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ICT USE BY SMALLHOLDER FARMERS IN RURAL MOZAMBIQUE: A CASE STUDY OF TWO VILLAGES IN CENTRAL MOZAMBIQUE

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ABSTRACT

This study adds to the empirical evidence of information and communication technology (ICT) use by smallholder farmers in Sub-Saharan Africa. The study draws on qualitative data collected from eight focus groups segmented by gender and consisting of adult farmers in two villages, in central Mozambique. Special attention was given to the types of ICTs that farmers have access to and the dissemination of agriculture information through various ICTs. Findings indicate that the characteristics of ICTs explain why cell phone and radio use is prevalent, while access to television remains limited. The type of information accessed also varied by ICT type, implying that innovation characteristics affect not only their diffusion, but practical use. Drawing from the Diffusion of Innovations theory, the characteristics and extent of use for each ICT were examined to understand ICT diffusion better.

Smallholder farmers are essential to food security and livelihoods in rural Sub-Saharan Africa (SSA). Representing an estimated 80% of SSA farms and 90% of the region's agriculture production, the typical African smallholder farmer earns income from a few hectares of land, owns about 10–20 animals, and often engages in both commercial and subsistence farming (Livingston, Schonberger, and Delaney 2011; Munyua, Adera, and Jensen 2009). The contributions of smallholder farmers are also integral to economic development as they add up to one third of the continent's gross domestic product (World Bank 2017). Although crucial to their communities and the region as a whole, smallholder farmers face enormous challenges to their well-being, including climate change adaptation, food insecurity, and poverty (IFAD 2008).

Information and communication technologies (ICTs) are a unique tool in the arsenal against poverty, which is exacerbated by weak market links, high transportation costs, and price volatility. ICTs have been associated with an increase in efficiency, productivity, and communication between buyers and sellers

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while reducing waste and price dispersion (Aker 2011; Lio and Liu 2006; Muto and Yamano 2009). More recent technologies, such as cell phones and increased internet access have the potential to democratize information access, especially in places where communication infrastructure is lacking. Despite these benefits of ICTs, their adoption throughout SSA has not been uniform. In Mozambique, for instance, where 68% of the population lives in rural areas, subscription rates for broadband services, an older technology that has been in use far longer than mobile phones, remains incredibly low at five (0.05) subscriptions per 100 people (World Bank 2017). Mobile phone subscription rates, however, grew from 10.8% in 2006 to 69.7% by 2014. This dramatic increase in cell phone ownership, coupled with the continued lack of adoption for older technologies, offers a unique opportunity to examine the role of technology characteristics in the diffusion process. This study contributes to the empirical evidence of ICT use in SSA by identifying the types of ICTs available to smallholder farmers and how they are used, including a gender component of ICT use and information access. The Diffusion of Innovations Theory is used to better understand how the technological characteristics of each ICT contributes to its diffusion (Rogers 2010).

Using qualitative data obtained from eight focus groups, this study pursued the following research questions: (1) What types of ICTs do smallholder farmers in Mozambique have access to? (2) How do they use them? and (3) What are the characteristics of the adopted ICTs that lend themselves to adoption? To examine this, we first present a review of both the sociological and economic literature on ICTs in SSA. Second, using our theoretical framework, we present our data and results. Third, we offer a discussion based on our findings on how increased technology adoption rates might benefit smallholder farmers in central Mozambique. Finally, recognizing ICTs as an increasingly important mechanism for social, political, and economic development, we suggest possible future study questions. Findings from this paper aim to contribute to the empirical evidence on ICT use, the characteristics of innovations that influence ICT adoption among smallholder farmers in Mozambique, and gendered differences in ICT use and access. The study contributes to the larger discussion on the role various communication devices have in disseminating agriculture information throughout developing regions.

LITERATURE REVIEW

Characteristics of Technology Adoption

Information and communication technologies (ICTs) refer to technologies that enable users to receive, process, transmit, or send information which maybe in form of voice, text, or picture (Ajani 2014). ICTs can offer smallholder farmers the opportunity to create networks with other farmers, obtain market information, and

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access information (IFAD 2008). Due to their potential, and the recent surge in mobile phones ownership throughout SSA, ICTs have become an important consideration for social and economic development programs.

Current research indicates that a variety of ICTs are utilized by smallholder farmers for agriculture purposes. While cell phones are an increasingly important source of information, ICTs such as radio, television, and, to a lesser extent, computers, are also sources of information for smallholder farmers throughout rural SSA and could foster networks and support systems among smallholder farmers (May 2012; Munyua et al. 2009; Oluwatayo 2014; Wasserman and Faust 1994). Findings from across the continent indicate the importance of ICTs for smallholder farmers. Angello (2015) found that ICT use among smallholder farmers in Tanzania was prevalent, with more than 90% reporting mobile phone use. In South Africa, findings indicate increased ICT use could foster virtual business opportunities (Masutha and Rogerson 2015).

Farmers that lack access to ICTs may experience “digital poverty,” increasing risk and transaction costs that, in turn, place further limitations on their ability to be innovative and participate in markets (Okello et al. 2014). The lack of access to ICTs may also prevent farmers from adopting additional agriculture-based technologies. For instance, recent studies suggest low rates of adoption for improved agriculture methods is not due to farmer disinterest, but a lack of information and financial constraints (Ringler 2010; Shiferaw et al. 2015). Improved access to ICTs, such as an increase in the coverage capacity of mobile phone networks, has been linked to reduced price dispersion, a higher rate of input use, and a reduction in information asymmetries (Akers and Fafchamps 2015; Ogutu, Okello, and Otieno 2014).

The growing importance of ICTs, however, does not mean that they are ubiquitous, as several barriers prevent the full utilization and adoption of these technologies. Previous research has indicated individual characteristics such as income, educational attainment, age, household size, gender, and livelihood activities are important indicators for technology adoption (May 2012; Oluwatayo 2014). Low-literacy rates, infrastructure issues, poor ICT policies, and a tendency for project-based development initiatives also hinder the full diffusion of ICTs (Angello 2015; Munyua et al. 2009). To effectively incorporate ICTs into development activities, both the cultural context and specific characteristics of innovations must be taken into consideration (Kyem 2012). To analyze the role of ICT characteristics in the diffusion process, this paper will incorporate Rogers’ Diffusion of Innovation (DOI) theory in the examination of ICT use in rural Mozambique.

Theoretical Framework

The Diffusion of Innovation (DOI) theory examines how and why decisions to adopt a new technology occur. Rogers (2010) defined diffusion as the process by which an innovation moves within a social system over time. While an innovation often refers to physical objects, it can also include ideas, behaviors, or practices that are new to the individuals within a system. An essential aspect of Rogers' DOI theory considers the specific characteristics of an innovation when explaining diffusion. This includes the innovation's perceived costs and benefits, its ability to be tested, a person's familiarity with the innovation, the difficulty of use, and its compatibility with the pre-existing social, economic, and environmental systems (Elia, Mutula, and Stilwell 2014).

According to Wejnert, an innovation's characteristics comprise two broad categories: *public vs. private consequences* and *benefits vs. costs of the innovation*. Public consequences can be considered as having macro-level outcomes aimed at addressing historical or social welfare. Examples of these include malnutrition campaigns that promote social well-being. Private consequences, on the other hand, have micro-level consequences that are localized due to their geographic proximity, interpersonal relations, communication channels, and pressure of social networks within which the innovation exists (Wejnert 2002). An example of a private consequence is ownership of a mobile phone following a women's empowerment program that promotes access to micro-credit loans or participation in entrepreneurial opportunities.

The intense information and data nature of agriculture means that ICTs can play a crucial role in the development, flow, exchange, and management of agriculture information (Nwagwu and Famiyesin 2016). However, the compatibility of a technology within a current system, including the availability of effective training, trust, and technology infrastructure, is necessary for innovation diffusion (Aubert, Schroeder, and Grimaudo 2012; Nwagwu and Famiyesin 2016; Taragola Van Lierde and Gelb 2005). A review of precision agriculture adoption in Canada found that the "perceived ease of use" and the usefulness of technology were significant indicators of technology adoption. The compatibility of precision agriculture with existing farm equipment was also important (Aubert et al. 2012). In a study on ICT use among livestock innovation chains, researchers found that while farmers used ICTs for marketing, they did not see the relevance of ICTs for other areas of agriculture. For those that did utilize ICTs, the quality of telecommunication services, the ease in which they could be used, and how the technology fit into their enterprise were key aspects of the decision to use ICTs (Nwagwu and Famiyesin 2016).

METHODS

This is a qualitative study based on a deductive content analysis process and case study approach. These approaches were chosen because they provide a wide lens for scrutiny and understanding of problems by allowing for multiple interpretive and material practices such as interviewing and literature review. Deductive content analysis is specifically used in the data analysis because it allows for subjective interpretation of data through a “systematic classification process of coding and identifying themes or patterns” (Hsieh and Shannon 2005; Moretti et al. 2011). A case study methodology is adopted because it allowed for a unique, flexible, and in-depth empirical inquiry within a bounded system (two rural villages in Central Mozambique). It allows us to optimize our understanding of how an innovation’s characteristics influences its adoption.

Focus Group Recruitment

A total of eight focus group discussions (FGDs) were conducted in the villages of Rotanda and Munhinga, both found in the Manica province of central Mozambique in March 2015. The purpose of the FGDs was to learn about the attitudes, preferences, practices, and resource networks of farmers in rural Mozambique. This was facilitated through the exploration of issues related to farming common beans and soybeans, as well as media accessed to obtain information on improved seed and farming techniques.

To ensure a diverse pool of participants was included, FGDs were segmented by location and gender. The location was defined by the traditionally established boundaries that identified one side of the village as “upper” and other as “lower.” Both sides sat along the main road of the village and adjacent to the local market. The groups were divided by gender because previous studies on Mozambique’s culture and agricultural practices note diverse gender roles and differences in asset ownership (Arnaldo 2004; Sevilla 2013; Boogaard et al. 2015).

The focus group interviews were approved by the Institutional Review Board at the University of Missouri before the field work. The interviews were conducted in English, Portuguese and other local languages. Participant recruitment, field visits, and interview translations were facilitated by Mozambique Institute of Agricultural Research (IIAM) and the local authority of both study villages. Each of the group discussions lasted approximately 60–75 minutes and a total of 86 participants contributed.

Geospatial Information

The two villages of Rotanda and Munhinga are culturally similar and sparsely populated. Rotanda village is located closest to the Zimbabwe boarder, about 100 kilometers west of Chimoio, the provincial administration center. Munhinga village

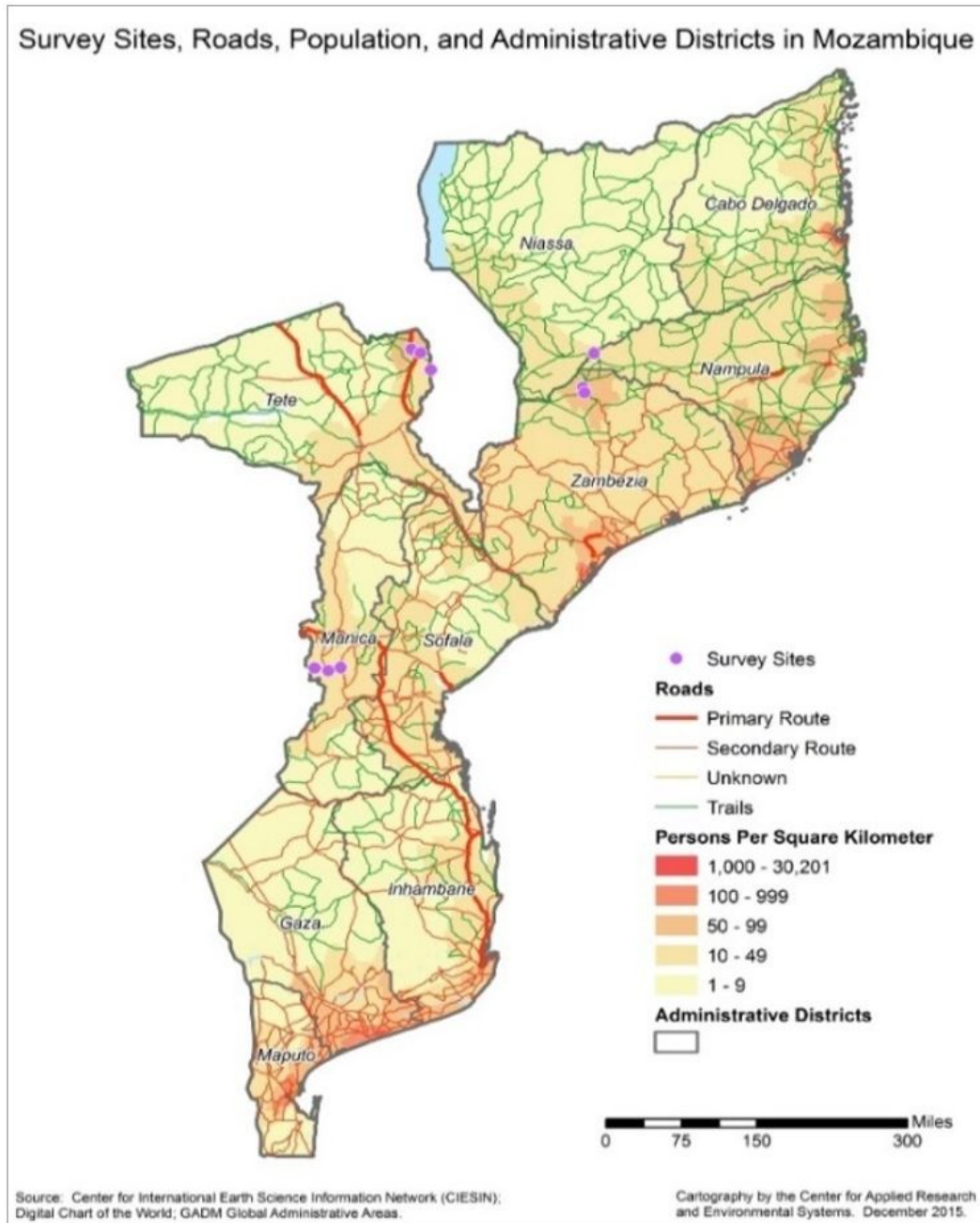


FIGURE 1. MAP OF MOZAMBIQUE ILLUSTRATING ROAD NETWORK AND POPULATION DENSITY

is located approximately 35 kilometers west of the provincial administration center. Munhinga village is semi-urban and located along a newly constructed national highway with access to electricity, a district hospital, and a vibrant market. Given its limited communication infrastructure and lack of access to electricity, Rotanda

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village is comparatively more remote than Munhinga village. Participants from both villages identified themselves as smallholder farmers engaged primarily in maize and bean farming.

Deductive Content Analysis Procedure

A deductive content analysis technique was used in this study. The deductive (directed) content analysis was chosen to apply the DOI theoretical framework. Moretti et al. (2011) noted researchers analyzing focus group discussions using deductive content analysis are guided by a more structured process based on “previously formulated and theoretically derived categories.” Our study sought to examine the types of ICTS accessed, types of information obtained, and the characteristics of the ICTs adopted. To achieve this, the obtained FGDs transcripts were first coded to establish key words, concepts and phrases as initial categories of analysis (Moretti et al. 2011). A summative content analysis technique was then used to group coded words and phrases into categories that were derived based on existing literature and the adopted theoretical framework. Both FGDs participants and translators were allowed to review responses to ensure the discussion had been correctly recorded. The data was further verified by comparing researchers’ field notes with FGD findings.

RESULTS

A majority (61%) of the focus group participants were from Rotanda village, with the remaining 39% from Munhinga village. More women participated (57%) than men (43%). The focus group participants were highly homogenous. At least 61% of the women in Rotanda village identified themselves as married, 14% as single, and 25% as widowed. In Munhinga, 94% of the women identified as married, 3% as single, and 3% as widows. All the men in Rotanda village and 95% of the men in Munhinga village identified themselves as married. The remaining

TABLE 1. FOCUS GROUP PARTICIPANTS’ BREAKDOWN BY GROUP AND VILLAGE.

VILLAGE & GROUP	MALE	FEMALE	TOTAL
Village 1a.....	11	16	27
Village 1b.....	9	18	27
Village 2a.....	10	10	20
Village 2b.....	7	5	12
Total.....	37	49	86

5% of the men in Munhinga village identified themselves as widowers. Most of the women had attained less than a secondary school education level and a few men some level of secondary education.

Research data suggests that smallholder farmers in rural Mozambique have access to a variety of ICTs, most notably radio, mobile phones, and television. Radio is the most prominent ICT equipment accessed for news, agriculture information, education, and leisure. Mobile phones are the second most accessed ICT. According to our focus group participants, most participants had access to radio and mobile phones, but not television. All the men in Rotanda village and Munhinga village said that they owned a radio. However, fewer women (78%) in Rotanda village and Munhinga village (85%) said they owned a radio. When asked about mobile phone ownership and access, 100% of the men in Munhinga village and 68% of the men in Rotanda village said they owned or had access to a mobile phone. On the contrary, fewer women said they owned or had access to mobile phones (89% in Munhinga village and 70% in Rotanda village). Only 7% of the participants from both villages said they owned television sets (see Table 2).

TABLE 2. COMPARISON OF ICT EQUIPMENT OWNERSHIP BY VILLAGE AND GENDER.

	ROTANDA		MUHINGA	
	MEN (N=20)	WOMEN (N=34)	MEN (N=17)	WOMEN (N=15)
ACCESS TO ICT EQUIPMENT				
% Radio ownership	100	78	87	85
% Mobile phone ownership	68	70	100	87
% Television ownership	5*	3*	12	13

NOTE: *Individuals own televisions but cannot use them due to lack of electricity.

Television, the third most prominent ICT, is used for national news and entertainment. The 2% in Rotanda village who owned a television said they were not able to view any nationally aired programs due to lack of access to electricity. At least 14% of the men and all the women in Munhinga village reported going to their neighbors' house in the evenings (8 PM) to watch television. The primary use for radio was to listen to news, as men and women from both villages reported that they used the radio to access news. While women in Rotanda reported listening to only news, women in Munhinga listened to the radio for several purposes, including news, entertainment, and educational purposes. Men in Rotanda reported listening to the radio for news, entertainment, and agriculture programs while men in Munhinga reported listening to more types of programs compared with the men

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and women in Rotanda. Although men in Munhinga reported listening to more stations compared with women in the same village, both listened to similar programs. For example, both men and women in Munhinga reported listening to educational programs that promoted literacy. Some women in Munhinga also noted that they used the radio to learn new gospel music that they later used in their church choir (See Table 3).

TABLE 3. COMPARISON ON RADIO STATIONS AND TYPES OF PROGRAMS LISTENED TO BY GENDER AND VILLAGE.

	ROTANDA WOMEN	MUNHINGA WOMEN	ROTANDA MEN	MUNHINGA MEN
Radio station listened to				
National	✓		✓	✓
Zimbabwe	✓		✓	
Local station	✓		✓	✓
Community radio		✓		✓
BBC.	✓		✓	
Types of programs				
News.	✓	✓	✓	✓
Weather				
Educational		✓		✓
Health.		✓		✓
Child nutrition		✓		
Music		✓	✓	
Agricultural.		✓	✓	✓
Religious			✓	

While radio use was high in both villages, there were notable differences between the two. For instance, men and women listened to the radio at different times. Men from both villages listen to the radio throughout the day. In comparison, women in Rotanda reported listening to the radio when they returned from their fields or in the evening. Another gender difference included the number and type of radio programming listened to. While both men and women turned to

the radio for news, educational programming, and health information, more men used the radio to learn agriculture information and men alone used the radio to access weather information. Women in Munhinga were especially limited in the type of information they received from the radio, reporting that they only listened to community stations for news. Specific radio channels are also determined by gender and location. Participants in Rotanda, both men and women, were more likely to listen to international stations such as the British Broadcasting Cooperation (BBC) station, and, due to reception issues, Zimbabwe-based radio stations (Rotanda is closer to the Zimbabwean border). Women in Rotanda also reported having limited access to radio programs since they did not understand English, the language used by Zimbabwe stations.

As for mobile phones, there are also gendered differences in ownership. Women in both Rotanda and Munhinga reported that mobile phones were shared among household members, while men reported that they individually owned cell phones. Participants said they used their mobile phones predominately for calling. Several noted that they also used texting, especially free preset messages that allowed them to send a “please call me” or request phone credit to their friends.

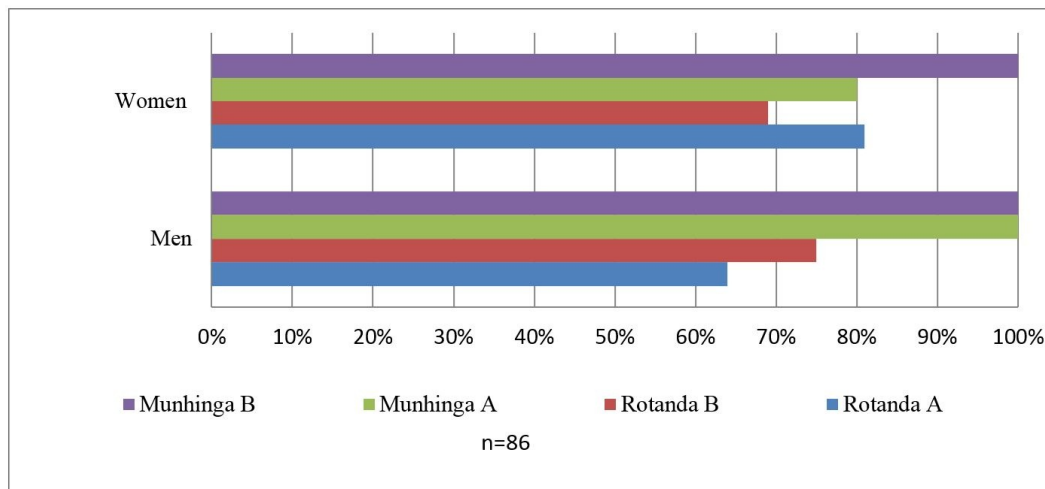


FIGURE 2. MOBILE PHONE OWNERSHIP BETWEEN WOMEN AND MEN ACROSS EIGHT FOCUS GROUPS IN CENTRAL MOZAMBIQUE

Very few used mobile phones for taking pictures, accessing agriculture information, or mobile banking. About one fifth of the men and women in both villages used their mobile phones to take photos. Only one male participant in Rotanda reported that he used his cell phone to access agriculture information. Use of mobile phones in money transfer and mobile banking was found in Munhinga.

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Two men said they used their mobile phones for money transfers, while a single woman said she used her mobile phone for mobile banking (See Table 4).

Table 4. Reported Mobile Phone Use by Men and Women Across Eight Focus Groups in Central Mozambique.

Group	Men				Women			
	Rotanda		Munhinga		Rotanda		Muhinga	
	a (n=9)	b (n=8)	a (n=10)	b (n=7)	a (n=16)	b (n=16)	a (n=10)	b (n=5)
Calls	✓	✓	✓	✓	✓	✓	✓	✓
Text/SMS	✓	✓	✓	✓	✓	✓	✓	✓
Photos	✓	✓	✓	✓	✓	✓	✓	✓
Ag. info	✓							
Money transfer				✓				
Mobile banking							✓	

Finally, the rate of televisions ownership was very low across all groups. Still, differences were exhibited between the two villages as Munhinga exhibits higher ownership levels than Rotanda. Again, the physical infrastructure likely plays a key role in the diffusion of television. In Rotanda, where television ownership rates are lower than Munhinga, access to electricity is restricted. Not only are the rates of television lower in Rotanda, but those that do own a television explained they are unable to use it.

DISCUSSION

Findings from this study further underscore the importance of ICT characteristics in the diffusion process. While radio has a longstanding role in relaying information to rural, smallholder farmers, newer ICTs have the potential to connect farmers directly to each other while overcoming several market barriers. However, despite this potential, DOI theory reminds us that just because an innovation offers benefits to its users, diffusion is not guaranteed. The innovation, and its use, must be compatible with the systems in which it is introduced (Elia et al. 2014). For instance, innovations perceived as too expensive or too difficult to use will have limited diffusion rates, despite the advantages they offer over current

technologies. The manner in which FGD participants discussed various ICTs suggested both a willingness and interest in adopting new communication technologies. ICT characteristics, however, played a role in both the types of ICTs adopted and the manner in which they are used. Gendered differences in both ownership and use of ICTs suggest that men are more likely to use ICTs to access agriculture-related information.

Radio

As previous research has shown, radio remains a highly relevant source of information access throughout SSA (Rodriguez et al. 2015) The high rate of radio ownership and use can be explained by several factors. Radios can be used without consistent access to electricity, are relatively inexpensive, and offer a variety of programming, including a mix of information and entertainment. Focus group respondents also emphasized the reliability of radio over other sources. For example, when focus group participants were asked about agriculture information delivered over the radio, one woman explained her preference saying, “They [radio presenter] tell you how many seeds to plant in each hole and how far apart to plant” (Female participant, Munhinga).

According to FGDs, Rotanda is unable to access community radio stations due to their geographic distance from transmission stations. Those in Munhinga listen to Mozambique’s national radio station and local community radio stations. The presence of a district community radio station and the proximity to Chimoio, a provincial capital, gave Munhinga improved access to Mozambique’s communication infrastructure compared with Rotanda. Radio was also from where most of the focus group members reported gaining agriculture information. Gendered differences are also especially important to note. As men reported listening to the radio throughout the day, and were more likely than women to say that they owned a radio, the scheduling of agriculture programs could increase the number of women using the radio to access agriculture-related information.

Radio also has the potential to inform farmers about weather, especially as climate change threatens to disrupt traditional precipitation patterns in much of SSA. Findings from this study, however, suggest that farmers are, for the most part, not using the radio to access weather information. The reason for this could also be explained by the DOI, especially the perceived benefits of use and the compatibility of the type of weather information available and its compatibility with the environmental systems farmers operate in. For example, the only farmers that used the radio to learn about weather were male farmers from Munhinga. Radio in Munhinga includes community radio, whereas both men and women in Rotanda listened to national or international sources of radio programming. Given this difference, it is possible that community radio is more likely to have relevant

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weather-related information, making it more beneficial for farmers and fitting their specific needs.

Mobile Phones

Using mobile phones for voice, text/SMS, and camera features are noted by focus group respondents. Participants explained that mobile phones are used to call and text friends or relatives for both personal reasons and loans. When women in Rotanda were asked the type of information they sent or received using text/SMS, one responded “to ask for credit.” Others shared that they too use the free texting service to get phone credit from their friends or kin. Mobile phone usage is higher in Munhinga than that of Rotanda. A potential reason for this may lie in the physical structures and geographies of each village. For instance, Munhinga is seated at the intersection of a large national highway, making it more accessible to companies and entrepreneurs. Structurally, Munhinga is concentrated along the main highway, power grid, local market, and other community infrastructure. Rotanda, on the other hand, is not close to a major roadway or market and is spread out.

While the potential for mobile phones to serve to connect remote regions to urban centers and increasing access to banking and market information, these uses were, for the most part, not cited by focus group members (Ajani 2014; Aker 2011). Mobile banking was reported, however, to a limited extent by both men and women in Munhinga. The use of mobile phones to access agriculture information was, again, limited to men in Rotanda. Here, the limited use of mobile phones for agriculture-related purposes, especially in Munhinga, could be due to radio’s dominance over mobile phones. As stated previously, farmers were more likely to trust the information they received from the radio. The lack of community radio programming in Rotanda may be a reason for farmers there to turn to their mobile phone to access information. Additionally, the physical characteristics of Munhinga could play a role in farmers’ limited use of mobile phones for agriculture-related purposes. As Munhinga is closer to a major road and local market, farmers in this village are perhaps more likely to share and gain information through word-of-mouth. Farmers in Rotanda are more geographically restricted and, in turn, may use their mobile phone to compensate for this deficiency.

Television

As previously stated, television ownership was extremely low in both villages. While the expense of purchasing a television limits ownership, the combination of that expense and the lack of access to reliable electricity may be responsible for making television ownership less enticing for villagers in Rotanda. As of 2012, only 20% of the Mozambican population had access to electricity that suggests that

television will remain rare in Mozambique households. While the ability for television to provide news and information is recognized, it appears that television is seen more as a source of entertainment:

“Television is for my kids.” (Male Respondent, Rotanda)

“I go to my friend’s house at 8:00 P.M. to see what’s going on. After news, we watch the novellas... kids and young girls know the names [of novellas].” (Female Respondent, Munhinga)

“I go to my friend’s house at night to watch news and the World Cup.” (Male Respondent, Munhinga).

“We see the television when we go to town.” (Male Respondent, Rotanda)

The combined factors of television as a source of entertainment and the limiting physical infrastructure (electricity access), it is an unlikely tool for dissemination of agriculture-related information.

Applying the Diffusion of Innovations Theory

Utilizing the DOI theory, findings from this study underscore the nature of ICT diffusion and the use of ICTs to gain access to agriculture information. Radio and mobile phones were the broadest reaching ICTs and may reflect their capacity to work within the community’s current technological infrastructure. Radio, the most diffused ICT, is compatible with current technology systems, is easy to use, and is easy for the user to test. The benefits of owning a radio, the relative ease of access to radio, and its low-cost support the near ubiquity of radio ownership and use. The use of radio as the only ICT used to access agriculture information can also be attributed to the characteristics of radio. For one, there is little cost or risk to accessing agriculture information via radio. Participants’ familiarity with radio and the trust that participants report in radio-accessed information also support the technology’s use for agriculture-related information.

While radio is an established technology within the region, mobile phones are newer and increasingly prevalent. Like radio, there is a relatively low cost of entry to purchase and use a mobile phone. The high level of mobile phone ownership also allows others to become familiar with the product. Again, like radio, while all members of a family may benefit from the presence of a mobile phone in a household, the benefits of a phone are limited to who is near it at any given time. While previous literature (Aker 2011; Angello 2015) has indicated the viability of mobile phones to transmit agriculture information, only one focus group respondent

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indicated that they used their mobile phones to receive such information. Several factors may explain this lack of innovation diffusion. A lack of precedence and infrastructure for receiving agriculture information through call or text/SMS technology may be one explanation for this barrier. For illiterate populations, which makes up half Mozambique's adult population (World Bank 2017), text-based information also serves as a barrier. As for the DOI theory, the lack of SMS-based agriculture information exchange (ex: farmers sharing market prices) can be explained the inability of the technology's to be compatible with pre-existing social structures.

Again, while both radio and mobile phones have been widely adopted, television ownership remains low. One reason for this is the inability of television to fit into the existing technological capacities of the community, therefore limiting its prevalence. In stark contrast to radio and mobile phones, the lack of access to a consistent source of electricity makes a television unusable in many circumstances. Additionally, the costs of television ownership are prohibitive for many and the benefits of ownership do not outweigh these costs. Compared to radio and mobile phones, both of which have a much lower cost of entry, the benefits of owning a television or accessing the internet through a computer is limited. The uncommon nature of television and the lack of reliable access to electricity could also explain its use as more of a form of entertainment rather than for gaining practical information.

CONCLUSION

This study sought to examine the ways in which smallholder farmers interact with ICTs, including the type of information accessed. To accomplish this, qualitative data from eight focus groups were conducted in two villages in central Mozambique. This paper examined the types of ICTs and the kind of information accessed through them by smallholder farmers in rural Mozambique, using the DOI theory as a framework to examine the transfer of new technologies. Findings from focus groups indicate that radio and mobile phones are the most common ICT used in the region. The lack of television ownership and use was also indicated through this research. The types of information accessed by these smallholder farmers also varied by ICT. News is received mostly through radio, but television can also be a source of news for those that have access to it. Television and radio are also a source of entertainment for users. Despite the potential of mobile phones to serve as a resource for agriculture information, it is mostly used for personal communications, including calls, texts, and photos.

The current use of ICTs reveals several ways in which smallholder farmers may benefit from them, especially mobile phones. Findings suggest that farmers are willing to use ICTs to receive agriculture information. While radio remains the

paramount source of agriculture information, the prevalence and increasing comfort with mobile phones technologies is an important factor to consider. As evidence indicates the continued importance of extension agents as an information source (Zanello and Srinivasan 2014), agriculture programs that utilize both radio and mobile phones may help to further the use of mobile phones for agriculture purposes. Extension services could incorporate ICTs into their current services, including both text-based uses and nontext services. Novel uses of mobile phones for agriculture information, including hotlines or prerecorded messages could not only provide another source of information for farmers, but may make mobile phones an inclusive source of information for the non-literate. Gendered differences in ownership and type of information accessed was also noted throughout this study. Not only did most of the women see ICTs as shared household items, compared with men who reported sole ownership of ICTs, women were much less likely to access agriculture information from ICTs.

Understanding the types of ICTs used by smallholder farmers in rural communities and what information they are accessing is useful for improving interventions aimed at agriculture innovation. Additional opportunities for future research include gendered access to ICTs and how ICT use differs between men and women. The role of ICTs in facilitating new or altering existing social networks may also be a topic of future exploration. This paper adds to the literature that aims to understand and explain technology adoption and the factors that facilitate it. By describing the characteristics of technologies and the role that these characteristics have in supporting the dissemination of agriculture information, this paper builds on both the theoretical understanding of technology adoption and the practical implications of it.

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