use of the mobile phone for monitoring financial transactions was mentioned by nearly 54% of the respondents. Monitoring financial transactions includes consulting with lenders on availability and guidelines of financial loans, reminding farm group members to repay loans accountable to the group as a whole, and monitoring domestic and business remittances. In particular, comments from interviewees focused on the ability of the mobile phone to increase their knowledge of, and access to, microfinance loans from VEDCO.

Approximately 52% of respondents cited at least one use of the mobile phone for consulting with expert advice from nongovernmental and governmental agriculture extension agents, such as VEDCO or The National Agricultural Advisory Services (NAADS). Consultation with expert advice includes using the mobile phone for information on livestock and crop maintenance, appropriate seed and livestock varieties, timely planting relating to weather predictions, and proper planting and harvesting techniques. Specifically, individuals indicated using the mobile phone to clarify agricultural methods learned previously during VEDCO training sessions.

Table 2. Agricultural Use Themes, Percentages, and Illustrative Examples of Agricultural Uses of Mobile Phones.

Coordinating access to agricultural inputs	**Accessing market information**	**Agriculture emergency security**	**Monitoring financial transactions**	**Consulting with expert advice**
Use coordination function: 86.5%	Use market function: 69.6%	Use agriculture emergency function: 57.3%	Use financial function: 53.9%	Use consultation function: 51.6%
Calls local dealers in seeds and livestock to know quality/ availability	Calls local businessmen to know local market prices	Calls veterinarian to treat sick cows, goats, hens, and pigs	Calls friends, family, and local businessmen for financial loans	Calls VEDCO for general agricultural maintenance questions
Calls agriculture dealers in Kampala for improved chicken breeds	Calls VEDCO to be informed of local market prices	Calls District Agriculture Office for assistance with pest or disease-stricken crops and livestock	Calls VEDCO to gain access to microfinance group loans	Calls VEDCO for updates about weather for timely planting
Calls farm group members to know about new livestock breeds and availability in the local area Calls VEDCO to obtain seeds, livestock, and plantings (cassava, potato, banana, orange trees)	Calls individuals in Kampala to get market pricing *"I call Kampala in order to get the fair market price for charcoal so as to not have a financial loss"*	Calls VEDCO for assistance with pests affecting crops *"My banana plants had banana bacteria wilt; I called VEDCO and service providers came to help me deal with the disease"*	Calls to coordinate payment of loans *"I call VEDCO and the businessmen that I owe money and inform them to stop by and collect money"*	Calls VEDCO or Community Nutrition Health Worker (CNHWs) for health advice for children Calls farm group members to clarify agricultural trainings from VEDCO
Calls farm group members and VEDCO to coordinate meetings and agricultural trainings	Calls local business people to negotiate price for bulk sale and transporting for sale in Kampala	Calls VEDCO to ask for assistance with sick livestock	Calls VEDCO to know of conditions of loan and repayment scheme Calls farm group members to remind of obligation to repay loans	Calls VEDCO or Rural Development Extensionists (RDEs) for advice on proper planting (i.e., spacing, depth, etc.), maintaining, and harvesting

Influence of Gender and Leadership Status on Agricultural Uses of Mobile Phones

Overall, men were found to have more agricultural mobile phone uses ($M = 3.62$ out of 5 uses, $SD = 1.09$) than women ($M = 2.88$ out of 5 uses, $SD = 1.32$), $t(87) = -2.81$, $p = 0.006$. In particular, more men (97%) than women (78%) use the mobile phone to coordinate access to agricultural inputs, X^2 (1, N = 89) = 7.09, $p = 0.008$. Also, more men (82%) than women (60%) use the mobile phone to gain access to market information, X^2 (1, N = 89) = 5.04, $p = 0.025$. Additionally, consultation with expert advice was mentioned more by men (64%) than women (42%), X^2 (1, N = 89) = 4.28, $p = 0.038$. Table 3 provides a distribu-

Table 3. Percentages of Women and Men Using the Five Agricultural Mobile Phone Use Themes.

Agricultural use themes	Women	Men
Coordinating access to agricultural inputs	78.0	97.4
Accessing market information	60.0	82.1
Agriculture emergency assistance	60.0	53.8
Monitoring financial transactions	46.0	64.1
Consulting with expert agriculture advice	42.0	64.1

Table 4. Percentages of Farm Group Leaders (i.e., RDEs, CNHWs, and Chairpersons) and Nonleaders Utilizing the Five Agricultural Mobile Phone Use Themes.

Agricultural Use Themes	Leaders	Nonleaders
Coordinating access to agricultural inputs	90.3	84.5
Accessing market information	83.8	62.0
Agriculture emergency assistance	64.5	53.4
Monitoring financial transactions	70.9	44.8
Consulting with expert agriculture advice	58.0	48.3

tion of percentages of women and men utilizing the five agricultural use themes.

Women lagged slightly behind men in uses except for agriculture emergency assistance, where they led slightly. Female respondents reported contacting veterinarians for livestock assistance on a regular basis. For example, a female respondent noted that consulting with the veterinarian via the mobile phone allowed her to save money that would have been spent on travel, and that it has allowed her to keep her pigs healthier and able to breed due to early detection and timely treatment of illness. Ugandan women are likely to "sell surplus from their own plots, chickens and pigs" (IFAD, 2000). Since women can sell these assets for profit, it is clear why a substantial portion of the women in this study would use the mobile phone for agriculture emergency assistance with these resources.

Farm group leaders were found to have more agricultural mobile phone uses ($M = 3.68$ out of 5 uses, $SD = 1.14$) than nonleaders ($M = 2.95$ out of 5 uses, $SD = 1.28$), $t(87) = -2.664$, $p = 0.009$. In particular, leaders (84%) were more likely than nonleaders (62%) to access market information via the mobile phone, X^2 (1, N = 89) = 4.54, $p = 0.033$. Additionally, more leaders (71%) than nonleaders (45%) use the mobile phone for financial monitoring, X^2 (1, N = 89) = 5.56, $p = 0.018$. These findings are likely supported by the fact that leaders tend to have a higher socioeconomic status in the community. Table 4 provides a distribution of percentages of farm group leaders and nonleaders utilizing the five agricultural use themes.

Perceived Impacts of Mobile Phone Uses

Diffusion theory emphasizes understanding the perceived impacts of adoption to recognize factors that impact sustained use and the reinvention of uses to deal with a greater spectrum of needs (Rogers, 2003, p. 436). Respondents were asked what they perceived to be the greatest impacts of mobile phone uses for their livelihoods. The responses have been categorized in relation to Hudson's 2006 framework of the impacts of telecommunication on social and economic activities. Perceived impacts include the following: 1) *efficiency,* increased productivity while minimizing wasted effort or expense; 2) *effectiveness,* increased productivity through access to resources; and 3) *reach,* the ability to communicate regardless of time or geographic boundaries (p. 12).

Responses categorized as impacts of efficiency

focused primarily on increased coordination for access to agricultural inputs and sales of outputs. In most cases, impacts of the mobile phone on levels of efficiency referenced the ability of increased coordination to result in financial savings. Numerous respondents indicated using the mobile phone to call ahead and coordinate a meeting time instead of travelling and guessing that someone may be at a particular location. By coordinating meetings, farmers are able to continue working in the field, instead of wasting valuable time looking for individuals. Respondents indicated using the mobile phone both to negotiate market price, and to coordinate with buyers to have them travel to the respondent to buy and transport goods to the market. Not only were the farmers saving travel costs from no longer meeting with buyers face-to-face, but they were also saving the cost of transporting goods to markets in which there was no guarantee of a buyer. One male respondent indicated saving 4,500 shillings (approximately US$2) each time he marketed his crops. "It used to cost me 5,000 shillings to travel to larger towns to market my crops; now I pay 500 shillings to call a buyer who comes to me." The ability to decrease transportation costs through increased coordination was reported by approximately 49% of the respondents.

Nearly half of the respondents (49%) indicated impacts on effectiveness, or increased productivity. Agricultural advice, as well as access to agricultural inputs, such as labor, seeds, plant cuttings, livestock, and loans from VEDCO or NAADS; consultation with veterinarians; and increased access to market information were mentioned as agricultural resources that increased productivity. Another aspect of increased effectiveness of agricultural methods was the ability to coordinate in an emergency. Nearly 22% of respondents indicated the impact of mobile phones during agriculture emergencies. As a result of continual consultation with veterinarians and agricultural experts, respondents indicated an increase in the overall health and productivity of their livestock and crops. For example, one female respondent indicated, "[Due to the mobile phone], I have been able to call the veterinarian to quickly treat my goats during emergencies. Since I started contacting the veterinarian, I increased my number of goats from two to nine."

Increases in reach, indicated by nearly 53% of respondents, include the ability to gain access to agricultural experts, including agricultural development-based organizations, veterinarians, and fellow VEDCO farm group members. Benefits, such as improved crop yields and livestock production, were attributed to the ability to consult with agricultural experts and coordinate agricultural training sessions. Remote agricultural consultation (e.g., proper spacing of banana plantings, timely planting advice due to weather patterns, etc.), awareness of agricultural trainings or meetings, and notification of the availability of agricultural loans were the most frequently cited impacts of reach. Impacts of reach also included access to information for sound decision making. In addition, numerous respondents stated that being able to contact VEDCO or multiple buyers allowed them to know the fair market price, and that they "no longer felt cheated." For example, one male respondent stated, "[Before I contacted buyers through my mobile phone,] I used to not know the current price for my produce, now I sell at a price 5,000 shillings higher."

Influence of Gender and Leadership Status on Perceived Impacts of Mobile Phone Uses

In total, the perceived impacts of mobile phone uses included: 1) transportation and operational efficiency through coordination; 2) benefits in agriculture effectiveness due to greater access to resources, including emergency assistance; and 3) increase in contacts and opportunities due to the ability to reach and be reached by agricultural specialists, veterinarians, and individuals offering financial opportunities. These were perceived as beneficial impacts more among men ($M = 1.71$ out of 3 perceived impacts, $SD = 0.80$) than women ($M = 1.36$ out of 3 perceived impacts $SD = 0.79$), $t(87) = -2.09$, $p = 0.039$.

The percentage of women (50%) and men (49%) who perceived transportation and operational efficiency to be a primary beneficial impact of the mobile phone was nearly equal. However, a greater percentage of men (64%) than of women (44%) felt the mobile phone increased their ability to reach new contacts and opportunities, X^2 (1, N = 89) = 3.55, $p = 0.059$. The finding that men associate the benefits of mobile phones with an increase in contacts and opportunities could be due to the fact that men are more mobile than women. Traditionally, women in Uganda are responsible for household

tasks, and they are thus less likely than their male counterparts to travel (World Bank, 2008b). Since women may travel less frequently and perhaps not as far as their male counterparts, they may be less likely to encounter new contacts and opportunities outside of the home.

Overall, farm group leaders ($M = 1.6$ out of 3 perceived impacts, $SD = 0.86$) did not differ from nonleaders ($M = 1.5$ out of 3 perceived impacts, $SD = 0.78$) in the perception of transportation efficiency, access to resources, and increase in contacts and opportunities as beneficial impacts of the mobile phone, $t(87) = -0.539$, $p = 0.591$. This finding indicates that leaders and nonleaders are using mobile phones for similar purposes and feel they are gaining the same advantages.

Reinvention of Mobile Phone Uses

Understanding the reinvention of mobile phone uses is important, as it shows how the use of a technology has grown to fulfill a wider range of respondents' needs. According to diffusion theory, reinvention allows for an innovation to fit more appropriately with local contexts. Innovations that can be reinvented to fit changing needs are more sustainable (Rogers, 2003, pp. 183–185). In this study, reinvented uses were classified as uses that were not employed at the onset of adoption, but were added as familiarity with the mobile phone device grew.

Initial uses of the mobile phone directly reflect the perceived relative advantages that led to adoption, including kinship maintenance, financial monitoring, consultation, and coordination with agriculture extension agents and farm group members. While the mobile phone served these initial purposes, the reinvented uses that were identified indicate the development of a broader spectrum of agricultural uses that, in turn, fulfill a wider range of needs. The mean number of agricultural mobile phone uses per person at the time of adoption was 1.75, which increased to 5.16 over time. This finding supports the claim that, over time, mobile phone uses are being reinvented to deal with a greater spectrum of needs.

Understanding unique uses of the mobile phone allows for the identification of applications that may be useful to others. In this study, unique uses were not employed at the onset of mobile phone adoption, but were added to deal with a particular need, did not fit easily into the five agricultural mobile phone use themes, and were atypical in nature. Examples of unique uses from the literature include the following: 1) storing agricultural information in the mobile phone (e.g., storing market prices in the mobile phone calendar); 2) using the speakerphone function of the mobile phone for group conferencing; and 3) receiving market prices through SMS (adapted from Burrell, 2008; FARA, 2009; Mittal, Gandhi, & Tripathi, 2009).

Unique uses found in this study include the following: 1) use of the calculator to figure proper market pricing, 2) use of the speakerphone function for group meetings, 3) storage of agricultural information, 4) voice recording of agricultural lessons, and 5) use of the phone's camera for educational purposes (see Table 5). None of the respondents indicated utilizing these unique uses at the onset of mobile phone adoption, indicating that they were added later. Percentages and illustrative examples for the unique use themes for all VEDCO farm group members, as well as a breakdown by gender and leadership status, can be found in Table 5.

Use of the calculator function of the mobile phone was mentioned by 45% of the respondents. For example, a CNHW reported using the calculator function to calculate body mass index, allowing him to increase the efficiency of his nutrition outreach objectives. Respondents also indicated feeling that they were no longer vulnerable to receiving incorrect market prices because they could calculate and verify the price with the calculator.

The speakerphone function of the mobile phone was used by 26% of respondents. The speakerphone function was used for remote conferencing with VEDCO, for group communication with loan officers on status of loans, and for including absent farm group members when decisions were needed during meetings. When the speakerphone function is needed, the mobile phone is placed in the center of the group, so that all members may participate in the conversation. According to one respondent, use of the speakerphone function came about because of training by VEDCO and VEDCO farm group members. To promote group transparency and increase communication effectiveness between VEDCO and VEDCO farm group members, the speakerphone function of the mobile phone was incorporated into remote consultations.

Table 5. Unique Use Themes, Percentages, and Illustrative Examples of Unique Uses of Mobile Phones.

Calculator	Speakerphone	Storage of information	Voice recording	Camera phone
Use calculator: Total: 45%	Use speakerphone: Total: 26%	Information storage: Total: 13%	Voice recording: Total: 3%	Use camera: Total: 2%
Gender: Female: 32% Male: 62%	Gender: Female: 16% Male: 38%	Gender: Female: 12% Male: 15%	Gender: Female: 0% Male: 8%	Gender: Female: 0% Male: 5%
Leadership status: Leaders: 55% Nonleaders: 40%	Leadership status: Leaders: 26% Nonleaders: 26%	Leadership status: Leaders: 10% Nonleaders: 16%	Leadership status: Leaders: 6% Nonleaders: 2%	Leadership status: Leaders: 0% Nonleaders: 3%
Do not know how to use calculator: Female: 40% Male: 13%	Uses speakerphone to communicate with VEDCO to clarify agriculture methods *"Everyone can hear the lessons first-hand."*	Storage of current farm group debt and debt relief training from VEDCO (in text messaging folder)	Records fellow group members stating when they will pay back loans to promote accountability	Takes photos of examples of good agricultural techniques during VEDCO trainings to review again
Uses calculator to know proper price before selling to the market *"I no longer feel cheated."*	Uses speakerphone to communicate with loan officer to encourage group and individual accountability	Storage of daily market prices in order to sell at a higher price (in calendar)	Records phone conversations when VEDCO provides remote diagnosis for group	
Uses calculator to calculate body mass index for health monitoring	Uses speakerphone to communicate with bulk buyer *"No one feels cheated, we all know the proper price."*	Storage of planting and expected harvesting dates (in calendar) Storage of names of appropriate drugs to treat livestock (in calendar)	Records VEDCO trainings to review again	
	Uses speakerphone when a member is absent to include individual in decision making			

Past research has found that mobile phones are used to store important information (Burrell, 2008, pp. 16–17). Storage of information was indicated by 13% of respondents. Farm group loan repayments, VEDCO loan repayment trainings, and notes on VEDCO agriculture development trainings were stored in SMS folders. Daily market prices, names of appropriate veterinary drugs, approximate dates when hens should start laying eggs, and timely planting and harvesting dates are all examples of types of information stored by respondents in the mobile phone calendar. Taught by other VEDCO-trained CNHWs, a female CNHW indicated that she had experienced financial impacts from storing local market prices in her mobile phone calendar to visualize local market trends. By doing so, she indicated that she knew when to store her agricultural products to sell later when prices had risen.

While not common, voice recording was indicated by 3% of the respondents, and use of the mobile phone camera was indicated by 2% of the respondents. These functions were mainly used to capture VEDCO training sessions for later reference, or to capture agricultural or health-related problems for consultation with VEDCO. For example, a CNHW indicated using the voice recording function to record the health status of individuals he serves. By doing so, the respondent noted an increase in the frequency of correct diagnoses, because the information could be shared with VEDCO officials in a timely and effective manner.

To maintain contractual agreements within the farm group, one individual reported recording fellow group members stating when they anticipated paying back their portion of the group loan. If the group member did not pay their portion back on the date specified, the recording would be played aloud to subject the individual to public accountability during farm group meetings. According to the respondent, viewing local community members recording important information, such as agricultural advice, gave him the idea to use the voice recording function to promote group accountability in the repayment of loans. The small number of individuals using the voice recording and camera functions may be due to the fact that mobile phones with these functions are more expensive or less accessible.

Influence of Gender and Leadership Status on Reinvention of Mobile Phone Uses

On average, at the time of adoption, women (M = 1.68 uses) were found to have slightly fewer agricultural mobile phone uses than men (M = 1.85 uses). Now, the gap between women (M = 4.4 uses, SD = 2.62) and men (M = 6.10 uses, SD = 2.35) seems to be widening, $t(87) = -3.10$, $p = 0.003$. The phenomenon of men having consistently had more agricultural uses for mobile phones than women may be due to a variety of reasons. Since men have owned the mobile phone longer than women, men may have had more time to become familiar with the device and learn new uses. Since men, more than women, perceive the mobile phone both as useful for increasing contacts and opportunities, and as having more agricultural uses, it seems that men may have more heterogeneous ties able to introduce new uses.

More men (69%) than women (48%) were found to have at least one unique use of the mobile phone, X^2 (1, N = 89) = 4.04, $p = 0.045$. The most drastic difference between genders was use of the calculator function. Approximately 62% of men and 32% of women use the calculator function of the mobile phone to calculate proper market prices. Nearly half of the women, 40%, indicated not understanding how to use the calculator function, compared to 13% of men. This finding indicates an opportunity to train women on how to use this application to increase informed decision making.

On average, at the time of adoption, leaders (M = 1.77 uses) were nearly equivalent to nonleaders (M = 1.74 uses) in the number of agricultural uses. Slightly more leaders (61%) than nonleaders (55%) were found to have at least one unique use of the mobile phone. See Table 5 for illustrative examples and a breakdown of reinvented uses by gender and leadership status.

Conclusions and Recommendations

This study indicates that the mobile phone is not only being adopted for social reasons, but is viewed by the farmer as a tool that will allow for more efficient response to economic opportunities or threats. This finding supports the ICTD perspective that mobile phones are tools that encourage

efficient and informed action to lead to greater productivity (Hudson, 2006; Saunders et al., 1994).

An overwhelming majority of respondents indicated use of the mobile phone for coordinating access to agricultural inputs and market information. The ICTD perspective emphasizes that mobile telephony can serve as a development tool, in that it allows for increased communication with institutions responsible for livelihood development (Donner, 2008). Since the majority of respondents use the mobile phone to communicate with those who offer agricultural inputs and markets, it is clear that rural farmers are using mobile phones for development initiatives.

Differences between genders and level of leadership status were, indeed, found. Women were later adopters than their male counterparts. The more recent adoption of mobile phones by women suggests that mobile phones are becoming more accessible to rural female farmers. More women than men indicated using mobile phones for agriculture emergency assistance, demonstrating that women are not using the mobile phone solely for kinship maintenance, but also to increase both agricultural productivity and their ability to sell surplus agricultural products for profit. This finding further underscores the necessity of continually incorporating stakeholders' needs into the development and training of agricultural mobile phones uses in order for implementation to successfully fit the social framework and fulfill local needs.

Women and nonleaders were less likely to use the mobile phone to access market information. Thus, it may be beneficial for development practitioners to train women and nonleaders on how to use mobile phones to 1) access and compare markets for sound decision making and 2) coordinate with others in the area to combine resources. First, it is important to train individuals to identify proper local market prices. Second, and more complex, it may be advantageous to develop a mobile phone application that can match buyers and sellers beyond the local market. Furthermore, it would be beneficial to use the mobile phone to coordinate collection and transportation of multiple farmers' agricultural products for selling in bulk to larger, more profitable markets.

In regard to gender, it seems that patterns of use follow the distribution of household tasks. Traditionally, men market large quantities of commercial crops, so they are thus more likely to use the mobile phone for market price information than women, who are more likely to market small quantities in local markets. In the development and teaching of agricultural uses, development practitioners must be cognizant of the social structure in which the mobile phone operates.

The perceived impacts of mobile phone uses in this study fit well into the perceived impact categories that were drawn from prior ICTD research (Burrell, 2008; Hudson, 2006; Saunders et al., 1994). Farmers strongly believe that the mobile phone increases efficiency and money savings by avoiding wasted travel; that it increases effectiveness of operations due to access to improved agricultural resources; and that it increases the ability to reach new information, such as market prices, agricultural advice, and financial opportunities. Men, unlike women, view transportation efficiency and access to new contacts and opportunities to be major impacts, suggesting that women are less mobile and may have less exposure to new contacts and opportunities.

Over time, the number and variety of agricultural uses for mobile phones increased among all users. Even those who originally adopted for social purposes embraced agricultural uses over time, indicating that mobile phones will be adopted for a few key purposes, but that uses will be added or reinvented to fit changing needs. A number of unique uses emerged from this study. Examples include storing planting and expected harvest dates in the calendar, and using the speakerphone function for group consultation with agricultural experts. Men, more than women, were found to have at least one unique use. Just as the mobile phone hardware was adopted in a diffusion process, so will the evolving unique uses. Since women have adopted more recently than men, they may be at an earlier stage of use, and may thus be likely to develop uses that fit their individual needs as experience with the device grows. There was no difference between leaders and nonleaders in either time of mobile phone adoption or reinvented uses. It seems that the greatest determinant of farmers' abilities to reinvent mobile phone uses is time spent with the technology.

The results of this study are useful for develop-

ment practitioners for two main reasons. First, while this study shows differences in time of adoption, use, and perceived impacts of mobile phones in relation to gender and farm group leadership status, it also makes clear that traditionally "marginalized" users (i.e., women and nonleaders) are now adopting and adapting the technology to fit their livelihoods. As such, this study shows that the mobile phone has become more accessible to a greater spectrum of users and is capable of being adapted to fit individual needs. Second, this study identifies user-developed agricultural uses likely to increase the productivity of organizations. Focusing not only on providing access to ICTs, but on *how* individuals use technologies for locally relevant means is imperative to understanding the necessary conditions for effective use of ICTs in development efforts. In conclusion, those wishing to use mobile phones in development operations should continually monitor and incorporate training of locally relevant, productive, and unique uses. The benefit in developing and sharing these uses is the potential to increase achievement of goals of the organization without necessarily increasing costs to the organization or the user.

While this study does provide an account of mobile phone uses and perceived impacts, it is recommended that future research attempt to measure actual impacts of mobile phone adoption and use (i.e., actual amount of time and money saved, etc.). It is possible that the respondents' perceived impacts recorded in this study were an overestimation of actual impacts. It would be beneficial for future research to ask respondents how frequently they use the mobile phone for each productive use, and whether these productive uses have been significantly enhanced through the use of the mobile phone. Additionally, asking respondents to rank the importance of each use of the mobile phone, along with how easily they could discontinue using the mobile phone, should better reveal the depth of impact of mobile phone usage. ■

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