



Smallholder farmers' knowledge of mobile telephone use: Gender perspectives and implications for agricultural market development

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Abstract: Recent growth in mobile telephone and mobile-based information services in many developing countries provides opportunities to reduce costly and incomplete information dissemination in the agricultural sector and ensure efficient functioning of markets. But in order to successfully use mobile phones for the optimal development of agricultural markets, understanding the impact of social structure on mobile phone adoption, its uses and perceived impacts are invaluable. Although global assessments of capacity in the use of information communication technology (ICT) devices have been considered, such assessments mask significant geo-spatial variations among local farmers—male and female—with respect to their capacity to effectively use basic mobile phone functions. Documenting and recognizing this is important for the development of national agricultural ICT policies, as well as programmes aimed at increasing farmers' knowledge and use of ICT for agricultural marketing. This article's contribution to agricultural marketing and the use

of ICT in developing countries (such as Ghana) is anchored in the assessment of the technical capacity and mobile telephone-based market information access to farmers in selected rural districts of Ghana. The selected districts are where most households are poor and heavily dependent on farming as their mainstay, and furthermore, where market information which mobile phones facilitate is crucial to maximizing their incomes.

Key words: gender, smallholder, technical capacity, mobile phone, market access

I Introduction

Shifts in demand and supply conditions of agri-food value chains are constantly reshaping the global agri-food marketing network (Bruinsma, 2009; Cunningham, 2007; Mensbrugge et al., 2009; Regmi and Gehlhar, 2005; World Economic Forum (WEF), 2010). Particularly, in developing countries where rural infrastructure is not fully developed, these changes present new opportunities and challenges to the potential use of information communication technology (ICT), including mobile telephone systems to develop domestic and international trade in food crops. Jensen (2007) and Srinivasan and Burrell (2015) mention that when information is limited or costly, agents are unable to engage in optimal arbitrage, leading to excessive price dispersion across markets and eventual inefficient allocation. This condition violates the law of one price and undermines the Pareto efficiency. Under such conditions, information access may improve market efficiency and performance while raising the welfare of all value-chain actors. Studies by Donner (2006), Hudson (2006), and Muto and Yamano (2009) have shown a strong linkage between mobile phone penetration (and adoption), and increased market efficiency and welfare.

ICT, therefore, has the potential to support the access to and exchange of information for smallholder farmers, and expand networks of farmers and agribusiness, so that they can support each other (World Bank/FAO, 2012). Wegner and Zwart (2011) also emphasize that measures to improve smallholder farmers' capacity to increase food production and productivity, as well as linking them to markets, will not only raise their income but also bring

about wider food distribution, greater availability and wider market accessibility, thereby contributing to global food security.

But in order to successfully use ICT for the optimal development of the market economy, understanding the impact of social structure on adoption and use of ICT devices are invaluable. Burrell and Oreglia (2015), Murphy and Priebe (2011), and Buskens and Webb (2009) argue that the dramatic positive changes brought about by mobile phones, however, have not touched all people. Zainudeen et al., (2008) assert that the 'digital divide' is especially large in low-income countries, where mobile phone penetration levels are also low. A key question in this study, therefore, seeks to assess the extent of mobiles' adoption, of IT knowledge, and its agricultural uses, and what might be the off-farm benefits for male and female smallholder mobile phone users. The European Union (EU) (2013) elaborates that to develop a competitive agricultural sector, investments in agricultural technology should be coupled with access to knowledge and measures for small-scale farmers to help improve their technical capacity. Since rural food crop farmers, who are at the forefront of the agri-food value chains (United Nations Conference on Trade and Development (UNCTAD), 2009; WEF, 2010), often have limited formal education (Asamoah et al., 2013; Wasihun et al., 2014), improving their capacity to use ICT devices would give farmers great impetus and benefit from the emerging changes in agri-food systems. This study, therefore, assesses the knowledge and capacities of male and female small landholders in mobile phone use from a 'gendered perspective' to help understand knowledge gaps that need to be bridged in

Africa's emerging mobile-based agriculture (mAgriculture) for gender mainstreaming (United Nations, 2002). The rest of the article, which follows on from this introduction, comprises the objectives of the field study, a review of existing development literature on the subject, data collection and analysis, results of the empirical study and conclusions.

II Objectives of the research

The growth of Ghana's mobile telecommunication sector over the past decades following the introduction of Ghana's National Telecom Policy (NTP) in 2005 (Ministry of Communications, 2005) and accompanying cost reduction in usage of data bundles has led to an increased number and wider coverage of mobile network operators, and growth of a large number of mobile-enabled information delivery models for the rural population and the agricultural sector. For instance, different models for call centre operations and partnerships as well as commodity prices are being tested by groups such as Esoko, Farm Radio International, Digital Green and the Grameen Foundation for smallholder farmers. Even though some African countries, including Ghana in contemporary times, have begun to experience increasing mobile phone use and wider regional penetration (Castells et al., 2007), the same cannot be said of smallholder farmers in rural and peri-urban areas. Therefore, understanding adoption and use of mobile phones among these more disadvantaged smallholder farmers are particularly important to ensure equity, and fairness is upheld in the country's rural sector.

Mobile phones alone cannot play the role of market information access, though they can be more appropriate to deliver content for customized, timely information delivery, if the ICT is developed appropriately. McNamara (2003) maintains that ICTs are enablers of change and not necessarily creators of change. There is the need, therefore, to address capacity needs of end users of the technology. Thus, understanding the social structure underlying the

context-specific application of ICT (Avgerou, 2010) and conceptualizing the utility of ICTs in relation to the social structure is important since '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' (Hosman, 2010: 50).

The ability to use ICT to achieve such a development goal is critical to economic, social, cultural and agricultural development (Mittal and Mehar, 2012; Srinivasan and Burrell, 2015). Yet, there is a mixed bag of rewards to men and women using ICTs. Whiles considerable gap in the global ICT arena is notable among gender groups, in Ghana much less has been written on gender differences among smallholder farmers in terms of technology adoption and practices (Sarfo et al., 2011). Jensen (2007) also notes that while much has been written on the global 'digital divide' between rich and poor countries, considerably less is known about local and regional digital divides within poor countries, and perhaps among gender groups of smallholder farmers who form the majority of the poor in these developing countries; and numbering about 1.5 billion (Ferris et al., 2014) in overall size.

Available information on gender and ICT familiarity estimates that there are about 300 million fewer female mobile phone subscribers in low- and middle-income countries, than male users (Zainudeen et al., 2008). The Food and Agriculture Organization (FAO) of the United Nations (2009) explains that rural women, due to low levels of education, high rates of illiteracy and lack of important developmental resources or assets, constitute the majority of the world's poorest (Meinzen-Dick et al., 2011; Peterman et al., 2010). These factors may delay the capabilities of women to use mobile phones for accessing market information (Warschauer, 2003); and thus, considering the gender dimensions of mobile phone use in developing countries in the context of Africa's emerging agriculture is important.

Empowering women farmers to adopt and use innovations is important to offset these structural imbalances, and that may require a global gender mainstreaming strategy (United Nations, 2002). The World Bank (2009) also warns that the failure to recognize the roles, differences and inequities between men and women poses a serious threat to the effectiveness of global agricultural development agendas.

The objective of this article, therefore, is to examine gender disparities in mobile phone adoption and use for agriculture and off-farm income generation among local smallholder farmers. Specifically, this study explores: (a) the overall and gender-based adoption and experiences in mobile phone use; and (b) the benefits and perceived impacts of mobile phone use in relation to agriculture and related uses of mobile phones. The findings have policy implications for telecommunication industry operatives including government, non-governmental organizations working in the sector, mobile network operators, other private sector players as well as users, and in developing evidence-based ICT policies and regulations (Gillwald et al., 2010). It also seeks to leverage agricultural market development to encourage (and engender) commercial agribusiness development by improving smallholder linkages aimed at increasing on-farm productivity (Yankson et al., 2016).

III Data collection and analysis

The empirical context of this study is a relatively low-income region in Ghana, inhabited by male and female smallholder, food crop farmers. Central Region is the most deprived, food insecure and poverty-stricken region in southern Ghana (Ghana Statistical Service (GSS), 2008; World Food Programme (WFP), 2009). Two districts, Twifo Atti-Morkwa and Twifo-Hemang Lower Denkyira, of the Central Region were randomly selected to serve as the study's field sites. According to the Ghana Statistical Service (GSS, 2014), the Twifo Atti-Morkwa District has a total trunk

road system of 145 km, out of which 65 km are tarred roads, while 80 km are un-tarred. The district has a total length of 425.60 km of feeder roads; 295.10 km of these feeder roads are properly engineered, while 59.50 km are partially engineered. The district has good access to all six telecommunication networks in Ghana and one radio station which facilitates access and dissemination of information in the district (GSS, 2014).

Twifo-Hemang Lower Denkyira District on the other hand, is also typically rural and was recently (2012) carved out of old Twifo-Hemang Lower Denkyira District, and hence it is characterized by a limited ICT and market infrastructure. Most of the communities are difficult to reach and food crop farming is the main source of livelihood in both districts. These selectively sampled districts can be stratified into five traditional council areas, namely: Twifo, Wawase, Morkwa, Hemang and Jukwa. Three of the traditional council areas (Twifo, Hemang and Jukwa) were randomly selected and further stratified into rural and Peri-urban communities.

The stratification was done through pilot reconnaissance studies and key informant discussions held with the planning officers of the two districts' director of the department of agriculture, traditional chiefs, assembly members, agricultural extension agents (AEAs) and chief farmers. Two communities—one peri-urban and the other rural—were selected randomly from each of the three traditional councils of the district. A simple random-sampling technique was employed to select 246 smallholder farmers, comprising 136 male-headed and 110 female-headed smallholder farmers across the study districts. This allowed for disaggregation of the data by gender. The selection of the sample size was based on a trade-off between resources and time.

In addition to the household survey and to provide in-depth understanding of gender differences in the ownership, usage and experience of mobile phone, two focus group discussions—one solely male and another

solely female—were held in each of the districts to determine some of the factors influencing mobile phone adoption and usage that cannot be determined by quantitative analysis, and also to provide additional insights to some of the results of the household survey related to gender. Both the instruments for the household survey and the focus group discussions were administered in local languages, thereby enabling farmers (male and female) to fully understand each other. Data was collected in June and July 2015, and data collected included farmer-specific attributes, household and community data, mobile electronic literacy, market transactions, and geo-spatial data of farmer's residence and community markets or other agricultural service providers.

IV Results and discussions

ICT indicators of the study districts and socio-economic profile of respondents

The use of mobile phones for communication is widespread across Ghana (Ayensu, 2003; Sarfo et al., 2011). However, national indicators of mobile phone penetration and ICT use mask important district- or regional-level indicators. Although data on mobile phone diffusion across the study districts is sparse, available data from the GSS (2013: 14) indicates that there are six mobile telecommunication network operators within the districts (Table 1). Mobile phone subscriptions per 100 people within the two districts amount to 32. The data also indicates that 38 per cent of the population of Twifo-Atti-Morkwa District own mobile phones.

Table 1. Socio-economic and ICT^a indicators of surveyed districts

Indicator	Twifo-Atti-Morkwa	Twifo-Hemang*	Both Districts
Total population	61,743	55,131	116,874
Male population	30,254 (49.0)	27,370 (49.6)	57,624 (49.3)
Female population	31,489 (51.0)	27,761 (50.4)	59,250 (50.7)
Total households	12,959	12,242	25,201
Households involved in agriculture	9,309 (72.0)	7,345(60.0)	16,654
Proportion of farmers engaged in crop farming	9,060 (97.3)	–	–
Number of mobile network operators	6	6	6
Mobile subscription per 100 people	–	–	32
Mobile phone ownership	15,433 (38.0)	–	–
Men owning mobile phones	8,849 (57.3)	–	–
Females owning mobile phones	6,584 (42.7)	–	–
Population using Internet	1,005 (2.5)	–	–
Male population using Internet	654 (65.1)	–	–
Female population using Internet	351(34.9)	–	–
Literacy (%)	77.7	–	–

Source: Compiled by authors from Ghana Statistical Service (GSS, 2013, 2014).

Notes: ^aPersons having mobile phones refer to respondents 12 years and older who owned mobile phones (irrespective of the number of mobile phones owned by each person).

* Implies authors' estimates based on available data. Figures in parenthesis are percentages.

Although females form the majority (50.7%) of the population within the two districts, relatively fewer numbers of females own mobile phones or use the Internet (persons using internet facility refers to those who have access to internet facility at home, Internet café and mobile phone or by other mobile devices; which differs from the national trend as reported by Scott et al. (2004) that female ownership of mobile phones in Ghana is higher than men). From Table 1, close to 72 per cent (9,309) of the total households of 12,959 in the Twifo Atti-Morkwa District and about 60 per cent of the entire households in Twifo-Hemang Lower Denkyira Districts are engaged in agriculture with a large percentage (98.3%) of the farmers engaged in crop farming.

Table 2 presents the summary statistics for the sampled respondents. From these results, the average age of the sampled farmers in the study districts is 47 years, which is above the national average for the youthful age group (the National Youth Policy of Ghana endorses ages in the range of 15–35 as youth; Ministry of Youth and Sports, 2010). This illustrates an ageing farmer population in the surveyed districts, supporting the national trajectory that 8 out of every 10 older people are engaged in agricultural activities (GSS, 2012; Mbamaonyekwu, 2001). Ageing farmer population may not only affect adoption or diffusion of technology in the districts but also the capacity—energy,

skills and resources—to implement new innovations even if they so want.

The farmers we surveyed also have an average of 19.5 years of experiences in farming. While these longer years of farming experiences might well enhance farmers' production skills (International Food Policy Research Institute [IFPRI], 2009), ageing and longer years of farming experiences could make farmers resistant and hardened to adopting or employing new innovations and technologies such as mobile telephones in agricultural production (Weir, 1999). Since there are no comparable statistics to show the exact number of years of farming experiences beyond which farmers become more resistant and hesitant to adopting new technologies, we cannot confirm the exact stage of adoption by the farmers in the districts. However, from the focus group discussions, there is sufficient confirmation that longer years of farming experience may have negative effects on adoption of new methods in terms of farmers getting stuck with what they know, and becoming unwilling to learn and adopt a new technology such as ICT.

The farmers in the survey districts have an average of 5.8 years of formal education, implying that the average level of education is basic- or primary-level education. Thus most had only primary level education (53.7%). The number of years of formal education of the surveyed farmers depicts high level of illiteracy,

Table 2. Socio-economic and ICT indicator of respondents

Variable	Overall		Male		Female	
	Mean	Std. dev	Mean	Std. dev.	Mean	Std. dev
Age of respondents (yrs)	47	11.70	48.3	11.59	45.4	11.67
Household size (Number)	7.2	3.27	6.9	2.85	7.6	3.71
Number of income earning household members	2	1.28	2	1.45	1.9	1.03
Years of formal education	5.8	3.67	6.4	3.88	4.9	3.21
Experience in farming (yrs)	19.5	11.98	20.9	12.03	17.7	11.75
Total landholding (ha)	2.8	2.23	3.1	2.13	2.6	2.34
Farm size (ha)	1.1	0.81	1.3	0.93	0.9	0.55

Source: Authors' fieldwork, 2014.

and further illustrates that farmers in Ghana are at relatively low levels of formal education (FAO, United Nations Environment Science and Culture Organisation (UNESCO)–International Institute for Educational Planning (IIEP), 2006; GSS, 2012). In situations where farmers have low years of formal education, knowledge of technology use becomes limited, and they are slow to learn or adopt new technological innovations.

Another characteristic of the farmers in the study area is their large household sizes (average of 7.2) relative to the national average of 4.4 (GSS, 2012) with only a few (2 out of 7) of the household members being employed. Though some of the household members may be in the unemployable age category (less than 15 and above 65 years), it is possible that the majority of the households were primarily unemployed. On the other hand, the large household sizes offer potential user markets for operators of mobile phone networks to explore. The average landholding of the farmers in the study area was 2.8 hectares, but the average farm size of the farmers was only 1.1 hectares, indicating that the majority of the farmers are predominantly smallholders. The interviewees were predominantly male (55.3%) and a majority of the sampled farmers (80.1%) were married.

Table 2 also provides gender-based summary statistics of the socio-demographic characteristics of the respondents interviewed for the study. Based on Table 2, the average age of male farmers was relatively higher than that of female farmers in the study area. Yet both gender groups' average ages were older than the youthful age group of 15–35 years; pointing to the ageing of both male and female farming populations. In addition, male farmers had many more years of farming experience and more formal education than female farmers. Male farmers in the districts had larger landholdings and cultivated relatively larger farm acreages than female farmers.

However, female farmers had relatively larger household sizes than male farmers with

few of the household members (1.9) employed in comparison to their male counterparts (2.0). Perhaps, this implies female marginality or vulnerability in the study location. Thus, while female farmers had large household sizes, they had fewer years of education, smaller landholdings; fewer employed household members and in general, cultivated smaller farms. All these comparisons point to increasing marginality and also as a possible source of poverty and food insecurity for female smallholders (United Nations Development Programme (UNDP), 1998). These comparative limitations of the female householders have implications for adoption and use of innovations in the study area since many vulnerable households tend to use basic and rudimentary technology and may be subject to self-exclusion from innovation adoption.

For instance, one informant, Afua (75 years) confirmed that 'although mobile phones are helpful in terms of calling and receiving market information, many smallholder farmers especially the women, are unable to purchase unit [recharge cards] and often rely on relatives working in big cities'. Notwithstanding these practical caveats, or consequential realities, mobile-based technology could be used to raise the income of poor farming households through knowledge of market, production or weather information, provided there are interventions that provide access and training to ensure ICT adoption.

2 Adoption and experiences in mobile phone use

A large percentage (87%) of the farmers owned and had access to mobile phones in their households. This shows that more farmers had adopted mobile phones compared to a recent extant of Ghana Statistical Service (GSS, 2014) finding that only 38 per cent of households used mobile phones in the districts. The remaining 13 per cent who did not own mobile phones is divided into 9 per cent female farmers and 4 per cent of male farmers. Put differently, this translates into 92.8 per cent

of male farmers as well as 79.9 per cent of female farmers now own mobile phones. This result, while supporting the earlier assertion of possible marginality among female farmers in the study location, also provides an important opportunity for innovative uses of mobile phones in agriculture in the study districts. Of particular importance is the possibility of dissemination of market conditions, production details and input information or weather information to farmers in the districts through mobile phones.

It goes without belabouring the obvious that experience and knowledge in the use of mobile phones is crucially important for the success of any mobile-based farmers' programme. Differential gender experiences with, and knowledge of, mobile phone use was clearly observed to factor into the picture. An analysis of the timing of mobile phone adoption shows that although some farmers at the time of the study neither owned mobile phones nor had access to mobile phones in their household; they had some years of experience or knowledge in the use of mobile phones. This was more common among women farmers in the study area as confirmed in the focus group discussions. Explains Obribea (32 years):

I used to have a chip [sim card] which I often pleaded with my friends to place in their phone and use for making my calls or 'flashing [giving someone a missed call]' market women. But now they resist with the excuse that their phone will spoil with frequent opening and closure. So now I receive or make calls using my male friend's phones.

Some other farmers who owned or had access to mobile phones in their household had no knowledge of how they worked. As noted in Figure 1, about 15 per cent of the respondents had no working knowledge in mobile phone use. The rest of the farmers had 1–14 years of experiences in the use of mobile phones. A large percentage of the respondents had about three to five years of experience in mobile phone use. The moving average, as shown in Figure 1, suggests that there was an increasing trend of mobile telephone ownership

and growing demand among farmers in the survey districts for the past 14 years.

Gender disparity in experience and years of adoption of mobile phone use was also observed. As shown in Figure 2, male farmers had many years (Mean = 5.03 years; SD = 3.122) of experience in mobile phone use in comparison to female farmers (Mean = 3.03 years; SD = 2.383). Specifically, the male farmers' years of experience in mobile phone use ranged from 0–14 years as compared to 0–9 years for female farmers.

Gladys (47 years) states:

If I hear my phone ringing [tone of my phone], I have to run to my neighbour's [proximate literates and trusted others as described by Dodson et al., 2013] if my children are not home for them to help me answer the call or make a call. I sometimes get fed-up with this running business.

Some farmers, especially men farmers, also use involuntary mechanisms such as voice of the person calling, ringing tones assigned to specific people with the help of trusted literates or nature of the mobile phone number for gauging who to call or know who is calling their mobile phone.

I feel shy going to my neighbour to ask him to help me make a phone call or know who is calling my phone. So I use their voice or watch their position on my phone book or tell my children to write their numbers in a book for me said Bonsu (51 years), a cassava grower with six children and a wife.

Beyond this, the percentage of male farmers with a lengthy number of years of experience (5 to 14 years) in mobile phone use was greater than that of female farmers. Also, close to 28 per cent of female farmers did not have any knowledge or experience in mobile phone use compared to 5 per cent for male farmers. Another prominent observation from the information shown in Figure 2 is that more female farmers have experience in mobile phone use in the range of 2.5–4.5 years than male farmers. This perhaps indicates a category of women farmers with changing lifestyles who have become interested in using mobile phones

or adopting new technologies. Overall, we find significant differences in the number of years of adoption of mobile phone between male and female farmers ($t(244) = 5.445$; $P \geq 0.01$) in the study districts. By comparison, Masuki et al. (2010) also found that women used phones less than men in a 2010 study on

the use of mobile phones to aid agricultural development in Southwestern Uganda.

3 Agricultural uses and off-farm income from mobile phone use

The relevance to farmers for adopting mobile phones within the agricultural sector was

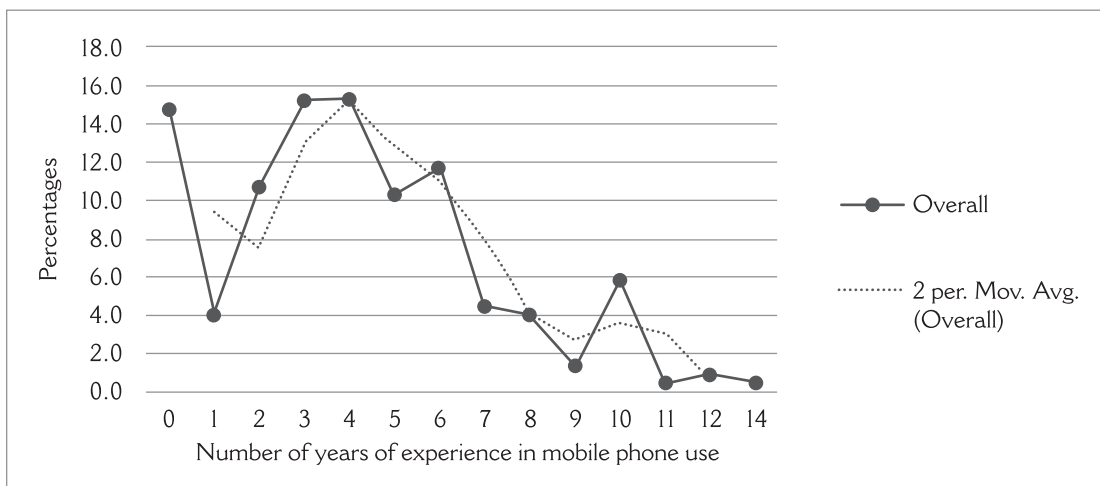


Figure 1. Sample distribution by years of experience in mobile phone use

Source: Authors' field work, 2014.

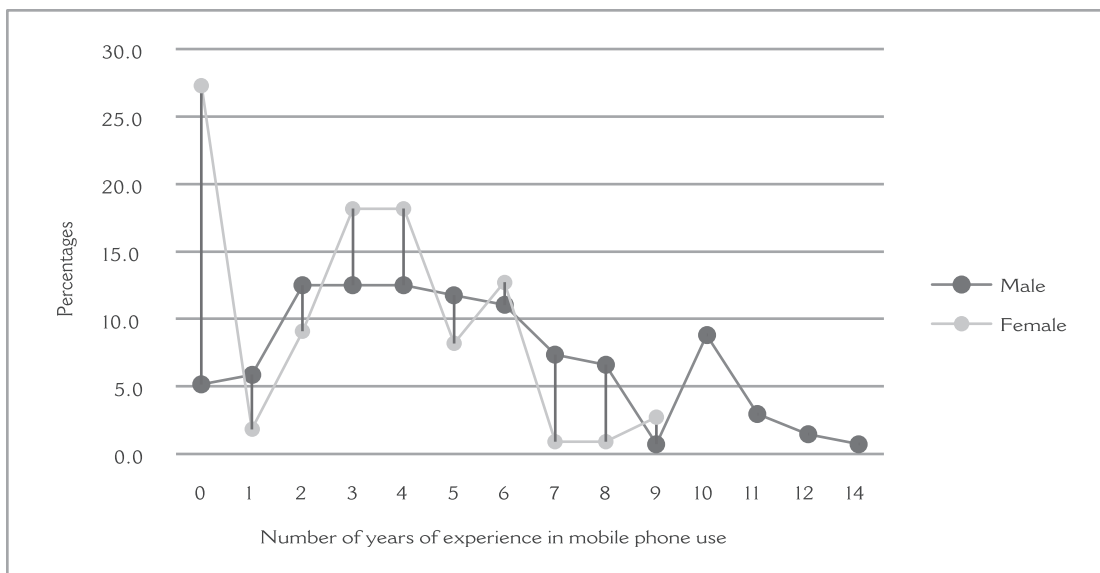


Figure 2. Sample distribution by years of experience in mobile phone use by gender

Source: Authors' field work, 2014.

relatively broad and wide-ranging. One main use was to find market prices of commodities in the product market, another was to contact input dealers in the factor market, while another was to contact extension agents and other specialized agricultural service providers such as veterinary officers. In addition, mobile phones were used to contact transporters of their produce and financial institutions (Table 3). From the estimates we calculated, a large percentage of the farmers use their mobile phones for accessing market information on commodity prices (95.6%) and inputs (46.4%). On the other hand, few of the farmers ever contact extension agents (12.8%) or financial institutions (17.6%). The majority of the male farmers used their phones for contacting input dealers, transporters and financial institutions compared to their female counterparts. Female farmers often used their phone for seeking information on

market prices, most probably because they are the main people involved in selling their farm produce in many rural parts of Ghana.

Data was also collected on the use of mobile telephones for generating off-farm income among the participants of the study (Table 4). Murphy and Priebe (2011) in their parallel study to ours mention that there are several entrepreneurial innovations of rural African cell phone users such as repairs and charging services. We expected that challenges in mobile phone use would generate spontaneous local service provisioning in rural areas. Our study found that mobile phones also provided off-farm income for some rural inhabitants, even though the service provision was not entirely related to the challenges in mobile phone use as noted by Murphy and Priebe (2011). In some rural communities where mobile phones were difficult to access or network coverage was low, farmers found

Table 3. Agriculture and related uses of mobile phones by farmers

Agricultural Uses of Mobile Phones	Overall (%)	Male (%)	Female (%)
Contacting market women and other sellers for market prices	95.6	53.6	77.6
Contacting input dealers	46.4	94.8	14.4
Contacting extension agents and other specialized agricultural service providers	12.8	24.0	14.4
Contacting transporters	25.6	46.8	28.8
Contacting financial institution	17.6	48.0	6.0

Source: Authors' fieldwork, 2014.

Table 4. Mobile-based off-farm activities of farming households

Activity	No. of Households Employed	Average Income/Year (GHC)
Local call centre	12.00	690.17
Local credit transfer	13.00	260.62
Local credit wholesale distributor	3.00	2,000.00
Local money transfer	0.00	0.00
Local phone charging	0.00	0.00
Other phone-based income generating activities: mobile phone sales	0.00	0.00

Source: Author' fieldwork, 2014.

it less attractive to own mobile phones. In such instances, many farmers used local call centres, popularly called 'space-to-space'. Some farmers also took advantage of the poor network by operating local call centres which generates income or serves as secondary source of livelihood for the farm family.

In our study, a total of 12 farming households were engaged in the provision of local call services. This provided them with an average annual income of GHC¹ 690.17 to supplement on-farm household income. We found that the majority of the operators of the 'space-to-space' business were female, especially school dropouts or those awaiting their school final examination results, or relatives brought in to purposely manage some such rural enterprises. Off-farm income according to Bryceson (1996) has the greatest poverty alleviating potential. Improved mobile network coverage and penetration will thus improve the rural business climate and enable the private sector to enter into other profitable mobile phone ventures. Giger (2004) also explains that ICT could be a vehicle for empowering the poor. Thirteen farming households engaged in local phone credit transfer and obtained an annual income of GHC 260.62. Three of the farming households were involved in local phone credit wholesale distribution and made an average income of GHC 2,000.00 per annum. No household was found to be involved in either local money transfer or phone charging.

4 Perceived impacts of mobile phone use

Our study was also interested in how farmers' mobile phone usage relates to market access, profitability and productivity (Table 5). Many farmers indicated that the use of mobile phones made it easier for them to communicate with their 'middle-women' providers and other market customers. Over 80 per cent of the farmers owning mobile phones also reported that ownership of mobile phones reduced their market transaction costs. Thus, they were able to inform itinerant traders and middle-women of quantities of specific agricultural produce that were available. Farmers also contacted other farmers or traders about prevailing market prices which enabled farmers to know the prevailing market prices of agricultural commodities in various markets within the district, and thus enabled them to negotiate and sell produce at competitive prices (better realization of price, 67.5%), and thereby improving their incomes (89%). For instance, Muto and Yamano (2009), investigating the expected reduction in marketing costs of agricultural commodities in Ugandan households, observed that expansion in mobile phone coverage induce the market participation of farmers who produce perishable crops in remote areas. Knowing market prices and information of tradable quantities of produce also helped the farmers to congregate themselves, blend their produce with others' and sell as a group, thereby reducing the individual's transaction cost and increasing profitability.

Table 5. Impacts of mobile-based information

Impact	Percent (%)	Chi-Square	Asymp. Sig.
Better price realization	67.5	30.065	0.000
Increased trading quantities	75.6	64.537	0.000
Reduced searching and transaction cost	82.3	149.854	0.000
Increased income	89.0	5.87	0.015
Easy access to support institutions	38.6	12.748	0.000

Source: Authors' field work, 2014.

Findings from the survey also indicated that mobile phone ownership also helped farmers in the acquisition of inputs such as fertilizers, seeds and pesticides, and farm tools such as cutlasses, hoe and axes from the input dealers. Farmers group themselves together to negotiate for input prices and purchase the essential inputs in bulk.

Mobile phone access also facilitated inter-market trading among the farmers as market information obtained by some farmers helped them to sell their produce in markets beyond their community. Although there were specific days set for each community market (periodic markets) in the districts, in some instances farmers did not sell their produce in some markets due to low demand and price (thus, they avoided markets where demand and prices are low at certain times). For instance, when it was realized that although there is a large market in Hemang, the district capital of Twifo-Hemang Lower Denkyira District, and its market day was always on Wednesdays, farmers in the community preferred to sell at Twifo Praso market or Cape Coast Market based on information obtained about prices in those markets. Their arguments were that Hemang market usually attracts fewer middle women and other buyers when compared to Twifo Praso or Cape Coast market.

Access to mobile phones facilitated accessing rural support institutions (38.6%). Some farmers used their mobile phones to contact extension officers who supported their farming activities. At the start of the farming season, the phones are used to enquire about the onset of the rains and time of planting, sources, and availability of seeds and other inputs. They also used phones to report the incidence(s) of pests and diseases on their farm. This served as an excellent means for initiating an early response to emerging environmental and ecological dangers. A few farmers also contacted rural financial institutions for accessing agricultural credit.

To summarize our findings, the main livelihood activity of the interviewees (namely

farming) and their phones were mainly used for contacting extension agents, agro-input shops, farm hands, and labourers and credit institutions at the beginning of the farming season, and in contacting market women in the middle and end of farming season or during the harvesting period. Saunders et al. (1994) similarly identified the benefits accruing from the widespread adoption of ICTs in developing countries to include increasing people's knowledge of market information; improving the coordination of transportation, especially during emergencies; and enhancing the effectiveness of development activities.

V Conclusions and recommendations

In many developing countries and rural parts of Africa, including Ghana, logistical constraints such as transportation facilities, and access roads to and from farming communities and markets pose an immense challenge to rural development. In most of these developing countries post-harvest losses are generally beyond threshold levels due to large infrastructural deficiencies. Storage facilities may be non-existent or very limited, and deplorable roads limit easy access to market centres, thereby reducing the profitability of the farmers. Access to mobile phones, therefore, bridges the gap between production and consumption centres, as it eliminates communication gaps that would have persisted due to the existence of deplorable road conditions and high transport cost.

Our study shows that the majority of smallholder farmers in our study districts own mobile phones. Other studies in Sub-Saharan Africa and other parts of the World (Asongu and Nwachukwu, 2017; Mittal and Mehar, 2012; Murphy and Priebe, 2011; Muto and Yamano, 2009; Scott et al., 2004; Srinivasan and Burrell, 2015) further assert that increased mobile phone penetration and access could reduce information asymmetry within rural production systems, enhance rural extension communication, access to agricultural market information and improve the performance

of agri-food chains of smallholder farmers through mobile-based telephony and information systems. Unfortunately, the majority of the smallholder farmers interviewed had limited or no knowledge in the use of mobile phones, predominantly among the female farmers. Scott et al. (2004) similarly identified low awareness and potential use of mobile phones among women in Ghana, Uganda and Botswana as major setbacks in the use of mobile-based information systems among men and women, as inferred from our study. But beyond awareness, capacity to use mobile phones to access information is key to the achievement of inclusive development as outlined in the Sustainable Development Goal seven (SDG7). Therefore, investing in ICT access and quality education is more critical for Africa, not only because growth potential of ICT in Africa is higher compared to other continents such as Asia, Europe and North America—which are currently experiencing stabilization in the growth of ICT and business opportunities related to mobile phones and the Internet (Asongu and Moulin, 2016)—but also because ICT has the potential to catalyse rural transformative agenda in Africa by fostering innovation, inclusive and sustainable industrialization.

It, therefore, implies that for effective use of mobile technology and other ICT devices for agricultural information dissemination and marketing, smallholder farmers' overall use—familiarity and effective capacity—range needs to be enhanced. This study, therefore, suggests that extension education in Ghana and other rural parts of Africa should go beyond awareness campaigns to include building the capacity of smallholder farmers, especially women farmers, to effectively use mobile phones in accessing useful agricultural and market information. While there are routine in-service, local or foreign capacity building and refresher training for staff of the Ministry of Food and Agriculture (MoFA) (as reported in the Annual Performance Review (APR) of MoFA, 2010, 2011, 2012), including AEAs, in

various fields such as food processing, integrated pest management, animal husbandry, environmental toxicology and rural development, the programme coverage should be broadened to include ICT. The Ghana Education Service through the National Council for Tertiary Education, in collaboration with MoFA, should also introduce diploma programmes in ICT and agro-technology to the smallholder farmers without barriers of academic background, age and gender in local languages.

Mainstreaming gender in agricultural ICT programmes would also serve to promote and increase the use of mobile phones among the gender groups. Therefore, Women in Agriculture Development (WIAD) directorate of MoFA—which is involved in the provision of technical backstopping for regional and district staff for effective transfer of appropriate technologies to women farm families in crop, livestock and fish production, processing, utilization and marketing—through regional officers and other stakeholders should also incorporate ICT programmes in their annual work plans for implementation and assessment. The agricultural information services directorate of MoFA should also support training of AEAs and farmers in the use of ICT devices, especially mobile phones since this could be an effective conduit for agricultural production as well as market information dissemination. Often farmers rely on relatives, friends or customers in various markets for prices of commodities. Meanwhile the Statistics, Research and Information Directorate (SRID) of MoFA collects weekly data on market prices. This data could be more useful to farmers when there is fast, efficient and reliable means of communicating the information to farmers. Therefore, the various ministries, departments and agencies in the agriculture sector should collaborate in the training of AEAs, particularly female AEAs (especially due to the inability of male AEAs to conduct some activities that are women related as noted in the 2010 APR of MoFA) on mobile telephone technologies and to facilitate information access by farmers.

Government, through MoFA, should work closely with cocoa marketing agencies in forming farmer-based organizations (FBOs) to facilitate ICT capacity building among farmers. Since cash crop FBOs survive relative to food crop FBOs and majority of food crop farmers are also into food crops, MoFA's FBO formation should be closely linked with already existing cash crop FBOs established by the cocoa marketing agencies.

Telecommunication agencies or organizations also stand to benefit by educating smallholder farmers on the use of mobile technology in general as well as the procedure for accessing their services, particularly Internet and texting. Farmers form the largest core of the Ghanaian population, and therefore increasing the knowledge of local farmers in ICT, particularly women farmers, would help improve market penetration and provide concomitant benefits to smallholder farmers. Also, to boost rural access to mobile-based services that improve smallholder market information, there is the urgent need to expand network coverage to rural parts of Ghana and Africa. For instance, extension offices often require smallholder farmers to send pictures of disease infection and other emerging production irregularities; however, sending such information using mobile phones at times takes days, or never arrives, due to poor network coverage and strength. This hinders emergency response to disease and pest outbreaks, for instance. There is, therefore, a pressing need for central governments and mobile network companies to collaborate to improve and expand mobile network infrastructure in rural parts of Ghana and other parts of rural Africa to spur rural diversification, expand the market for the mobile operators and improve access to market information by women smallholder farmers.

Note

1. GHC is Ghana Cedis, the national currency of Ghana; GHCI = 0.2886 USD Retrieved 26 February 2015, from Bank of Ghana http://www.bog.gov.gh/index.php?option=com_wrapper&view=wrapper&Itemid=89

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