

Participatory Digital Extension in Agriculture: A Study from Ghana

by

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A Thesis

presented to

The University of Guelph

In partial fulfillment of requirements
for the degree of

Master of Science

in

Capacity Development and Extension

(International Development Studies in Specialization)

Guelph, Ontario, Canada

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ABSTRACT

PARTICIPATORY DIGITAL EXTENSION IN AGRICULTURE: A STUDY FROM GHANA

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The mobilization of scientific knowledge for agricultural application has long been supported by Radio broadcast in Africa. Digital radio and mobile phone integration are becoming linked with radio and physical extension services, known as Radio+. Farm Radio International provides radio extension services in Ghana and participated in a research attachment for this study. There is a need to improve the content and delivery of agricultural extension services. The study utilized Collaborative Inquiry interviews, a process involving semi-structured, in-depth and interactive discussions. Farm Radio International employees were the interview demographic. The interview data was analyzed using a deductive thematic coding process using NVivo. Issues with funding and capacity, participatory processes, and digital development consistently effect all sectors of agricultural extension in Ghana. Based on these results, the recommendation provided is the development of a digital extension application to serve as a mobile communications and information hub to farmers in rural Ghana.

ACKNOWLEDGEMENTS

Personal thanks are in order to many people. My advisor, Dr Helen Hambly, for her patience and support of me and my thesis. My committee member, Dr Silvia Sarapura, and my external examiner, Dr Ataharul Chowdhury, for their contributions. CDE's graduate program assistant, Lorena Barker, for her aid whenever I required support. My many classmates, for their unwavering confidence in me. My mother and father, Douglas and Julie, for their continued encouragement throughout my education. Finally, my own small family, my girlfriend Marie-Ange and my two cats who supplied a great deal of emotional support during trying times.

I am grateful to have been able to study and write at length about such an exciting and impactful development topic. A special thanks are in order to the University of Guelph, Farm Radio International, and the people of Ghana, to whom I hope this research will benefit.

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LIST OF ACRONYMS

Acronyms/Abbreviations	Explanation
AFRRI	African Farm Radio Research Initiative
AA	Analytical Analysis
BBC	British Broadcasting Corporation
CARGS	Competitive Agriculture Research Grant Scheme
CBC	Canadian Broadcasting Corporation
CSIR	Ghana's Council for Scientific and Industrial Research
CF	Conceptual Framework
FRI	Farm Radio International
GCRN	Ghana Community Radio Network
HCD	Human Centered Design
ICT	Information Communication Technology
ICT4AG	Information Communication Technology for Agriculture
IoT	Internet of Things
MNO	Mobile network operator
MOFA	Ghana's Ministry of Food and Agriculture
OS	Operating System
PRC	Participatory Radio Campaigns
Radio+	Digitally enhanced Radio
RELC	Research Extension Farmer Linkage Committees
WAAPP	West African Agricultural Productivity Program

Chapter 1: Introduction

1.1 Background and problem statement

In Africa, agricultural and rural extension advice and services have been long supported by local FM broadcast radio helping to mobilize and translate scientific knowledge into plain language in local vernacular (Ilboudo & del Castello, 2003; Manyozo, 2017). The advent of digital radio makes an interactive exchange of knowledge among and from local communities and farmers with outsiders possible, often using online tools and mobile phone technologies to mobilize farm or agricultural “Radio+” knowledge systems where various information and communication technologies are used, such as mobile phone call-in-to-radio and live radio internet search programs. These systems support public agricultural extension services which seek to get farmers technical advice, weather, market information updates, educational and skills training in their local language. Conventional face to face or group agricultural extension services are often unavailable due to lack of investments in public extension (Rivera & Sulaiman, 2009). Public, and even private sector agricultural advisory services were strained during the COVID-19 Pandemic when direct visits to farmers groups or farms are not possible or even more rare (Farm Radio International, 2020).

These limitations can be potentially overcome by introducing digital agricultural extension methods (Farm Radio International, 2020). Research has so far shown that such efforts must engage farmers and communities to ensure the interactive opportunities of Radio+ are maximized (Hudson et al., 2017). In Africa, these methods are underway and smart phone penetration has seen an enormous increase in the last decade (GSMA, 2020) and projects to continue its meteoric rise. This has set the stage for the Radio+ which is a convergence of mainstay mediums, in the case of this study, mobile devices and conventional community radio.

In Ghana, there is a specific interest in building digital extension strategies. Various programs linking conventional community radio and digital advancements have already been implemented between local actors, civil society, non-governmental organizations, and MOFA (Ghanaian Ministry of Food and Agriculture)(MOFA & CSIR,

2013). The non-governmental organization, Farm Radio International, is a longstanding actor in radio extension services in Africa, and specifically in Ghana. To address the gap within the existing literature and strategic initiatives on digital extension using Radio+ approaches, a study by the author was proposed by FRI to understand what content and methods of Radio+ are valuable to Ghanaian agricultural extension staff in government, private sector and NGO organizations which are working with rural radio stations across the nation.

The study focuses on FRI's current 'Green Leaf' program, which partners with MOFA and a Ghanaian network of community radio stations, as it provides a pertinent example of digital extension in action, as well as a ready partner for the potential integration of this research's findings. The Green Leaf program is a highly interactive and user focused agricultural community radio initiative that is designed to continue long after the involvement of FRI (Betteridge-Moes, 2019). Green Leaf will be discussed further in the literature review portion of this paper.

The context of digital agricultural extension in Ghana is important because of the RELC (Research Extension Farmer Linkage Committees) which are multi-stakeholder groups charged with strengthening the linkage between research, extension, and value chain stakeholders to improve agricultural development (le Coq, 2003; MOFA & CSIR, 2013). The RELCs issue reports and releases them through MOFA to generate what equates to a 'state of affairs' of Ghanaian agriculture. There is a great level of interest from FRI to better understand how the RELC report is created, how the information within it can be distilled toward a more actionable information through Radio+ approaches, and how the report itself could be improved to aid stakeholders. This study responds to FRI's interests in RELCs although it also focuses more specifically on participatory digital agricultural extension in Ghana.

1.2 Goal and objectives

The goal of this research is to improve the content and delivery of digital agricultural extension services to Ghanaian agriculturalists.

The first objective of this study is to examine the development of a farm Radio+ method for digital interactions and e-extension work that ultimately engages with and support smallholder farmers and their rural. A Radio+ Extension App model is the next logical progression of the convergence between the steady development of community Radio+ and Ghana's trajectory of large-scale smartphone penetration while making such an application accessible to youth and women in agriculture.

The second objective of the study aims to inform the future content creation of FRI agricultural extension services using participatory Radio+ techniques in Ghana.

1.3 Overview of the thesis

This thesis is structured by five chapters with varying levels of subtopics within those chapters. The first chapter introduces the reader to the research topic with a brief explanation of relevant background information. There is a focus on agriculture and extension in the context of Africa and Ghana, the definition of Radio+ and the digitalization of the medium with cellular technology, along with briefly presenting FRI, MOFA, RELC, and their relevance to the research project.

The second chapter outlines the literature review, presenting relevant information to the background, discussion, and findings of this research. Topics such as radio as a development tool and digital agriculture are discussed at greater length than in the introduction. The chapter ends with the presentation of the conceptual framework.

Chapter Three presents the research methodology. The epistemology and methodology that form the basis of the research of this thesis are discussed and the positionality and ethical considerations are expanded upon. The data collected and analyzation methods are presented, in addition to the steps taken to do so. Research ethics approval and the pandemic-related issues affecting the process of data collection are also considered.

The fourth chapter focuses on the findings of the research. An analysis of the data drawn from the collaborative interview process will be presented through the use of thematic sections, followed by the emergent trends.

Chapter Five explores the research discussion. This outlines the narrative discussions, the proposed e-extension application's features, a reflection on the research goal and objectives, and the analytical approach. Here the researcher examines the efficacy and needs of a new form of digital agricultural e-extension in Ghana and what it means in relation to the future of setting FRI and MOFA's extension content agenda.

Chapter Six provides a final summary of the research. The conclusions drawn from the findings will be expanded upon. A set of recommendations for the practical application of this knowledge as well as possible avenues for future research.

Chapter 2: Literature Review

2.1 Introduction

This chapter takes aim at discussing the most relevant literature to the topic of digital extension for agriculture in Ghana. The literature review will consist of three main sections, consisting of two overarching topics, followed by a third section with the study's conceptual framework. The first main section of the literature review is radio for agricultural and rural development. This consists of a brief history of rural and agricultural radio, participatory radio and programming, and digital radio and ICT's, for development in Ghana. The second main section centers on the agricultural extension and advisory services in Ghana. This focuses on the sub-topics of a brief history of extension and advisory services, digital agricultural extension, and the participatory dimensions of digital extension services and methods in Ghana. The third and final section of Chapter 2 are the figure and explanation of the conceptual framework of the thesis. The framework displays the researcher's conceptualization of the structure of Farm Radio International's Radio+ delivery of digitally enhanced agricultural radio extension in its present form.

2.2 Radio for agricultural and rural development

2.2.1 Brief history of rural/farm radio broadcasting

Rural and farm radio broadcasting has been a longstanding staple of extension in Africa. The use of this popular medium has contributed to agricultural development across Africa, and more recently Ghana, for over 60 years (Hudson et al., 2017). Rural radio broadcast has supplied information en masse with little expense to the agriculturalists who require agricultural information and recommendations. The community-oriented aspect of radio stations (Sullivan, 2011) allows for more targeted distribution information to specific areas and communities, while providing a catalyst for cooperation and kinship (Sullivan, 2011). Community based radio has enjoyed an even longer history than specifically agriculturally oriented broadcasts. Examples of community radio aiding rural workers dates close to as long as three quarters of a

century ago. Miners in Bolivia used community radio to connect to their distant homes, families, and other workers. The community ownership of the radio stations greatly contributed to the independence and control of the communication medium through many shifts in the Bolivian political and industrial mining landscape (Gumucio Dagron, 2001; Harris, 2019). The promotion of information from the workers union and general community messages cannot be undersold in its value to the Bolivian workers as well as an example to other developing contexts of venerable working people. A similar example of a relevant use of non-agricultural community radio communications serving as a boon to rural peoples is the use of participatory media in many Pacific island nations. Countries such as Fiji or Malawi are examples of Community Radio empowering and informing people during natural disasters when other communications methods have faltered. Radio has also provided the means for a participatory tool to address the communities' needs, especially for those whose voices are traditionally less recognized due to power relations (Harris, 2019).

2.2.2 Participatory farm radio stations and programming in Ghana

Ghana's relationship with community radio is considerable when considering its history and current standing as an agricultural education and community staple. The first radio broadcast took place in Ghana on July 31st, 1935 in Accra by what would eventually become the Ghana Broadcast Corporation, a government organization akin to Great Britain's BBC or Canada's CBC (GBC, 2022). Ghana has a network of 20 community radio stations (and an additional community TV station) that began its formation in 1999. This group is known as the Ghana Community Radio Network (GCRN). The GCRN provides radio broadcasts to 11 of the 16 regions of Ghana in English as well as 17 indigenous languages. The network states that it seeks to aid marginalized peoples and aims to help and advocate for those without a strong voice (GCRN, 2022). In addition to the strong network of existing community radio stations, there is civil society dedicated to aiding the effectiveness and continued growth of community radio and for-profit radio within Ghana. The GCRN has partnerships with well-known international organizations such as UNESCO and UNICEF (GCRN, 2022).

Civil society does not stop at aiding to maintain the status quo. A research project named the African Farm Radio Research Initiative (AFRRI) was conducted in 2011 with an interest in improving the best practices for the advancement of food security in Africa using radio-based communications. This initiative was headed by Farm Radio International (FRI) and supported by the World University Service of Canada (WUSC) the Bill & Melinda Gates Foundation (Sullivan, 2011). Additionally, the Ministry of Food and Agriculture of Ghana (MOFA) partners with FRI and other international government aid agencies such as Canada's department of foreign affairs (formerly CIDA or Canadian International Development Agency) and the United States Agency of International Development and on matters of agricultural development and ICTs4Ag (Betteridge-Moes, 2019; FAO & ITU, 2022; Sigman, 2015).

FRI's AFRRI findings could be considered what set the stage for the continued development of Radio+ as a staple of agricultural radio extension. This initiative showed how farmer participation in and uptake of extension information from radio extension broadcasts significantly improved when accompanied by digitalization methods (Hudson et al., 2017; Sullivan, 2011). These basic Radio+ methods include SMS text alerts as reminders of programs and the ability for farmers to participate in the content or direction of the program through voting on their phones. The farmers are able to call into the radio station following a prompt, they then navigate a menu, and are able to vote on specific extension topics they would like to hear more about during the broadcast using a '2 beep' system that represents 'this or that' options. This process helps prioritize extension needs and is known as pairwise ranking (Hudson et al., 2017; Sullivan, 2011). Another example of current Radio+ is the voice-based registration trees. This technology allows FRI to create a listener database, helping to establish who is listening, what their needs are, and what language they are comfortable calling into the Radio+ broadcast in (Hudson et al., 2017; Sullivan, 2011). Figure 2.1 from Hudson et al. provides greater detail of some of the additional Radio+ technologies utilized by FRI radio extension programs. These Radio+ methods of engaging with farmers are part of the radio for extension strategy of Participatory Radio Campaigns (PRC). This concept moves further into the realm of extension and will be discussed in greater detail in the following section. As the PRC's, digital extension methods, and

Radio+ relate to radio as a development tool, the main factor is the ability to reach specific audiences with targeted information. This is known as narrowcasting and has provided the framework for the continued development of highly relevant and in demand agricultural extension (FAO & ITU, 2022; Hudson et al., 2017; Sullivan, 2011). Radio has evolved into a strong and lasting piece of the agricultural and rural development sphere. Even as the digital world evolves, the radio has and will continue to play a vital role in development and agriculture in Ghana.

Technological innovations used in FRI projects.

Problem addressed	Technology used
Increasing listenership	SMS text message reminders
Ensuring radio coverage in hard-to-reach locations	Wind-up radios with SD card slots
Ensuring interaction by large numbers of audience members	Beep-2-vote missed call technology
Building a local listener database	Voice-based registration trees
Ensuring deeper interactions with targeted information	Interactive voice response (IVR) polls and quizzes
Providing content for later programs	Interactive voice response (IVR) "leave a message" service
Linking listeners with valuable services	Beep-4-services
Capturing voices of farmers	Low-cost MP3 recorders

Figure 2.1 – Current FRI Radio+ Methods (Hudson et al., 2017)

2.2.3 Participatory radio for development in Ghana

The participatory aspects of radio for development in Ghana have been evolving rapidly. So much so, that the progression of participatory radio is now rooted in the fabric of what agricultural radio is in Ghana. As discussed in the previous section 2.2.1, the GCRN network of community radio stations provide services for Ghanaian communities while providing the institutional space for stakeholders to participate.

Participatory radio helps to give a voice to those who are at times withheld from voicing their concerns and needs due to cultural or structural barriers (Harris, 2019; Quaye et al., 2019). Giving stakeholders the ability to call into or vote on subject matter during an agricultural radio broadcast allows them an anonymous voice within the that space (Betteridge-Moes, 2019; Sullivan, 2011). Unfortunately, the lack of stakeholder inclusion is not a unique problem to Ghana but rather a commonality within the developing world. Community Media workers with a UNESCO project in Bangladesh were told by the employer officials there would be no value in targeting working women in interviews as they would not be interested in talking. This was a completely false narrative as the women raced to the media workers as soon as they spotted recording equipment. The workers took this opportunity to have their voices heard and admonished their employer for the abysmal conditions on the job (Harris, 2019). Employers attempting to silence working voices using unfavorable power dynamics is not a new concept. What is clear from this Bangladeshi anecdote is that if marginalized peoples are given the opportunity to participate and have their voices heard, they will. Participatory Radio is a key to unlocking what is most needed by those who extension workers are targeting with agricultural or associated value chain needs information. Community Radio, agricultural or not, provides a level of community engagement through its rooting as a participatory medium(Harris, 2019; Sullivan, 2011).

FRI has a longer history of using participatory methods in radio programming to ensure the relevance of their outreach to the intended audience. Their strategy known as Participatory Radio Campaigns (PRC) was evolved with funding from the Gates Foundation in the first decade of the millennium under the African Radio Research Initiative (AFRRI) phase 1 and 2 projects (Oyaro & FRI, 2013; Sullivan, 2011). The

PRC approach is an interactive strategy to increase farmer adaptation of new or improved agricultural practices. PRC utilizes ICT-enhanced radio, known as Radio+, to reach a wider and more targeted audience. These campaigns typically run for a four-month span (Hudson et al., 2017). The PRC focuses on increasing the participation of farmers and amplifying their influence in the featured extension topics, discussing the pros and cons of adopting the information presented, constantly gathering feedback from listeners, and focusing on creating engaging and entertaining educational segments (Hudson et al., 2017; Oyaró & FRI, 2013). This two-way delivery format and participatory medium is so effective that the likelihood for the uptake/adoption of information and practices is fivefold when compared with farmers who do not take part in the PRC's (Hudson et al., 2017; Oyaró & FRI, 2013; Sullivan, 2011).

Farm Radio International's next iteration of their PRC's is the advent of the Green Leaf program. The Green Leaf model is everything that the previous FRI PRC were with the addition of enhancements to increase the sustainability, entertainment value, and campaign length of the program (Betteridge-Moes, 2019). Green Leaf seeks to continue running broadcasts past the involvement of FRI by connecting the community radio with local partners who wish to advertise their products that are relevant to the agricultural listeners. The large draw to the Green Leaf format is rooted in programming's ability to hold the attention of the listener, driving interest in tuning into broadcasts for entertainment in addition to education (Betteridge-Moes, 2019). This can be referred to as 'Edutainment', a newfound staple of the lively and engaging agricultural broadcasts.

2.2.4 ICT's and digital radio for development in Ghana

Digital radio and ICT's are primed to take off in Ghana and across the entirety Africa. The boom in digital connections in all of Africa has seen heightened levels of access to information, growth, and development in rural communities. This rapid expansion of inexpensive and readily available digital connectivity has provided agricultural information and economic benefits over the past quarter century (Adenubi et

al., 2021; GSMA, 2020). It would appear this expansion and the associated benefits have only just begun.

As of 2011, 76% of households in Africa owned a traditional radio (Hudson et al., 2017), a percentage that has remained relatively constant and expects to remain so (GSMA, 2020). The digitalization of Ghana's ICT's from traditional radio is well on its way. Nearly four fifths (79.1%) of Ghanaians owned a mobile phone in 2016, and 8.3 percent of those mobile phones were smartphones (FAO & ITU, 2022). GSMA, a mobile network operators industry representation organization, estimates that as of 2020, 50% of African mobile phones are smartphones, with that smart digital penetration being higher in Ghana due to Ghana's ahead-of-the-curve status as a technologically developed African nation (Darko-Adjei, 2019; 2020). A 2020 study conducted in the Ghanaian Region of Greater Accra showed about 74% of respondents had smartphones (A. Adams et al., 2020), however this may be slightly skewed as a representation of smartphone adoption in the greater population as about 2/3rds of the sample group was under the age of 35. Youth and working age people are more likely to own and use a mobile phone and even more likely for that phone to be a smartphone in Ghana (A. Adams et al., 2020; Darko-Adjei, 2019), in addition to other developing contexts (Benson, 2019).

A study in Ghana from 2011 showed that women who work in agriculture are less likely to own a cell phone than their male counterparts, with 64% of male farmers owning a mobile phone and only 39% of female farmers owning a cellphone (Sullivan, 2011). An external review of the improvement agriculture in Ethiopia, Ghana, Malawi, Mozambique, Senegal and Tanzania found that two thirds of farmers who utilized ICT interactive techniques were men (Landell Mills, 2019). Additionally, households that are headed by females are less likely to have ICT/IoT connections in Ghana (A. Adams et al., 2020). There are many factors that the gendered divide in cellphone ownership could be attributed to, but it is common across Africa that women's access to cellphones can often be subject to men's 'gatekeeping', stopping women from either owning a phone or reporting mobile ownership when questioned (Kitsao-Wekulo et al., 2021). Cultural barriers to women using their smart phones to search online and learn or to

conduct mobile banking are present in Ghana (A. Adams et al., 2020; Bailur & Masiero, 2017). This is certainly problematic when considering it has been shown to reduce income inequality in African nations when women's access to ICT infrastructure been overcome (S. Adams & Akobeng, 2021). In fact, Mobile technology has already been shown to be vital to small and micro businesses in rural Ghana, as mobile phone use eases business and its associated costs (Frempong, 2009). However, there is a clear need for the improvement and adaptation of existing and new technologies to help increase the significant gains found with mobile phones in agriculture and the agribusiness value chain (S. Adams & Akobeng, 2021; Frempong, 2009; Kwakwa, 2012).

All mobile phones and associated digital connections (Internet of Things or IoT) function by a specific operating system. Operating systems are complex sets of software that, in simple terms, allows a technological device to perform its basic functions. Mobile operating systems that would be immediately familiar to North Americans would be Apple's Apple IOS or Google's Android OS. While North American has a strong connection to the Apple brand, the same cannot be said for the rest of the globe. The international mobile OS leader is Android by a large margin, with an estimated 72% of market share belonging to Android (GS Statscounter, 2022). The African context is even greater in its Android market dominance, with an estimated market share of 86%. Ghana as a country is just under 75% of estimated mobile operating systems being android (GS Statscounter, 2022; Nkrumah et al., 2015). Ghana is well suited to continue to expand its mobile smartphone penetration with four network providers operating within the country. These MNO's are MTN, Vodafone, Airtel-Tigo and Glo, and stand to provide the competition necessary to lower prices and drive improved network coverage (GS Statscounter, 2022).

Currently, Ghana is the third largest representative of all IoT connections in Africa, as Ghana is only behind South Africa and Nigeria in digital connections, respectively (GSMA, 2020). This is especially impressive when considering that Nigeria and South Africa have the largest GDP's within Africa in 2020, compared to Ghana who was the fifth largest (IMF, 2022). This speaks to the present development of the ICT tech sector in Ghana relative to the size of its economy. In addition to the physical

structures in place in Ghana, such as digital networks and mobile phone penetration, the cultural adaptation of ICT's are also present. Ghanaians are internet savvy, and it is a normal practice to integrate IoT devices and processes into business ventures. Banking and payments have also become a normal practice through cellular phones, tablets, or computers. However, E-commerce is not the extent of culturally accepted uses of digital products. IoT products are a norm within Ghana and are commonplace in entertainment and relaxation. Video games, social media/networking (ex. Facebook, Twitter, Instagram, etc.), music consumption, and video streaming (ex. Youtube) are all a daily activity for many Ghanaians (GSMA, 2020; Nkrumah et al., 2015). Data suggest that over three quarters of Ghanaians have been using the internet since 2010 (Nkrumah et al., 2015). This existing structure, interest, and adaptation to digital connection bodes well for the future of ICT, IoT, digital agricultural, and Radio+ development in Ghana.

2.3 Agricultural extension and advisory services in Ghana

2.3.1 Brief history of agricultural extension and advisory services in Ghana

Ghana has a longstanding history with the use of Agricultural extension and advisory services. The Ministry of Food and Agriculture is the arm of the government responsible for the implementation and execution of agricultural extension within Ghana. MOFA has been running programming from the 1970s, while the present-day format of MOFA's agricultural extension and advisory services took form in 1987 when the agency centralized all extension services (Sigman, 2015). Many of the organizations previously mentioned in section 2.2.1 have overlap between their work with radio and their programming within Ghana's agricultural extension and advisory services. This can be attributed to the connection between the two disciplines within capacity development in Ghana, and that Radio+ is essential to extension as a whole. MOFA has long enjoyed relationships with organizations that provide agricultural extension, capacity development, and advisory services within Ghana. These include, but are not limited to, the Bill and Melinda Gates Foundation, FRI, Global Affairs

Canada, and USAID (Betteridge-Moes, 2019; FAO & ITU, 2022; Sigman, 2015; Sullivan, 2011).

2.3.2 Research extension farmer linkage committees

A significant portion of the focus of MOFA's extension efforts are related to a process named the RELC (Research Extension Farmer Linkage Committees) report. The RELC was created by MOFA in 1994 with the cooperation of Ghana's Council for Scientific and Industrial Research (CSIR) (Doamekpor, 2005; MOFA & CSIR, 2013). RELC's focus is to establish what research and extension information that is most needed from farmers and others within the agricultural value chain, through a public-private partnership of stakeholders. The RELC ensures this goal through research, planning sessions, technical training, extension work, reviews of programming, and the annual meeting and a subsequent annual findings report (MOFA & CSIR, 2013). Not all this work is carried out by MOFA and CSIR as the agencies do not have the internal capacity. Much of the work is contracted to differing civil-society actors and aid agencies. Additionally, there are examples of the tasks not being completed due to the lack of available resources (Sigman, 2015). The RELC was initially focused on a nation-wide approach, divided into five zones based on an agroecologically basis. Presently, the RELC takes form in all 16 regions within the nation (Shilomboleni et al., 2020), with extension conducted by MOFA and research and development conducted by a branch of CSIR (MOFA & CSIR, 2013; Sigman, 2015). It should be noted that Ghana re-organized from 10 to 16 regions in 2018, (van Gyampo, 2018) but this literature review was not able to identify a new publication from MOFA detailing the regions to their corresponding CSIR coordinating research institutions. Please see Figure 2.2 below for MOFA's last published list of regions and their corresponding research institution.

REGION	COORDINATING RESEARCH INSTITUTION
Greater Accra	CSIR -Animal Research Institute
Eastern	CSIR -Oil Palm Research Institute
Volta	CSIR -Crops Research Institute
Western	CSIR -Oil Palm Research Institute
Central	CSIR -Animal Research Institute
Brong Ahafo	CSIR -Crops Research Institute
Ashanti	CSIR -Crops Research Institute
Northern	CSIR -Savanna Agricultural Research Institute
Upper East	CSIR -Savanna Agricultural Research Institute
Upper West	CSIR -Savanna Agricultural Research Institute

Figure 2.2 - RELC Regions (MOFA & CSIR, 2013)

Through the RELC system, constraints to agriculture are identified and sought. A leading portion of CSIR's role in addressing these constraints is the development of new technologies to target these issues. There is also a push for the constraints to be addressed using support systems for demand driven research. New developments in agricultural extension have been supported by CSIR through the introduction of the Competitive Agriculture Research Grant Scheme (CARGS). This program supplies funding to researchers who aim to solve RELC identified agricultural constraints facing farmers in Ghana (MOFA, 2016; MOFA & CSIR, 2013).

In addition to CARGS and the development of technological responses to extension constraints, uplifting women and youth is seen as a key to the future of the agricultural extension and advisory services in Ghana. The Rural Enterprise Program (REP) is a MOFA youth training initiative that seeks to alleviate rural poverty through training in variety of agribusiness sectors. The program trained just short of 1000 youth with a 2:1 Male to Female ratio. Examples of the agribusiness training programs spanned a wide variety sectors, ranging from livestock production, beekeeping, mushroom production, and baking & confectionery (MOFA, 2016). While this was positive program aimed at youth that made an effort to include young women, the pitfall of the program is there was no budget past the training program, as the trainees were not provided with start-up capital or supplies to continue with their newfound skills (MOFA, 2016). Women are specifically targeted by MOFA's extension efforts through various training and capacity building programs. Training programs such as cassava processing seminars have been held to teach groups of farmers (around 95% women or

young women) how to create high quality cassava flour in 2016, helping improve Ghanaian women's ability to create high value goods from crops. Additionally, the subsidization of machinery is lauded as a women friendly practice as it improves their productivity while reducing physical labor-intensive work (MOFA, 2016). While these example programs can be seen as a strong step to the empowerment of women and youth within Ghana's agricultural sector, there is admittedly more that needs to be done in this area. An example of the gap between MOFA's aim and actual outcomes to improve women's and youth inclusion is a study from Southern Ghana focused on youth 'agripreneurship'. The study followed the development of high levels of youth interest in farming mangos due to its status as a high value good within Ghana. Regrettably, the same reasons hindering youth from entering the mango market were the same that MOFA purports to address through its RELC programming. Access to credit, extension information, and equipment that would have led to the productivity and quality of the youth farmer's mango production increasing dramatically was not available (Akrong et al., 2021). MOFA, through RELC and their partner organizations, are seen to need to improve their institutional support of youth in agriculture if there is to be development within the agricultural industry and make good on their self-designated goals (Akrong et al., 2021; Sigman, 2015).

2.3.2.1 Critiques of RELC

In addition to gaps in supporting women and youth, the literature has shown that RELC (MOFA's driving force behind extension and advisory services in Ghana) has repeatedly been shown to fall short of the greater goals of the initiative. RELC's stakeholder gatherings are limited to meeting annually, leading to a lack of up-to-date stakeholder needs being identified and addressed with new research, understanding/knowledge, and action (Ankrah & Freeman, 2021). The RELC stakeholder meetings did not provided contributors feedback on their inputs. Additionally, stakeholder participation was limited to information collection from the stakeholders. This information was used for the generation of knowledge at CSIR and not with the contributors themselves. This dissuaded participation and the generation of

ideas from the end users (Ankrah & Freeman, 2021). RELC has been seen as an inefficient committee by experts for nearly 20 years. The inability of the RELC to identify what is truly within grassroots/local needs has been repeatedly identified due to the top-down nature of the content and priority meetings. The stakeholders within the agricultural value chain, who the RELC is meant to aid, are consistently not seen to be prioritised throughout the process of establishing content objectives (Ankrah & Freeman, 2021; Doamekpor, 2005; Klerkx et al., 2010; Sigman, 2015).

2.3.3 Digital agricultural extension in Ghana

Digital agriculture is a booming industry that offers countless options that are available globally. In the context of this study, much of these agricultural applications and software from the global north are simply not applicable to the majority of developing contexts as they are focused on large scale industrial farming. However, there are many new ICT digital extension innovations that stand out in their ability to function in the Ghanaian agricultural value chain context, many examples of which are developed and operate within Ghana. These innovative and homegrown services are vital to the growth of digital and agricultural literacy and empowerment (Frempong, 2009). Figure 2.3 below provides a brief description of several new innovators within Ghana, with a few highly relevant examples developed elsewhere that are applicable to this context with Ghanaian end users in mind. Most of these digital extension applications and software have been recently developed (FAO & ITU, 2022) and are providing a first step into the new world of digital extension. These digital agricultural extension services rendered range broadly from connecting farmers to markets, crop growth and care information, storage best practices, and more. There appear to be gaps in connecting these many digital extension softwares, applications, and services to end users (FAO & ITU, 2022). Many of these startups do not have the resources of existing traditional physical extension services when considering access to networks of extension workers and large sums of funding that MOFA and FRI have. Bridging the gap between innovation and distribution appears to be an exciting next step for Ghanaian agricultural extension.

Company Name	Digital Extension Tool/Tech Type	Base of Operations
Esoko	Online agricultural marketing and messaging service	Accra, Ghana
Cow Tribe	Animal vaccine logistics platform	Accra, Ghana
Syecomp Ghana Limited	Remote sensing and geographic information system company for agri-stakeholders. Commercial agricultural optical and Radar Satellite monitoring and mapping systems	Accra, Ghana
Farmerline	Value chain and commodity optimization technology & communications	Accra, Ghana
Trotro Tractors	Agricultural technology and farm mechanization services provider	Accra, Ghana
Sesi Technologies	Affordable technology development for farmers & agri-business. Small holder extension lessons and market connection	Kumasi, Ghana
Agrocenta	Seed to market extension tool. Agri value chain market linkage and financial inclusion	Accra, Ghana
AgroInnova	Livestock mangement application. Cocoa farmer specific business solutions. Poultry biometric management app & e-commerce sales and services for poultry	Accra, Ghana
International Institute of Tropical Agriculture (IITA)	Seed Tracker. Cassava & yam digital extension application & sales and services aid	Ibadan, Nigeria
PlantVillage	Nuru application, AI tech for diagnosis of multiple crop pests, diseases, and infections. Crop health information hub	Pennsylvania, USA

Figure 2.3 – Existing Ghanaian Agricultural Tech - Source: Author

MOFA has placed a considerable number of resources in the development of digital agricultural extension in the last decade in Ghana. The ministry understands the need for its extension agents stay up to date with the level of digital adoption seen amongst the rural Ghanaian farmer. Through cooperation with the West African Agricultural Productivity Program (WAAPP), a multinational agricultural development project, ministry extension officers have been provided smart phones with e-extension apps to help collect and track information on farmers and their needs in the field (MOFA, 2016). MOFA believes there is potential this sort of mobile technology could provide early indicators for food security issues as well as the ability to connect with farmers directly, if they were to adopt the e-extension app on their smartphone (MOFA,

2016). The implementation of additional IoT devices, such as tablets, with extension workers could see great benefit to farmers in need of extension (Gow, 2022). Portable video as a digital method has shown to provide access, interest, and, perhaps most importantly, empowerment to participate in the use of and creation of agricultural information in developing contexts (Gumucio Dagrón, 2001; Harris, 2019). This is not to say that Ghanaians are not capable of reading extension information on their cellphones, as the Ghanaian adult literacy rate is 79%, while youth literacy is much higher at 92.5% (FAO & ITU, 2022). Rather providing a visual learning experience could benefit farmers who has different learning styles and would be better served with a video format. ICT's are a portal to the digital agricultural world, connecting those who wish to access narrowcast and targeted information to the extension materials they so desire and require. Mobile technologies allow rural people in developing contexts to feel a sense of empowerment and belonging (Harris, 2019). Even those who are without prior experience have been shown to strongly take to informal digital communities through social media networks (Facebook, Twitter) for their day-to-day agricultural extension needs (Harris, 2019).

2.3.4 Participatory dimensions of digital extension services and methods in Ghana

Radio+ and participatory radio are strong points within Ghana presently, however there is potential for the further development of the participatory dimensions of these services and the methods that drive them. Emphasis on the use of methods and theory that places importance on participatory, ground-up, and stakeholder driven/focused extension and research is vital to the continued success of agricultural extension within Ghana.

2.3.4.1 - Human-centered design

The co-creation of knowledge with farmers in a ground-up development format is vital to identifying the actual pressing needs of farmers. Human-centered design (HCD)

seeks to place stakeholders within the problem-solving development process through discourse and cooperation (McC Campbell et al., 2021). While HCD's themselves cannot completely guarantee digital innovations that are responsible, they have been shown to have the potential to respond to the needs of end users in low-income countries (McC Campbell et al., 2021). Focusing on co-creation of knowledge and ground-up development is important to true participation. WAAPP's aforementioned e-extension app could be seen as more of a farmer data mining tool as its main function is to collect information on farmers for knowledge creation to be completed by researchers away from the farmers and their participation. Harris argues that this form of extractive digital media could be more exploitative than participatory in practice (2019). Extension practitioners must recognize the potential for digital agricultural HCD and ICTs for development as essential, while also remaining vigilant for the potential pitfalls that must be safeguarded against throughout the design and implementation of these processes (Dodson et al., 2012; McC Campbell et al., 2021).

2.3.4.2 - Participatory communication theory and co-creation of knowledge

In a USAID funded report on agricultural extension in Ghana, Sigman reports that a key objective to strengthen linkages between stakeholders within agricultural extension should be achieved through the promotion of farmer driven extension (2015). Working in a farmer focused framework to co-create knowledge, content agendas, and solutions is not currently emphasized enough by the RELC and MOFA and recommends its promotion (Doamekpor, 2005; Sigman, 2015). Participatory Communication Theory is rooted in stakeholders being able to take part in a 'two-way' dialogue. The process of participatory communication is seen as a benefit in its own right, placing more weight on stakeholder engagement than the end product of the research itself (deHaan, 2020). Focusing on human-centered designs with an emphasis on the co-creation of knowledge with farmers should provide considerable steps toward ensuring the participatory communication is taking place. This theory can be seen in action within FRI's digital extension method of their participatory radio campaigns and the new green leaf approach (Hudson et al., 2017; Oyaro & FRI, 2013).

The increase in engagement from farmers when the participatory aspects of PRC's are implemented speak to the benefits of a two-way dialogue (Sullivan, 2011). Farmers are voting with their engagement and clearly prefer the ability to communicate their needs to extension service providers while having direct impact on the content they receive.

2.4 Participatory Radio+ extension and content creation: A conceptual framework

Figure 2.4 expresses a simplified rendition of the current Radio+ framework that governs decisions and rollout of Radio+ extension work from FRI, their work and partnership with MOFA and RELC committees, and community radio networks. The value chain actors, mentioned above, are able to give input to the physical extension services provided by FRI and MOFA as well as interacting with the agricultural broadcasts from community radio stations using Radio+ methods outlined in figure 2.3. Communication between extension service providers allows for the coordination and distribution of quality agricultural extension to value chain actors, stakeholders, and end users. In conceptualizing this project, it was assumed that there would be a greater level of participatory methods within the initial conceptual framework, yet it would appear that the current flow of information is a top-down process, as highlighted in the CF. Harris highlights that participatory communication through participatory forms of media creates new forms of empowerment and the power for people in developing contexts, especially women and youth, to take hold of power within their contexts (Harris, 2019). This is not represented with enough strength within the current Radio+ conceptual Framework, and these participatory concepts will be explored later within the analytical analysis.

Current Radio+ FRI Ghana Conceptual Framework

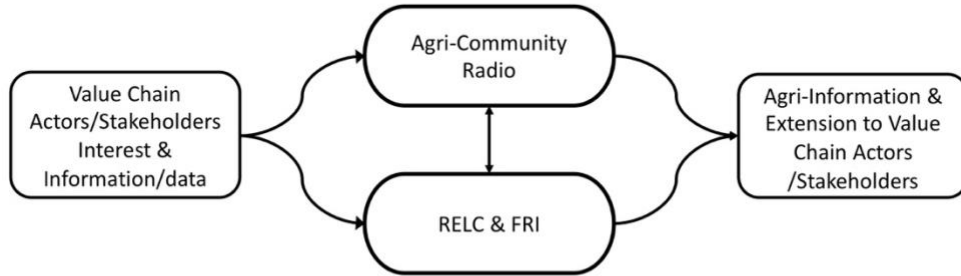


Figure 2.4 - Current Radio+ FRI Ghana Conceptual Framework – Source: Author

2.5 Summary

This chapter has presented the relevant literature to this research. The core concepts of Radio for agricultural and rural development, agricultural extension and advisory services in Ghana, and the research’s conceptual framework was presented to give the reader an understanding of pertinent topics and concepts when considering the future of Ghanaian digital agriculture and Radio+ in a participatory context.

Chapter 3: Methodology

3.1 Introduction

In this chapter, the epistemology and methodology that form the basis of the research of this thesis will be discussed. The positionality of the researcher and how that may have impacted the methodology and outcomes will be examined. The selection of the methods and sampling strategies used to achieve the objectives of the research will be highlighted. The steps in the analysis of the primary and secondary data are discussed. Other methodological considerations such as research ethics approval and the pandemic-related issues affecting the process of data collection are addressed.

3.2 Epistemology: Realism and a pragmatic worldview

This research has been framed by the influence of Realism and a worldview associated with pragmatism (Morgan, 2014). The author's interest in tangible and real issues with a focus on practical and applicable solutions led to the research aiming to present the current affairs and future needs associated with the value chain of Ghanaian Radio+ in a real and truthful manner, as it plainly is. Of course, defining what is true and real is as difficult as defining realism itself. Statements of what is true or real may be distorted or differ based on the goals, interests, or lived experience of those who claim them (Morris, 2003). However, Morris best defines the epistemological version of Realism as, "The values of accuracy, adequacy and truth are fundamental to [Realism as an] empirical view of knowledge and its representational form" (2003). The worldview that guided this research runs in concert with the ideals of Realism, as classic pragmatism is rooted in problem solving, especially when considering its longstanding relationship with mixed methods and human-centric research (Morgan, 2014). Later in this chapter, the method of Collaborative Inquiry will be introduced as the method adapted and utilized in the interview process with Farm Radio International employees. This form of humanistic research runs completely in line with the values of the Pragmatist worldview. The co-founder of pragmatism, John Dewey, wrote about how

the practice of inquiry was central to the facilitation of growth and problem solving in the human experience (Hickman, 1997). This is reflected throughout the entirety of the process of this research. From the inception of the problem the author wished to address, to the method of research, and the hope for future application to real and tangible issues.

International development practices, policies, and outcomes have long held different impacts on women versus men which means that adopting a feminist standpoint on international development research and policy is widely recommended (Bastia, 2014; Peet & Hartwick, 2015). Issues affecting the lives of women in developing nations are inherently intersectional and complex, much like our general understanding of the complexity of development issues when not considering a feminist approach (Bastia, 2014). The issue is when development practitioners do not take into account how general solutions will, most times, allow women and other sensitive populations to fall by the wayside. Hoping marginalized populations are caught in a generalized plan for development is folly. The author of this research comes from a background of viewing development issues through a feminist lens with a critical eye for inequality and gender relations. This viewpoint could be described as a researcher who leans toward operating within the feminist theory of Gender and Development. This theory emphasizes the importance of women within development work while understanding that women are not a homogenous group and have divisions characterized by many things such as, class, race, creed, etc. (Peet & Hartwick, 2015). With that in mind, the researcher created the research design to ensure Ghanaian and Canadian women's representation throughout the interview process. In addition to this, the digital extension app's conceptualization sought to include and address marginalized populations, with emphasis on women, within the app design.

The digital extension android app is, by design, an attachment to longstanding and proven participatory methods of extension in the form of Radio+ (Betteridge-Moes, 2019). This is to say, the app is not meant to replace a well-established and bottom-up form of agricultural extension. It is an additional digital piece to an ever-evolving participatory framework that is Radio+ in Ghana. It is the researcher's belief that the

inclusion of an app in the overarching web of Radio+ and e-extension is one of the few ways to ensure that participatory development work is the legacy of this research. The reason being for this is, this app design allows for the flow and co-creation of knowledge, data, and extension information manifesting the as an expression of participatory communication and human-centered digital extension. This free exchange through the digital extension app will create a dialogue between the stakeholders of MOFA, FRI, and value-chain actors within or attached to Ghanaian agriculture. More about the connection of the digital extension app and participatory communication's use will be expanded upon further in the methods section of this chapter. It is important for the conceptualization of the Radio+ app to be rooted in participatory theory if it is not directly developed through interviews with the end users, as mandated by restrictions of the COVID-19 pandemic.

3.3 Positionality

A driving motivation for the conceptualization and completion of this research comes from the researcher's core belief that improving marginalized populations' access to information is a vital tool in participatory and ground-up development. The researcher has long held an academic passion for fostering meaningful progress within the developing context. This is specifically reflected in the design of the mobile e-extension app and its connection to the mobilization of information within the RELC reports as well as between stakeholders. Agriculture, gender issues, and their intersectionality within development have long been key academic interests of the researcher, stemming from early exposure to the topics in the researcher's undergraduate degree in International Development Studies. However, it seems important to disclose the positionality of the researcher as he is decidedly not female, nor from Ghana or any developing context for that matter.

The researcher is a white male from Ontario, Canada, who is of no particular religious affiliation, and studied international development with a focus on rural and agricultural development throughout both his undergraduate and master's degrees. It was early on during his undergraduate degree that the researcher found a niche interest

in the rural and agricultural field as a manner of addressing the myriad of issues in the developing world. At this time, the university of Guelph's International Development program began as a more general introduction to global affairs, development issues, and interdisciplinary studies. Beginning in the second year of the student's studies, they were expected to choose a specialization with the discipline of international development. Almost to say to the students, 'alright, we have shown you the many issues with the world and the less developed areas... now how are you going to fix a small part of it?' At this time, the researcher was convinced that no ills of the world could be solved with people going hungry. The idea that any complex structural or interpersonal issues could be remedied without a population being food secure seemed to be a fallacy. This conviction remains to this day. The researcher hopes that this thesis will contribute in small part to improving lives in relation to this issue in.

The researcher is clearly of a background of privilege and understands the developing context through an academic and non-lived experience lens. It is not lost on the researcher that being able to analyze, research, and attempt to recommend the implementation of new Radio+ technologies is a privilege in and of itself. It is additionally a privilege to not be personally dependent on the outcomes that may result from any potential changes in content agendas, extension technology and programs run by FRI or MOFA. It is important to communicate the level of genuine interest in improving live as an outsider from the context that the research takes place. The researcher has long wanted to foster a career that leads to a positive impact on their fellow man, without imposition, and with sincere understanding that there are many things he does not understand from an others perspective.

3.4 Methodology

3.4.1 Selection of partner organization

The desire to work in a real-world context in agricultural extension in Africa led to the need to identify a partner organization. Farm Radio International was selected as the partnering organization for the thesis as a research attachment. The researcher's

advisor had a longstanding history with the organization, dating back to her time as an undergraduate translator for Farm Radio International (Hambly et al., 2020). Ghana is one of the most active countries in the FRI network of African broadcasters and radio stations. Selection was influenced by the availability of relevant literature, produced by the University of Guelph, on rural and agricultural radio in Ghana (McKay, 2003; Whaites, 2005; Yordy, 2007). This connection coupled with the interest from the researcher on the topic of digital extension, community radio and the potential for improving life through new applications of the development method, led to this thesis research attachment with FRI.

Farm Radio International (FRI) is a Canadian non-profit organization that has sought to provide small farmers with the information they need through the medium of radio since the late 1970s. FRI has grown to create a wide-reaching network of support to 780 radio stations throughout 40 countries (Farm Radio International, 2020). As Hudson et al indicate, FRI has used rapid advances in ICTs to continue to provide relevant information and programs for smallholder farmers in Africa (2017).

With FRI providing radio extension services across Africa, why did the research focus on Ghana specifically? While this research would have been applicable in multiple African countries, the Ghana office was uniquely primed to partner with a researcher who was looking towards the development of ICT's and Radio+ due to their current rollout of programming in connection with the Ghanaian Ministry of Food and Agriculture (MOFA). FRI was in the process of developing and testing a new interactive radio broadcasting initiative during the early stages of the research development (Betteridge-Moes, 2019). This program was called Green Leaf and focused on sustainable agricultural radio broadcasting that ran long after FRI programming met its completion date. Green Leaf promoted the use of local partnerships to form the economic basis for the sustainable continuation of quality and digitally interactive Agri-Radio (Betteridge-Moes, 2019). In addition to this, there was high levels interest from the connections within the Ghana office in having a researcher focus efforts on the development how to better utilize and the efficacy of the Research Extension Farmer Linkage Committees' (RELC) report. The RELC report is an annual report on the state

of Ghanaian Agriculture that is product of a private-public partnership (MOFA & CSIR, 2013). This multi-stakeholder partnership is varied across the Ghanaian agricultural value chain. FRI was interested in having access to a scholarly review of RELC's production of knowledge, the recommendations made, and synthesizing or distillation of the content produced in the annual document.

3.4.2 Methods

This research involved the use of a number of methods. These methods included a collaborative inquiry interview process with Farm Radio International employees, coding the notes taken during those interviews using software program NVivo, an academic literature review, and participatory communication theory. The following sub-sections will address these methods individually in greater depth.

3.4.2.1 Collaborative inquiry interviews

The first method employed in this research was the use of Collaborative Inquiry (CI). Collaborative Inquiry involves general, unstructured, in-depth and interactive individual and group discussions about models or ideas, as opposed to the formal interview method (Bray et al., 2000). As discussed above, CI techniques are entirely consistent with participatory research methodology.

The CI Interview was organized in the following way. First, the researcher welcomed FRI employees to join for a general and unstructured one-on-one interview to discuss a broad range of topics relating to e-extension, RELC, and FRI. The interviews were a minimum of 40 minutes and some stretched to 2.5 hours. The extended length of certain interviews can be attributed to the strengths of the research method. The unstructured nature of the collaborative inquiry process was vital to the creation of data from experts who work so closely to FRI's e-extension in Ghana. This relaxed format allowed the interview participants to freely give their insight on a wide range of associated topics at whatever length of detail they felt necessary. This wide variation of topics was utilized to garner a breadth of information from the FRI Ghana staff, who are

all attached to the topic of Radio+ and Ghanaian agriculture but in vastly differing specialties. The interviews began with a reaffirmation of the participant’s understanding of the research and the agreement to participate.

Collaborative Inquiry Interview Process Diagram

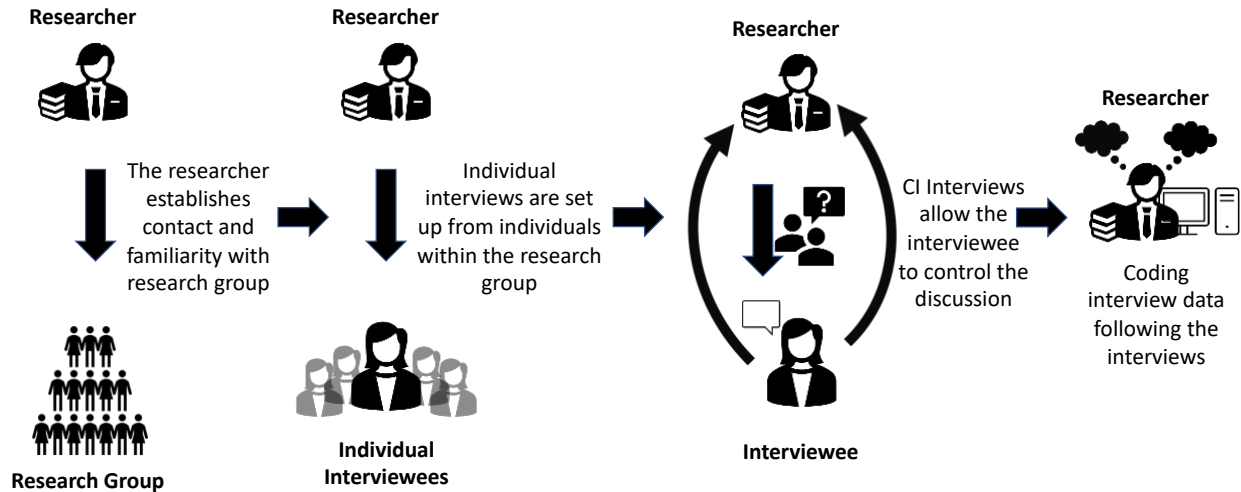


Figure 3.1 – Collaborative Inquiry Interview Process Diagram Source: Author

Then the interview participant was introduced to topics of focus for the interview and asked to begin with their thoughts on them. Those topics were as follows. First, the state of FRI and Radio+ and what challenges and opportunities exist. Second, MOFA and RELC and their perception of them, and if they believed they fostered bottom-up development. Third, interactive Radio+, and how does FRI encourage the co-creation of knowledge through it. Fourth, their perception of an Android app as an extension service, and do they believe it has the potential to serve as a KTT tool for co-creation of knowledge and two-way dialogue. Fifth, the development of women and youth’s agency and capacity building within agricultural extension sphere in Ghana. Sixth, any topic they feel is relevant to the research that has not already come up in the dovetail conversation from the set topics.

As mentioned, a range of associated topics arose throughout the collaborative inquiry interview process. Examples of this would be, the importance that regional

context plays in development work in Ghana, religious and cultural barriers to shifting cultural norms, and confidence (or lack thereof) in the capacity of MOFA to continue with digital extension work following the completion of FRI programs. To identify participants, the researcher was given an email list of FRI employees based in Ghana and Canada who were associated with Radio+, extension work, and ongoing e-extension programs. A call for volunteer participants was sent to the contact list and subsequent respondents received follow-up emails with interview times. The interview was then held over the digital video and audio-conferencing platform Zoom. Zoom was selected as the conferencing platform following the recommendation of the University of Guelph's Research Ethics Board. These zoom meetings were not audio or video recorded, another stipulation of the remote researcher from the ethics board to protect the confidentiality of the participants.

3.4.2.2 Data analysis in NVivo

The data gathered from the collaborative inquiry process was coded to identify trends in the interview responses using the software program NVivo. The coding of the data was completed in a relatively straight forward manner. The data set consisted of handwritten notes taken by the researcher during the collaborative inquiry interview process. Notes were taken to highlight the core points made by interview participants. A direct transcription of interviews was not utilized due to research ethics concerns regarding the security of the data and the deidentification of the data drawn from the interviews which were conducted remotely. These notes were digitalized and loaded into NVivo for coding. The data was then reviewed within NVivo to establish trends that appear with the interview data. These trends, often repeated keywords, or themes are referred to as 'Nodes' (NVivo, 2022). Initially, the researcher planned to have the coding follow an open coding inductive process that was followed by axial coding in the second pass through the data, with a final selective coding. However, as the researcher began the data coding, it became clear that beginning with a coding down process was far more prudent due to the collaborative inquiry key informant interview method's format.

This process took the form of thematic coding. The analysis began with coding down, using the 6 question topics from the interviews as the thematic parent codes. This was followed by coding to establish multi-level child nodes below the parent node topics/themes, in what can be described as an iterative process throughout the coding sessions. The first level of child nodes detailed the positive and negative associations within the parent node topic. The second level of the child nodes were more specific and detailed themes that were able to show more detailed trends within those dualistic emotional themes. The researcher was able to draw conclusions towards themes within the data, such as content distillation with FRI and RELC or the potential for the development and use of an e-extension application.

3.4.2.3 Deidentifying data and use of quotes

The sensitive nature of the interview participants taking part in a highly personalized long form interview format has led the researcher to decide that utilizing full quotes or a participant profile table within the findings is not possible. Even with the deidentification of the interviews, quoting direct responses poses too much of a risk to the interviewee, as the findings will be reported to the employer of the respondents and potentially circulated throughout the relatively small organization.

3.5 Prototype design

The digital extension app concept was designed using influence from a number of methods. Information gathered from the collaborative inquiry interview process and the literature review contributed to the design. A portion of the interviews focused on the opinions of extensions experts' regarding how and if an app would be a useful extension tool, as well as what aspects of the app should be emphasized. An example of what the interview participants thought was vital to the design was the inclusion of individual profiles on the app. This allowed for accurate and up-to-date user demographics and the trends for needs within specific demographics. This would expand on the existing practice of Ghanaian agriculturalists completing surveys and

receiving compensation in return (Benson, 2019). The app would provide many more opportunities for the flow of dialogue and co-creation of data and knowledge, which will be presented in the Discussion Chapter of the research. These methods contributed to the app design with academic rigor to help the app stand the test of potential use cases in developing contexts in future research.

3.6 Ethical considerations

The University of Guelph requires proposed research to undergo a stringent ethical review process. The body responsible for this ethical review process is the REB (Research Ethics Boards). The researcher prepared many documents to receive ethical clearance for the research from the REB. These documents included, the involvement of human participants form, an ethical research certificate, a research attachment acceptance letter from FRI, a certificate of research registration from the Government of Ghana, a cross cultural sensitivity form, a confidential disclosure agreement with FRI, and a request to use WhatsApp as an accepted form of communication with interviewees. The involvement of human participants form was essentially the core application form. The following forms were supplements to the core application. The remaining forms were ordered through Appendixes A through G as attachments to the core ethics board application. It should be noted that the WhatsApp communication method was rejected and Zoom, and University of Guelph Microsoft supported email were the methods accepted forms of communication. The process took a total of 13 months to complete due to complications with Covid-19 adjusting the needs of the REB process and issues within staffing changes at the REB.

One of the most evident ethical considerations for this research is the end users of the Radio+ digital extension app and the RELC content agenda outcomes are not directly included in the methods of this research. Farmers who would be utilizing the extension tool or impacted by the coding outcomes of the RELC are not directly included in the interview process. At face value, this should be troubling as it mirrors the past ills of top-down development that result in more damage than good (Dodson et al., 2012). In addition, the researcher is an outsider to the context of the research.

There is little in the ways of a shared experience between those who could benefit from the findings of the research and the researcher themselves. Compiling lack of direct contact with end users and stakeholders with the outsider nature of the researcher, which will be explored further in the Researcher Positionality section below, it would appear this research could be fraught with unethical and unreliable outcomes and impacts. However, there are legitimate reasons for the design of this research as well as mitigation strategies to lessen these perceived ethical and/or structural woes of this methodological design.

3.7 Justification of remote research

The COVID-19 pandemic created a number of issues for so many globally. There is little need for this thesis to underscore the tragedy of the long-term effects, lives lost, and many difficulties presented by the pandemic, as most have already personally felt detrimental effects of the past few years dominated and dictated by COVID-19. The direct effect of the COVID-19 pandemic specifically to this research was the multiple redesigns of the focus and methods of the thesis, so meaningful and academically rigorous findings could be produced, while adhering to the many barriers presented by the University of Guelph's just and reasonable travel bans during this time. In-person participatory methods with Ghanaian rural agricultural stakeholders were made largely inaccessible by the COVID-19 pandemic. As such, this research was conducted remotely from the University of Guelph, whenever possible, and at the personal residence of the researcher. To mitigate the barriers presented by COVID-19, the Radio+ digital extension method outline in this thesis was developed with the method of participatory action research known as collaborative inquiry with professionals who work consistently alongside the targeted end users. Collaborative inquiry will be further explored in the methods section later in this chapter.

3.8 Summary

This chapter has presented the epistemology and methodology that were the structure for the research conducted for this thesis. This chapter outlined the ethical considerations, challenges of performing quality development research during a pandemic, and the justifications for partnering with Farm Radio International's Ghana office. The methods were outlined and supported for the research. The following chapter will present the findings of the research.

Chapter 4: Findings

4.1 Introduction

This chapter will focus on the research findings. The collaborative inquiry key informant interviews were analyzed thematically with a process that involved a deductive approach to the coding strategy. The analysis began with “coding down” or using the six question topics from the interviews as the thematic parent nodes. This was followed by further coding to establish “child nodes” within the parent node topics/themes, in what can be described as an iterative process until data was exhausted and no new child codes were identified. The final section of the chapter will focus on presenting a summary of the emergent trends found within the data through the use of a data themes and trends chart.

4.2 Collaborative inquiry key informant interview findings

4.2.1 Interview data “coding down” and thematic nodes

The broad six topic/question sets of the interviews provided the thematic parent nodes to begin the coding down process. These parent themes were then characterized as and split between positive and negative nodes. The second level child nodes were various themes found within those positive and negative child nodes. This approach to coding allowed the researcher to better utilize the data to address the objectives of the research, as it formatted the parent nodes in a manner that related strongly to core topics and themes that are present in the agricultural extension field in Ghana. As mentioned in the methods section, the key informant question topics were as follows:

Table 4.1 - Interview Topic Table

Question Topic:
1. FRI and Radio+ Challenges and Opportunities
2. RELC and MOFA (Research Extension Farmer Linkage Committees and Ministry of Food and Agriculture of Ghana)
3. Participatory Radio and Co-creation of Knowledge
4. The Development of an E-extension Application
5. Women and Youth's Agency and Capacity Building
6. Points of Interest (Interviewees Felt Compelled to Share)

The first five of the parent codes were characterized as positive or negative. The sixth group of findings did not have a positive or negative split. Table 4.2 summarizes the parent codes and the characterization of the positive/negative thematic child nodes.

Table 4.2 - Data Themes and Trends Chart

Parent Codes	Positive Theme Key Words/Phrases	Negative Theme Key Words/Phrases	Highlighted Trends and Overarching Theme
1. FRI and Radio+ Challenges and Opportunities	<ul style="list-style-type: none"> Capacity, Radio+ and E-Extension Increasing Unique Digital Delivery (Radio+) MOFA Partnership 	<ul style="list-style-type: none"> Issues with need-based programming Content set by outside factors 	<ul style="list-style-type: none"> Increases Capacity in Ghanaian Agriculture needed Needs more Funding to reach delivery and Radio+ potential

<p>2. RELC and MOFA (Research Extension Farmer Linkage Committees and Ministry of Food and Agriculture of Ghana)</p>	<ul style="list-style-type: none"> • Promotes some Engagement and Participation • Identifies data and content agenda for extension 	<ul style="list-style-type: none"> • Unreliable and Lacks Capacity, Funds • Inefficient, Poorly Run • ICT and Radio+ Deficient/Illiterate • Not participatory or focused enough on grassroots/co-creation of knowledge 	<ul style="list-style-type: none"> • Lacks Capacity and Funds • ICT and Radio+ incapable for need level • Participatory, inclusivity, and grassroots levels lacking
<p>3. Participatory Radio and Co-creation of Knowledge</p>	<ul style="list-style-type: none"> • More ICT and Radio+ would be beneficial for participation and inclusion 	<ul style="list-style-type: none"> • RELC and MOFA lack emphasis and execution in this area 	<ul style="list-style-type: none"> • Participatory measures and Co-Creation of knowledge are valued and need focus
<p>4. The Development of an E-extension Application</p>	<ul style="list-style-type: none"> • Improved accessibility and content • Free- flow of info between stakeholders • Likely to improve funding 	<ul style="list-style-type: none"> • Certain barriers to wider stakeholder group • Cost across stakeholder chain 	<ul style="list-style-type: none"> • Aids Funding and Capacity • Radio+ and Participatory friendly

	and content agenda		
5. Women and Youth’s Agency and Capacity Building	<ul style="list-style-type: none"> Youth and Women benefit from ICT development 	<ul style="list-style-type: none"> Youth and Women experience difficulty participating in meaningful ways 	<ul style="list-style-type: none"> ICT and Radio+ sidestep current issues with access to/and participation in extension
6. Points of Interest (Interviewees Felt Compelled to Share)	<ul style="list-style-type: none"> Capacity building and funding appear consistently across topics 		<ul style="list-style-type: none"> Capacity building for MOFA and RELC and Radio+ development needed

4.3 Findings presented by theme

4.3.1 FRI and Radio+ challenges and opportunities

A dominant sub-theme that appeared was that interviewees clearly believed that Farm Radio International was doing good or beneficial work. FRI was seen as a positive force that was unique is its ability to provided extension that was digitally focused in its approach, helping differentiate it from other NGOs. FRI was reported to be actively increasing the capacity of and provide extension materials for the existing network of Radio+ extension in Ghana. Its collaboration with MOFA was considered an opportunity.

The challenges of FRI as an organization were associated with a negative characterization. Specifically, it was found that the current content agendas of FRI catered too much to the “wishes” (intentions) of “outside factors” and specifically, the

funding sources. It was reported that content must be geared towards the best practice and most pressing needs of stakeholders and end users within Ghana's agricultural sector.

4.3.2 RELC and MOFA (Research extension farmer linkage committees and ministry of food and agriculture of Ghana)

The second of the six parent nodes grouped data associated with RELC and MOFA. The positive sub-theme did not result in many child nodes. The findings observed were that MOFA provides sustainability within FRI's extension projects by consistently assuming control of those projects following the end of FRI funding. RELC was reported to provide low level support of participatory methods and stakeholder engagement.

MOFA and RELC's negative sub-nodes had a higher level of frequency. Data indicated that that MOFA was reported as far too reliant on outside actors with less than necessary internal capacity to effectively carry out physical and, to a greater extent, digital extension work. Interview respondents attributed this to a lack of funding and ICT/Radio+ (digital) literacy. This lack of funding and digital literacy resulted in extension programming that was budgetarily realistic and not targeted or stakeholder needs based. RELC was perceived by respondents as ineffective as a content setting and outreach program. Interviewees reported the RELC process is not transparent or inclusive enough. The data indicated other weaknesses included that RELC runs too infrequently and it creates too many content agenda priorities.

4.3.3 Participatory radio and co-creation of knowledge

The state of participatory radio and co-creation of knowledge in the Ghanaian agricultural sector was generally seen to be deficient. However, FRI's support of the Radio+ network system was seen to be a positive aspect of participatory radio and co-creation of knowledge, with especially positive feedback from interview participants on the recent Greenleaf edutainment programming. As a structural concept RELC was

also seen as positive, albeit failing in practice. The interviewees believed the focus of co-creation of content with the most vulnerable stakeholders was either non-existent, or at minimum not transparent enough as a process in order to have confidence in RELC's purportedly participatory nature. When asked a probing question about how to address these issues, some interviewees stated a belief that increased dialogue between extension providers and stakeholders, using Radio+ advancements, could be an avenue towards increased participatory engagement.

4.3.4 The development of an e-extension application

The fourth topic of the collaborative interviews was the development of an e-extension application. The interview transcripts generated substantial data that provided many child nodes characterized as positive. Most frequently, it was reported that the e-extension application was consistently viewed to have a strong potential for the two-way conveyance of information between stakeholders. More specifically, interview participants believed FRI would be able to gather valuable information or data on farmers or end users' needs to benefit the content delivery accuracy and impact. The app would enable end users to access information that was meaningful to their most pressing issues, on demand. Other frequent positive findings were the possibility of an e-extension app augmenting existing Radio+ structures. The app was considered as an "added learning medium" that increased empowerment for farmers. The app, it was reported, could aid with the alignment of funding donor priorities with FRI content agenda priorities.

There were instances of negative attributes to the data in these child nodes pertaining to the app. There were concerns expressed surrounding the barriers to entry for certain vulnerable stakeholders. This was due to additional cellular phone costs, such as extra charging or mobile phone/smartphone ownership, as well as cultural and religious barriers. Finally, concern was expressed about the additional cost of providing the digital extension application and the capacity of FRI and MOFA to deliver new digital extension products.

4.3.5 Women and youth's agency and capacity building

Within the positive group of findings, the child nodes were identified as a frequent mention of the belief that a focus on youth and women in agricultural extension is vital. Additionally, this sentiment was accompanied by the sense that FRI's Radio+ programming and the development of a digital e-extension app would positively impact young women at a crucial point in their life and socio-economic development. The example mentioned was that an app could help young women access information by side stepping barriers associated with traditional interpersonal or farmer group extension and participatory radio programming.

The negative findings reported concerns surrounding the RELC process and its failure to mitigate religious and cultural barriers that contributed to a lack of access to participation and capacity building for youth and women in Ghana. The specific barriers for women and children that were repeatedly found in these child nodes were a lack of meaningful participation in RELC, the lack of relevant extension broadcasts, little or no access to inputs, and a general lack of economic power and social agency in women and youth's lives.

4.3.6 Points of interest (interviewees felt compelled to share)

When nearing the end of a given interview, the researcher asked the interviewee if there were any points of interest within Radio+ and Ghanaian extension that they felt should be included in such a conversation and had not already been discussed. It was also emphasized that they could reiterate points from earlier topics that they felt required expansion or clarification. This technique allowed interviewees to share many additional points of interest on the topic of Radio+ and digital agricultural extension in Ghana. The findings of this section have a slightly different organization compared to the previous five topics. The findings under each initial child node do not have a positive or negative characterization split due to the open-ended nature of the question/topic. Although sub-themes could be found within the interviewees' points of

interest. These sub-themes included capacity building, COVID-19 and the push for digital extension, and funding difficulties across extension stakeholders.

Capacity building had the greatest frequency of any of the sub-themes found within the points of interest section of the interview. Concern surrounding the general capacity of MOFA and its heavy reliance on outside actors was a consistent point. There was a particular emphasis on MOFA's ability to follow up on the operation of the ICT aspects of the new Greenleaf extension program. Nevertheless, interviewees mentioned their belief that digital extension was key towards the overall capacity building effort of Ghanaian agriculture.

The impact of COVID-19 pushed forward the emphasis on, and development of, remote extension programming in Ghana, reported interviewees. This was reported to be a validation of the success of FRI and their capacity building and Radio+ extension efforts. FRI's ability to provide extension content remotely was seen to be a strong fit for the needs of vulnerable stakeholders during the disruptions of the pandemic.

A final set of findings related to funding as a barrier at all levels of extension services and this issue was commonly referenced in the interview data. The stakeholders mentioned as impacted by funding issues were community radio stations, end users of existing extension services or the potential digital extension app, FRI, and MOFA. The data within the child nodes were centered on how issues with funding to FRI and MOFA would result in the creation of more financially realistic, sub-ideal extension programming. Some interviewees reported that more impactful programming could be achieved with an increase in targeted funding for ideal programming and capacity building.

4.4 Emergent trends from the findings

Data coding summarized in Table 1 generated three key trends across the parent codes to the child nodes. While not strictly axial coding of the data, trends identified in the chart (Table 4.2) helped to connect the findings to three areas of Ghana's agricultural extension system and networks. These are funding and capacity,

participatory processes, and digital development. These key trends were identified within most of the six parent codes that were associated with the question topics. However, not every parent code expressed all three key trends.

4.4.1 Trend 1: Funding and capacity

Funding and capacity was assigned a yellow highlight. This trend was evident within parent codes 1, 2, 4, and 6. The trend was not evident within parent codes 3 and 5. The trend associated with funding and capacity was present alongside the other key trends of participatory processes and digital development, at least once within the same parent code and child nodes.

Data specific to issues of funding and capacity were often associated or used interchangeably. It was generally expressed that more money alone was not the natural conclusion or salve to a given issue, such as the lack of activity or capacity. When increased funding was mentioned there was the understanding and belief that funding was a shorthand expression for an increase in effective capacity. An increase in appropriately allocated funding was seen by interviewees as an avenue to the necessary capacity improvement.

4.4.2 Trend 2: Participatory processes

The participatory process was assigned a green highlight. This trend references the current practice of participatory methods within extension, the potential for participatory practices within the digital e-extension app, and incidences in the data that referred to a need for the increased use of participatory methods. The participatory processes trend was found within parent codes 2, 3, 4, and 5. The trend did not appear within parent codes 1 and 6. The key trend of participatory process was present alongside capacity and funding and digital development at least once within the parent codes and child nodes.

4.4.3 Trend 3: Digital development

Trend 3 was assigned a blue highlight. The digital development trend refers to evidence of the need for, or existence of, ICT, Radio+, and/or the digital extension applications reported within the overall interview dataset. This key trend was evidence within parent codes 1, 2, 4, and 6, while not appearing in 3 and 5. Digital development was like the other two key trends as it appeared alongside both of the others at least once.

4.5 Summary

This chapter presented the findings based on the qualitative coding of the collaborative key informant interviews. Six main parent codes were used for “coding down” followed by the creation of their corresponding child nodes to group the findings thematically, and support characterization as positive/negative (or not). The following chapter provides a discussion of the findings and a further elaboration of the key trends observed in the data analysis.

Chapter 5: Discussion

5.1 Introduction

Chapter 5 will draw conclusions from the findings produced by the interview data. To begin, the discussion chapter will consider the narratives that the researcher has drawn from the interview processes' six questions topics and the themes gathered from the data. Secondly, the e-extension application's proposed features will be profiled. The remainder of the discussion chapter's organization will be structured by addressing the two research objectives of the thesis using the findings from the interview data, with an emphasis on the emergent trends. This will focus on the creation of a new Radio+ method and the research's implications for the future content agendas of FRI and MOFA. Finally, the study's analytical approach will be presented. The analytical approach will demonstrate the potential positive shift within Ghana's current digital extension and Radio+ ecosystem.

5.2 Narrative discussion

This subsection will focus on the narratives that can be drawn from the six sets of findings that were presented by theme in the previous chapter. More specifically, this narrative discussion aims to present what the researcher believes the data truly means in a pragmatic and applicable sense for Radio+ extension in Ghana.

5.2.1 FRI and Radio+ challenges and opportunities

It would seem that FRI digital extension work is adding value to MOFA's agricultural development goals. FRI has been building capacity for end users, the community radio network, and MOFA through their distance and digital extension programs. There are clearly more opportunities for FRI to continue this vital work, while the main detractor would be the difficulties with funding projects that are aligned with the needs of Ghanaian agriculturalists.

5.2.2 RELC and MOFA (Research extension farmer linkage committees and ministry of food and agriculture of Ghana)

The narrative surrounding MOFA and RELC from this research is one of limits and lacking. This is especially relevant to the future recommendations of this research as there was clearly a general lack of trust in MOFA's capacity to take over the stewardship of FRI's Greenleaf program and the ministry's ability to develop new Radio+ technology and programming. RELC seemed to be lacking in its delivery of specific content agenda priorities and ability to promote inclusivity and participation from less influential stakeholders. Overall, MOFA's internal capacity to drive impactful agricultural extension programming seems to be doubtful.

5.2.3 Participatory radio and co-creation of knowledge

The interview data showed that the RELC process was not something that promoted true participatory practices for content agenda generation and inclusion of stakeholders. Ground up and participatory methods were clearly important to the interviewees. While FRI's Greenleaf program is currently running edutainment programming that seeks the Radio+ engagement of the extension end users, it would seem a logical step towards increasing the participatory co-creation of the extension needs (content agenda) would be connecting directly and digitally with the end user through an extension application.

5.2.4 The development of an e-extension application

The development of an e-extension application was seen by the interviewees as a tool that could give farmers and extension providers with great mutual benefit. For the farmer, the access to specific extension information on demand, in varying visual or audio formats, is clearly a boon. Up to the minute digital user demographics and rapid survey is of benefit to FRI and MOFA when they are considering their content agendas for the year's extension efforts. The concept is clearly something that could be of great benefit to the agricultural extension ecosystem within Ghana, and potentially other

developing contexts. While it should be noted that this is not to say caution should not be exercised when planning and implementing the testing of a new extension medium such as this.

5.2.5 Women and youth's agency and capacity building

What can be drawn from the women and youth's agency and capacity building topic within Ghanaian agriculture is that women and youth are especially vulnerable groups. It seems clear that both women and children are not stakeholder groups that are particularly well represented in content agenda creation or general traditional extension and Radio+ participation. It seems likely that an extension app would be an effective tool for reaching, and increasing participation with, women and youth, when considering their respective likelihood to have greater access to a smartphone than traditional extension method participation (Harris, 2019; Quaye et al., 2017). There are also barriers to representation and participation with increased levels of ICT integration within agricultural extension, due to smartphone access, however it should be noted that not every solution solves all dilemmas.

5.2.6 Points of interest (interviewees felt compelled to share)

Digital extension is the future, while MOFA, the organization ultimately in charge of Radio+ and ICT development with Ghana, seems ill positioned to take charge of those key areas of emphasis shown within the data. A lack of appropriate funding and internal capacity are, in great part, responsible for this. FRI also seems to fall short of the necessary appropriately targeted funding, while their capacity is not seen to be in question.

5.3 Android e-extension application proposed features

Both of the research objectives are attached to the e-extension application. Prior to the discussion of how the research goal and objectives are reached, a profile of what

the e-extension application entails will be explored in this section. Each feature of the app was selected with a multitude of aspects from the research in mind. These include noteworthy points of Ghanaian agriculture and extension from the literature review, the application ability to either continue positive or resolve negative key themes found within the data themes and trends chart, and how the application could assess the first research goal and both objectives.

5.3.1 Personal profile

The application's first feature aspect is the personal profile that all users would create upon opening the application. The app user would input basic personal information such as age, sex, area of residence, their profession, and general extension interests. This would provide FRI with a constantly up to date data on who is seeking extension services and what their general needs are.

5.3.2 Extension topic database

The e-extension application would hold a database of pertinent agricultural extension information. This section of the app would be organized through agricultural topics and then subdivided into more specific subtopics. The key to this delivery is that the information is available to be communicated through many learning mediums that are most effective for the learning style or literacy capacity of the user. This means delivery of information in English and locally relevant languages, audio formats, and visual formats like video or picture instructions. This multiple language delivery would keep within the effective norms of Radio+ extension currently in practice in Ghana (GCRN, 2022).

5.3.3 Survey page

The practice of farmers calling into Radio+ broadcasts to complete interactive surveys is a standard practice within Ghanaian extension. The repayment for the

farmer's time and phone usage is simply a phone credit (Hudson et al., 2017). This reciprocal exchange is seen to benefit both parties. The e-extension app would continue this process, as there are certain to be questions surrounding extension needs that cannot be answered simply by monitoring the topic access traffic on the application. To continue this mutual flow of information and knowledge, the application's extension information articles, videos, etc., would be locked, with each topic requiring the use of an in-app token. These tokens would be earned simply by completing a survey within the app. This should not be a time consuming or prohibitive process, merely a fast and reciprocal exchange of information and knowledge between extension provider and user.

5.3.4 Market pricing and weather

A market pricing and weather facet to the application would provide users with additional information, in a centralized location, that is vital to their farming and business of agriculture. The market pricing function would allow users and FRI to update what the prices for certain commodities are at a given market. Whether a farmer is looking to buy fertilizer or sell a specific crop, the most advantageous prices will be available to them. This could help farmers make business choices that would lead to lowering costs and heightening income.

5.3.5 Digital radio, broadcast schedule, and push notifications for radio shows

The e-extension application is not an ICT innovation with the purpose of replacing the existing Radio+ extension network. The app is meant to be an adjunct to the Radio+ network currently within Ghana. The app would be best serving the user population if it were to support digital radio broadcasts. Farmers would be able to log into the app, go to the digital radio streaming section, and tune into traditional broadcast through their smartphones. A database of previous programs from that radio show could also be made available in a podcast form, allowing for off air listening. In this

same section, there would be a schedule and descriptions of upcoming agricultural extension radio shows to ensure the continued consumption of these broadcasts, increasing the listenership and effective utility of the existing traditional extension format. Finally, farmers will be able to set push notifications as reminders of their favorite broadcasts as well as notifications of other shows that match their personal profile extension interests. This would continue to support the existing Radio+ network and provide greater access to information for end users.

5.4 Reflections on the research objectives

This study sought to improve the content and delivery of digital agricultural extension services to Ghanaian agriculturalists. The objectives established to realize this goal were twofold. First, the study sought to produce the conceptual development of a new digital method extension method that would engage with and support smallholder farmers and the rural communities they work and live within. The second objective was understanding how improve the future content agendas of FRI for their Radio+ digital extension in Ghana. The findings of this research substantiates that the production and implementation of a farmer targeted android smartphone application would address both research objectives, and subsequently the overarching goal of the research. This section will present how the new Radio+ method addresses both the research objectives, while considering how the three emergent trends key terms produced by the findings are present within these objective solutions.

5.4.1 New Radio+ method: e-extension application

An FRI digital extension app would bridge the gap in existing and new e-extension technologies while creating a strong and actionable linkage to traditional extension and Radio+ practices and structures. The app would remove what is left of FRI's dependence on the RELC via bypassing the top-down nature of the RELC process and replacing it with the content agenda creation directly from the end users. This would create a new and far more accurate and comprehensive profile of

stakeholders in the value chain who consume FRI extension, allowing FRI to improve targeted narrow cast, broadcasts, content agendas, and increased delivery detail and accuracy. This is essentially the digital evolution of the PRC that FRI has found to be so successful in increasing the participation, inclusion, and uptake of extension from end users.

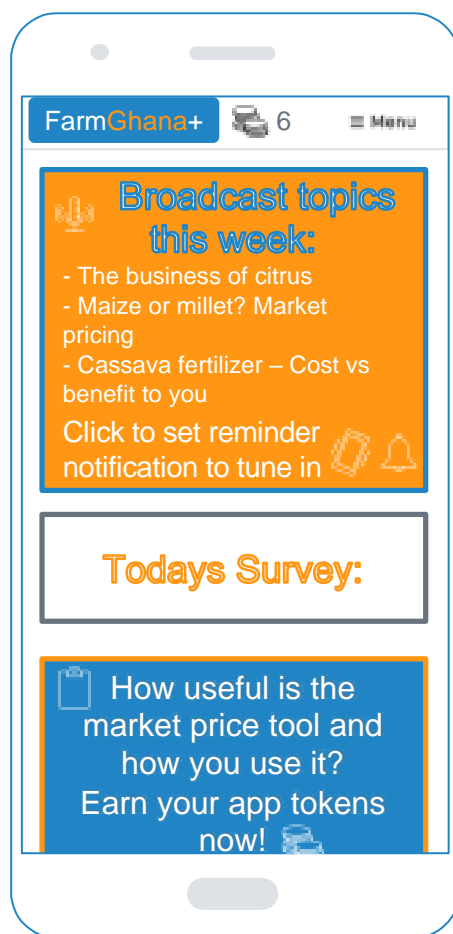


Figure 5.1 – Example Radio+ Application

Figure 5.1 provides a visual example of what that e-extension application could look like. This possible example shows a bright and engaging home page, filled with useful prompts and features, to ensure user engagement and value provided.

5.4.2 Objective one's emergent trends solutions

This research's first objective focused on the need for the creation of a new Radio+ method that prioritized relevant content and engaged with small holder farmers. This development was to be supported by the literature review and the interview data. The key to the development of the new Radio+ method is the three emergent trends that were established within the data findings. The following section will display how the funding and capacity, digital development, and participatory processes emergent trends are resolved through the application design.

5.4.2.1 Funding and capacity

Objective one's creation of a new e-extension application addresses the emergent trend of funding and capacity by providing the agriculturalist end users greatly improved access to on demand extension information. Ghanaian farmers who have access to the e-extension app would be able to raise their agri-business skills and knowledge exactly when they would need to, or when they feel is convenient for them. Capacity building was a consistent trend found within the interview data for both extension providers and recipients, and this ICT for agriculture advent represents a strong opportunity to address this topic.

5.4.2.2 Digital development

Digital development was an unsurprising emergent trend for a topic that focused on digital radio extension. There is strong potential for nationwide adoption of this sort of digital development considering that Ghanaians already use IoT devices to bank and use social media (GSMA, 2020; Nkrumah et al., 2015). Ghana is primed for the development of a specifically android e-extension application, as three quarters of the IoT devices in Ghana are android operating systems (GS Statscounter, 2022; Nkrumah et al., 2015). The nation also has the third most IoT connections in Africa signaling Ghana's digital development relative to its own economy and other African leaders (Omondi, 2020). The digital development impact of the app is that it would contribute to

advancing the existing digital radio extension network offerings from FRI and MOFA, while continuing to add increased utility to existing programming, with the potential to scale up rapidly in an exceptionally cost-efficient manner. For example, if a radio broadcast is live and able to reach 200 local listeners with impactful extension programming, the app's digital radio listening feature could allow thousands of users outside of the signal's reach to consume the information, with no additional cost to the given extension programming that is proceeding. This is highlighted by the potential for utilizing the nation's relatively advanced existing digital infrastructure, its potential for growth, and rural connectivity.

5.4.2.3 Participatory processes

Mobile tech and ICT4AG are shown throughout the literature and the interview data to be vital to the next step of the success of Ghana's agricultural stakeholders. Readily available extension information on mobile smartphones in accessible formats was shown to improve the fortunes of small business owners, farmers, value chain actors, and stakeholders alike (S. Adams & Akobeng, 2021; Frempong, 2009; Kwakwa, 2012). This indirectly improved the livelihood of vulnerable populations, such as women and children, by increasing the general households' income, access to information, and independence. Youth who have access to ICT's, mainly smartphones, are likely experience positive shifts in their relative income inequality (S. Adams & Akobeng, 2021). If researchers or extension entities are able to provide digital extension services through smartphones, and potentially through an FRI specific e-extension app, at an early age, women will be able to see even greater benefit to their wellbeing as agriculturalists and businesspeople through increased access to participation within the extension sphere. Being able to arm young women with access to information and active participation before they are saddled with the responsibilities and burdens of being a wife and mother should lead to improvement in their agency, both at the young age and beyond, as it is like to set the president for what is considered to be normal in their lives and work settings.

5.4.3 Content creation reform

This research substantiates the need for a shift in the manner that the FRI and MOFA content agenda and content creation is set. A modernization of the process is required to move past the current static methods and towards the use of the digital extension application for a more stakeholder and human focused approach to informing the content agenda. Both the end users and extension providers will benefit from a more streamlined and needs based content agenda.

5.4.4 Objective two's emergent trends solutions

The second objective of the study aimed to inform the future Radio+ content creation of FRI. The current agricultural extension services setting process is one that relies heavily on the RELC's, less efficient Radio+ methods, and where funding doners feel money is best spent. This section will examine the ways that the FRI content agenda setting process can be adjusted while considering three emergent themes, of digital development, participatory processes, and funding and capacity, from the findings.

5.4.4.1 Digital development

Digital methods have long been used by FRI alongside the RELC's to set content agendas. These existing Radio+ methods include pairwise ranking and voice-based registration. As mentioned in the literature review, pairwise ranking is the process that provides radio listeners the ability to vote on the extension topic or their current and future needs. The voice-based listener registration is a Radio+ method used to create a database profile of the end users of FRI extension information (Hudson et al., 2017). The content agenda setting can be updated with digital development through the e-extension application, with confidence as the use of digital technologies is a proven method of quickly and accurately assessing target populations and their needs (Benson, 2019). Pairwise ranking would shift to data collected automatically from individual on-demand extension choices made by app users, giving way from far less rigid, 'this or

that' ranking of extension needs and moving towards a nuanced view of the present needs of farmers. The local listener data base would shift towards a far less work intensive and efficient process of the e-extension applications personal profile to produce the end user demographic data. The use of digital development in the content agenda setting process would push towards a continuously evolving view of stakeholder needs, interests, and profile.

5.5.4.2 Participatory processes

This research substantiates the need for farmer driven extension and content that is farmer focused. The e-extension application's influence on the content agenda was designed with human-centered design and co-creation of knowledge in mind. In keeping with HCD, the app concept was built by placing the stakeholders in a position to actively take part in the content agenda setting through their interaction within extension resources (McCampbell et al., 2021). Doamekpor in 2005, Sigman in 2015, and this study nearly two decades later, have produced research findings that detail the extension processes, RELC especially, in Ghana are not focused enough on the end user (2005; 2015). There are far too many constraints to the current extension models that underutilizes end users and the possibility of moving towards digital advances to address these gaps between extension and consumers. Ghana's position as an ICT advanced nation must be considered. The proposed use of an e-extension app would lead to direct participation from stakeholders who would have been relatively unrepresented in the currently existing RELC process for content agenda setting. The content agenda would be informed by real-time interactions with extension consumers while allowing for the bypassing of many traditional barriers to participation that physical or existing Radio+ present.

5.4.4.3 Funding and capacity

The research found that FRI's content agenda was to be seen as focused on doner wishes and not what is known to be needed to aid stakeholders within agricultural

extension. The application directed content agenda creation format would provide the information necessary to accurately and rapidly visualize needs for farmers and other stakeholders. The information produced by new content agenda setting system could be translated into easy-to-absorb and actionable media using data visualization software, such as Tableau. A call for funding could then be released by FRI to funding sources who are more inclined to align with those needs, replacing the current model of FRI bending programming to the directives of the funding organization. This would improve the capacity building and value added currently provided by FRI that the interviewees felt was so core to the mission of FRI and the needs of stakeholders in Ghana’s agricultural sector.

5.5 Analytical approach

Proposed Radio+ FRI Ghana – Analytical Approach

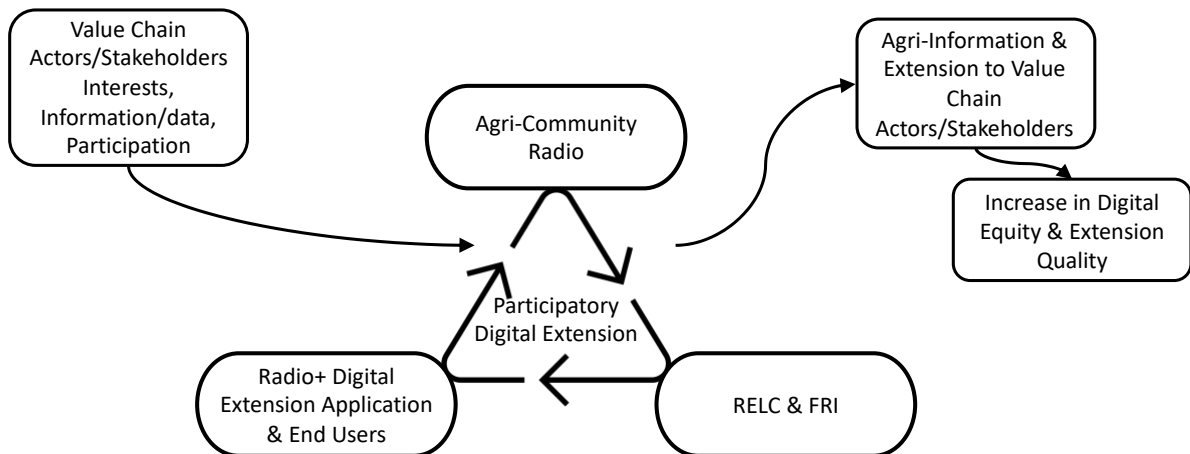


Figure 5.2 – Proposed Radio+ FRI Ghana analytical approach

This analytical approach reflects FRI’s Radio+ agricultural extension potential, following the implementation of new digital extension methods in concert with the existing Radio+ and extension structures. The existing Radio+ extension structure was

previously displayed within the conceptual framework in Chapter 2.4. The graphic showed a static and one-way flow of information and content agenda setting, with that information gathered and disseminated by FRI, RELC, and their agri-community radio partners. The analytical approach shows a heightened level of participation in the creation of extension information. Participatory communication theory helps to provide the backing for the use of an app to open and strengthen dialogue between the extension structural establishment (MOFA, FRI, Community Radio) and the end user (Farmers, value chain actors, youth and women). Participatory communication focuses on the importance of an equal and free dialogue between stakeholders (deHaan, 2020; Tufte, 2017). Stakeholders would take greater part in this process through immediate, direct, and consistent interaction with the extension application, agri-community radio network, RELC and FRI. Farmers and other value chain actors would be able to take a far more active and detailed role in helping to produce the extension content they consume. In this diagram, the triangle represents the flow of participatory communication between three branches of content creation stakeholders. This is in contrast to the current format of two main actors who influence extension content, where farmers are not active or co-equal contributors to the knowledge production. The application provides a structural position for farmers to consistently display what content is a priority. FRI does already emphasize participatory methods within their participatory radio campaigns, with Greenleaf being the most recent edition. However, the addition of the e-extension application as a tool for farmers would be a continuation of digital extension that is farmer focused with human-centered design. This is especially true for farmers who are marginalized or less able to take part in more traditional Radio+ extension, such as women and youth. The analytical approach concludes with the focus on women, youth, and other marginalized stakeholders having an improved ability to access information, resulting in increased in digital equity and overall extension quality.

5.6 Summary

This discussion chapter explored the various narratives that the researcher drew from the collaborative inquiry interviews. Additionally, the response to the research goal and objectives were examined, followed by the analytical approach that displayed the potential for implementing the research's findings.

Chapter 6: Final Summary, Conclusions, Limitations and Recommendations

6.1 Final summary

This research set out to improve the content and delivery of digital agricultural extension services to Ghanaian agriculturalists through identifying a new digital extension method and to examine the content agenda setting process of FRI. The method used to establish the research data was the use of collaborative inquiry key informant interviews. The data analysis was performed using a program named NVivo to perform a thematic coding process. This produced 6 core topics with positive/negative splits, producing overarching themes and emergent trends that informed the key findings. These key findings were the development of an e-extension application could represent the next advancement in Radio+ extension methods, while informing the future content agenda setting process. The android e-extension application was designed using the emergent trends and themes as the basis of the design. The current content agenda setting process was not found to be optimal, with those issues being remediable by the implementation of the e-extension application. The literature was filled with many critiques of MOFA's RELC process, while there was very little literature that supplied a solution to these ills. This gap within the literature was filled by the study through establishing a Radio+ development that leads to tangible improvements for extension stakeholders situated on both sides of extension consumption and delivery.

6.2 Conclusions

This research produced the conceptual backing for the development of a new digital extension method that will contribute to redevelopment of the MOFA and FRI's content agenda setting process. Ghanaian agriculturalists require extension that is timely, accurate, and personally relevant to their extension needs. Extension providers must consider how they can enhance their processes respond to these needs. This research provides a mutually beneficial resolution to both sides of this proverbial coin.

To conclude, this research identified the need and desire for the implementation of a digital agriculture e-extension application in Ghana, as a next step in the development of Radio+ offerings by Farm Radio International and Ghana's Ministry of Food and Agriculture. Supporting Ghanaian agriculturalists through digital extension is the future.

6.3 Limitations and informal discussion

6.3.1 Limitations of the research

The limitations of the research are a direct result of the Covid-19 pandemic. Due to travel restrictions set in place by the University of Guelph the researcher was not able to go to Ghana to conduct field work. This positioned the research at somewhat of a disadvantage as it made the inclusion of potential end users and the most vulnerable stakeholders impossible to access. While the research was designed to mitigate these issues, the limitations of participatory design conducted remotely are unavoidable.

6.3.2 Informal discussions

An interesting note that should be made within this study, is the somewhat odd happening of informal group discussion not mirroring the collaborative inquiry interview's individual interviews when the digital e-extension application was discussed. The researcher sat in on many meetings with Farm Radio International during the early portion of the research to become more familiar with the organization. During this time,

the researcher was developing more of the potential scope of the study as a research attachment to FRI's work in Radio+ extension. Naturally, FRI was interested in the researcher presenting his concepts for the research. During group discussions pertaining to the potential creation of the e-extension application, sentiments were generally tepid and unenthusiastic toward the concept of the application. The researcher has established three possible reasons for this difference. First, there is a likelihood that respondent had time to reflect on the proposed aspects and potential benefits of the app in-between the initial informal group discussion and the formal interviews. Given the reflection period, the respondent opinions could have naturally shifted. Second, the e-extension application would lead to drastic shifts within the way FRI organizes its funding and extension delivery processes. Due to this, there may have led to a sense of participants not wanting to stick out and be one of the first to embrace a drastic change when others were not similarly and overtly interested. Third, it is also possible that the respondents were sensitive to being perceived as rude or negative during the one-on-one interviews with the researcher. Interview participants may have been seeking to lessen a perceived awkward encounter of rejecting a premise that had been presented by the researcher.

6.4 Recommendations (for further research, development work, who should act on the recommendations e.g., RELC, FRI, etc.)

This research recommends the following two main development practice actions and further research. The first, FRI and MOFA need to take action with the development and use case testing of the e-extension application with Ghanaian farmers. This would facilitate the supplementation and potential replacement of the failing and outdated RELC practices for the overall betterment of the agricultural extension ecosystem within Ghana. Secondly, a study should be conducted to evaluate the efficacy of the e-extension application through a use case research project. This future research project should focus on the differences between traditional Radio+ extension and e-extension application enhanced groups, specifically the differences in access to information and effective uptake of extension materials between the two

groups. The study should also consider the application's support needs for effective usage. This entails support aspects such as, would extension workers have to provide training or encouragement to end users with the application and how in depth would that need to be. In addition to the 'on the ground' extension workers, the extension radio network would also have to be consulted and train on how they might blend their Radio+ extension to work in concert with the e-extension application. Finally, the study would need to generate findings on how the data produced by the application could benefit the FRI and MOFA's content agendas as well as their ability to secure appropriately aligned funding sources.

6.5 Epilogue

Introducing new digital agricultural extension methods can greatly increase the interactive exchange of knowledge between all stakeholders within Ghana. We must continue to focus our efforts on pushing the boundaries of existing practices to create a system that benefits those in need. Ghanaian agriculturalists and the extension practitioners who support them exist within an increasingly digitalised world. It is imperative not to fall behind our rapidly developing surroundings, to embrace and harness the power of the change enveloping us.

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APPENDICES

Appendix A: General Introduction, Request for Participation & Consent Form

Ghanaian Radio+ and Agricultural Extension

You are invited to participate in a research study conversation about the state of agricultural extension work in Ghana. This information letter is to help you decide if you want to be involved in the project.

Who is conducting this research study?

- This research study is being conducted by Austin Brown, MSc Candidate under the supervision of Dr. Helen Hambly, Professor & CDE Graduate Coordinator, in the department of SEDRD at the University of Guelph in Guelph, Ontario.

Who is this research funded by?

- This research is not a funded project

Who do I contact if I have concerns or need more information?

- *Please feel free to contact Austin Brown (abrown37@uoguelph.ca) with any questions you might have about the project.*

- *Any questions about the research study may be directed to Dr. Helen Hambly at hhambly@uoguelph.ca and 519-824-4120 ext. 53408*

Are there any conflicts of interest involved?

- The researcher is conducting this project as a research attachment with Farm Radio International.
- Information concerning the possibility of commercialization of research findings must be provided to manage real, potential or perceived conflicts of interests.
- *The results of this research may contribute to the commercialization of this project/process/concept.*

What is this research study about?

- The operative concepts of the study are the use and stewardship of information and communications technology in agricultural and rural extension services specifically using digital broadcast radio methods and radio stations to engage in participatory farm radio activities (referred to as radio+).
- The goal of the study/project is the development of the farm radio+ approach/model to prioritize relevant content and topics for digital interactions and e-extension work that ultimately engage with and support smallholder farmers and their rural communities.

Why am I being invited to participate in this research study?

- You are being invited to participate in a conversation about agricultural extension in Ghana due to your expertise or professional connection to the topic. The researcher values your positionality and opinions on the matter and would like you to help better their understanding on the topic. Your participation would greatly benefit the above research goal.

What will I be asked to do and how long will it take?

- You will be invited to take part in one 30-60 minute conversation on the topic of agricultural extension in Ghana. This conversation will take place over phone/voice over internet protocol (VOIP) while the researcher takes written notes. Please note that confidentiality cannot be guaranteed while data are in transit over the internet.

What are my responsibilities?

- As an informant, you must only do your best to represent your opinions and knowledge on the topic of agricultural extension in Ghana.

Are there any risks or possible negative outcomes for me if I participate?

Government or NGO employees may be concerned about social status if they were to give their opinions on agricultural extension if it were not aligned with their coworkers/peers. The opinions shared during the interview will be de-identified to mitigate the likelihood of this risk.

All correspondence by email or an initial phone text message to set up the phone discussion with key informants will be treated as private and confidential. No phone numbers or emails received from FRI will be shared to anyone else.

These risks are minimal. All of the risks listed above are mitigated by taking appropriate measures to keep all communications with contacts or key informants private and confidential so that participant phone/email contacts are not shared with anyone else. The informants record of consent will be held private by the researcher. No personally identifying information will be included in the research. Please be aware that confidentiality cannot be guaranteed if the interview is conducted alongside a coworker. If you participate in a group call, please respect the privacy of these conversations and the privacy of your coworker. Employment with FRI will not be affected by either participating or not participating within the research. Your participation status will remain private.

What are the benefits of the research project to participants?

There are no direct personal benefits to the any participants. It is possible that the research will result in favorable outcomes for participants through future programs enacted by Farm Radio International due to the shift in the organization's content agenda of agricultural e-extension as a result of this research. Such outcomes are difficult to qualify as they are abstract in nature. Taking part in the research will not result in direct or immediate benefit to an individual participant.

What are the benefits of the research project to society and the research discipline?

The research will improve Farm Radio International's current practices in/ability to discern what agricultural extension measures are most needed by rural Ghana farmers, especially in a digital extension (radio+) format. These outcomes will benefit rural farmers by increasing their capacity to access relevant information for farming, leading to improved output and quality of life. FRI will see benefit by receiving information and findings that will improve their extension capabilities. There is currently limited information regarding the digitalization of agricultural extension using digital techniques in farm radio. The discipline of capacity development and extension studies will gain new information and analysis of the radio+ use case including what it is, what currently works and what needs to be improved upon, at least in relation to rural and agricultural extension services in Ghana.

After I agree to participate and sign the Info/consent letter, can I change my mind?

Participation is completely voluntary. You can change your mind at any point during the conversation with the researcher. You may skip any question you do not wish to answer. You will not be forced to continue with the call. You can withdraw or

change information at any point before the report of the study is prepared – up to the designated date of August 1, 2021.

Who will know what I said or did in the study?

Only the student researcher will know what you said or did. Identifying information in the student researchers notes will be marked with a code. This code will only be known to the student researcher. You will not be directly quoted in the interest of protecting your status of participation and privacy.

How will the researcher protect the information I provide?

The identifiable personal information will be secured in a excel sheet on the researcher's laptop and then transferred to an encrypted hard drive immediately following each interview. Devices will be stored in a locked home office. The data/personal information will be kept no longer than 6 months following the completion of the researcher's thesis and will be destroyed by deleting it from the external hard drive. The audio of our conversation will not be recorded, rather the researcher will take written notes.

What will the researcher use the information collected for?

The information collected will be used to inform the researcher on the context of agricultural extension on Ghana. The written notes will be anonymized and will be shredded following the completion of the research.

Will I receive any incentives for my participation?

No incentives are given for participating in this study. Reimbursement will be provided in the case that phone costs incurred through communication with the researcher.

Will I be given new information about participation throughout the course of the project?

You will be informed in a timely manner about any new information which may affect your decision to participating in this study.

Can the researcher remove me from the study?

The researcher may remove you from this study at any time.

Will the study be published or otherwise disseminated?

It is possible that the results of the study may be published in Austin Brown's Master's thesis and potentially in an academic journal. The results will be shared with FRI.

Will I receive information about the results of this research?

You may receive a copy of any publication resulting from this research by emailing the principal investigator and requesting that a copy be provided to you. If you are a Farm Radio International employee, the results of this study will be presented to you following the completion of the thesis. Your participation will not be made clear by this presentation.

What are my rights as a research participant?

- *You do not waive any legal rights by agreeing to take part in this study.*
- *This project has been reviewed by the Research Ethics Board for compliance with federal guidelines for research involving human participants*

- *If you have questions regarding your rights and welfare as a research participant in this study (REB#.....), please contact: Manager, Research Ethics; University of Guelph; reb@uoguelph.ca; (519) 824-4120 (ext. 56606).*

Retaining a copy of the info/consent letter:

- *Please print a copy of this information for your records*

Verbal Consent:

I have read the Information Letter and have had an opportunity to have my questions about the project answered. I freely consent to participate in this research.

Participant Name

Date