Community, Crowdsourcing, and Commerce: WhatsApp Groups for Agriculture in Kenya

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Submitted in partial fulfillment of the requirements for the
Master's degree in Globalization and International Development

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Abstract

WhatsApp's growing presence in the developing world has led to a grassroots movement of messaging groups designed to serve relevant needs for small scale farmers in Kenya. These groups provide the means for as many as 256 members to ask questions, share experiences and solutions, gain access to information, and access markets for their products. This research project examines the use of these WhatsApp groups for agriculture in Kenya. The project seeks to understand the existing barriers to participation, and the use, benefits, and shortcomings of these groups for their members. Research findings indicated that farmers' overall access to smart phones is a substantial barrier to their participation in groups for agriculture, and these barriers are expectedly more difficult for the poorest and most vulnerable (in which intersectional poverty creates additional barriers). However, while each group can vary significantly, members report that WhatsApp groups as a whole overwhelmingly benefit their livelihoods and practice. Systemic and societal change occurs when the experiences and successes of one individual are shared with a larger group – leading to rapid and shared prosperity. As each individual learns a new skill, technique, or input, the group must also learn and benefit from that knowledge. WhatsApp provides the means and the platform for this type of information exchange to occur at scale, and with individuals who would otherwise be unlikely to communicate. This research project examines the emerging use of grassroots WhatsApp groups as a potential example of this positive and inclusive approach to extension and development in agricultural communities.

Acknowledgements

My father, Marc David, for getting me to this point in my life, and surely wherever else I'll end up.

My mother, Mary Elizabeth (Lisa) David, for a lifetime of love, caring, and support.

My stepfather, Lynn Lystang, for being the only one to read my undergraduate thesis, and somehow still being interested to read the sequel.

My sister, Willow David, for waving on facetime when I'd call home to say "I'm still not finished yet".

Caroline, Elliott, Marleau, and Remy Sullivan-Brown, for giving me a roof over my head after returning from field research (for far longer than expected!), and for making Ottawa feel like home every day. Caroline was unrelenting in providing both the motivation to complete what seemed like an insurmountable challenge, and the celebrations of every little win – I wouldn't have done it without her.

Mila Kamenova, for giving me the much-needed daily scolding to get this finished, and for assuring me that I had it in me.

Everlyne Binyanya Obwocha, for being the best research assistant I could have ever hoped for, and Izo for the great conversations on the road.

My kind and incredibly supportive supervisor Dr. Joshua Ramisch, for his thoughtful and ongoing encouragement throughout this experience.

And of course, I would like to thank all of the kind, patient, and welcoming research participants, without whom this research project would not have been impossible.

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List of Acronyms

CoP	Communities of Practice
GDP	Gross Domestic Product
ICTs	Information and Communication Technologies
ICTD	Information and Communication Technologies for Development
ILO	International Labour Organization
INGO(s)	International Non-Governmental Organization(s)
NGO(s)	Non-Governmental Organization(s)
SMS	Short Message Service
VCoPs	Virtual Communities of Practice
VoIP	Voice over Internet Protocol

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Chapter One: Introduction

The international community has made great strides towards providing the necessary support to grow the developing world's agricultural sector. However, many farmers continue to lack the necessary information and support networks to avoid crop and animal loss, find markets, or adapt to the effects of climate change. Attempts have been made by some NGOs to design technological services to fill this gap, but they have fallen short due to a top-down structure and inability to provide the means for a community of farmers to communicate and share information on a participatory and horizontal basis. When faced by a gap in their needs, the developing world is extremely adept at using their available resources in search of a solution. As a result, farmers throughout sub-Saharan Africa, and particularly in Kenya, have turned to WhatsApp.

WhatsApp is a mobile application that allows users to communicate through encrypted messages, and to place audio or video calls. WhatsApp replaces the need to use traditional cellular connectivity for the same services by using internet connectivity.[1] While WhatsApp is only available on internet-enabled devices (most commonly smartphones), its rate of use in the developing world is becoming increasingly ubiquitous.[2] This is due primarily to its drastic reduction in the costs associated with communication - as the data required to use the application is far less expensive than the traditional per-minute and per-SMS rates of cellular services. WhatsApp also offers additional functionality to that of traditional cellular communication, including the ability to send images, links, videos, and to create group conversations with up to 256 users.

WhatsApp's growing presence in the developing world has led to a grassroots movement of messaging groups designed to serve relevant needs for the world's poor. Farmers lacking adequate information and seeking to join a community of practice have created WhatsApp groups that are specific to agriculture livelihoods. These groups provide the means for as many as 256 members to ask questions, share experiences and solutions, gain access to information, and access markets for their products. WhatsApp's emergence has contributed to the understanding of ICTs for development, technological leapfrogging, and virtual communities of practice. Likewise, as there is very limited academic discourse on this specific use of WhatsApp for agricultural development, its utility and existence can be examined through the same lenses. WhatsApp is still a relatively new platform for the developing world, and its use to create livelihood groups a likewise emerging phenomenon. The literature review of this project will be comprised of an analysis of the introduction of ICTs in sub-Saharan Africa; the role of mobile phones and mobile internet technology in the developing world; the concept of technological leapfrogging; and the emergence of virtual communities of practice.

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[1] Robert McMillan, You May Not Use WhatsApp, but the Rest of the World Sure Does," *Wired Magazine,* February 20th, 2014.

[2] Laura Silver, Aaron Smith, Courtney Johnson, JiniJini Jiang, Monica Anderson, and Lee Rainie. "Mobile Connectivity in Emerging Economies." *Pew Research Center*, (March 7th 2019).

This research project examines the use of WhatsApp groups for agriculture in Kenya. The project seeks to understand the existing barriers to participation, and the use, benefits, and shortcomings of these groups for their members. Field research was conducted from July 4th – October 4th 2018, and included 60 remote interviews[3] and 30 farm visits with farmers using WhatsApp groups for agriculture. The project also included 60 interviews with farmers in village markets and agricultural areas who were not targeted for their use of WhatsApp, in order to establish a baseline participant pool. Three focus groups with WhatsApp group member farmers were conducted, as well as five interviews with actors in the field of agricultural development.

Research findings led to three primary conclusions. First, that farmers' overall access to smart phones is a substantial barrier to their participation in groups for agriculture, and these barriers are expectedly more difficult for the poorest and most vulnerable (in which intersectional poverty creates additional barriers). Additional barriers related to awareness were also discovered, indicating a sizeable group of farmers who know these groups exist, but are unaware of how to join them. Research findings indicate that the use of WhatsApp groups for agriculture is far lower than the existing use of WhatsApp among farmers. When considering the use of smartphones in the developing world as a tool often shared by families and neighbours, the gap between farmers using WhatsApp groups, and farmers with the necessary technology to access them, is wide. This gap indicates that modest investments in raising awareness of the existence of these groups and how to join them could substantially increase use among those who already have the necessary resources to participate.

Second, while each group can vary significantly, members report that WhatsApp groups overwhelmingly benefit their livelihoods and practice. Nearly all (91.7%) respondents indicated that WhatsApp has directly led to an increase in their income. This was described as having been achieved primarily through increased access to markets and market information, and better or new farming practices leading to increased production and/or reduced loss. These benefits are enhanced by the virtual community of practice formed within strong groups, in which all members can communally learn from and interact with each other's questions and feedback.

Finally, the groups which have the highest level of satisfaction among members are those with established rules, strong administration, and include a diversity of members (specifically including experts). At their most basic form, a 'successful' group requires a handful of members and at least one administrator tasked with keeping discussion on topic and ensuring bad actors are promptly removed. This indicates an opportunity for WhatsApp groups to continue to grow in numbers, and may increasingly be used by government and NGO/development actors to reach rural farmers. Establishing semi-formalized groups with a minimal investment could allow a handful of paid experts to serve multiple groups and thousands of farmers. This may include thinly-resourced agricultural extension officers or agricultural organizations working directly with small-scale farmers in rural areas.

[3] Initial interviews were conducted by participants online by using a link to the survey, while the majority of interviews were conducted over the phone.

When internet access was first being introduced in the developing world, it was heralded by some as a potential silver bullet to poverty. The assumption was that as every individual increasingly gained access to the wealth of knowledge, they could leapfrog past the need for adequate education and physical resources to fill existing gaps through decentralized digital mediums. WhatsApp's utility is demonstrated by the fact that access to WhatsApp implicitly includes access to the internet as a whole. While information and knowledge are necessary and powerful tools, change does not come from the myopic pursuits and accomplishments of individuals. Rather, systemic and societal change occurs when those experiences and successes are shared with a larger group – leading to rapid and shared prosperity. As each individual learns a new skill, technique, or input, the group must also learn and benefit from that knowledge. If the internet alone was enough to solve the challenges faced by small-scale farmers in Kenya, WhatsApp groups for agriculture would not exist. Instead, these groups provide the opportunity for communities to emerge, gain positive reinforcement, and share in mutual prosperity. This research project will examine the emerging use of grassroots WhatsApp groups as a potential example of this positive and inclusive approach to development in agricultural communities.

This research project will have the following structure. Beginning with a literature review, the related and foundational issues of agriculture in Kenya, ICT leapfrogging, and previous attempts to harness ICTs for agricultural development will be examined. Following this, a brief description of the WhatsApp application and group-chat functionality will be provided, leading to an understanding of how these groups are being used in Kenya through the lens of virtual communities of practice. The following chapter will describe the research design and methods, including a description of each pool of research participants. The first results chapter (chapter four) will describe the issues of access and awareness, particularly focusing on the barriers that prevent or preclude increased participation in WhatsApp groups for agriculture. The second and final results chapter will describe the use, utility, and experiences of those farmers who have used WhatsApp groups as a tool for their agricultural livelihoods. The project will conclude with a summary of the research findings, as well as recommendations for further study. Annexes are also provided, including details of the groups joined by the researcher; demographic information of each respondent, by participant pool; and the locations of field visits and interviews conducted in Kenya.

Chapter Two: Literature Review

2.1 Agriculture in Kenya

The Kenyan economy, and over half of the Kenyan population itself, is reliant on the agricultural sector as a primary source of income generation. Kenya's agriculture, forestry, and fishing sectors contributed 34.2% to its GDP in 2018.[4] In comparison, the same sectors in Canada contributed only 1.7% in the same year.[5] Kenya's domestic agriculturalists produce 63% of the food consumed in the country,[6] and small-scale production represents roughly 75% of the total agricultural output and 70% of the marketed agricultural produce.[7] Agriculture serves as a major source of domestic economic activity, but also forms up to 65% of Kenya's merchandise exports.[8] Kenya's prosperity and overall development is still highly dependent on its agricultural sector, and this is not likely to change in the coming years.

These rates upon which Kenya's economy is highly dependent rely on a majority of Kenyans who gain their income through agricultural activities. The ILO estimates that 57% of the Kenyan population is employed in the agricultural sector.[9] This rate is higher for women when compared to men, at 63.4% and 50.9%, respectively.[10] Furthermore, agricultural income remains the largest income source for both poor and non-poor households in rural areas.[11] While a limited number of agricultural producers in Kenya are able to prosper on a large scale, the majority of those working in agriculture do so within the context of smallholder farming. 87% of farmers in Kenya work on less than two hectares of land, and 67% work on less than one hectare.[12] Kenya's poor are indeed overwhelmingly involved in the agricultural sector, but much of that activity is based around immediate survival. Improvements in the quality and scale of production yields can provide a substantial change in income for smallholder farmers, who currently only sell about a quarter of what they produce - consuming the rest for subsistence.[13]

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[4] World Bank, "Agriculture, forestry, and fishing, value added (% of GDP) - Kenya, Canada." *World Development Indicators* (2019).
[5] Ibid.
[6] George Rapsomanikis, "The Economic Lives of Smallholder Farmers: An Analysis Based on Household Data from Nine Countries," *Food and Agriculture Organization of the United Nations* (2015): 6.
[7] Stephen P. D'Alessandro, Jorge Caballero, John Lichte, and Simon Simpkin, "Kenya: Agricultural Sector Risk Assessment," *World Bank Group Report Number 97887* (2015): 9.
[8] Ibid, 1.
[9] World Bank. "Employment in agriculture (% of total employment) (modeled ILO estimate) – Kenya." *World Development Indicators* (2019).
[10] World Bank. "Employment in agriculture, male (% of male employment) (modeled ILO estimate) – Kenya." *World Development Indicators* (2019).; World Bank. "Employment in agriculture, female (% of female employment) (modeled ILO estimate) – Kenya." *World Development Indicators* (2019).
[11] World Bank. "Kenya Economic Update: Transforming Agricultural Productivity to Achieve Food Security for All" *World Bank Publication* (April 2019).
[12] Stephen P. D'Alessandro, Jorge Caballero, John Lichte, and Simon Simpkin, "Kenya: Agricultural Sector Risk Assessment," *World Bank Group Report Number 97887* (2015): 9.
[13] George Rapsomanikis, "The Economic Lives of Smallholder Farmers: An Analysis Based on Household Data from Nine Countries," *Food and Agriculture Organization of the United Nations* (2015): 27.

While Kenya's agricultural sector is overwhelmingly formed by its poorest and most vulnerable rural population, agriculture in Kenya appears to provide the potential to lift millions out of poverty. Efforts to improve the experiences of Kenyan agriculturalists can have a significant impact on Kenya's GDP, and on the wellbeing of a majority of its population. Recent research supports this claim. A 2019 study by the World Bank concluded that Kenyan households exclusively engaged in agriculture as a livelihood contributed 31.4% to reductions of rural poverty in the country since 2006.[14] It is clear that even moderate improvements in the capacity, knowledge, and inputs available to agriculturalists can lead to significant changes in the socio-economic status of Kenya's poor and vulnerable.[15]

Yet the transfer of knowledge alone may not always be enough to motivate a change in practice. Farmers may be provided a variety of sources of information that could theoretically improve their livelihoods, but applying knowledge can be a complicated issue, particularly for the poorest and most vulnerable. Issues related to risk tolerance can be significant, leading the most vulnerable farmers to avoid improvements that carry a chance of failure or uncertainty.[16] This is particularly true for capital investments (such as installing a greenhouse or fishpond) but can also include less obvious examples such as being recommended a new seed or input. While a new seed variety may carry the potential to increase yield and reduce loss, be more climate-resilient, or increase nutritional output; a farmer may be reticent to risk planting a crop they feel unfamiliar or inexperienced with.

An insight into overcoming the challenges of transforming knowledge into practice may come from understanding the preference of small-scale farmers in how they receive agricultural extension. A study in Nigeria from 2008 surveyed preferred sources of extension services, in which multiple preferences could be selected.[17] Research findings included a preference for extension agents (71.2%); farm demonstrations and agricultural shows (31.5%); friends and relatives (27.2%); and fellow farmers (27.1%). The most preferable extension source that did not include specialist or farmer-to-farmer interaction was radio (28%).[18] This indicates an overall preference for interpersonal extension services among smallholder farmers, with a clear bias towards extension agents.[19] Interpersonal contact allows a farmer to ask follow-up questions, gain trust in the information being provided, and thereby reduce the perceived risk of implementing the knowledge being transferred. In this sense, the issue of risk tolerance becomes interwoven with the issue of trust, and may increase the likelihood of knowledge being applied into practice.

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[14] World Bank. "Kenya Economic Update: Transforming Agricultural Productivity to Achieve Food Security for All" *World Bank Publication* (April 2019).
[15] Ibid.
[16] César Salazar, and John Rand. "Production Risk and Adoption of Irrigation Technology: Evidence from Small-Scale Farmers in Chile," *Latin American Economic Review* 25:2 (2016): 22-23.
[17] Umunna Nnaemeka Opara, "Agricultural Information Sources Used by Farmers in Imo State, Nigeria." *Information Development* 24:4 (2008): 293.
[18] Ibid.
[19] Ibid, 292.

Traditionally, efforts to promote better practices and increased access to modern farming inputs have been based around the existence and provision of agricultural extension services by the government and some NGOs.[20] The primary source of extension service delivery in Kenya comes from the physical presence of agricultural extension officers throughout the country.[21] These individuals are most often employed by the government and tasked with providing support to agriculturalists, particularly smallholder farmers and livestock producers.[22] Farmers often lack the time or resources to frequently travel to town to inquire about issues, and instead request officers to visit them on their farms – allowing officers to observe and provide support. However, extension services in Kenya face the common challenge of the widely dispersed nature of smallholder farmers, coupled with a lack of sufficient resources to adequately serve all of those individuals.[23] While this 'training and visit' approach to extension was key to earlier rural development models in Kenya, structural adjustment programs severely reduced the available resources to continue this one-on-one approach to extension. As a result, the capacity of extension officers to reach all farmers in their responsible areas has been far lower than was available in the past. Farm visits are a valuable component of agricultural extension services, yet they are severely limited in their ability to maximize impact in farming communities as a whole by the available human and financial resources in each particular region.

The reduction in available extension services has had led to an increased emphasis on innovative and alternative approaches to agricultural extension.[24] These new models are driven by approaches that are participatory, demand-driven, client-oriented, and farmer centered.[25] A 2014 study in Kenya of one such model, volunteer-farmer-trainers (VFTs), indicated that farmers were motivated to participate as long-term volunteers to support other farmers in an official capacity – indicating the viability of farmer-to-farmer extension.[26] The model was also found to be positive in complimenting the existing services available.[27] This indicates both the changing trends in agricultural extension in Kenya, whereby farmers are increasingly supporting each other to fill persistent gaps, and the benefits that such models can provide for the application of knowledge. Farmers are

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[20] Elizabeth Nambiro, John Omiti, and Lawrence Mugunieri, "Decentralization and Access to Agricultural Extension Services in Kenya," *Contributed Poster Prepared for Presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia* (August, 2006): 6-7.
[21] Ibid.
[22] Ibid, 8.
[23] Elizabeth Nambiro, John Omiti, and Lawrence Mugunieri, "Decentralization and Access to Agricultural Extension Services in Kenya," *Contributed Poster Prepared for Presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia* (August, 2006): 9.
[24] Everlyne Kiptot and Steven Franzel, "Farmer-to-Farmer Extension: Opportunities for Enhancing Performance of Volunteer Farmer Trainers in Kenya." *Development in Practice* 25:4 (2015): 504.
[25] Ibid.
[26] Everlyne Kiptot and Steven Franzel. "Voluntarism as an Investment in Human, Social and Financial Capital: Evidence from a Farmer-to-Farmer Extension Program in Kenya." *Agriculture and Human Values* 31:2 (2014): 231-32.
[27] Everlyne Kiptot and Steven Franzel, "Farmer-to-Farmer Extension: Opportunities for Enhancing Performance of Volunteer Farmer Trainers in Kenya." *Development in Practice* 25:4 (2015): 504.

able to trust other farmers, and that trust can provide the means for effective knowledge transfer to lead to a successful change in practice.[28]

However, the nature of one-to-one support can lead to a lack of consistency in acquired knowledge among farmers in a local area. Further, as a result of thinly stretched resources, service delivery of this type can be more reactive than proactive. Extension officers interviewed through this research project indicated that in many cases, multiple visits to a single farm were necessary to combat a pest or blight. When considering that these crop and/or livestock related issues are often prevalent and widespread within a local area, the challenge of supporting a large group of farmers is considerable. A study in Bungoma County, Kenya, found that the average farmer in Kenya had a mean of one visit by an extension officer per year.[29] While extension officers may be aware of a relatively simple and low-cost solution to eradicate and prevent further invasion of pests, they are often limited to visiting farms that were already afflicted in an effort to support farmers. This decentralized and siloed approach to service delivery can lead farmers to focus on solving problems rather than investing in prevention or improving production. Overall, extension officers are limited by distance, time, and resources in their ability to assist large numbers of farmers in Kenya. Some have begun to argue that this will continue to be the case without the use of innovative approaches (specifically ICTs) to fill these existing gaps.[30]

Through the literature examined above, a number of conclusions can be drawn. First, that agriculture is arguably the most important sector for the livelihoods and wellbeing of Kenya's rural poor, and that efforts made to reduce rural poverty must be closely linked to interventions in and support of the agricultural sector. Next, that such efforts can find real success in reducing the rate of rural poverty, with the benefits of increased GDP and reductions in rural poverty cascading throughout the country. Finally, that while traditional agricultural extension services are valuable and necessary for the future prosperity of Kenya's agriculturalists, they are unable to provide the scale of support needed by a community that is, by its nature, geographically dispersed and disparate. This indicates a gap that, if closed, could have far reaching effects on the prosperity of Kenya's rural population and the prosperity of the country itself.

Conveniently, Kenya is well positioned for the integration of innovative approaches in agricultural extension services, particularly due to its relatively well-connected and technologically advanced nature when compared to its neighbours and sub-Saharan Africa as a whole. This gap has increasingly been targeted by technologically based solutions, predicated on Kenya's relatively advanced position in technological access and adoption.

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[28] Ibid.
[29] Eric O. Gido, Kenneth W. Sibiko, Oscar I. Ayuya and Joseph K. Mwangi, "Demand for Agricultural Extension Services Among Small-Scale Maize Farmers: Micro-Level Evidence from Kenya," *The Journal of Agricultural Education and Extension* 21:2 (2014): 183.
[30] Elizabeth Kabura Nyaga, "Is ICT in Agricultural Extension Feasible in Enhancing Marketing of Agricultural Produce in Kenya: A Case of Kiambu District." *Quarterly Journal of International Agriculture* 51 (2012): 255.

2.2 ICTs and Leapfrogging in Kenya

Kenya, like the rest of the developing world, has benefited immensely through the rollout of cellular communications networks in recent years. Kenya is one of the most well-connected countries in Sub-Saharan Africa. In December 2019, Kenya had a total of 39.6M mobile data subscriptions (which account for 99% of Kenya's data/internet subscriptions), reflecting a 74% penetration rate.[31] However, some individuals may pay for multiple data/internet subscriptions. This is suggested by Kenya's 114.8% mobile (SIM) penetration rate, and may inflate the actual number of individuals using the internet.[32] Regardless, these figures are significant, and indicate Kenya's position as an increasingly connected country through its use of mobile networks. This places Kenya in a unique position, combining advances in mobile networks with large numbers of agriculturalists living in rural poverty. These factors provide the necessary enabling environment for innovations in technology that can revolutionize the experience of farmers with minimal investment.

This growth and widespread inclusion in communication networks that has been experienced throughout the global south is a direct result of technological leapfrogging.[33] Technological leapfrogging describes the process by which incremental progress in a (often technological) field of study can lead to radical innovations, allowing other less technologically advanced groups to skip numerous steps and access an almost equal position in the linear progression of that technology's development.[34] Many of the recent impacts of ICTs in the developing world are predicated on the concept of technological leapfrogging, and can likewise be examined through that lens to best understand how technological innovation can so rapidly impact a society or group.

The introduction of mobile phone technology is one of the most commonly identified examples of technological leapfrogging, but its diverse and wide-ranging effects continue to emerge, warranting ongoing study. While the developed world slowly installed the major infrastructure needed to provide telecommunication access, the developing world lacked the capital to both establish a communication network and to invest in new solutions. This seemingly insurmountable problem was almost entirely solved by the introduction of cell-phone towers, which allowed even the most remote areas to gain access to global telecommunication networks.[35] International mobile companies began pursuing a bottom of the pyramid strategy in the global south, profiting handsomely while providing an invaluable tool to millions.[36]

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[31] Communications Authority of Kenya. "Second Quarter Sector Statistics Report for the Financial Year 2019/2020 (October-December 2019). *Statistical Report Q4* (2019): 19.
[32] Ibid, 9.
[33]Jeffrey James, "Relative and Absolute Components of Leapfrogging in Mobile Phones by Developing Countries," *Telematics and Informatics* 31 (2014): 52.
[34] Barney Tan, Evelyn Ng, and Junhui Jiang, "The Process of Technology Leapfrogging: Case Analysis of the National ICT Infrastructure Development Journey of Azerbaijan," *International Journal of Information Management* 38 (2018): 311.
[35] Jeffrey James, "Relative and Absolute Components of Leapfrogging in Mobile Phones by Developing Countries," *Telematics and Informatics* 31 (2014): 52.
[36] Chris Foster and Richard Heeks, "Innovation and Scaling of ICT for the Bottom-of-the-Pyramid," Journal of Information Technology 28 (2013): 296-315.

As a result, mobile phones in the developing world have radically changed the nature of connectivity and communication for the world's poor and have had impacts throughout its societies. This has ranged widely, affecting migration, rural entrepreneurship, and health care service delivery among a multitude of others.[37] Access to mobile phones has been found to be a contributing factor to economic growth and poverty reduction in the global south. In a 2010 study in rural Peru, the introduction of cellular networks was measured to have increased real household consumption by 11%, and led to an 8% drop in poverty incidence.[38] As a result of these networks, individuals are more connected and are able to be more productive than was possible prior.[39]

Leapfrogging in mobile phone technology and other new examples of ICTs in the global south has led to the flourishing of a field of study referred to as Information and Communication Technologies for Development (ICTD). ICTD examines the use of ICTs in a development context, with a particular focus on opportunities to harness ICTs for positive development outcomes.[40] Research in ICTD can take two primary forms: observational and applied. While many efforts have been made in recent years to use ICTs as part of applied research, the ways in which technology can be appropriated by local groups and harnessed to serve their own goals warrants increased attention and study.[41] This quasi-participatory approach of observing the grassroots use and applications of existing ICTs allows for a rich understanding of the gaps faced by the developing world. As they seek to fill those gaps with the available ICT solutions, the approach can then be used to inform evidence-based applications that support the key goals of this grassroots use of ICTD.[42]

Leapfrogging provided immeasurable direct benefits to the Kenyan population, but has also provided the enabling environment for rapid innovations in harnessing technology for the wellbeing of its agricultural community. Beginning first with SMS and phone calls, the number of ICTD tools available to Kenya's farmers continue to grow in number, with many recent innovations based on the opportunities afforded by leapfrogging in the area of mobile-only internet and smart-phone mobile applications. Mobile phones have provided an opportunity to link technological innovation to the traditional practice of agriculture, filling gaps left open by the limited ability of extension services to adequately serve Kenya's agriculturalists.

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[37] Jenny C. Aker and Isaac M. Mbiti. "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives* 24:3 (2010): 207-208.
[38] Diether W. Beuerman, et al., "Mobile Phones and Economic Development in Rural Peru," Journal of Development Studies 48:11 (2012): 1618.
[39] Ibid.
[40] Roger Asta Etoundi, Serge Flavien Mani Onana, Adolphe Ayissi Eteme, and Marcel Laurent Fouda Ndjodo. "Special Issue on ICT for Africa Development: An Introduction and Framework for Research." *The Electronic Journal of Information Systems in Developing Countries* 76 (2016): 10.
[41] Chris Giotitsas, "Open Source Agriculture: Grassroots Technology in the Digital Era," *Palgrave Advances in Bioeconomy: Economics and Policies* (2019): 2-3.
[42] Susan Wyche, "Exploring Women's Everyday Mobile Phone Experiences in Nairobi, Kenya." *Interacting With Computers* 29:3 (2017): 400.

2.3 Previous Attempts to Harness ICTs for Agricultural Development

Services designed to promote information dissemination to farmers in Kenya and elsewhere are not a new phenomenon and have seen many innovations in recent years. Traditional examples outside the realm of mobile phones have included a mix of ICT (radio, television) and non-ICT (print, extension officers) services.[43] These have been used to provide information to farmers including updates on market prices, weather trends, best practices, and success stories – and have been found to positively benefit the production of farmers they serve.[44] However, the ability for farmers to solicit specialized assistance in these cases is still mostly limited to the use of extension officers and other interpersonal contact, which they also appear to prefer.[45]

As highlighted in section 2.1, the issue of knowledge being transformed into practice is a key issue that faces additional challenges in the ICTD environment. In the absence of interpersonal contact, farmers are unable to ask the questions that may help reduce their perceived risk. Without opportunities to hear direct personal experiences about the use of a particular input or technique, farmers may be less likely to trust and thereby implement the information they are provided. Trying to overcome the challenges of risk and trust through platforms that do not allow for follow-up questions can be difficult and may limit the scale of practice that is changed as a result.

Yet some examples have had positive results in overcoming this issue with trust and knowledge application. A 2012 study in Ghana examined the impact of low-cost, on-demand access to information for farmers, specifically a small device called a 'Talking Book'.[46] Talking Books allowed users to listen to pre-recorded audio, record their own messages, and copy those recordings directly to any other Talking Book device.[47] The study concluded that 91% of farmers who used Talking Books learned the information provided, trusted the information, and applied what their learned.[48] This is a positive indication that extension through ICTD can overcome the issues highlighted above. However, a number of challenges were also highlighted, including limited awareness; intimidation of farmers in using what was perceived as a complex device; and that there were too few devices to go around.[49] In this way it is clear that the provision of information to farmers in a top-down method can certainly have positive results. However, using a platform or technology that is new to farmers poses a challenge for

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[43] Joseph Kiplang'at and Dennis N. Ocholla. "Diffusion of Information and Communication Technologies in Communication of Agricultural Information Among Agricultural Researchers and Extension Workers in Kenya." *South African Journal of Libraries and Information Science* 71:3 (2005): 240.
[44] Sylvester Ochieng Oguntu, Julius Juma Okello, and David Jakinda Otieno. "Impact of Information and Communication Technology-Based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya." *World Development* 64 (2014): 319.
[45] Umunna Nnaemeka Opara, "Agricultural Information Sources Used by Farmers in Imo State, Nigeria." *Information Development* 24:4 (2008): 293.
[46] Cliff Schmidt, Trina Jean Gorman, Michael Shayne Gary, and Andrew Azaabanye Bayor. "Impact of Low-Cost, On-Demand Information Access in a Remote Ghanaian Village." *Information Technologies and International Development* 8:2 (2012): 87.
[47] Ibid.
[48] Ibid, 98-99.
[49] Ibid, 91.

uptake. These results indicate that the technology platform itself is key to the success of a farming support service. Further, they suggest that improvements in the ability to share information through mobile networks would lead to increased benefit to users, as Talking Books could only transfer recordings from one device to another.[50]

Rather than rely on new electronic devices, organizations in Kenya have sought to harness the advantage of leapfrogging in cellular technology to reach farmers directly and provide information through automated recordings and Short Message Service (SMS).[51] In this way, farmers do not need to purchase a newspaper or listen to the radio at the correct time, as information can be provided directly to the farmer's phone at a low access cost.[52] Examples from Kenya include iShamba[53]. Introduced in 2014, iShamba is a private sector platform that emerged through an existing television program targeting agricultural extension ("Shamba Shape Up", funded largely by the NGO and IT sectors, continues to produce programs in Kenya). The iShamba platform provides weekly updates on weather and market trends through SMS or an automated voice system, in addition to other extension services, connecting over 350,000 profiled farmers.[54]

These services were an innovative approach, as they reduced the cost of information while also increasing access. However, the information was still provided in a top-down method and did not allow for follow up discussion. A study from 2011 surveying earlier instances of this model concluded that direct, top-down information services can fall short in providing clear and measurable changes to livelihoods and practice, arguably due to their mostly non-participatory, hierarchical structure. [55] A similar study in rural India around the same time concluded that while SMS information services for agriculture were effective in reaching a large number of members, they did not lead to a significant change in practice.[56] In these cases, it is clear that the provision of information can be positive for smallholder farmers in that even limited information is still preferable to a complete lack of information. Yet it is extremely difficult for a top-down model to account for all the information needed in the diverse field of agriculture, particularly in a country with a range of climates and crops specific to those regions.

The next development in SMS information systems was the addition of basic interactive functionality, allowing farmers to request and receive information that was specifically relevant to their own needs. An example of this is MbeguChoice, which allows farmers to

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[50] Ibid, 98.
[51] Susan P. Wyche, Melissa Densmore, and Brian Samuel Geyer, "Real Mobiles: Kenyan and Zambian Smallholder Farmers' Current Attitudes Towards Mobile Phones," *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development,* Article No. 9 (2015): 2.
[52] Sylvester Ochieng Oguntu, Julius Juma Okello, and David Jakinda Otieno, "Impact of Information and Communication Technology-Based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya," *World Development* 64 (2014): 316.
[53] "Shamba" is the Swahili word for "farm" or "field".
[54] iShamba. "Partners" *iShamba Online*.
[55] Jenny C. Aker, "Dial 'A' for Agriculture: A Review of Information and communication Technologies for Agricultural Extension in Developing Countries." *Agricultural Economics* 42 (2011): 632.
[56] Marcel Fafchamps, and Bart Minten, "Impact of SMS-Based Agricultural Information on Indian Farmers," *The World Bank Economic Review*, 26:3 (2012): 411-12.

send a message indicating a specific type of crop and receive information on available seeds and accompanying information.[57] Other services like WeFarm allow for an anonymous question-and-answer model, where questions are relayed to other users in a crowd-sourcing approach.[58] If a peer-farmer knows the answer to the question, they can respond, which will be forwarded back to the original questioner. This approach relies on the assumption and hope that at least one of the farmers sent the question will be able to provide a response, does not allow for follow-up questions, and does not allow users to learn communally. WeFarm and similar services are still valuable to farmers in Kenya, particularly those without smart-phones, but the limitations of an SMS-only system are difficult to overcome.

The rise in low-cost smartphone use in Kenya has led to a rapid uptake, leading some organizations to design mobile applications designed for agricultural extension. An example is DigiCow, which provides farmers the opportunity to keep simple records and gain on-demand information for dairy farming.[59] These applications appear to be an improvement for those who can afford to access them.[60] However, any new platform faces challenges in awareness, ease of access, and uptake generally. Further, while nearly every smart-phone in Kenya already has WhatsApp installed, and the country's mobile providers now offer access to WhatsApp and Facebook even when a subscriber's data bundles run out, low-cost phones typically have very limited storage space, reducing the opportunity to download multiple applications. Overall, the progress in using mobile-only internet and applications in ICTD for agriculture appears valuable, albeit limited by additional barriers when compared to already common applications like WhatsApp.

A 2015 study in Kenya concluded that mobile phone farming applications can be successful in disseminating information, reducing search for information costs, and providing access to better markets and prices for their goods.[61] However, the study concluded that these applications had limited effects on the smallholder farmers' overall access to agriculture extension and production information.[62] The authors suggested that the service providers fell short in providing sufficiently detailed information on production techniques.[63] It can be extremely difficult to account for all of the information requests needed in a diverse agricultural community, and likewise difficult to appropriately collect and disseminate that information. While these approaches are interactive and tailored, these mobile applications are still essentially top-down approaches to extension - relying on the provider to address all of the potential needs of its diverse users.

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[57] Anonymous. "Kenyan Website Matches Seeds to Local Growing Conditions." Appropriate Technology 42:3 (2015): 24-25. (Note that "mbegu" is the Swahili word for "seed".)
[58] WeFarm. "What is WeFarm?" *Online Resource* (2020).
[59] DigiCow. "App Features" *Farmingtech Solutions Ltd*, Accessed February 3, 2020.
[60] For additional examples, see: Anonymous, "Top Mobile Applications Transforming Farming." *Standard Media: Kenya*, May 28, 2018.
[61] Fredrick Odhiambo, "Market in their Palms? Exploring Smallholder Farmers' Use of Existing Mobile Phone Farming Applications: A study in Selected Counties in Kenya," *CTA Working Paper* 15:6 (2015): 7.
[62] Ibid.
[63] Ibid.

When viewing the evolution of mobile-based agricultural extension, a number of insights can be drawn. First, that these services are attempting to fill a gap in the extension services required by small-scale farmers in Kenya. Those needs primarily include the ability to receive relevant and on-demand information on when to plant their crops, prepare for weather changes, and identify the market price for their products. Second, the potential shortcomings of these platforms indicate additional needs of Kenya's farmers, including the ability to receive personalized information based on questions and challenges they may have; the ability to follow up on responses and bring others into a discussion; and the ability for all farmers benefiting from a particular discussion to grow and learn communally. As smart-phones gain in popularity throughout Kenya, opportunities to close these final gaps may be within reach through an application that was never specifically designed to assist the agricultural sector.

2.4 The WhatsApp Application and WhatsApp Groups

WhatsApp provides a fascinating case study into the use of a leapfrog technology to serve the needs of poor and vulnerable individuals in the developing world. WhatsApp is a smart-phone application that allows users to chat through private messages, and to place voice or video calls to their contacts – replacing the need to use traditional cellular connectivity by using internet access for the same services.[64] While WhatsApp is popular in the developed world, its application to the developing world is particularly relevant, where telecommunication costs can maintain a digital divide among the world's poor and vulnerable.[65] At over two billion users, WhatsApp is increasingly providing communication and connection to those in the global south.[66] WhatsApp leverages the internet access of a cellular device to drastically reduce the costs associated with mobile phone use, including voice over internet protocol (VoIP), video calls, and instant messaging.[67] The use of the internet rather than traditional cellular services eliminates the need for long distance rates, and has considerably lower access costs in comparison to typical SMS and voice communication.[68] This drastic reduction in communication costs has led to the proliferation of WhatsApp use throughout the developing world.[69]

WhatsApp is typically used for private and encrypted conversations among known contacts, but the application also provides users the opportunity to create invitation-based groups and broadcast lists with as many as 256 users.[70] While broadcast lists are used to directly send individual messages to a large number of users at once, groups allow for open communication amongst all participants - essentially forming a virtual community based around a particular issue or topic. These groups are used by many to have shared conversations with friends, family, and community members. Groups can be formed to

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[64] Robert McMillan, "You May Not Use WhatsApp, But the Rest of the World Sure Does," *Wired Magazine,* February 20th, 2014.
[65] Vermeulen, Jan. "WhatsApp vs SMS: How Much a Message Costs." *MyBroadband*, December 7, 2015.
[66] WhatsApp, "Two Billion Users - Connecting the World Privately," *WhatsApp Blog* (February 12, 2020).
[67] Robert McMillan, "You May Not Use WhatsApp, But the Rest of the World Sure Does," *Wired Magazine,* February 20th, 2014.
[68] Richard Shambare, "The Adoption of WhatsApp: Breaking the Vicious Cycle of Technology Affordability and Non-Adoption," *Journal of Economics and Behavioral Studies* 6:7 (2014): 542-5.
[69] WhatsApp, "Using Broadcast Lists," *WhatsApp FAQ* (2020).
[70] WhatsApp, "How to Create and Invite into a Group," *WhatsApp FAQ* (2020).

discuss planning an upcoming family event, or used by members of a church community to share relevant information and news.

As a result of the increasingly ubiquitous use of WhatsApp in the developing world, WhatsApp groups have come to fill a gap in information dissemination and collaborative communication among practitioners of a particular livelihood group or sector. The existing use of WhatsApp groups for development outcomes has been a mix of applied research and more spontaneous, grassroots-led practices. The existing literature focuses much more on the former, probably because NGOs or private sector actors want or need to evaluate the impacts of their own interventions. For example, researchers in Kenya conducted a feasibility study on the use of WhatsApp groups for providing support to pregnant women and new mothers.[71] The project concluded that participants reported several benefits and that the groups led to higher rates of recommended postpartum practices.[72] Overall, the approach was determined to be safe and feasible, with no observable harms or negative effects.[73] A similar study in rural Malawi found positive results in the use of WhatsApp groups for community health workers. Identified benefits included the enhanced ease and quality of communication among a geographically distributed health workforce, and the heightened connectedness of a professionally isolated health workforce.[74] WhatsApp was ultimately determined to be a useful tool to support distributed rural health work.[75] These findings are valuable to the understanding of agriculturalists, who likewise often operate in rural and isolated contexts.

There is also some limited academic research on the subject of WhatsApp groups for agriculture, mostly focused on examples in India. This has pointed to the potential benefits of these groups as a form of agricultural extension, and the appropriateness of WhatsApp as a platform. Research on the social media readiness of agricultural professionals in India concluded that applications and websites like WhatsApp, Facebook, and YouTube were the most preferred platforms due to their easier user interface and higher percentage of active users.[76] The study concluded by advocating strongly for the increased use of social media in agricultural extension and advisory services.[77] A 2017 study in India found that WhatsApp groups were not only connecting farmers to their customers through a virtual market, but also creating a network of resources and support for farmers in the country who need it most.[78] The study concluded that WhatsApp groups were useful to farmers in seeking information on farm operations;

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[71] Suha J. Patel, et al. "Providing Support to Pregnant Women and New Mothers Through Moderates WhatsApp Groups: A Feasibility Study," *mHealth* 4:14 (2018): 1-8.
[72] Ibid, 6.
[73] Ibid.
[74] Christoph Pimmer, "Mobile Instant Messaging for Rural Community Health Workers: A Case from Malawi," *Global Health Action* 10 (2017): 9.
[75] Ibid.
[76] Suchiradipta, Bhattacharjee. and Saravanan Raj. "The Online Culture of Agriculture: Exploring Social Media Readiness of Agricultural Professionals." *CSI Transactions in ICT* 6:3 (2018): 289.
[77] Ibid, 298.
[78] P.S. Naruka, Shilpi Verma, S.S. Sarangdevot, C.P. Pachauri, Shilpi Kerketta, and J.P. Singh, "A Study on Role of WhatsApp in Agriculture Value Chains," *Asian Journal of Agricultural Extension, Economics, and Sociology* 20:1 (2017): 6-7.

clarifying doubts on plants/livestock disease symptoms; and provided immediate access to market related information.[79]

Another study of farmers in India examined the differences in agricultural livelihoods between farmers using ICTs (including WhatsApp) and those who were not.[80] The study concluded that a number of barriers existed that prevented the uptake of ICT solutions in farming, particularly: access, cost, and awareness.[81] However, non-ICT farmers ultimately lagged behind their counterparts using ICT solutions.[82] This indicates that efforts made to reduce the digital divide in agriculture can lead to the positive uptake of ICTs, improving the wellbeing and livelihoods of smallholder farmers.[83]

These examples point to three primary insights. First, that WhatsApp's position as an extremely common platform in the developing world lends itself effectively to its use in a development context. For example, when compared to the Talking Books highlighted above, the issues related to usability and technological barriers are nonexistent for someone who is already using WhatsApp for their daily mobile communication. Second, WhatsApp's ability to provide the means for information to flow between users, rather than in a top-down vertical format, allows for complex discussions and relationships between farmers to emerge - creating the opportunity for communities to develop. Third, for the reasons stated above, WhatsApp groups can positively serve a diverse range of self-selecting users, with particular benefits to those in rural and geographically isolated contexts. Given the importance of rural agriculture to Kenya's poor and vulnerable, it is no surprise that WhatsApp groups specific to agricultural livelihoods have begun to emerge in Kenya in a grassroots manner, without the need for intervention by development actors.

2.5 Grassroots WhatsApp groups for agriculture in Kenya

The spread of WhatsApp and the use of WhatsApp groups in Kenya has led to the creation of groups specific to agricultural livelihoods.[84] These groups, almost exclusively formed on a grassroots level without intervention by formal agricultural development actors, effectively serve to fill the remaining gaps in the existing (and more formalized) agricultural-ICTD landscape described above.

The groups are established specifically by and for small-scale farmers and practitioners of agriculture, agribusiness, and other professions associated with agriculture, livestock, and fish production. A farmer who may previously have only been in contact with the other farmers and extension officers in his local area can now have access to up to 255 other farmers (per group) they would not have been able to communicate with otherwise. Further, group membership can be as diverse as the groups themselves. Members can

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[79] Ibid.
[80] Jose, A M. and K Lokeswari. "A Study of Users and Non-Users of ICT Among Farming Community." Global Media Journal 16:31 (2018): 1-8.
[81] Ibid, 5-6.
[82] Ibid.
[83] Ibid.
[84] Eva De Vries, "Are You on a Farmers' WhatsApp Group? It is My Easy Way to Network," *The Nation (Kenya)*, October 8th, 2016.

range from experienced professionals through to non-practicing observers who are considering entering agriculture or introducing a new input onto their farm.[85] In this way, the groups provide mutual opportunity for practicing farmers to ask questions and gain support, while those considering a new input can learn about common challenges and mitigating techniques to avoid failure

The focus of WhatsApp groups for agriculture can also be very diverse, with some groups serving broad needs and interests, and others focused on a highly specific sector or geographic area (or both) (see Figure 1). Generalist groups can include farmers of all types, and from all regions. For example, a single 'agribusiness' group can include members from throughout Kenya (and in some cases neighboring countries such as Uganda and Tanzania).[86] More specific groups can emerge independently, or from these generalist groups. Specialized groups may include groups specific to a particular region, groups specific to a particular type of farming (tomatoes, chickens, etc.), or a combination of both regional and activity specific (i.e. Kericho Poultry Farmers).

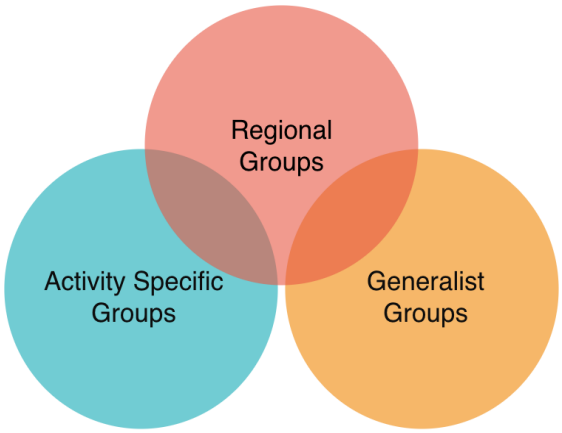

Figure 1. Topics of WhatsApp groups for agriculture

These groups serve a multitude of needs to small-scale farmers in Kenya, and likewise serve to identify the gaps in extension services that farmers are seeking to fill. However, there has not been a rigorous examination of the grassroots use of WhatsApp groups in Kenya's agricultural sector. As a result, the existing literature on this subject is nearly entirely based on news articles and editorials, whose intent has been to raise awareness or celebrate such groups. These articles have indicated that the groups are positively benefiting their members, including benefits of passive membership and observing the group; active and self-directed participation; and contributions a farmer can make back to the group and community. [87]

While some grassroots-level WhatsApp groups for agriculture in Kenya have been highlighted by journalists, there has been insufficient academic research on how these groups have been used, and whether they are succeeding in poverty reduction, information sharing, agricultural extension, and other externalities. That is, while the potential benefits appear clear, and while there are limited, yet exciting, examples of success in these areas, a research project that rigorously surveys the model in the Kenyan context as a whole is currently nonexistent. This project will attempt to fill that gap, and determine if WhatsApp groups have the potential to benefit a majority of its members,

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[85] Farmbiz Africa, "WhatsApp Group Help Farmers Access Farming Information," *FarmBiz Africa Online*, August 01, 2017.
[86] Farmbiz Africa, "Kenya, Uganda Mushroom Farmers' Networking Saves the Growers Training Costs," *Farmbiz Africa Online*, July 08, 2019.
[87] See: Waikwa Maina, "WhatsApp Farmers Chatting Their Way to Better Returns," *Africa Business Daily*, March 25, 2019.; Anonymous, "Young Kenyan Farmers Use Social Media to Bypass Brokers, Earn More," *Xinhua Africa,* October 24, 2018.

and potentially replace or supplement more traditional models typically implemented by practitioners and organizations.

WhatsApp groups are currently being used by agriculturalists throughout Kenya to fill the remining gaps in their available agricultural extension services and knowledge. While many of the benefits offered by these groups are likewise offered through existing ICT for agriculture services (SMS and internet-based), their horizontal and participatory structure allows for an online community to develop and thrive as a group. This experience mirrors many of those exhibited in a virtual community of practice, and will therefore be examined through that lens.

2.6 Virtual Communities of Practice

Wenger defines communities of practice (CoPs) simply as "groups of people who share a concern or a passion for something they do, and learn how to do it better as they interact regularly".[88] Adherents to the value of communities of practice argue that the experiences of a single person can have the potential to inform and benefit members of a larger group of like-minded individuals.[89] Furthermore, the concept argues that discourse and discussion on a subject or piece of information can have a value-added effect, and lead to the collective benefit of the group as a whole.[90]

Communities of Practice have been found to be successful in supporting small-holder farmers with value chain development. Using a case study nutrition and food security project in the Caribbean, Lowitt et al. argued that identifying and supporting communities of practice in agricultural value chains "may provide the glue that facilitates coherent and coordinated action."[91] Though not always labelled as such, CoPs for agriculture exist in Kenya in a number of forms, ranging from village-based farming groups and cooperatives to regular workshops and agricultural meetups.[92] Communities of practice are also directly linked to the concept of social capital, which has been identified as a key factor in the adoption of innovation such new farming practices. Van Rijn, Bulte, and Adekunle suggest that structural social capital (especially in the form of connections beyond one's local village) is associated with more extensive adoption of innovation compared to social capital based around a localized or homogenized community.[93]

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[88] Wenger, E. (2006). Communities of practice: A brief introduction.
[89] Maida, Carl A. and Sam Beck. Towards Communities of Practice in Global Sustainability." *Anthropology in Action* 23:1 (2016): 1.
[90] Kuman, Haradhan. "Roles of Communities of Practice for the Development of the Society." *Journal of Economic Development, Environment, and People* 6:2 (2017): 28.
[91] Lowitt, Kristen. Gordon M. Hickey, Wayne Ganpat, and Leroy Phillip. "Linking Communities of Practice with Value Chain Development in Smallholder Farming Systems." *World Development* 74 (2015): 371.
[92] Elina Andersson and Sara Gabrielsson, "'Because of Poverty, We Had to Come Together': Collective Action for Improved Food Security in Rural Kenya and Uganda," *International Journal of Agricultural Sustainability* 10:3 (2012): 249-52.
[93] Fédes Van Rijn, Erwin Bulte, and Adewale Adekunle, "Social Capital and Agricultural Innovation in Sub-Saharan Africa," *Agricultural Systems* 108 (2012): 113.

Wenger suggests that there are signs which indicate that a CoP has been formed. These signs include: Domain - an identity defined by a shared domain of interest; The Community - that in pursing their interest in their domain, members engage in joint activities and discussions, help each other, and share information; and Practice - the development of a shared repertoire of resources (experiences, stories, tools, ways of addressing recurring problems) through time and sustained interaction.[94]

The ability offered by internet connectivity to create virtual groups has led to the emergence of Virtual Communities of Practice (VCoP). VCoPs are communities of practice formed in digital spaces and through digital platforms.[95] They increase the potential scale and diversity of actors who are able to interact and share information, primarily due to the low cost of global connectivity. Virtual communities of practice, particularly for those in rural areas throughout the world, can be seen as another example of the benefits of technological leapfrogging. Those in areas with very limited opportunity to meet and travel to their peers are provided the ability to communicate with anyone else and gain the benefits of group-learning and support. WhatsApp has been identified by some as a platform upon which virtual communities of practice can be formed and thrive.

Some literature has already examined WhatsApp groups as a form of VCoPs, particularly in the health and education sectors. A study of teachers in rural South Africa found that the effective use of WhatsApp groups (and online social media networks broadly) as communities of practice is dependent on participants' awareness of the purpose and context of the community, and the willingness of the participants to accept differing views and opinions.[96] Another study examined the use of WhatsApp based virtual communities of practice among frontline nurses in Zambia.[97] Findings suggested that facility heads successfully strengthened their leadership and management competencies; increased their ability to lead frontline teams; and strengthened their skills and confidence in use of technology.[98] The study concluded that using WhatsApp groups as a platform for VCoPs can assist frontline workers with navigating complex health systems and advance their interests in primary and universal health care.[99] These examples suggest that the utility of WhatsApp as a platform for group discussion is cross-sectoral, and appropriate for the context of a diverse range of actors in the developing world. WhatsApp groups for agricultural practitioners fit the criteria of VCoPs and do so through a platform that is increasingly intuitive and accessible by the world's poor.

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[94] Etienne Wenger, and Beverly Wenger-Trayner. "Communites of Practice: A Brief Introduction." *Wenger-Trayner Online*, 2015: 2.
[95] Etienne Wenger, *Communities of Practice: Learning, Meaning, and Identity* (Cambridge, UK: Cambridge University Press, 1998): 113.
[96] Maglin Moodley, "WhatsApp: Creating a Virtual Teacher Community for Supporting and Monitoring After a Professional Development Programme," *South African Journal of Education* 39:2 (2019): 8.
[97] Allison Annette Foster, Marjorie Kabinga Makukula, Carolyn Moore, Nellisiwe Luyando Chizuni, Fastone Goma, Alan Myles, and David Nelson, "Strengthening and Institutionalizing the Leadership and Management Role of Frontline Nurses to Advance Universal Health Coverage in Zambia," *Global Health: Science and Practice* 6:4 (2018): 736.
[98] Ibid.
[99] Ibid.

Viewing WhatsApp through the lens of VCoPs will allow for a thorough understanding of the potential benefits offered by this grassroots movement of communal learning.

Access to the internet as a whole is often simply insufficient in satisfying the necessary trust to overcome risk-adversity among vulnerable farmers. Further, while access to information is a key factor to the wellbeing of any practitioner, information learned by a single individual does not have the power to change the world. A website found on the third page of a google search, providing incredibly useful information on organic pest reduction, may not be relevant to the person who finds it. Even if a person comes across this website, farmers in the nearest village with a similar problem may never be aware of the innovative solution. Instead, change is a group effort, with individuals constantly building on the experiences and accomplishments of their peers to a shared and common result. Communities of practice, virtual or otherwise, provide the opportunity to develop and grow social capital and trust – increasing the likelihood that information will be turned into practice, and ensuring that those experiences can benefit individuals and the group as a whole. WhatsApp groups potentially provide the means for these groups to be formed and thrive in areas that are desperate for additional extension support. As such, the examination of WhatsApp groups as VCoPs will be a valuable lens for this project.

Chapter Three: Research Design and Methods

3.0 Research Questions

This project sought to explore two primary research questions. These questions were targeted by specific and narrow sub-questions related to each research area, in addition to other questions to provide the opportunity for additional horizontal analysis (e.g. demographics).

1. What are the push and pull factors associated with the use of WhatsApp groups for agriculture, and what barriers prevent access and use of these groups?

2. In what ways are WhatsApp groups for agriculture used by small-scale farmers in Kenya, what benefits and shortcomings do they provide to their users, and how have users applied the information gained by these groups to impact their activities?

3.1 Methodological Approach

Research methods for this project applied a mixed-methods approach through the use of multiple surveys, specific to each pool of research participants. Surveys were designed through the SurveyMonkey platform and allowed for empirical data (through binary and scale-based responses), in addition to qualitative responses to provide context and insight into quantitative data. Survey questions were designed in a manner that could provide direct understanding of key research sub-questions. The survey itself pooled questions into four sections: demographics; awareness and access; use and utility; and comparisons to other existing extension services. This allowed for narrowly framed questions to contribute to the overall understanding of the key research questions identified above.

Field research was conducted in Kenya from July 4th to October 4th, 2018. The researcher was based in Nairobi for the initial period of research, during which the primary research group was identified, and remote interviews were completed (60). After completing initial interviews, the researcher was accompanied by a Kenyan research assistant for 30 in-person interviews and farm visits conducted primarily in three counties: Kericho, Nyamira, and Nakuru. While travelling for the farm visits, 60 baseline interviews were conducted (primarily within local markets) with those who gain their income from agricultural activities but were not directly targeted through their use of WhatsApp groups (that is, cold-interviews with agriculturalists in markets or nearby farms). Interviews were also conducted with stakeholders from five non-governmental organizations operating in Kenya with a specialization in agriculture. Finally, 3 focus groups were conducted with new WhatsApp member participants in Kericho, Nyamusi, and Naivasha.

3.2 Data Collection and Composition of Research Groups

3.2.1 Agricultural WhatsApp Users group (n=60)

The primary research group targeted individuals identified as being members in existing WhatsApp groups for agriculture and agribusiness. All participants were farmers, either for income generation or personal consumption, while some (25) had additional sources of income in the agricultural sector (agronomists, extension officers, specialists, etc.)

Over the course of research activities, 28 WhatsApp groups (listed in Annex A) were joined by the researcher. These groups were not selected through a particular set of attributes or constraints. Rather, all groups the researcher could identify through available online invitation links were joined. These links were identified primarily through Facebook groups dedicated to sharing WhatsApp group links in Kenya, as well as Facebook groups dedicated specifically to agriculture in Kenya.[100] These groups varied, including general groups for farming in Kenya broadly (i.e. "*Agribusiness Kenya*"), as well as more specific groups dedicated to a particular activity (i.e. "*Catfish Solution Place 2*"), or region (i.e. "*Dairy Farming Kiambu*"). After joining these publicly available groups, the researcher observed the groups for a period of time (1-3 days) in order to determine if they were being actively used to discuss issues related to agriculture in Kenya. Groups that did not have active posts, or groups that had posts that were overwhelmingly unrelated to agriculture, were exited by the researcher.

After joining a variety of active agricultural WhatsApp groups, members were contacted by the researcher to explain the project and invite their participation. Over time, through these initial interviews, the researcher was invited to join other more selective groups[101] that rely on referrals and moderate their membership lists tightly. The criteria for participants in the WhatsApp user research pool was not defined by geographical scope or demographics, except to target those groups which were ostensibly focused on the Kenyan agricultural context. Some of these groups were limited to members in a specific geographic region, which led to a greater proportion of participants from these areas (i.e. "*Kericho Poultry Forum*"). In some cases, friends and colleagues of past participants were referred to the research project and subsequently interviewed. The criteria for these members remained the same, determined simply by their active use of WhatsApp groups and their farm residing within Kenya. Participants were included from 19 of 47 counties in Kenya.

3.2.2 Baseline group (n=60)

In order to determine an estimated baseline of WhatsApp use among agriculturalists in Kenya as a whole, an additional research pool was conducted targeting those who self-identify as gaining their livelihood from small-scale farming but were not originally

[100] Facebook groups used to find initial WhatsApp invitation links included "*Kenya WhatsApp Group Invite Links*", "*Dairy Farming Kenya – DFK*", "*Digital Farmers Kenya Market*", "*AGRIBUSINESS* KENYA", and "*Digital Farmers Kenya"*, among other less useful and/or active groups.

[101] See Annex A. Groups that were joined by way of a direct invitation tended to be more active, and had better moderation of posts by administrators. Particularly selective (and strong) groups included "*Kericho Poultry Forum*", "*Kilimo Bora Public Private Partnership*", "*Dairy Holding Forum*", and "*KILIMO BIASHARA*".

targeted through their use of WhatsApp groups. For the purposes of this project, this pool of participants will be referred to as the 'baseline' pool. The baseline pool included a variety of participants but was primarily based on interviews with individuals selling their agricultural products in local markets. The villages and towns these participants reside in include the counties of Nakuru (20); Kericho (14); and Nyamira (26) (see Annex C for a list of village and market sites). As a condition for eligibility, these participants were confirmed to be the original producers of their products (therefore excluding those who buy wholesale from brokers and resell in markets). Other baseline farmers included farmers in the same areas where fieldwork was being conducted (cold-calling small farms while travelling for scheduled farm visits). The baseline pool included 60 participants. The questionnaire provided to these participants differed slightly from the primary research group of targeted WhatsApp users (removing the assumption that participants were already users), and provided separate channels of questioning for those who use WhatsApp groups, those who use WhatsApp but do not use groups for agriculture, and those who do not use WhatsApp or do not have access to a smart phone.

3.2.3 In-Person Interviews and Farm Visits (n=30)

In-person interviews and farm visits were conducted with half (30) of the participants of the primary research group. Selection for farm visits was determined loosely, and based primarily on participant interest, depth of responses during the original interview, and the geographical location of participants. Farm visits were conducted in three research areas (counties, see Annex C), determined primarily by their proximity to multiple research participants: Nakuru, Kericho, and Nyamira. These visits provided the opportunity to observe the skills and practices 'gained' from WhatsApp, and to have a longer, more in-depth conversation about their specific experience using the groups. Questions for this group were mostly qualitative, but also included some constrained responses (multiple choice, rating scale) to provide lateral analysis across all those visited. Photos were also taken at these farms to document the application of skills, practices, and inputs learned through WhatsApp groups. 30 in-person interviews and farm visits were conducted over the course of field research.

3.2.4 Focus Groups (n=3)

Three focus groups were conducted during field research, with one group in each primary research area (Naivasha, Kericho, and Nyamusi). These groups were organized with the assistance of a local farmer in each area who participated in a farm visit for the primary research group. The WhatsApp user in each area who appeared to be most supportive of the research project during the farm visit was asked to assist in organizing local focus groups. They contacted 10-15 farmers in each area who were WhatsApp users on agricultural groups, but had not been contacted by the research project prior. These groups were held at a local community space. Focus group members were not paid to participate, but were provided lunch and a small stipend to offset the cost of travel. In total, 30 farmers participated in the focus groups. 27 of the 30 participant farmers used their agricultural production as the primary source of their livelihood. Others work primarily as extension workers (2) or input dealers (1). These individuals also farm, but not as their primary source of income.

Table 1. Demographics of focus group participants.

Focus Group Participants	Naivasha	Kericho	Nyamusi	Total
Number of Participants	11	9	10	**30**
Men:	7	4	8	**19**
Women:	4 (36%)	5 (56%)	3 (30%)	**12 (40%)**
Age range:	32-41	24-54	28-62	**24-62**
Agriculture for primary income:	9 (82%)	9 (100%)	9 (90%)	**27 (90%)**
Specialists, extension officers, dealers:	2	2	1	**5**

3.2.5 Interviews with Development Actors in the Field of Agriculture (n=5)

An additional five interviews were conducted with actors in the agricultural development sector. These interviews included representatives from Farm Concern International; AgroKenya; Sustainable Agriculture Community Development; One Acre Fund; and FarmBiz Africa (an online agricultural media organization). These interviews were entirely qualitative and sought to gauge the current understanding and use of WhatsApp groups for agriculture in Kenya among media, NGO and INGO communities. The duration of these interviews ranged from 1-2 hours, and were conducted over the phone or at the Nairobi office of each organization.

3.3 Analytical Approach

Analysis of data has mostly been completed manually, with charts and other visuals designed on excel and similar platforms. The SurveyMonkey platform used to collect survey information provides the means to export datasets as an excel file, allowing for additional analysis and visualization of data. The overall scope of this research project was to study the personal experiences of individual farmers using WhatsApp groups, and the overall awareness and understanding among farming populations. In this way, the conclusions of the project were designed to be drawn out of multiple pools of research participants. Data gathered (excluding supplemental information provided by NGO and media representatives) is entirely based on participant experiences and opinions.

As each research question was targeted through a large number of related sub-questions, the various results drawn from each individual question provides insight into the overall understanding of the primary topics of the research. Quantitative data, based on binary response or scale questions, provide empirical evidence of the preferences, experiences, and opinions gauged through this research project. That data is then supplemented by qualitative follow-up questions which serve to provide the means for individually lived experiences, nuance, and qualifications to be drawn out and supplement overall understanding. Together, this data provides the means to make empirical arguments that are crosscutting across each participant pool and comparable to other pools (i.e. targeted members vs baseline farmers), while backing those claims up through additional qualitative insights.

3.4 Positionality and Associated Limitations

It is necessary to acknowledge the nature of the researcher's own positionality in a research project, and how that positionality may have a direct effect on the results and

conclusions drawn therein. The researcher's own identity and cultural background are important considerations to note. Primarily, the researcher is a white Canadian, which can immediately impact the perception of a project when approaching potential participants, particularly the vulnerable. Participants can likewise be discouraged for this reason due to fear or apprehension, or motivated to participate due to the novelty or excitement of participating in foreign research. In some cases during farm visits, a sizeable contingent of family and friends would be waiting to welcome the researcher as a visitor. While this does not necessarily suggest that the responses would be biased or skewed, it does indicate that a foreign researcher may be treated differently than a Kenyan national. The project's research assistant noted that the presence of a foreigner on a rural farm was in many cases considered an 'honour' and opportunity to impress others. Contrarily, some participants who were aware of the legal requirements for research to be conducted in Kenya requested proof of the researcher's credentials and permits prior to participating. This may suggest a level of skepticism towards foreign researchers operating in Kenya, though it is similarly unlikely that such skepticism had an impact on research results.

Self and visibly identifying as a male, particularly when interacting with relatively vulnerable women, can have a direct impact on the scope of individuals willing to participate in a research project. It is very possible that women would be more reluctant to engage with a male rather than female researcher, therefore affecting the demographics and experiences of research participants. This is particularly relevant for the initial phone interviews, and any associated farm visits. Interviews with baseline agriculturalists (those in local markets, neighbours in farming areas), were conducted with an accompanying research assistant who was a female Kenyan and fluent Swahili speaker. Given the considerable bias towards women in this research pool (based on a majority of those in local markets being female), it is likely that the presence of a female Kenyan assistant had a positive impact on the participation of women for baseline interviews.

The researcher's own experience in technology and development is purely academic and informed by a personal belief that ICTD can have extremely powerful effects for the world's poor (most often positive, though at times negative). While the research project was designed to be open ended to allow for both positive and negative experiences, the hypothesis of the researcher was that these groups would be positive and beneficial to their users. The utmost care was paid to ensure this hypothesis would not influence the data and results collected.

The researcher's current and past employment with Global Affairs Canada has focused on multilateral health and nutrition; sexual and reproductive health; maternal, newborn, and child health; and sustainable economic growth in agricultural settings. This experience is not comprehensive, but has served to guide the analysis and understanding of the core research project through unrelated but relevant professional experience.

3.5 Selection Bias and Potential Favourability of Responses

The structure of this project - in which the main pool of participants was identified through their active use of WhatsApp groups - poses some potential issues related to selection bias and the favourability of responses. It was expected that those who were

using WhatsApp groups for agriculture on an active basis would be biased towards having broadly positive experiences with the application. That is, if a farmer had overwhelmingly and recurrent negative experiences, they likely would have stopped using the groups, making their recruitment through WhatsApp itself unlikely. Further, given that the project was clearly focused on the use of WhatsApp groups for agriculture, member farmers who participated may have been inclined to provide positive responses for a variety of reasons.

While identifying a group of individuals who have since stopped using the groups may have provided a useful complimentary analysis, such an approach would have been extremely difficult in terms of participant recruitment. With relatively low rates of active use, finding those who have since stopped using the groups altogether can be like searching for a needle in a haystack - making cold interviews impractical.

It is important to note that this project sought to serve as a direct lens into the experiences of farmers using WhatsApp groups in Kenya, and the barriers that prevented access for others. Yet the experiences of users were not expected to be homogenous, nor was the project designed to be representative of the entire farming community in Kenya. In this sense, the project sought to address the issues of selection bias and potential favourability of responses through two primary means.

First, the project attempted to compare results against a more representative sample of farmers in Kenya, accomplished through the baseline group identified above. These farmers, as they were not explicitly identified as being members of the groups, were able to provide some comparative insight into the differences between active members and the broad farming community in Kenya. The baseline pool also allowed results to be better grounded in the realities of Kenya's agricultural system, where issues like education, age, gender, and other barriers could be explored and compared. In cases where baseline participants had used WhatsApp groups for agriculture, results could be compared against the primary group which had a more likely selection and/or favourability bias.

Second, despite being expected to broadly support the groups, the project was designed in a manner that would explore a diversity of experiences among member farmers. In order to address the interrelated issues of selection bias and favourability, the design of the research project was such that each binary statement on a particular issue was followed up with qualitative questions to provide detail, examples, and evidence. Further, rather than simply asking if participants had seen a change (such as in their income), separate questions were used to draw out both sides of a potentially diverse experience.[102] Finally, farm visits were conducted with half of the WhatsApp member participants, allowing for a far more in-depth discussion on the ways the groups have been both positive and negative, and allowing the researcher to observe reported experiences first hand.

This approach led to the observation of a diversity within broadly positive experiences, reinforced by almost half (48%) of WhatsApp member respondents who indicated that

[102] i.e. separate questions for any increase and loss of income, including qualitative follow up questions for specific examples and detail.

the groups have shortcomings - providing examples and potential mitigation strategies. Through the use of a baseline control group and surveys designed to explore a diverse range of experiences and examples among users, the project sought to reduce the issues of selection bias and favourability of responses. The project may have not avoided these issues entirely but was not designed to provide statistically significant or empirical results. Rather, the project was a survey of an emerging phenomenon in Kenya, and the diverse range of experiences therein.

Chapter Four: Results - Access, Awareness, and the Barriers Therein

While WhatsApp groups for agriculture may provide a wealth of support and opportunities for the increased prosperity of their members, a number of economic and other key barriers must be surmounted before those benefits can be enjoyed. This section will examine the prerequisite issues of access and awareness, and how the barriers therein pose challenges to the wide use of WhatsApp groups as a tool for agricultural development. Research findings concluded that while access has a diverse set of barriers that may be increasingly difficult to overcome for some groups rather than others, awareness tends to be a more universal issue that could be targeted directly to increase use among those who have already gained access to the requisite technology.

4.1 Primary Barriers to Access

4.1.1 Economic barriers and the Digital Divide

The most intuitive barrier to the use of WhatsApp groups for small-scale agriculturalists is the direct access to smart phones and related access costs. Mobile phone penetration in sub-Saharan Africa has been significant. In 2018, Kenya had 96.3 cellular subscriptions per 100 people.[103] However, the rate of smart-phone use among Kenya's poor and vulnerable small-scale farming community is expectedly lower than that of traditional voice and SMS based phones. As highlighted in the literature above, which examines the 'digital divide' in the developing world, the available economic resources of the average Kenyan farmer in many cases preclude the ownership of expensive and fragile devices like smart phones. The average small-scale farmer in Kenya earns $2,527 per year through their combined economic activities, suggesting the cost of a smart-phone to be prohibitive for most farmers unless considered a necessary tool for their work.[104]

Avoiding the use of smart-phones is a personal choice for some. Baseline participants were polled on their primary reason(s) for not owning a smart phone. In opposition to the original hypothesis of the research project, which assumed that cost was the primary barrier to access, amongst the 37 respondents in the baseline pool without access to a smart phone, the most commonly stated reason for not owning one was because they did not know how to use a smartphone (23 responses, or 62%). The second most common response was not wanting to use a smart phone out of preference (43%, 16 people). Only 27% of baseline respondents (10) without a smart phone indicated they could not afford a smart phone or the necessary data bundles. Ten people (27%) also suggested they were afraid of damage, loss, or theft of the device. It is possible that some participants avoided responding truthfully due to the sensitive nature of admitting a lack of financial access. This may include some of those respondents who indicated they were worried about damaging, losing, or having their device stolen. In either case, the concern about initial cost of the device, as well as the potential to lose that sum invested, appears significant, yet far lower than originally assumed. The greatest challenge to smart-phone penetration

[103] World Bank. World Development Indicators (2020). *Mobile Cellular Subscriptions (per 100 people)*.
[104] George Rapsomanikis, "The Economic Lives of Smallholder Farmers," Food and Agriculture Organization of the United Nations, Technical Report (December 2015): 21. Rate from 2009.

among small-scale farmers in Kenya appears to be personal choice, reticence, or challenges in using the technology (technological literacy).

Table 2. Most common responses for not having a smartphone (n=60, "baseline" respondents).

What are the main reasons you do not have a smartphone and/or WhatsApp (multiple responses were possible for each respondent)	Baseline Farmers
I have access to a smart phone AND use WhatsApp	**25**
I don't know how to use a smart phone	23
I don't want to use a smart phone (preference)	16
I can't afford a smart phone and/or data bundles	10
I am worried about damage, loss, or theft	10
I have language or literacy challenges	5
I don't know how to use WhatsApp	2
I already have access to another smart-phone (someone else's)	2
I don't have an interest in using WhatsApp	1
I wasn't aware of WhatsApp groups	1
Other (please specify)	4
Source: Respondent interviews with 60 baseline farmers, July – October 2018	

While an increasing number of small-scale farmers in Kenya see smart phones as necessary for their success, the rates of awareness of WhatsApp groups for agriculture and other agricultural applications lead many farmers to see cell phones simply as an advanced form of communication, and not an extension tool. This divide in digital access was noted in the research findings of this project. A lack of access to smart phones was observed in the baseline participant group, with only 45% of participants (27) having access to phones with internet or app functionality. Amongst these 27 smartphone users, nearly all (25) were actively using WhatsApp, although only 9 (33% of the smartphone users and 15% of the whole baseline group) were using WhatsApp groups for agriculture. Still, this rate was surprisingly higher than originally hypothesized. This may be a result of the rapid growth of the low-cost smartphone market in sub-Saharan Africa, driven particularly by Chinese technology companies such as Tecno and Huawei.[105] The lower than expected reported barrier of cost may also be due to a relatively common practice among vulnerable farmers – sharing of key inputs and technologies.[106] Similar to how a tool to spray pesticides on crops may be shared communally among neighbours when not in use by the owner, smart-phones are also being shared among families, friends, and colleagues.

[105] Susan Wyche, Nightingale Simiyu, and Martha E. Othieno, "Understanding Women's Mobile Phone Use in Rural Kenya: An Affordance-Based Approach," *Mobile Media and Communication* 7:1 (2018): 102.
[106] Hamza Haider, Melinda Smale and Veronique Theriault. "Intensification and Intrahousehold Decisions: Fertilizer Adoption in Burkina Faso," *World Development* 105 (2018): 310-320.

This difference between ownership and access must be highlighted. While the expectation for every farmer to purchase and use a smart phone is highly unlikely, smart-phones are increasingly seen as an expensive yet valuable tool by many participants polled. As a result, participants commonly approached the use of smart-phones in a communal manner, particularly within families and close friends or colleagues.[107] While the net rates of smart-phone ownership may be low, the rate of access to a shared smart phone is substantially higher. In one example, a neighbour of a WhatsApp member respondent had asked that member to post a question on the group, after hearing about the groups from the member but not having a smart-phone himself. Another participant of the baseline farmer group, when asked why they did not have a smart-phone, responded that "all my family already has one."[108]

Sharing a single smart phone within a family, or at times within a group of friends and neighbors, indicates a workaround to the barrier of economic access. This suggests that solely looking at the rates of direct ownership is not enough to identify the amount of people that could currently benefit from a technological tool like WhatsApp Groups. Overall, this unexpectedly high rate of access to smart phones indicates that scaling the use of WhatsApp groups may be easier than originally assumed - with as many as 40%+ of small-scale farmers in Kenya potentially having direct or indirect access to the requisite technology already.

While these results are promising for opportunities to scale participation in WhatsApp groups, ownership of a smart-phone comes with additional and ongoing costs for access. Active members of WhatsApp groups for agriculture surveyed pointed to the cost of internet 'bundles' (pay-as-you-go packages for mobile data and/or cellular access) as an ongoing challenge to their participation. Those surveyed during farm visits estimated their monthly costs for internet bundles as ranging from 500KSH to 4000KSH, with greater costs for admins who are more active on the groups. Depending on the annual income of the farmers, these costs are not unsubstantial.

However, research findings indicate that after a farmer has gained access and participated in WhatsApp groups for agriculture, they increasingly view the service as necessary for their success. All (100%) of those surveyed during farm visits indicated they would continue to pay for access to internet bundles even if the price doubled overnight. Many likened the costs of bundles to the cost of fuel – a frustrating yet necessary cost that is outweighed by its benefits. Some indicated that while costs for continued access were high, the income generated through increased access to markets was higher, and therefore justified. This indicates that for those who have participated in these groups, the benefits serve as an ongoing pull factor towards the continued use of WhatsApp groups for agricultural livelihoods, outweighing associated costs.

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[107] Murphy, Laura L. and Alexandra E. Priebe. "'My Co-Wife Can Borrow My Mobile Phone!': Gendered Geographies of Cell Phone Usage and Significance for Rural Kenyans." *Gender, Technology, and Development* 15:1 (2011): 8.
[108] Baseline respondent #37.

> *"I don't think I could ever stop using it. It's like fuel, you need it, it's beneficial, and price keeps going up. Even if it's expensive it's very hard to stop using it. Of course, there is a cost benefit ratio, but WhatsApp is so helpful I can't stop no matter the cost."*[109]

Farmers' overall access to WhatsApp/smart phones is a substantial barrier to their use of groups for agriculture, and these barriers are expectedly more difficult for the poorest and most vulnerable (in which intersectional poverty creates additional barriers, see below). Still, research findings indicate that the use of WhatsApp groups for agriculture among baseline participants (15%, 9 people) is far lower than the existing access to smart-phones among farmers would predict (45%, 27 people). Further, for those who use the groups actively, the benefits (both intangible and income related) outweigh the required cost of entry. This indicates that modest investments in raising awareness of the existence of these groups and how to join them could substantially increase use, especially if coupled with policies that reduce access costs to internet bundles in rural areas.

4.1.2 Formal Education and Technological Literacy

The level of education among WhatsApp users provides a strong insight into their inherent barriers of entry. The primary requirements to participate in WhatsApp groups for agriculture are the ability to afford a smart phone and data charges, and the requisite technological literacy to navigate the application and phone itself. Further, Kiswahili is not an available language on all mobile operating systems (which determine the language for WhatsApp's interface), making English literacy an additional barrier for some. These problems - economic security, technological literacy, and English literacy - are likely much less significant for those who have attended a post-secondary institution in comparison to those who have only completed a primary school program (which was the case for a majority of baseline farmer participants). Among the Baseline Farmer pool, four had formalized agricultural education at the undergraduate (3), or graduate (1) level, while the remainder (56) did not. Most (41%) had only finished primary school. This can be compared to the WhatsApp Member pool, where 90% had some form of post-secondary school education. This indicates a highly significant bias of WhatsApp group participation towards the most educated farmers.

Table 3. Educational levels of the targeted and baseline response groups (n=60 for both groups).

Highest level of education attained	WhatsApp members	Baseline Farmers
Primary	0	25
Secondary (Incomplete)	3	10
Secondary (complete)	2	16
Tertiary	54	8
No formal education	0	1
Prefer not to answer	1	0

[109] Farm visit respondent #7.

Source: Respondent interviews with 60 targeted and 60 baseline farmers, July – October 2018

Educational demographics among the baseline farmer pool of participants indicated significantly lower levels of formal education than those farmers identified by their use of WhatsApp groups.

Technological literacy can be an additional and intersectional barrier that is difficult to overcome, but this challenge is aided by the increasing ubiquitous use of WhatsApp, and the availability of friends and family members to explain the basic skills necessary to navigate WhatsApp. Challenges in technological literacy are being addressed on a grassroots level in a similar way to the challenges in direct access to smart phones. Just as smart-phones are being shared among families and with colleagues, so too are WhatsApp accounts themselves. Multiple respondents mentioned asking younger family members to operate their account on WhatsApp groups in order to post questions and images. As a result, the existing 'potential' membership of WhatsApp groups (those with access to a smart phone, but not currently using the groups) may be higher than their actual membership, particularly in cases where multiple individuals use the same WhatsApp account to interact with the groups (this was common among husband-wife couples polled). However, it should be noted that some problems can emerge in cases where a farmer asks another person to interact with the groups. Sensitive information may not be raised due to the lack of privacy when having another person act on their behalf. Additionally, those with more technological capacity may become frustrated at frequently being asked to use WhatsApp groups for their parents or friends, leading to a lack of effort and the potential for information to be relayed without sufficient detail. These factors would potentially reduce the benefits gained by membership in these groups.

As a result of this widespread use of WhatsApp groups generally, many people in the developing world are already very familiar with the platform and its tools. This indicates that harnessing WhatsApp as a platform for development livelihoods can benefit from a form of technological leapfrogging. Rather than needing to explain and train users on a new tool or platform (as is common in the use of mobile technology in agricultural development), farmers are able to use their existing knowledge and the knowledge of their friends and family to effectively use the platform without intervention. However, while there are opportunities to overcome barriers to access related to education, the overwhelming bias towards post-secondary educated members indicates that those solutions are not the norm among small-scale farmers.

4.1.3 Gender

Literature on the digital divide indicates a considerable bias towards men when compared to women.[110] Women are less likely to have access to expensive technological devices like smart phones, less likely to hold control of family resources to purchase ongoing internet bundles, and less likely to be educated in post-secondary institutions.[111] This often leads to a relative lack of female participation in innovative technological/leapfrog solutions.

[110] Nicholas O. Alozie and Patience Akpan-Obong. "The Digital Gender Divide: Confronting Obstacles to Women's Development in Africa." Development Policy Review (35:2): 137-160.
[111] Ibid, 143-146

Issues related to the shared ownership of smart phones may have an impact on the rates at which women can access these devices and use WhatsApp groups. On one hand, as described in section 4.1.1, communal use of a smart phone within a family or among friends suggests that while the direct rate of ownership of smart phones may be low, more people may be using these devices than can be measured by ownership alone. This may suggest that while women are less likely to own a device of their own, they do in fact have access and the opportunity to enjoy the benefits of a smart phone. This was indeed observed in some cases during data collection for this research project, in which husband and wife farmers identified how they both share the same phone to access WhatsApp groups, in a manner that appeared to be relatively gender blind and equitable.[112]

However, even if women may have a smart phone available in their home, their use of the device may be curtailed by gender biases, leading to a lack of participation in platforms like WhatsApp groups. While the range of direct causes for the reported gender bias was not included in the design of this project, a clear digital divide seems to have been reflected in the results. Most (71.7%) of WhatsApp member respondents were men, while 28.3% (17) were women. The gender distribution in the baseline group was skewed in the opposite direction, with women dominating (80%), yet only 10% (6) of the baseline group were users of WhatsApp groups for agriculture.

It is also possible that women simply felt less willing and/or interested in participating in this research project. However, the focus groups provided a greater balance of gender, with 40% (12/20) participants being women. While gender was not identified by any participants as a barrier to access and participation, there was a bias towards male respondents among targeted member farmers. This indicates a bias of use towards men overall. Additional research could be conducted in the future on the relation of gender to the use and enjoyment of these groups (see recommendations section).

Another potential reason for low female participation in this research project, and in WhatsApp groups as a whole, may be related to a long running and persistent male bias in employment in agricultural extension in Kenya. Male extension officers may carry with them a bias towards preferring to interact with other men. Likewise, women may be reticent to interact with male extension officers for a variety of reasons. In those cases, the role of women has the potential to be normalized as passive participants in their farming activities, secondary to their husbands. This may also contribute to the observed gender bias of WhatsApp groups.

Yet WhatsApp may include some opportunities to overcome this challenge. WhatsApp allows users to select their own username and profile image, and as such, women have the choice to present as a gender-neutral member (without identifying factors that point to

[112] This equitable use of smart phones was not documented in an empirical sense, but rather based on the qualitative responses of both husband and wife. In these cases, both individuals indicated a clear understanding of how the groups work, with individualized personal experiences and responses. This suggests that both husband and wife were active participants, but this was not verified absolutely. It is also not clear if this shared use of the groups is consistent across all activities, from gaining information, implementing new techniques, through to marketing and selling products.

their gender). In this way, women's interactions with fellow farmers and any extension officers on the groups could be done without identifying themselves as female, and therefore may have the potential to reduce the perceived chance of stigma or bias in responses – increasing participation among women in a manner that is unique to a digital platform. While this was not directly observed in this research project, further research could be conducted on the value of digital anonymity in overcoming gender biases in the application of ICTD for agricultural extension.

4.1.4 Age

Table 4. Approximate age of targeted and baseline response groups.

What is your approximate age?	WhatsApp Members	Baseline Farmers
18-24	7	5
25-30	16	6
31-40	19	14
40+	18	35
Source: Respondent interviews with 60 targeted and 60 baseline farmers, July – October 2018		

An original hypothesis during the proposal process for this research project was that those using WhatsApp groups would be predominately "young males". This was due to preliminary research into public WhatsApp groups (of any topic) in Kenya, in which young males were apparently the most active members.

A report from 2012 likewise suggested that while ICTs can provide benefits to agriculturalists of any age, youth are likely the best positioned to take advantage of innovation as a tool to succeed.[113] A 2015 study indicated that until recently, Kenyan youth often perceived farming as a profession for elderly or uneducated individuals without a better option.[114] However, that study rather optimistically suggested the introduction of ICTs in rural agriculture has created a new wave of youth entering agricultural production.[115] Participation in online social networking was identified as a motivating factor to enter farming as a livelihood, as well as a support system for learning and overcoming challenges.[116] Indeed, the reported age range of each participant group indicated a bias towards WhatsApp farmers as being younger than the random sampling of farmers in the baseline research group. Farmers targeted by their use of WhatsApp groups for agriculture were on average approximately 35.2 years of age, while those sampled randomly in local markets were on average approximately 40.5 years of age. This, in conjunction with the data on education above, suggests that users of WhatsApp groups for agriculture tend to be younger by approximately five years, and more educated (nearly entirely at the tertiary level) than farmers in Kenya generally.

[113] Felicity Proctor and Valerio Lucchesi, "Small-Scale Farming and Youth in an Era of Rapid Rural Change," HIVOS/IIED Report (2012): 39.
[114] Irungu, K.R.G., D. Mbugua and J. Muia, "Information and Communication Technologies (ICTs) Attract Youth Into Profitable Agriculture in Kenya," *East African Agricultural and Forestry Journal*, 81:1 (2015): 26.
[115] Ibid.
[116] Ibid, 30.

4.1.5 Intersectionality

The barriers listed above are not independent of one another, but rather intersect and compound their effects based on the circumstances of each individual farmer. Intersectional poverty and the challenges facing small-scale farmers in rural Kenya also come with additional barriers that can contribute to these more universal challenges. A female, uneducated farmer will have greater difficulty to participate than a college educated male colleague. Being a caregiver can lead to less available time and resources to participate in activities like WhatsApp groups. The myriad barriers related to intersectional poverty have wide ranging effects, and it is very likely that these challenges lead to a diverse rate of access and participation based on the individual farmers' circumstances.

Disability of farmers can preclude their participation in WhatsApp groups. This may range from vision challenges through to a wide range of physical or cognitive disabilities. While individuals with barriers of this type were not directly interviewed (or if interviewed, they did not disclose their disability), disability is a constant in every society. It is highly likely that the reason no members with disabilities were encountered was that they are simply far less likely to participate due to their existing barriers.

WhatsApp groups for agriculture represent the types of opportunities that can come with technological leapfrogging and innovation when they are combined with cross-cutting development gains. However, these benefits cannot be enjoyed without a requisite set of skills and resources to promote access. In many cases, those skills and resources are enjoyed in an asymmetrical manner depending on the context of each individual. In order to be a universally available service, WhatsApp groups require a bedrock of basic development in education and economic growth, combined with changing social norms that promote equality and accessibility among the vulnerable.

4.2 Primary Barriers to Awareness

The nature of WhatsApp groups for agriculture as a small-scale grassroots platform includes inherent barriers of awareness among a majority of small-scale farmers. While a lack of direct access to a smart-phone and the necessary internet bundles can serve as terminal barriers, awareness of the existence of groups, and how to join them, is equally important. In order to adequately scale participation, these additional barriers related to awareness must be addressed.

4.2.1 Awareness of the existence of WhatsApp groups for Agriculture

Having a smart-phone is only the first step to using WhatsApp groups for agriculture. If a farmer purchases a WhatsApp-ready device, they may never join a group for agriculture if they are left unaware that such livelihood groups exist. This forms a substantial barrier to entry in addition to the access barriers highlighted above. Positively, research findings indicated that a greater number of farmers were aware of the existence of WhatsApp groups for agriculture than originally hypothesized. Among baseline farmer participants, 70% (42) were already aware of the existence of these livelihood-based groups, and 15% (9) were dormant or active members of such groups. Comparatively, three (5%) of baseline respondents were active users of Facebook groups for agriculture; two (3.3%)

were active users of SMS based agricultural services; while three (5%) previously used SMS services but had since stopped.

Of all baseline respondents who were not active users of WhatsApp groups for agriculture, 90% (46 of 51) indicated they would be interested in joining the groups after given a brief description of their function.[117] Those who indicated they were not interested in joining WhatsApp groups for agriculture after hearing about them primarily indicated a general apprehension and lack of technological literacy with both smart phones and WhatsApp. This suggests that the access barriers highlighted above remain a primary challenge. Other responses included a lack of time and interest, and fear of owning a smart-phone due to the risk of theft. This further suggests that a lack of use is not necessarily related to a lack of interest in the platform. Instead, the access and awareness barriers appear to be the most common and consistent throughout the baseline participants.

An additional barrier which was not directly mentioned by participants of this research project could include the financial challenges associated with implementing information gained on a group. While a farmer may be able to afford access to the phone and data subscription, some advice provided requires the farmer to have an existing amount of working capital to invest in their livelihood. New seeds and fertilizers, or other projects like creating a fish pond or greenhouse, require capital to purchase and/or install. In this sense, it stands to reason that some farmers may not have an interest in joining these groups as they would be unable to practically implement the information being provided.

It should be noted that a preference for voice communication may also impact participation rates in WhatsApp groups. A 2012 study examined Kenyan farmers' preference for voice calls versus SMS. The study indicated voice to be preferable due to cost of multiple messages and time spent typing and waiting for responses.[118] This is understandable, but WhatsApp may address these issues. Cost is reduced significantly through the application, and while texting can certainly be more time consuming than voice calls, being able to communicate with 256 people with a single text is arguably far more efficient than a one-to-one phone conversation. The additional benefits of being able to send voice recordings, photos, and videos, allow for those with additional (and intersectional) challenges like eyesight and literacy to participate at a greater rate. This further suggests that WhatsApp provides additional benefits to SMS, which would not have been reflected in the 2012 study.

Among those baseline farmer participants who were already aware of the existence of WhatsApp groups for agriculture, the majority were informed by their friends and other farmers (45%). This was mirrored by participants in the WhatsApp member pool (56%), with an additional 15% creating their own group after hearing about the existence of other groups. A sizeable portion of baseline respondents indicated they had heard about

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[117] Participants were informed that WhatsApp groups for agriculture are virtual messaging groups where farmers can share and request information with other agricultural practitioners.
[118] Angela Crandall, "Kenyan Farmers' Use of Cell Phones: Calling Preferred over SMS," Fulbright Research Program (2012): 1-10.

the existence of these groups through media (radio, TV), but that these broadcasts were not accompanied by information on how to join groups or where to find them.

Table 5. Means by which farmers were made aware of the existence of WhatsApp groups for agriculture (n=60 for each group).

How were you made aware of WhatsApp groups for agriculture?	WhatsApp Members	Baseline Farmers
Farmer was not aware of WhatsApp groups for agriculture prior to being contacted for this project	0	18
Friends/Other farmers	34	19
Family	0	1
Radio	0	12
TV	0	6
Internet	10	0
Newspaper	1	0
Started their own group	9	0
Extension officer / Other professional	6	4
Source: Respondent interviews with 60 targeted and 60 baseline farmers, July – October 2018		

In comparison, WhatsApp farmers did not report learning about the groups from media, but rather from various internet pages (most often Facebook). Becoming aware of the groups through an online medium can make joining a group far easier, as links can be directly followed to join a group, and additional information can be searched for through the use of more advanced technological literacy (Facebook groups, web searching, etc.). Comparatively, those in the baseline pool who were more likely to learn from traditional media were unable to follow a direct link or seek out additional information without requisite internet-navigation skills and even knowing where to start. Therefore, while rates of awareness of the existence of these groups were found to be high, the other compounding barriers of general access and awareness of how to join keep the rate of participation far lower. Accompanying media broadcasts with a detailed description of how to find and join groups, or create your own, could potentially improve the rate of participation among the less technologically literate who already have access to smart-phones.

WhatsApp groups for agriculture are a decentralized and relatively new phenomenon. As a result, it was expected that most farmers had become aware of these groups recently. This was partially disproven among the targeted farmer group. Among WhatsApp member farmers surveyed, 68% had joined these groups more than two years ago, with 36% of member farmers joining more than three years ago. This suggests that among members who participate in WhatsApp, many remain active members for the long-term. Contrarily, among the baseline research pool, only 26% of participants had been made aware of these groups for a year or more prior. This may be due to the means by which farmers were made aware of the groups (Table 4). As described above, baseline farmers were more likely to rely on traditional media (TV, radio), which can be more delayed in covering an emerging grassroots phenomenon.

Table 6. Time elapsed since learning about WhatsApp groups (n=60 for each group).

When were you made aware of (or when did you join) WhatsApp groups for agriculture?	WhatsApp Members	Baseline Farmers
Farmer was not aware of WhatsApp groups for agriculture prior to being contacted for this project	0	18
Less than one month	0	4
1 month - 3 months (e.g. mid 2018)	0	9
3 months - 6 months (e.g. late 2017 to early 2018)	1	9
6 months - 1 year (e.g. mid to late 2017)	5	9
1 year - 2 years (e.g. 2016-2017)	13	5
2 years - 3 years (e.g. 2015-2016)	19	0
3 years or more (e.g. before 2015)	22	6
Source: Respondent interviews with 60 targeted and 60 baseline farmers, July – October 2018		

4.2.2 Awareness of how to join WhatsApp groups for Agriculture

Being aware of the existence of WhatsApp groups, or even of WhatsApp groups for agriculture, is different than being aware of how to join them. WhatsApp provides a platform for small, semi-private groups which function on an invitation-only basis – either through private invitations or by posting invitation links on public forums.[119] As a result, most farmers are only able to join these groups if they are aware of other farmers who are already members, or if they are able to successfully find public invitation links that are relevant to their livelihood practices.

Typical places that invitation links for agriculture specific groups are found include Facebook pages/groups for agriculture, and other Kenyan social networking groups (Telegram, WhatsApp, Facebook, etc.) that are otherwise unspecific to agriculture. Further, finding WhatsApp groups for agriculture in Kenya on social media provides mixed results. Only 256 members can be in a single WhatsApp group. Those who find invitation links online will frequently attempt to join the group, only to discover it is already full. When other groups run off topic or are plagued by spam, members mute the group and become inactive, disincentivizing any new members from participating in that group (and potentially in seeking out other groups for the same purpose). Those who are lucky enough to find an invitation link often find themselves arriving too late to participate. This is a major challenge to participation in groups for agriculture, yet it indicates an opportunity for intervention.

When compared to dedicated agricultural extension applications available on smart phones, or even to Facebook groups which are most often public and allow unlimited members, WhatsApp groups are exceedingly difficult to access. The lack of awareness of the existence of WhatsApp groups for agriculture, coupled with an additional lack of access and understanding needed to join groups, leads to many groups being formed through existing social networks. Among targeted WhatsApp member farmers, 56.7%

[119] WhatsApp. "How Do I Use a Group Chat?" *Online Resource*.

were made aware of the groups by friends and/or other farmers. Through a combination of effective administration and an observant membership, a group can become viewed as an incredibly valuable community to all those who are a part of it. As a result, some of the 'best' groups have a waiting list, while others charge a small monthly or annual fee to its members.[120] This adds additional complication to awareness of how to join and leads many farmers to simply create their own groups.

4.2.3 Existing use of WhatsApp Providing an Enabling Environment

Some of the barriers identified above can be partially bypassed through the existing enabling environment surrounding WhatsApp's use in the developing world. WhatsApp benefits from its position as a nearly ubiquitous application for messaging and communication in the developing world.[121] Among WhatsApp users identified in the baseline pool of participants (25 out of 60), 76% were already using WhatsApp groups for communication with friends, church communities, and family. As such, the majority of existing users of WhatsApp are already equipped with the necessary technological literacy to use and create groups, and understand their limitations.

In this way, WhatsApp can be differentiated from agricultural extension applications that require a smart-phone and internet bundles, but also require the farmer to be fully aware the application exists in order to download it. Proprietary apps (iShamba, iCow, etc.) are similar to standalone extension technology like the 'talking books' examined in the literature review. In addition to the common barriers above, they require an additional set of technological literacy skills, awareness, and phone capability challenges (many of the cheap smart-phones available have extremely limited storage capacity).

One benefit of WhatsApp's status as the most common messaging application is that an awareness of WhatsApp groups for agriculture already existing is not a necessary prerequisite to being a member in an agriculture group. WhatsApp groups for agriculture are a truly grassroots phenomenon, that have the potential to emerge independently anywhere that there is a critical mass of WhatsApp users. That is, it is highly improbable that the existing WhatsApp group landscape could be tracked back to a singular 'group-zero'. One participant of this research project confidently argued that he was the original creator of the phenomenon of groups for agriculture. While there is a small chance this is true, it is far more likely that the individual simply used his existing knowledge and use of WhatsApp groups to see an opportunity to create his own agriculture specific group, while similar cases occurred independently elsewhere.

There is a potential that this existing enabling environment has allowed for farmers who were unable to join existing groups to create their own groups as administrators, and

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[120] This fee structure varies wildly across groups. In some cases, the fee is used to offset the increased data costs that an administrator incurs while managing the group. In others, the fee is collected and saved for the intention of renting a physical office and formalizing the virtual group in a manner that is most closely compared to a farming cooperative. Others still reserve the fee to organize group workshops, farm visits, or to assist members who are in dire need of support. The researcher also observed a group (focused on a specific geographic area) raising money to pay for funeral costs of a fellow member.

[121] Bucher, Birgit. "WhatsApp, WeChat, and Facebook Messenger Apps - Global Messenger Usage, Penetration, and Statistics." *MessengerPeople Online* (February 12, 2020).

invite friends and colleagues from their existing social relationships. Multiple respondents indicated that after being frustrated at not being able to find publicly available groups, they sought out to create their own. Of the member farmers interviewed, 15% (9 people) had started their own groups.

4.3 Summary of Access and Awareness Chapter

Before farmers are able to take advantage of WhatsApp and WhatsApp groups, they must first overcome a multitude of complex and interconnected barriers. These barriers are multifaceted, and directly linked to the intersecting challenges that can typically be associated with rural agriculture, technological adaptation, grassroots movements, and interdimensional poverty as a whole. Access and use of smart-phones can be limited for Kenya's poor, and also potentially inaccessible due to challenges such as disability or illiteracy. Additional challenges exist in rural settings, where having access to low-cost devices is also limited. Considering the additional barriers of scaling small technological platforms (groups) of a particular livelihood group, within a geographically disperse area - WhatsApp groups may appear to be an unlikely solution for most agriculturalists in Kenya.

Yet the existence and use of these groups is in many ways an indication of their viability and potential. The members of these groups have overcome the myriad barriers listed above, and have done so without intervention or direct support. In some cases, the members have had to find solutions to specific barriers, such as having their children read the group's contents and write responses to overcome their challenges with technological or English literacy. While WhatsApp groups for agriculture are still mostly unknown and inaccessible, the various factors associated with technological leapfrogging and bottom-of-the-pyramid telecom strategies will likely continue to increase the spread and use of groups for agriculture – whether on WhatsApp or another platform.

Still, more can be done to make these groups - and the devices that support them – accessible to small-scale farmers or other potentially relevant livelihood groups. Some NGOs have targeted smart-phone access as an output for their agricultural interventions. In an interview with a program officer from One Acre Fund, the officer indicated that smart-phones had recently been added to the list of inputs available to beneficiaries through their micro-finance program. This indicates that the development community is increasingly viewing smart-phones as a complementary tool for small-scale agriculturalists, recognizing the inherent barriers to access while valuing the cost of intervention as lower than their potential benefits for small-scale farmers.

Chapter Five: Results - Use and Experiences of WhatsApp Users

As outlined above, participating in WhatsApp groups for agriculture requires overcoming a multitude of barriers that are particularly high for those that could benefit the most. Yet in spite of these challenges, many vulnerable and small-scale farmers in Kenya have successfully become active and participatory members. WhatsApp groups for agriculture are still a growing phenomenon, and their use must be examined in order to understand the value these groups have for their members. For those who gain access to these groups, the benefits can be considerable – making the requisite barriers all the more worthy of overcoming. This section will examine its use, utility, and the experiences of those farmers who have joined WhatsApp groups for agriculture.

5.1 Pull factors

Table 7. Motivations to join WhatsApp groups ("Targeted respondents" n=60).

Why did you originally join WhatsApp groups for agriculture? (multiple responses were available to each participant)	WhatsApp Members
Finding markets to sell and buy	15
Building a farming community	26
Soliciting / sharing experiences and practices	40
Source: Respondent interviews with 60 targeted farmers, July – October 2018	

The pull factors that motivate farmers to join and participate in WhatsApp groups can be diverse, but typically revolve around a gap in existing extension services; an interest to learn new information; the opportunity to find new markets; and the chance to build a community of likeminded practitioners. In many cases, respondents mentioned a combination of these factors as motivating their interest to join. This suggests that while WhatsApp may provide different solutions to the goals of each farmer, the overall understanding of the groups among new members is based around marketing, community building, and the access to new skills, inputs, and practices.

5.2 Level of activity and participation

Among targeted WhatsApp member farmers, 63% considered themselves highly active (regular participation), and 33% considered themselves to be somewhat active (occasional participation). Only 3% identified themselves as 'viewers', who read the contributions of others but did not post themselves. This indicates that for many members, WhatsApp groups become an integral part of their livelihood practices. By staying up to date on discussion, farmers reported that they are able to become aware of new skills and experiences before they need to solicit advice themselves. This allows farmers to avoid problems before they arrive, while focusing on advancing their practice rather than spending time to combat challenges – transitioning from a reactive to a proactive approach.

5.3 Perceived benefits and shortcomings

When asked about their overall opinion of WhatsApp groups for agriculture, farmers had overwhelmingly positive views. All (100%) of the farmers who were already using WhatsApp reported that their opinion of these groups was either 'very positive' (65%) or 'positive' (45%). No participants reported neutral or negative opinions of the platform. It should be noted that any farmers who have had negative experiences may be have been less likely to contribute to the research project, as they would expectedly leave the groups or not respond to the researcher's invitation to participate. Still, among a nation-wide sample of 60 farmers identified through their use of WhatsApp groups, the experience of using the platform is overwhelmingly positive. This suggests that even with the shortcomings described below, WhatsApp groups are successfully filling a necessary gap in the available agricultural extension services for small-scale farmers in Kenya.

The overall opinion of WhatsApp groups does not necessarily suggest that members have not had any negative experiences. Those situations may be rare, and heavily outweighed by the positive experiences, though they still must be noted. Nearly half (43%) of the farmers reported that they had previously exited at least one WhatsApp group for agriculture. The most common reason for this was poor administration leading to irrelevant posts and spamming. Some reported that due to the limit on members in each group, they did not want to take the space that another farmer could occupy if the group was not particularly relevant to their activities – suggesting some form of mutual support for the community as a whole. Others joined groups for a specific product (tomatoes, onions, etc.) and later determined the information was not specific enough to that product. No one reported stopping their use of all WhatsApp groups permanently, and all respondents remained active members in other groups.

Likewise, 29 (48%) members surveyed indicated that the groups could have some shortcomings, problems, or be unhelpful in some ways. Comparatively, 24 (40%) members reported not having experienced any shortcomings. Seven (11.7%) respondents reported mixed feelings when asked about shortcomings, as each group can be widely different from another. Once again, the qualitative responses to this question were overwhelmingly based around experiences with groups with poor administration, leading to irrelevant posts, or a general lack of useful information. If a group as a whole is not actively participating, there is also the chance that individual members post well-intended, but ultimately incorrect information. Without other members to clarify any erroneous posts, members who read the group have the potential to be misinformed. Others mentioned the challenges related to access: the cost of smart phones and internet bundles, which preclude a wider and more diverse number of farmers participating.

Table 8. Most significant group problems as seen by WhatsApp Group members (n=60, of which 24 had not experienced shortcomings and therefore skipped this question).

In what ways can these groups have shortcomings or problems? (multiple responses were available to each respondent)	WhatsApp Members
Farmer had not experienced shortcomings	**24**

Irrelevant posts	30
Spammers/Fraud	8
Poor administration	9
Unreliable or confusing information	6
Competition between members (undercutting, etc.)	4
Source: Respondent interviews with 60 WhatsApp members, July – October 2018	

5.4 Direct Experiences: How have WhatsApp groups helped or hindered?

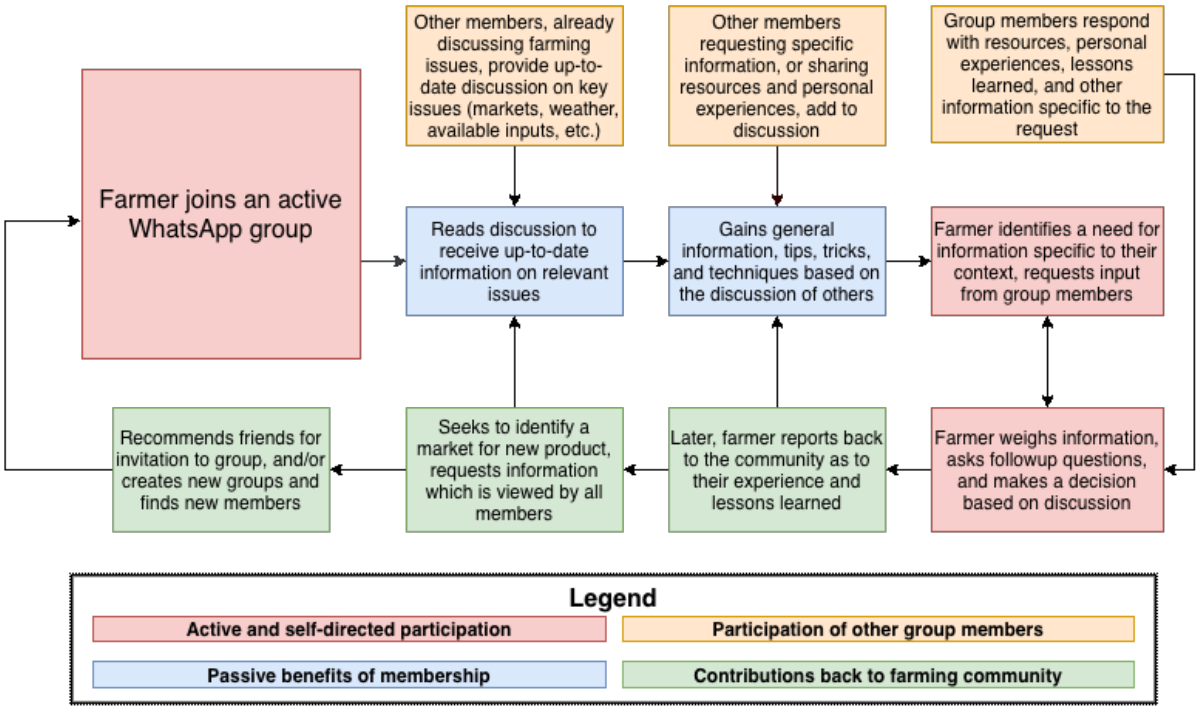
The farmers surveyed for this research project each use WhatsApp in the manner that best suits their individual needs. Their engagements ranged from reading ongoing discussion, soliciting advice, responding to the questions of others, and finding markets. This mixed-use approach further suggests that these groups serve as more than just a tool to solicit specific information. The nature in which farmers remain active and participatory in these groups continues to mimic the structure and benefits of a virtual community of practice. Farmers can gain the assistance they need by asking questions of their own, but as Table 9 shows, nearly equal numbers are eager to support others or discuss issues of interest, and almost all farmers read the posts made by other members. Through sharing mutual yet diverse goals related to farming, a given group as a whole is able to learn communally and contribute back to the group at the same time.

Table 9. Most significant group contributions as seen by WhatsApp Group members (n=60).

In what ways have you used WhatsApp groups for agriculture? (multiple responses were available to each respondent)	WhatsApp Members
To ask questions and receive feedback	54
Reading the questions and responses of other members	58
Provide assistance by answering others' questions	52
Find buyers or brokers for my products	43
Other (please specify)	16
Source: Respondent interviews with 60 WhatsApp members, July – October 2018	

The means in which farmers use these groups are diverse, but tend to follow a consistent flow of actions that can be qualified as self-directed; contributions back to the community; and the passive benefits of membership. By combining this approach, farmers are able to read existing discussion (informing them of issues prior to their need to solicit advice); contribute with their own past experiences for the benefit of the group; request specific information; and provide additional information on their experiences of using information learned on the group (see flowchart in Figure 2 below).

Figure 2. Farmer's Experience Using WhatsApp Groups for Agriculture.



During farm visits, participants were asked for specific examples of how they have applied knowledge and practices gained through their participation in WhatsApp groups. These responses point to the diverse needs and requests of each member, and how WhatsApp has allowed them to increase productivity, reduce loss, and diversify their farming activities.

> *"Technologies like biological control including traps and attractants for pests. This is much different than we used to use, as it used to be much more chemical oriented. Another example is the types of equipment we use now, like hives for bee keeping … We learn exactly which plants are helpful for bees, so we plant those nearby and customize the area to be more conducive for our bees.*
>
> *For poultry, initially we used to have indigenous chickens, now we have improved hybrid chickens. Over time we found some that are … more adaptable to stress, diseases, and our region as a whole. So we learned of broiler chickens that are a hybrid and allow us to have better production, yield, price for our chickens, and it is helping us very much. Having companies that produce these breeds in the group is very helpful. "*[122]

When surveyed, farmers who were already members of WhatsApp groups identified that the platform has alleviated some of their fears for the future, and in fact has assisted them in planning for improvements. This contributes to shifting the farmer's approach from

[122] Farm visit respondent #23.

one of reactivity (addressing emerging pest problems, losing income due to crop loss, etc.), to one of proactivity.

> *"I would say that the groups have taught us the concept of how to do a farm plan for overall management. I've diversified my farm through this plan, which allowed me to reach higher production and yield. After learning how to deal with pests and diseases, I am having much less loss of crops and animals. Also introducing things like bio-gas, new innovations to use every aspect of our waste and save money. It's a mutual benefit, I both save money and gain fuel I would have had to purchase before. With the knowledge we can subdivide the farm and get the greatest possible potential while ensuring our production is not reliant on a single product."*[123]

5.5 Markets and Economic Benefits

Nearly all (55, or 91.6%) of participants reported that their use of WhatsApp groups has directly led to an increase of their income and livelihoods, while 8% were unsure. None reported with certainty that WhatsApp has not contributed positively to their livelihoods.

Table 10. Means by which income has increased by use of WhatsApp groups (n=60).

In what ways has your income increased as a result of using WhatsApp groups? (multiple responses were available to each respondent)	WhatsApp Members
Access to new markets	36
Increased production (new techniques, crops, etc.)	40
Reduced loss (pest control, disease prevention, etc.)	21
Market information (commodity pricing, etc.)	9
Source: Respondent interviews with WhatsApp members, July – October 2018	

Similarly, only 11.6% of participants (7) reported they had lost income by using the groups, with 83% reporting they had not lost any income (5% were unsure). Those who lost income included farmers who had sent a mobile-money transfer for inputs that they did not receive[124], while others reported that after marketing a specific input (in this case pesticide), members had poor experiences that they reported to the group – leading to what was described by the participant as 'mob psychology' in which overall purchases of their input in future were reduced. This issue can come up frequently and has led to some groups to ban any members who have a vested interest in marketing a specific input (seed brokers, agrochemical dealers, etc.).

When asked how long (on average) it takes to find a buyer through WhatsApp groups, 38% of participants (23) mentioned being able to find a buyer within 24 hours, with many reporting experiences that only took a few hours or minutes. Only 7% of those surveyed stated that finding a buyer through WhatsApp groups can take more than 72 hours.

[123] Farm visit respondent #16.
[124] It was unclear whether this was a deliberate act or an oversight, but the participant believed it to be the result of a scam.

Respondents stressed that the ease with which they could use WhatsApp groups to market their products while remaining on the farm was an incredible benefit. In many cases, buyers would travel directly to the farmer, reducing the costs associated with transporting a large amount of agricultural products to and from the nearest local market (83% of respondents lived within 1 hour of travel from their nearest main market). Some were able to identify buyers prior to harvest, ensuring that no produce would be spoiled or lost due to time spent searching for a market.

> *"Without WhatsApp we would be back in time, using newspapers for advertisements. When things are time sensitive, you have a huge risk to lose your value if it takes too long."*[125]

Further, WhatsApp allows farmers to be aware of the price of specific products in each region, ensuring they are able to demand a more equitable price depending on market trends. The groups also allow farmers to field multiple offers from prospective buyers. When compared to a farmer desperately attempting to sell a large amount of tomatoes in a local market while they are on the verge of spoiling, WhatsApp groups allow farmers to have more control, freedom, and power in finding the best market for their goods at any time. Finally, some participants identified the benefits of being able to cut out agricultural brokers, who had traditionally underpriced products to resell in markets. WhatsApp farmers are now able to use direct trade, ensuring the already slim profits remain with the producer rather than being spilt with middlemen.

> *"Our market is volatile in terms of pricing and cannot be predicted. The groups have helped me be able to talk to other farmers and know approximately how much a product will cost in the market. In the past we needed to go to brokers, but now we can rely on each other."*[126]

5.6 Trust

A key concern of relying on WhatsApp groups is the trustworthiness of information. As highlighted in sections 2.1 and 2.3, trust is key to reducing the perceived risk of a farmer that is considering applying the knowledge they have gained. It must be noted that each WhatsApp group is different from the next, with memberships that can come with a highly diverse range of backgrounds and expertise. Often these are networks of people who do not know each other in other contexts. Success and trust through WhatsApp groups stems from more than a question-and-answer process. This is where the concept of a virtual community of practice becomes highly relevant. Through a shared understanding of farming and efforts to promote reciprocity, farmers support each other as a whole rather than as individuals. When one farmer requests specific information, one or more other farmers will typically reply with advice or information. At that point, other members on the group chat can read the information and may decide to contribute additional advice that confirms or disputes the information previously provided, or may choose to implement the advice gained independently, later reporting their experiences.

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[125] Farm visit respondent #2.
[126] Member farmer participant #28

In a similar way, even the negative experiences of farmers can be useful when shared. In one case, a farmer requested information through a Kenya-wide group on what type of fertilizer would be best for their tomato crops. After one member suggested a specific input, another reported that they had used that input on their farm with disastrous results. After additional discussion, it was concluded that the fertilizer was only useful in specific regions where the soil quality differed from others. Ultimately, the farmer who asked the question was advised on a fertilizer that best suited their farm, while other farmers throughout the country were better informed on matching inputs to their respective soil types. In the end, well-intended information that may have devastated the farmer's crops was clarified as relevant only to a particular set of circumstances. These experiences are the hallmark of a truly successful WhatsApp group, in which trust is built through a virtual community of likeminded yet diverse practitioners who can bring their wide-ranging experiences together to benefit the group as a whole.

> *"The quality of discussion is key. If it is just question and answer you can't always be sure, but when others weigh in it becomes more certain because it relies on the experience of the group and not just one person. This is a lot different than before WhatsApp, where I would just call one or two friends for advice and sometimes it wouldn't work. I would hear the same things from them as I was doing, WhatsApp has opened me up to new ideas and techniques I had never heard of before."* [127]

When asked how trustworthy and reliable they consider the information gained through WhatsApp groups to be, member farmers were divided but universally favourable. Half (50%) reported they considered the information to be very trustworthy, while the other half reported it to be only somewhat trustworthy. No respondents believed the groups to be untrustworthy overall. Qualitative responses helped to clarify this. Those who found the groups to be very trustworthy had most often requested advice that was ultimately successful and helpful. Others stated that being a member of a WhatsApp group for agriculture suggested you were a 'serious farmer', who would not post information without confidence in their experiences. Those who found the groups to be somewhat trustworthy were more skeptical, but ultimately confident that most information was shared in good faith. Respondents reported receiving advice that they later researched independently, in order to confirm its validity.

> *"In the group we normally vet information, we debate a lot and clear up bad information ... To vet info we like to have multiple people using the same product with similar experiences"*[128]

Issues that led to a lack of trustworthiness were often based around the self-serving interests of agrochemical dealers seeking to sell their inputs without advising on alternatives. Many farmers reported that while WhatsApp groups are a useful tool, the information gained is still only as reliable as the person who shares it. This suggests an increasing awareness of the risks inherent to following the advice of strangers over the internet. Ultimately, applying a degree of skepticism to all information gained should be

[127] WhatsApp member respondent #15.
[128] WhatsApp Member Farmer #54

considered best practice when using these groups, yet the overwhelming experiences of members in active groups thus far have been positive and reliable.

5.7 Social Capital Growth Through Virtual Communities of Practice

While the research project included hypotheses around the value of such groups for growing social capital among rural and disperse farmers, it was a surprise that many participants made direct mention of the benefits of building a community of farmers rather than seeing WhatsApp simply as a tool for soliciting information.

WhatsApp groups highlight and reinforce the intricate relationship between social and economic capital. Mehta et al. argue that there is a dynamic interdependence between social capital and agricultural entrepreneurship.[129] Entrepreneurship requires a number of requisite factors (such as information, capital, skills, and labour) to succeed. While entrepreneurs may have access to some of these resources, they are increasingly accessible when using social networks, and even more so in combination with mobile phones that extend those networks past localized areas.[130] However, the paper suggests that successful integration of agricultural entrepreneurship, social networks, and cellphones are unlikely to occur without the establishment of inter-personal relationships built upon mutual trust.[131] Such trust is most easily built in networks that have a pre-established record of success, and those in which members share common experiences and/or backgrounds.[132] WhatsApp provides the means for this dynamic relationship to flourish, and serves as a platform for social networks to be developed in tandem with trust and reciprocity, allowing agriculturalists to harness their growing social capital in pursuit of peer-supported economic growth.

All (100%) of member farmer respondents stated that they felt their social networks had grown as a result of using WhatsApp groups for agriculture. Nearly all (57 respondents, or 95%) had private messaged or phoned fellow members, whether to gain additional information, or to market their products. This indicates how these groups can open geographically isolated farmers to networks of peers far outside of their local area – providing access to more diverse experiences and information.

When asked during farm-visits who they considered to be the most valuable members of these groups, responses of farmers varied. Half of respondents had a preference either for the responses of fellow 'average farmers' (20%) (who they felt had the least to gain from providing bad information, and the most relevant experience in respect to their needs), or of 'experts' (veterinarians, agronomists, extension officers, etc.) (26%), as they were perceived to have the most reliable and fact-based information. However, the other half (47%) of respondents stated that a 'mixture of all members' led to the greatest amount of trustworthiness. This reflects the benefits for social capital that are gained through

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[129] Khanjan Mehta, A. Maretzki and L. Semali, "Trust, Cell Phones, Social Networks, and Agricultural Entrepreneurship in East Africa: A Dynamic Interdependence," *African Journal of Food, Agriculture, Nutrition, and Development*, 11:6 (2011): 5375.
[130] Ibid, 5379.
[131] Ibid, 5383.
[132] Ibid, 5381.

participating in a virtual community of practice, in which the diverse experiences of many members can come together through sharing and discussion to provide quality and on-demand information in a reliable manner. The end result is a community of others (in many cases, those who a farmer would not be able to communicate with otherwise) that can be relied on, and that seeks to support each other whenever and however possible.

5.8 Summary of Use and Experiences Chapter

For farmers who are able to overcome the barriers related to access and awareness, the benefits of joining and using WhatsApp groups can be incredible. After using the groups for a short time, they often become an integral part of the farmers' ongoing livelihood practice. This was reflected in research results. As highlighted above, 100% of WhatsApp farmers interviewed during farm visits stated they would continue to use these groups even if the cost of internet access doubled overnight. As noted by one respondent earlier, WhatsApp is increasingly seen as a necessary and integral tool for agricultural livelihoods ("like fuel"), which will be used regardless of the cost.

Similarly, when asked what they would do if WhatsApp disappeared tomorrow, most responses related to the personal devastation it would cause rather than alternative solutions they could use to fill the gap. This is because WhatsApp is effectively closing an ever-present gap in the lives of farmers: an enormous shortage of extension services and support to small-scale farmers. In addition, while closing this gap, farmers also benefit from the opportunity to connect with likeminded practitioners in their region and throughout the country and form virtual communities of practice. This provides a benefit that would go unaddressed even if extension services were rapidly scaled up and expanded. In short, WhatsApp provides a solution to immediate gaps while also providing the opportunity for additional benefits that would be unthinkable for a group that is, by its nature, widely spread and geographically dispersed.

> *"We are so used to phone technology now. Yesterday I forgot my phone and I felt almost naked. I even came home earlier to be with my phone and read the groups. If I lost WhatsApp it would make me miss a lot, I would waste a lot of time, lose money in marketing, and have many headaches and problems trying to solve issues. If you can't figure it out, it really makes you feel like you are failing, and you lose your motivation so quickly. It's demoralizing. I would need to travel to other farms more often in order to learn and communicate. It's helpful, but it's time consuming and expensive to do that"* [133]

WhatsApp groups have provided unique benefits to those who have been able to access them. Through the grassroots formation of virtual communities of practice, small-scale farmers in Kenya have worked to close the wide gap in available extension services. While the groups appear to be overwhelmingly positive for their members, the barriers related to access and awareness remain the key challenges to the universal enjoyment of this innovative tool. The following section will briefly discuss opportunities and

[133] Farm visit respondent #17

recommendations for additional research and provide a concluding summary of the results gained through this project.

Chapter Six: Conclusion and Recommendations

6.1 Conclusion

This research project attempted to provide the first comprehensive understanding of WhatsApp groups for agriculture in Kenya by examining the motivations for farmers to join and create these groups, and the experiences of farmers using these groups in an attempt to benefit their livelihoods. Many of the initial assumptions of the project around these groups' overall utility and value to their members were confirmed. Yet while a more diverse range of experiences was expected, the results were overwhelming in identifying these groups as valuable to their members. For active members, the groups have become an integral tool to their continued success. This is because the groups serve to fill gaps in their experiences that remain unfilled despite efforts by government and development actors. These gaps serve as the immediate motivations to join and create the groups, and their persistence among farmers is the reason the groups are used so actively and with such positive experiences.

The most common gaps filled by WhatsApp groups are a lack of access to information, a lack of diverse peer-support networks, and a lack of access to wider markets. Farmers require a significant amount of information on a day-to-day basis, ranging from weather trends to the current price for an agricultural product. While some services exist to provide this information in a top-down approach, WhatsApp's provision of this type of information only begins to skim the surface of what knowledge is available to learn through the groups. A farmer can at any time ask any other farmers in their area or a neighbouring county what the weather is like currently, and likewise what they have most recently sold their tomatoes for. This immediate access to key information is a valuable resource for farmers. Yet beyond this information that can be considered more immediate and precise, farmers also have a gap in access to new and innovative knowledge that can transform their livelihoods. Learning new techniques and approaches to farming are most often best gained by the experiences of fellow farmers, and WhatsApp provides the means for that learning to take place.

Rural small-scale farmers are often by their nature geographically distant, with other farmers in their immediate area serving as the only fellow practitioners they can meet and communicate with on a regular basis. While workshops and conferences can be attended in some areas, the opportunity to maintain communication and develop ongoing relationships is limited. The introduction of mobile phones made considerable improvements for individuals at great distances to communicate with each other, but did not provide the means for new social networks to develop at scale. WhatsApp groups harness the opportunities afforded by leapfrogging in mobile phone technology, providing a platform by which farmers can meet other farmers in distant areas to gain peer-support through virtual communities of practice. This innovative use of messaging groups to form virtual livelihood communities is the hallmark of what makes WhatsApp groups for agriculture so powerful, and serves to fill two gaps simultaneously. Information dissemination is increased, as farmers increasingly have access to knowledge they may not have even considered to request in the first place. Additionally, that information is gained through ongoing communication with a group of fellow

practitioners, allowing lived experiences to be introduced that may provide additional benefit to the unique context of each particular farmer.

Some of the most practical information, such as how best to support tomato plants using plastic cord for better yields, may never be requested by a farmer without knowing it exists in the first place. This is why the virtual communities of practice found through WhatsApp groups can be so useful to their members. Proud and excited farmers may post their experiences and innovations without a prompt from others, allowing the group to learn as a whole about something they may never have thought to ask in a straight forward question-and-answer approach. Even if this information was requested from a particularly specific question, the other group members can learn without ever having had the question themselves. The nature of these groups as being mutually reinforcing, where members support each other nearly as much as they benefit themselves, suggests the groups are serving a need greater than direct information dissemination alone.

By combining the benefits highlighted above, access to information of all forms and the nature of virtual communities of practice, farmers can fill the final gap of accessing markets. The information from fellow farmers on current commodity prices throughout Kenya can ensure a farmer knows where they should sell their product at any given time, and the ideal price they could receive. WhatsApp farmers expand their available markets far beyond their local marketplace, at times finding buyers in neighbouring or distant counties. They can negotiate prices and delivery through a phone while tending to their crops, and even organize pick up at the farm itself – drastically reducing the cost and time spent to sell goods in a crowded local marketplace. Farmers can even find buyers for products just before they are harvested, reducing the potential for spoilage and ensuring they can receive the best price for their crops. All of these factors, from finding new and more equitable buyers to doing business while remaining on the farm, lead to positive impacts on the livelihood of the farmer – who may end up with more time and money than before to invest in the next harvest.

In this way, WhatsApp groups provide a complimentary suite of benefits that are mutually reinforcing. A farmer can learn (perhaps without asking themselves) about a new crop that may do well on their farm. They can request specific advice related to that crop throughout their attempts to plant and grow, which other farmers of the same crop may benefit from prior to requesting the information themselves. Finally, after successfully harvesting the crop with all the advice given, they can use the same groups to find buyers and expand their potential markets for the new product. This ultimately closes the gaps targeted by farmers in Kenya through an interrelated approach, using WhatsApp groups for agriculture as the inclusive means by which their needs are served.

Still, a number of barriers persist that prevent the widespread use of these groups. These barriers are diverse but relate most directly to access and awareness. Access to WhatsApp groups is limited by a farmers' ability to purchase an internet-capable mobile phone, and to pay regularly for the data bundles used by WhatsApp. Even with these requisite investments, the farmer may still be at the mercy of an unreliable electrical and/or cellular network. While this digital divide is slowly shrinking, particularly as low-cost

smart phones are increasingly available in Kenya, the number of farmers with access to a smart phone remains low (45% among baseline participants in this research project, with 15% using WhatsApp groups for agriculture). If WhatsApp is ever to become truly widespread among Kenya's farmers, interventions must continue to be made to further reduce the access costs associated with smart phones and WhatsApp itself.

Many barriers still remain after gaining access to the technology and service and itself. Research findings also indicated that awareness itself existed as a sizeable barrier. Awareness of the groups existing is an obvious prerequisite to join, unless a farmer is creating a group independently. The process for inviting members to a WhatsApp group includes limitations that reduce access to some. Groups require invitation links to join, and also have a limit of 256 members. For farmers who hear about these groups through the radio or other media, they are often left unaware of how to find and join these invitations. Farmers who are able to find where some these invitation links are posted may discover that the group is already full. These barriers can severely reduce the number of farmers that already have access to smart phones from participating, yet they also serve as the most immediate barriers to eliminate. By accompanying media reports on these groups with clear information on how to join, or creating an easily accessible online portal where groups could be posted and joined, the number of farmers using WhatsApp groups can grow closer to the amount of farmers who currently have access to a smart phone.

Additional barriers related to access include intersectional challenges such as English literacy, technological literacy (likely overcome among those with higher levels of education), gender, and disability. These barriers are arguably more difficult to overcome than those related solely to cost, but must also be considered if WhatsApp seeks to become available to all farmers in Kenya. Overall, the use and enjoyment of WhatsApp groups, like most development issues, still relies on a requisite set of skills and resources that continue to be shared asymmetrically across the farming population in Kenya. In order for WhatsApp to reach as many individuals as possible, and in order for that to lead to the betterment of Kenya's farming community as a whole, a bedrock of basic development in education, social and behavioural change, and economic growth is still required.

WhatsApp is not the silver bullet to agricultural development, and there remain a number of barriers to entry as well as challenges for widespread use. It is difficult to argue that WhatsApp will be immediately transformative for all of the poorest and most vulnerable farmers in Kenya, as they are the most likely to be shut out by the access barriers highlighted above. Even with access to new tools and techniques, those farmers are also the least likely to be able to afford investments for their farm. WhatsApp use as an agricultural tool appears to be dominated by tertiary educated men, who although work as small-scale farmers, likely have a considerable advantage over their less educated female counterparts. Though just as mobile phones were originally only available to the privileged and wealthy, and made more accessible as time went on, so too may WhatsApp eventually become a ubiquitous tool for communication in the developing world. This process has certainly already begun, and one hopes that the groundwork laid

by the early-adopters in Kenya will contribute to a growing phenomenon leading to more farmers having access to these groups in the future.

Unlike some technological trends that can gain great fanfare but fail as design challenges emerge, WhatsApp has the potential to be an extremely powerful and ubiquitous tool for farmers throughout Kenya. This is increasingly supported by the existing use of WhatsApp in the developing world, creating a growing enabling environment. WhatsApp wasn't designed for farmers, it was identified by farmers as a platform that could serve their immediate needs through an innovative approach. WhatsApp groups are a clear indication that when provided the right tools, farmers in the developing world can create the solutions to improve their experiences - in spite of persistent gaps in the support offered by governments and NGOs. If these groups are an early indication of how technology will increasingly be used on a grassroots level in developing countries, we can hope to see many more exciting innovations that may serve to replace or supplement the ongoing efforts of governments and development actors throughout the developing world.

6.2 Recommendations

WhatsApp groups for agriculture are an emerging phenomenon that have not been previously studied in great depth. While this initial examination of these groups has attempted to provide a broad understanding of their existence and use, the subject provides opportunity for additional research gaps that could warrant further study.

A comparative assessment between WhatsApp groups and other platforms could help identify additional gaps that are being filled by Kenya's agricultural community on a grassroots level. These can include other agricultural groups such as those on Facebook and Telegram (another messaging app, similar to WhatsApp, but with group limits of 10,000 members). These platforms operate similarly to WhatsApp, but include differing functionality that may lead to different experiences when compared to WhatsApp. Other platforms to be compared to WhatsApp could include those provided by agricultural extension organizations in Kenya, such as iShamba, WeFarm, and MbeguChoice. These services are designed in an attempt to serve farmers directly, with diverse approaches ranging from crowdsourcing questions to SMS broadcasts. However, they appear to be less popular among the farmers polled.

Research that targets the gender dynamics of WhatsApp use among Kenya's farmers would be valuable, as this analysis was regrettably absent from this research project. While the project identified a bias towards male use of WhatsApp groups, no questions were directly targeted to better understand the reason for this bias. Attempts to disaggregate data by gender did not provide any clear insights into how men and women may interact with the groups differently, or why there is such a considerable bias towards men. Existing literature on the subject of the digital divide between genders in the developing world appears to suggest these results are consistent with technology use generally, though more understanding could be gained as to whether WhatsApp groups for agriculture provide different benefits or shortcomings based on the gender of its users.

An applied research pilot project could be introduced in an attempt to understand if these grassroots formed WhatsApp groups could be harnessed in a semi-formalized manner to support the work of extension officers. While 20% of farmers appeared to favour farmer-to-farmer relationships in the groups, 47% indicated that they preferred groups with a mix of participants ranging from farmers through to specialists. Some participants indicated they did not welcome participation from brokers and input dealers, but none mentioned a dislike for the participation of extension officers. Should extension officers use their clients to join existing groups, or to motivate new groups to form with the extension officer as a member, they may be able to reach many more farmers while maintaining the benefits observed in this grassroots phenomenon. Additional research could include whether an extension officer acting as the administrator of a group could lead to differing use and experiences with the groups, as they may transform into a top-down approach rather than one that is mutually reinforcing.

Annex A: List of groups joined by the researcher

Table 11: List of groups joined by the researcher

Group Name	Members	Method of joining	Date Created
🐄Agri-Market Network 🍍	34	Public Link	6/24/2018
🐔FARMERS GROUP	226	Public Link	9/21/2015
Agri Business Group	81	Public Link	4/22/2015
Agribusiness	142	Public Link	7/5/2016
Agricultre Practicals	169	Public Link	2/22/2017
BEEF FARMING & MARKETING	101	Direct Invitation	12/19/2016
CATFISH SOLUTION PLACE 2🐟	240	Public Link	9/14/2017
Dairy Farmers Kenya	148	Direct Invitation	5/4/2016
DAIRY Farming Kiambu🐄🐄🐄🐄🐄	211	Direct Invitation	10/23/2016
Dairy Holding Forum	252	Direct Invitation	9/20/2015
Digital Farmers Kenya 🇰🇪	71	Public Link	11/22/2017
Digital Farming in Kenya	82	Public Link	1/24/2018
EGERTON UNIVERSITY DAIRY	9	Public Link	12/7/2016
Geese & Guinea fowl Famer	56	Public Link	6/24/2018
Kericho Poultry Forum	252	Direct Invitation	9/20/2015
Kericho Tomato v.chain	97	Direct Invitation	3/15/2015
KILIMO BIASHARA	114	Direct Invitation	11/6/2016
Kilimo Bora Public Private Partnership	211	Direct Invitation	2/20/2017
KILIMO KINALIPA	212	Public Link	11/7/2014
Kukuchic Agents	96	Direct Invitation	4/9/2017
LAYERS FARMERS ONLY🐣	6	Public Link	3/29/2018
Let's talk tractors.	66	Public Link	12/15/2017
Naivasha small farmers FB	65	Direct Invitation	4/6/2018
No risk no gain	126	Public Link	9/19/2017
SHEEP and GOAT farming	215	Public Link	2/19/2017
Sillage Making Kenya	22	Direct Invitation	4/26/2017
SmartAgroBusiness🌻	58	Public Link	8/22/2017
WHITE GOLD 🐄....	54	Direct Invitation	2/23/2017

Annex B: Demographic information by participant group

Table 12: Demographic information of 'Targeted Farmers' participant group

Targeted Farmers using WhatsApp Groups for Agriculture								
Respondent #	**Any other agricultural employment or sources of income?**	**Length of time using WhatsApp groups for Agriculture**	**County**	**Gender**	**Approx. age**	**Highest level of education**	**Any formal training for agriculture or agribusiness? (self reported responses)**	**Respondent visited for in-person farm visits from researcher? (unable to confirm 7 participants as phone numbers differed)**
1	Farmer only	3 years or more	Kiambu	Male	18-24	Secondary (incomplete)	No	Yes
2	Farmer only	2 years - 3 years	Nyeri	Female	25-30	Secondary (incomplete)	No	Yes
3	Farmer, agronomist	2 years - 3 years	Kisii	Male	31-40	Tertiary	Agribusiness	Yes
4	Farmer only	3 years or more	Nyamira	Male	31-40	Tertiary	No	Yes
5	Farmer only	1 year - 2 years	Nyamira	Male	40+	Tertiary	No	Yes
6	Farmer only	1 year - 2 years	Nyamira	Male	40+	Tertiary	No	Yes
7	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	3 years or more	Nakuru	Male	31-40	Prefer not to answer	No	Yes
8	Farmer, also works for an organic farming company	3 years or more	Nakuru	Male	31-40	Tertiary	Sustainable agriculture	Yes
9	Farmer only	6 months - 1 year	Nakuru	Female	40+	Tertiary	No	Yes
10	Farmer, Agricultural business (stockist, broker,	3 years or more	Nakuru	Male	25-30	Tertiary	No	Yes

	wholesaler, etc.)							
11	Farmer only	2 years - 3 years	Kisii	Female	25-30	Tertiary	No	-
12	Farmer only	1 year - 2 years	Nakuru	Male	40+	Tertiary	No	-
13	Farmer only	3 years or more	Kericho	Male	25-30	Tertiary	No	-
14	Farmer, extension officer or consultant	3 years or more	Kericho	Female	31-40	Tertiary	BsC in agriclulture	-
15	Farmer only	2 years - 3 years	Nairobi	Female	40+	Tertiary	No	-
16	Farmer, educator for female agriculturalists	2 years - 3 years	Uasin Gishu	Female	31-40	Tertiary	No	-
17	Farmer, extension officer or consultant	2 years - 3 years	Kisii	Male	18-24	Tertiary	Undergraduate degree in agricultural education and extension (currently enrolled)	-
18	Farmer, agronomist	3 years or more	Kericho	Male	18-24	Tertiary	Undergraduate in agronomics and dryland agriculture	-
19	Farmer only	3 years or more	Nakuru	Male	40+	Tertiary	No	Yes
20	Farmer only	3 years or more	Kericho	Male	31-40	Tertiary	various short training programs	Yes
21	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	3 years or more	Bomet	Male	40+	Tertiary	Community development	-
22	Farmer only	2 years - 3 years	Kericho	Male	25-30	Tertiary	No	Yes
23	Farmer, extension officer or consultant	3 years or more	Uasin Gishu	Male	31-40	Tertiary	College program in agricultural extension	-
24	Farmer only	3 years or more	Kericho	Female	25-30	Tertiary	No	Yes
25	Farmer only	1 year - 2 years	Nyamira	Male	40+	Tertiary	Farming at college level, certificate	-
26	Farmer only	3 years or more	Kericho	Male	25-30	Tertiary	Horticulture graduate	-

27	Farmer, extension officer or consultant	2 years - 3 years	Kericho	Male	40+	Tertiary	masters in rural development	-
28	Farmer, irrigation specialist	6 months - 1 year	Nakuru	Male	31-40	Tertiary	Training through employment on a flower farm	-
29	Farmer only	1 year - 2 years	Nakuru	Female	40+	Tertiary	I travel with my husband to seminars a lot. We did not learn poultry in school, so we do it from farm visits and seminars	Yes
30	Farmer only	6 months - 1 year	Kericho	Male	18-24	Tertiary	No	-
31	Farmer only	3 months - 6 months	Nakuru	Female	40+	Secondary (complete)	No	Yes
32	Farmer only	1 year - 2 years	Nyamira	Female	25-30	Tertiary	Bachelors of nutrition and food science	-
33	Farmer, extension officer or consultant	2 years - 3 years	Trans Nzoia	Male	18-24	Tertiary	No	-
34	Farmer, extension officer or consultant	2 years - 3 years	Kericho	Male	40+	Tertiary	A degree in agriculture, but I am still learning! I am a student in my masters in agricultural extension	Yes
35	Farmer, animal production specialist	1 year - 2 years	Kericho	Female	25-30	Tertiary	Animal science	Yes
36	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	3 years or more	Nakuru	Male	40+	Secondary (complete)	No	Yes
37	Farmer only	2 years - 3 years	Kitui	Male	31-40	Tertiary	poultry training	-
38	Farmer only	2 years - 3 years	Kitui	Male	40+	Tertiary	No	-

39	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	3 years or more	Nairobi	Male	31-40	Tertiary	No	-
40	Farmer, extension officer	3 years or more	Uasin Gishu	Male	31-40	Tertiary	Short courses for dairy, horticulture	-
41	Farmer only	6 months - 1 year	Nyeri	Male	18-24	Tertiary	Wambugu Farm in Nyeri	-
42	Farmer only	1 year - 2 years	Bomet	Male	31-40	Tertiary	No	-
43	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	2 years - 3 years	Nakuru	Female	18-24	Tertiary	Numerous seminars on value addition, selling produce, meeting buyers and sellers.	-
44	Farmer only	2 years - 3 years	Kajiado	Female	31-40	Tertiary	No	-
45	Farmer, extension officer or consultant	1 year - 2 years	Nyamira	Male	40+	Tertiary	Diplomacy in livestock and animal husbandry production	Yes
46	Farmer, extension officer or consultant	6 months - 1 year	Laikipia	Male	25-30	Tertiary	some small workshops, seminars	-
47	Farmer, extension officer or consultant	2 years - 3 years	Machakos	Male	31-40	Tertiary	No	-
48	Farmer only	2 years - 3 years	Kericho	Female	40+	Tertiary	just small seminars	Yes
49	Farmer only	1 year - 2 years	Nairobi	Male	31-40	Tertiary	Workshops and training on planting and farm management	-
50	Farmer, veterinarian	3 years or more	Kajiado	Male	31-40	Tertiary	PhD in vetrenary medicine	-
51	Farmer only	1 year - 2 years	Machakos	Male	25-30	Tertiary	No	-
52	Farmer, extension officer or consultant	3 years or more	Bomet	Male	31-40	Tertiary	agribusiness in undergrad and masters	-
53	Farmer only	3 years or more	Kericho	Male	25-30	Tertiary	I do this as my profession	Yes

54	Farmer only	3 years or more	Migori	Male	25-30	Tertiary	One year YPARD mentorship, trained with STRIDE (NGO for youth), and workshops	-
55	Farmer only	1 year - 2 years	Homa Bay	Male	25-30	Tertiary	Artificial insemination for dairy cows and crop husbandry courses	-
56	Farmer only	3 years or more	Nyandarua	Female	40+	Tertiary	One day programs/workshops, specifically farm tours	Yes
57	Farmer, Agricultural business (stockist, broker, wholesaler, etc.)	1 year - 2 years	Isiolo	Female	31-40	Tertiary	Poultry farming	-
58	Farmer only	2 years - 3 years	Narok	Male	25-30	Tertiary	No	-
59	Farmer only	2 years - 3 years	Uasin Gishu	Female	40+	Tertiary	Short course on poultry rearing at university	-
60	Farmer only	2 years - 3 years	Kericho	Male	25-30	Secondary (incomplete)	No	-

Table 13: Demographic information of 'Baseline Farmers' participant group

Baseline Farmer Respondents								
Respondent #	**Access to an internet capable phone?**	**WhatsApp user?**	**Member of Whatsapp groups for agriculture?**	**County**	**Gender**	**Approx. age**	**Highest level of education**	**Formal training for agriculture or agribusiness? (self-reported responses)**
1	No	-	-	Nyamira	Female	40+	Primary	No
2	Yes	Yes	No	Nyamira	Female	18-25	Secondary (complete)	No
3	No	-	-	Nyamira	Female	40+	Primary	No
4	No	-	-	Nyamira	Female	26-30	Secondary (Incomplete)	No
5	No	-	-	Nyamira	Male	40+	No school past nursery	No
6	No	-	-	Nyamira	Female	40+	Primary	No
7	No	-	-	Nyamira	Female	18-25	Secondary (complete)	No
8	Yes	Yes	No	Nyamira	Female	26-30	Secondary (complete)	No
9	No	-	-	Nyamira	Female	40+	Secondary (Incomplete)	No
10	No	-	-	Nyamira	Male	40+	Secondary (complete)	No
11	No	-	-	Nyamira	Female	31-40	Secondary (Incomplete)	No
12	No	-	-	Nyamira	Female	40+	Secondary (Incomplete)	No
13	No	-	-	Nyamira	Male	40+	Primary	No
14	No	-	-	Nyamira	Female	40+	Primary	No
15	Yes	Yes	-	Nyamira	Female	31-40	Primary	No
16	No	-	-	Nyamira	Female	31-40	Primary	No
17	Yes	Yes	No	Nyamira	Female	31-40	Secondary (complete)	No
18	Yes	Yes	No	Nyamira	Female	40+	Secondary (complete)	No
19	No	-	-	Nyamira	Female	40+	Secondary (complete)	No
20	No	-	-	Nyamira	Female	40+	Primary	No
21	No	-	-	Nyamira	Female	40+	Primary	No
22	No	-	-	Nyamira	Female	40+	Primary	No
23	No	-	-	Nyamira	Female	40+	Primary	

								No
24	No	-	-	Nyamira	Female	31-40	Secondary (Incomplete)	No
25	No	-	-	Nyamira	Female	18-25	Secondary (complete)	No
26	Yes	No	-	Nyamira	Male	40+	Secondary (Incomplete)	No
27	Yes	Yes	Yes	Kericho	Female	40+	Secondary (complete)	No
28	No	-	-	Kericho	Female	40+	Secondary (Incomplete)	No
29	Yes	Yes	Yes	Kericho	Female	31-40	Tertiary	No
30	No	-	-	Kericho	Female	40+	Primary	No
31	Yes	Yes	Yes	Kericho	Female	40+	Tertiary	No
32	Yes	Yes	Yes	Kericho	Female	31-40	Secondary (complete)	No
33	No	-	-	Kericho	Female	40+	Secondary (Incomplete)	No
34	Yes	No	-	Kericho	Female	40+	Primary	Short seminars and trainings
35	No	-	-	Kericho	Female	31-40	Primary	No
36	No	-	-	Kericho	Female	40+	Secondary (Incomplete)	No
37	Yes	Yes	Yes	Kericho	Male	26-30	Tertiary	No
38	Yes	Yes	Yes	Kericho	Female	18-25	Tertiary	Agronomy bsc in agriculture
39	Yes	Yes	Yes	Kericho	Male	31-40	Tertiary	Bachelor of science in agriculture
40	Yes	Yes	Yes	Kericho	Male	40+	Tertiary	Masters in agricultural extension
41	Yes	Yes	No	Nakuru	Female	40+	Primary	No
42	No	-	-	Nakuru	Female	40+	Primary	No
43	Yes	Yes	No	Nakuru	Female	40+	Secondary (complete)	No
44	No	-	-	Nakuru	Female	40+	Primary	No
45	No	-	-	Nakuru	Female	40+	Primary	No
46	No	-	-	Nakuru	Female	40+	Primary	No
47	Yes	Yes	Yes	Nakuru	Female	40+	Secondary (complete)	No
48	Yes	Yes	No	Nakuru	Male	40+	Secondary (complete)	No
49	Yes	Yes	No	Nakuru	Female	26-30	Primary	No
50	No	-	-	Nakuru	Female	18-25	Primary	No

51	Yes	Yes	No	Nakuru	Male	40+	Secondary (Incomplete)	Short training in agricultural management
52	No	-	-	Nakuru	Male	31-40	Secondary (complete)	No
53	No	-	-	Nakuru	Male	40+	Secondary (complete)	No
54	Yes	Yes	No	Nakuru	Female	26-30	Primary	No
55	No	-	-	Nakuru	Female	40+	Primary	No
56	Yes	Yes	No	Nakuru	Male	26-30	Primary	No
57	Yes	Yes	No	Nakuru	Female	31-40	Tertiary	No
58	Yes	Yes	No	Nakuru	Female	31-40	Primary	No
59	Yes	Yes	-	Nakuru	Female	31-40	Secondary (complete)	No
60	Yes	Yes	No	Nakuru	Female	31-40	Tertiary	No

Annex C: List of villages and markets where field research was conducted

Kericho County:

- Belgut
- Kipkelion
- Sossiot
- Kericho East
- Kericho township
- Kiptere

Nakuru County:

- Naivasha
- Kayole
- Karakta
- Karate
- Kinungi
- Kinamba
- Maraiguchu

Nyamira County:

- Nyamira township
- Nyamusi
- Konate
- Nyabite
- Ekerenyo

Markets visited:

- Nyamusi market
- Nyabite market
- Naivasha market

Focus Group Locations :

- Naivasha (Nakuru County)
- Kericho Township (Kericho County)
- Nyamira Township (Nyamira County)

Location of Farmers interviewed for the Targeted respondent group (remote interviews, n=60).		
Bomet County	5.00%	3
Homa Bay County	1.67%	1
Isiolo County	1.67%	1
Kajiado County	3.33%	2
Kericho County	23.33%	14
Kiambu County	1.67%	1
Kisii County	5.00%	3
Kitui County	3.33%	2
Laikipia County	1.67%	1
Machakos County	3.33%	2
Migori County	1.67%	1
Nairobi County	5.00%	3
Nakuru County	18.33%	11
Narok County	1.67%	1
Nyamira County	10.00%	6
Nyandarua County	1.67%	1
Nyeri County	3.33%	2
Trans Nzoia County	1.67%	1
Uasin Gishu County	6.67%	4

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