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Investigating Knowledge and Behavior Intention among Ghanaian Smallholder Farmers

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Investigating knowledge and behavior intention among Ghanaian smallholder farmers

By

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Investigating knowledge and behavior intention among Ghanaian smallholder farmers

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Rural farmers in developing countries lack knowledge, access to educational resources, and capacity to stay informed of and implement current farming and health practices. The purpose of this research was to determine the effect of an educational program on the utilization of native plants in farming and health practices among rural farmers in Ghana. The research objectives were to describe the population, assess farmers' knowledge of farming and health practices, describe participants' current and planned behavior, and observe the implementation of the practices taught. Results indicated participants' knowledge of farming and health practices increased after the workshops. Results also indicated participants of both workshops intended to use all of the practices more often in their farming practices. Future research should include focus group interviews with farmers to gain a deeper understanding of the issues farmers are facing. Future trainings should incorporate experiential learning opportunities for farmers.

DEDICATION

This research is dedicated to the memory of Chelsea Lynne Sellers. She was a true friend, an inspiration to me, and will always hold a special place in my heart.

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CHAPTER I

INTRODUCTION

Introduction

Agriculture has always been a major driver of economic development (Alwang & Siegel, 2003; Fan, Shenggen, Brzeska, Keyzer, & Halsema, 2013; UN FAO, 2012). With over half of the developing world's population living in rural areas, about 2.5 billion of them make their living in agriculture (Fan et al., 2013; UN FAO, 2012). Although agriculture is responsible for employing two-thirds of the labor force and contributing up to 30% of the Gross Domestic Product (GDP) in developing countries (UN FAO, 2012), the majority of the farming population are living in poverty and comprise half the world's undernourished population (International Food Policy Research Institute, 2005). Hunger and poverty can be suppressed in developing countries through educational investments in both people and agricultural productivity and promoting economic growth by encouraging the utilization of innovations strongly embedded in agriculture (UN FAO, 2012).

Since determining poverty is incredibly complex, the World Bank uses US$1/day as a rough poverty indicator to determine levels, or dimensions, of poverty (UN FAO, 2003). According to the World Bank, "growth in the agricultural sector can be up to 3.2 times more effective at reducing US$1/day poverty than growth in other sectors" (UN FAO, 2012, p. 5). This means growth in the agricultural sector is more likely to reduce

the number of people living under the poverty threshold of US$1/day than growth in any other sector. Poverty should be addressed when improving agriculture because it is not just a subject of "a lack of income or consumption: it includes deprivation in health, education, security, empowerment, and a lack of dignity" (UN FAO, 2012, p. 82). Addressing poverty is important because it is a major barrier to the adoption of innovations (Lambert, Ryden, & Esikuri, 2005).

Rural areas in developing countries are in dire need of restoration and cultivation (UN FAO, 2012). Infrastructure in rural areas is either completely missing or is extremely unstable which limits agricultural efforts and the creation of successful markets (UN FAO, 2012; Government of Ghana, 2010; Sale & Olujobi, 2014). Agricultural growth in these areas will ensure that people are able to support themselves through locally produced foods. Diao, Hazell, and Thurlow (2010) indicated that investments made in the rural areas of Africa do not have to be excessive in order to have a great impact.

The UN FAO (2012) indicated local production is a major influence on poor populations in areas of sub-Saharan Africa where populations are increasing. This leads to consumption outstripping land that is in current production use (UN FAO, 2012). As more and more people move to urbanized areas, agriculture will need to experience crucial changes (Fan et al., 2013). Smallholder farmers in developing countries will play a vital role in making these changes (Fan et al., 2013).

Statement of the Problem

Rural farmers in developing countries lack knowledge, access to educational resources, and capacity to stay informed of and implement farming practices (Buadi,

Anaman, & Kwarteng, 2013; Lambrecht, Vanlauwe, Merckx, & Maertens, 2014; Unilever, 2014). Such practices include: cropping techniques, fertilizer application, and plant usages. Providing farmers with access to information and training to improve farming practices can cause an increase in yields, income, and empowerment (Unilever, 2014).

Academic institutions from developed nations have been partnering with developing countries in an effort to educate farmers for many years. Many agricultural partnerships are created through U.S. land-grant universities such as Michigan State University, University of Minnesota, Kansas State University, University of Massachusetts, Purdue University (Tuttle, Wedding, & Applefield, 2011) as well as Mississippi State University (International Institute, n.d.).

Tuttle et al. (2011) states that a major problem associated with Africans studying in the U.S. is that what they learn is directed toward U.S. agriculture and not changed to suit the needs for African environments. Educational interventions should be tailored toward African farmers' needs and production practices (Fan et al., 2013). The problem, therefore, is farmers are in need of educational resources that inform them of current and relevant innovations that can lead to increased crop productivity, income, and health.

Background of the Problem

Currently in Africa, farming areas are non-expandable in the north and an increase in yields due to inputs, technology, and irrigation are the only reasons land and water resources have been able to meet rising demands (UN FAO, 2012). Nineteen African countries hold over 60% of the continent's population and are very dependent on the production of roots, tubers, and plantains for more than 20% of caloric consumption

(UN FAO, 2012). Thus, farmers need up-to-date knowledge on how to implement farming practices to increase yields of their produce and, in turn, improve their health.

In order to make any necessary changes or to adopt technology, farmers must first be made aware of relevant information regarding these changes or technology (Lee, 2005). "Information may shape problem awareness and attitudes, which have been shown to be important factors in framing the outlooks and expectations of farmers toward resource problems and technology choice" (Lee, 2005, p. 1329). When learners are made aware of an innovation's existence, their motivation tends to increase in learning more about it, which could potentially lead to adoption of the innovation (Rogers, 2003).

Purpose of the Study

The purpose of this study was to determine the effectiveness of an educational program in influencing the utilization of native plants and materials for farming and health practices among rural farmers in Ghana. This study investigated the effects of the workshops on Ghanaian farmers' knowledge and behavior in terms of learning and implementing selected practices. The interventions also determined changes in knowledge, current practices utilizing native plants, and the extent to which they plan to utilize native plants in farming and health practices.

Research Objectives

The study aimed to determine the change in knowledge among participating farmers, as well as their current and planned farming and health practices. The specific research objectives of this study were:

Objective 1: Describe the demographic characteristics of Ghanaian farmers who participated in an agricultural education workshop.

Objective 2: Assess rural farmers' knowledge of farming and health practices before and after an agricultural education workshop.

Objective 3: Determine farmers' current behavior and intent to implement farming and health practices.

Objective 4: Determine the level of implementation of farming practices by farmers at the time of the agricultural education workshop and three months after the agricultural education workshop.

Significance of the Study

Many studies have documented the benefits of incorporating native plants in the diets of rural households in developing countries (Babu, 2000; Grivetti & Ogle, 2000; Legwaila, Mojeremane, Madisa, Mmolotsi, & Rampart, 2011; Thurbey & Fahey, 2009). Studies have also used native plants for multiple purposes on farmland (Djogo, Siregar, & Gutteridge, 1995; Lambert, Ryden, & Esikuri, 2005; Sale & Olujobi, 2014; Shelton & Jones, 1995; Stewart & Simons, 1995; van den Beldt, 1995), but there is a need for research on the utilization of native plants in farming practices (Babu, 2000) as well as investments in agricultural research to stimulate agricultural development (Diao, Hazell, & Thurlow, 2010).

This research contributed to the literature in two ways. One, the study was modeled after Rogers' (2003) innovation-decision process for technology adoption by addressing the foundational stage of the adoption process which is knowledge. Agricultural education workshops provided rural farmers in Ghana with knowledge on

the utilization of native plants in farming and health practices. Two, the study acquired information on the utilization of native plants by farmers in a developing country by obtaining self-reported current and planned behavior of farmers in rural Ghana. This will help fill in the knowledge gap of rural farmers utilizing native plants for both farming and health practices.

Definition of Terms

Subsistence: A farming system where the food and goods produced are predominantly consumed by the farm family and there is little surplus for sale in the market (USDA, 2000).

Agricultural Extension: The entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being (World Bank, n.d.).

Multipurpose Trees: Tree species that are grown to provide more than one significant crop or function or form. These may include soil conservation, shade, fuelwood, timber, fiber, fodder, food or medicine (Forestry/Fuelwood Research and Development Project (F/FRED), 1994).

Extension Agents: An educator employed by a county and/or a State cooperative extension service to bring research-based agriculture and quality of life education to local people to help them address farm, home, and community problems at the local level (USDA, 2000).

CHAPTER II

REVIEW OF LITERATURE

Introduction

The following chapter examines literature related to this study. The literature review provides a theoretical framework for the study and a summary of research related to agricultural and extension education in developing countries and more specifically, Ghana. This chapter will also address the knowledge gap that exists regarding rural farmers' utilization of native plants for farming practices and human health in developing countries.

Rogers' Diffusion of Innovations

The theoretical framework of this study was Rogers' Diffusion of Innovations (2003). The innovation-decision process model, in particular, was used to guide an assessment of the knowledge level of rural farmers as it relates to the adoption of farming and health practices. The innovation-decision process model consists of five stages where an individual passes from obtaining knowledge, to forming an attitude, to deciding to adopt or reject, to implementation, and to ultimately confirm the decision to adopt or reject the innovation (Figure 1) (Rogers, 2003). For individuals to begin the innovation-decision process they must start by obtaining knowledge of the innovation.

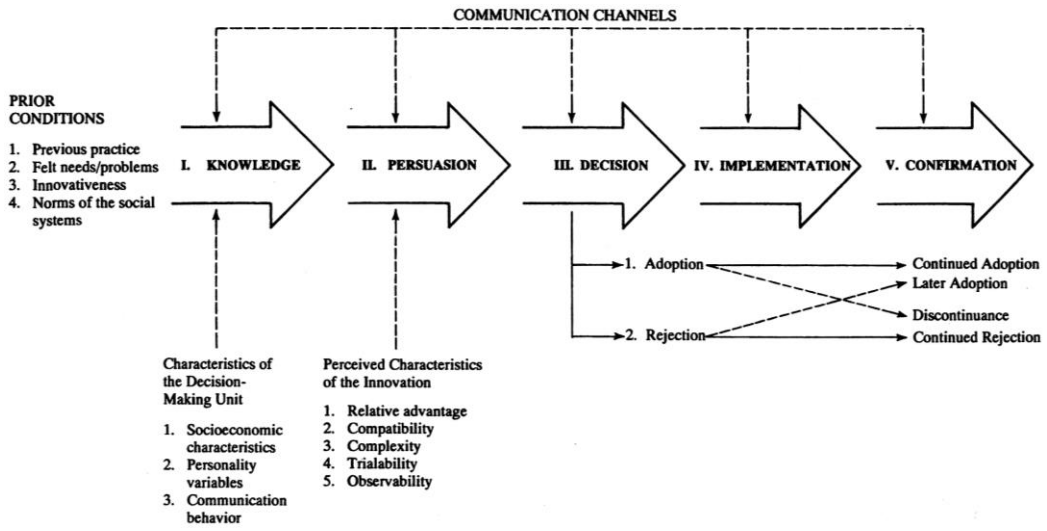

Figure 1 Five stages in the innovation-decision process

Adapted from "Diffusion of Innovations," by E.M. Rogers, 2003.

Knowledge lays the foundation for dissemination of information to take place. It occurs when someone is made aware of the existence of an innovation and understands how it works (Rogers, 2003). The acceptance and adoption of an innovation is also a process (Rogers, 2003). The innovation-decision process has many choices and actions that will take place in order for a decision to be made (Rogers, 2003). An individual must gain information about an innovation, how it works, its uses, value, and pros and cons to make a final decision in adopting an innovation. Ghanaian rural farmers were exposed to an innovation's existence and provided with knowledge on utilizing the innovation. The innovation for this study was represented by the utilization of native plants and materials in farming and health practices.

Rogers (2003) discusses three types of knowledge: awareness knowledge, how-to knowledge, and principles knowledge. Awareness knowledge is when an individual is given information about an innovation that exists (Rogers, 2003). This type of

knowledge may motivate an individual to seek out further types of knowledge (Rogers, 2003). How-to knowledge is information an individual needs in order to use an innovation correctly (Rogers, 2003). Principles knowledge consists of understanding how an innovation works (Rogers, 2003).

This study focused on awareness-knowledge and how-to knowledge. Awareness knowledge was created among Ghanaian rural farmers by introducing the idea of utilizing native plants and materials in farming and health practices. How-to knowledge was addressed by an agricultural education workshop teaching farmers how to effectively utilize the plants and materials in farming and health practices.

Innovations can include new knowledge that has a positive effect on farmers' "productivity, competitiveness, and livelihoods" (Asenso-Okyere, 2009, p. 1), but "cannot occur without the creation, accumulation, sharing, and use of knowledge" (p. 4). For farmers to adopt an innovation, they must be aware of it, have valid and up-to-date information on it, and receive the technical assistance necessary to adopt the idea (Asiabaka & Owens, 2002). It was important in this study for farmers to obtain an accurate knowledge base of farming and health practices to be more inclined to adopt instead of reject the practices, because if an "adequate level of how-to knowledge is not obtained prior to trial and adoption of an innovation, rejection and discontinuance are likely to result" (Rogers, 2003, p. 173).

When individuals take the step toward finding a solution to their problem they become active information seekers (Rogers, 2003). Information disseminators can then be more effective in promoting farmers' adoption of innovations (Asenso-Okyere, 2009). "Adoption decisions are dependent upon the degree of exposure to a piece of

information" (Asiabaka & Owens, 2002, p. 14) and farmers are more likely to adopt an innovation when certain conditions are met such as: simplicity, comparative advantage, compatibility with current practices, availability, and affordability (Asiabaka & Owens, 2002; Rogers, 2003).

Asiabaka & Owens (2002) conducted a study in Nigeria to determine what factors influence the adoptive behavior of rural farmers with respect to technology using a business communication theory. They found that the most influential characteristics of adoptive behavior were the farmer's personal characteristics, information source, and technology attributes (Asiabaka & Owens, 2002). Results also indicated that farmers with higher education are more likely to adopt a new technology by seeking/reading more information (Asiabaka & Owens, 2002). The authors concluded that if extension services should want to introduce a technology, they need to check the credibility of their information source as well as its usefulness (Asiabaka & Owens, 2002).

In areas where farmers have had informal education, information disseminated through extension should be delivered as simply and definitively as possible (Asiabaka & Owens, 2002). The need for credibility among extension agents and information sources is connected to Rogers' (2003) second step in the role of change agents which states, "The change agent can enhance… relationships with clients by being perceived as credible, competent, and trustworthy… Authors often must accept the change agent before they will accept the innovations that he or she is promoting" (p. 369).

Thurbey and Fahey (2009) utilized Rogers' (2003) to investigate the recent increase in the adoption of a particular plant called *Moringa oleifera* by international NGO's and various other groups. There has been a major push for locally-produced

foods that provide nutrients in local diets and *Moringa oleifera* is a possible nutrient source that can be grown and used locally (Thurbey & Fahey, 2009). Thurbey and Fahey (2009) use the five attributes of technology used by Rogers' (2003), which are relative advantage, compatibility, complexity, observability, and trialability to explain why this plant is being adopted. Each attribute is discussed in detail in relation to *Moringa oleifera*.

Moringa oleifera provides an abundance of micro- and macro-nutrients that most malnourished populations are missing (Thurbey & Fahey, 2009). It also naturally grows in tropical and subtropical areas in the world which coincide with regions experiencing malnutrition (Thurbey & Fahey, 2009). The findings given by Thurbey and Fahey (2009) on the five attributes of *Moringa oleifera* indicate that Rogers' (2003) diffusion of innovations theory supports *Moringa oleifera*'s use as a nutritional supplement. Thurbey and Fahey (2009) conclude that further investigations and clinically-based trials are needed with *Moringa oleifera* to gain scientific insight into its nutritional properties.

Agricultural Extension in Ghana

An effective agricultural education intervention can be created by studying types of extension systems that focused on agricultural education and health promotion. Extension systems can be one of the most effective ways to educate farmers. UN FAO (2001) stated:

> Agricultural and rural extension is one of the means available to help alleviate poverty and improve food security… In addition to technology transfer, agricultural and rural extension is a unique service in that it provides access by

small farmers and rural poor living far from the urban centers to non-formal education and information services (p. 3).

Alwang & Siegel (2003) support this, stating, "Technical change in agriculture, the major source of increased productivity, requires sustained investments in agricultural research and extension" (p. 1). There are four main approaches in Ghanaian extension that are currently being used and have been studied by the Ghanaian Ministry of Agriculture to determine their effectiveness. These approaches are Training and Visit (T&V), Participatory, Farmer Field Schools (FFS), and the Commodity Approach. The four approaches share the following characteristics: non-formal education, agriculturally related content, communication techniques and aids, and goal to improve the capabilities of people in rural areas (MoFA, 2011).

The Training and Visit (T&V) approach places "emphasis on frequent in-service training for staff, regular visit to farmers' farms, promotion of extension/research linkage and improved extension management" (Benor, Harrison, & Baxter, 1984 (as cited in MoFA, 2011, p. 13)). This approach incorporates extension methods such as "group discussions, seminars, and in-service training courses for extension staff and farmers, on-farm demonstrations and farmer field days" (MoFA, 2011, p. 14).

A study by Bindlish and Evenson (1997), found T&V made extension more effective, encouraged agricultural growth, and brought high rates of return (as cited in Ajayi & Akinnagbe, 2010 and MoFA, 2011). T&V was made to be cost-efficient and economic, but further study resulted in criticisms on the cost of financing, irrelevance, inefficiency, ineffectiveness, and lack of equity (Rivera, 2001 (as cited in Ajayi & Akinnagbe, 2010 and MoFA, 2011)) as well as farmers fulfilling a very passive role and

failing to factor in diversity of farmers and generating behavior change (Chambers & Ghildyal 1984; Birner et al., 2006 (as cited in MoFA, 2011)).

The participatory approach is where the extension agent provides knowledge and technical assistance to farmers (MoFA, 2011). The agent helps the farmer to address problems and find technologies and provide technical knowledge that fits their needs (MoFA, 2011). This approach really takes on a very close likeness to Rogers' (2003). To address problems and answer farmers' questions in the correct manner, researchers have to understand "local constraints, risks, and cultural preferences" (MoFA, 2011, p. 15).

Farmers are involved in all stages of the research process of this approach by taking a more active role in making decisions, defining goals, planning, implementing, and evaluating activities (MoFA, 2011). The largest criticism of the participatory approach is the reality of conducting it (MoFA, 2011). This approach depends on a political and administrative environment conducive to the program. Having the need for this attachment causes a lot of pressure on the program and can create imposed solutions which causes risk of rejection and "subsequently degenerating into a mechanistic application of the instruments" (MoFA, 2011, p. 15).

The Farmer Field School (FFS) approach is where farmers learn about technologies and application by participating in experiential learning activities (Ajayi & Akinnagbe, 2010; MoFA, 2011). Ghana uses FFS to cover multiple activities such as food security, animal husbandry, and soil and water conservation (MoFA, 2011). According to Ghana's Ministry of Food and Agriculture (2011), FFS "aims to increase the technical competence of farmers concerning a single crop (e.g. rice, cotton, beans) or

livestock, and to strengthen the social competence and confidence of farmers" (p. 16). FFS meets this goal by using activities such as hands-on opportunities, small group discussion, observation, reflection, and decision-making, as well as facilitating farmers' learning by conducting research on farm site demonstrations (MoFA, 2011). The greatest weakness of FFS is the cost of training farmers, but the strong points of this approach are its ability to build community leaders and communication and management skills among farmers (MoFA, 2011).

The Commodity approach is facilitated by governmental organizations or private sector firms (MoFA, 2011). The companies or agencies partner with farmers and specify what crops and quantity of crops the farmers should grow or what animals and animal products they should produce. Farmers grow and sell those products to the company/agency. The company/agency, in turn, provides the farmers with inputs, credit, extension, quality management, and marketing services (MoFA, 2011).

> Its advantages include high returns on crops, increasing the income of farmers as well as their technical and managerial skills while reducing farmers' risk and uncertainties. It may also provide small and medium farmers with access to profitable competitive markets to agricultural inputs, technology and advice from which they would be excluded otherwise. One of its disadvantages is that extension content is limited to technical and administrative or commercial aspect of the particular commodity or crop. Farmers become dependent on commodity organizations for advice, inputs, and sale of crops (MoFA, 2011, p. 20).

There are many factors that must be taken into account when choosing an extension service approach. Knowing the community, farmers' needs, cultural and social

norms, and resources available can help determine the extent to which technologies may be adopted in the area, as well as how yields, family income, and empowerment may be affected (MoFA, 2011). The problem with most of these approaches is that farmers are not receiving relevant or useful information, which indicates an assessment of farmers' needs has to be conducted for the information to be made relevant (Asenso-Okyere, 2009).

The four approaches discussed are also used in other sub-Saharan countries in Africa, but are not the only ones (MoFA, 2011). Table 1 shows other models currently being used in sub-Saharan African countries. Many of the models listed are pluralistic approaches which is what Ghanaian extension is reforming too (MoFA, 2011). "Extension today, must be pluralistic and inclusive (involve various players using knowledge, skills, and various tools) to be able to react to the needs of agricultural industry" (MoFA, 2011, p. 41).

Table 1 Models of extension in various countries of sub-Saharan Africa

Country	Current Model(s)
Angola	Rural Development and Extension Program; FFS
Benin	Participatory management approach; decentralized model; FFS
Burkina Faso	FFS
Cameroon	National Agricultural Extension and Research Program Support Project; FFS
Ethiopia	Model based on SG-2000 approach: Participatory Demonstration and Training System; FFS
Ghana	Unified Extension System (modified T&V); pluralistic with NGOs and private companies part of the national extension system; decentralized FFS
Kenya	Pluralistic system including public, private, NGOs; FFS; stakeholder approach (NALEP): sector-wide, focal area, demand-driven, group-based approach
Malawi	Pluralistic, demand-driven, decentralized; "one village one product"; FFS
Mali	Modified T&V; both private and parastatal services for cotton; FFS; SG-2000
Mozambique	Government-led pluralistic extension; FFS
Nigeria	FFS; participatory; SG-2000
Rwanda	Participative, pluralistic, specialized, bottom-up approach; FFS
Senegal	FFS; government-led, demand-driven, and pluralistic system; FFS
Tanzania	FFS; group-based approach; SG-2000; modified FSRE from Sokoine, University of Agriculture's Centre for Sustainable Rural Development; private extension; decentralized Participatory District Extension; pluralism
Uganda	Pluralistic; National Agricultural Advisory Services (NAADS) is demand-driven, client-oriented, and farmer-led; SG-2000; FFS
Zambia	Participatory Extension Approach; FFS

Adapted from "Agricultural extension approaches being implemented in Ghana" by MoFA, 2011, *Directorate of Agricultural Extension Services*, p. 22.

Agricultural Programs in Africa

One example of a successful program is the Companion Village Project (CVP) in Tanzania. It was created by the Institute for Agriculture at the University of Iringa "to improve farmers' knowledge and adoption of improved production practices through demonstration, education, and engagement at a local level" (Malima, Blomquist, Olson,

& Schmitt, 2014, p. 19). The program modeled after the T&V and FFS extension approaches as well as the Sasakawa Global 2000 program (SG 2000) (Malima et al., 2014).

SG 2000 programs were located in 14 African countries, including Ghana from 1986-2003 (Sasakawa Africa Association (SAA), n.d.). These programs focused on introducing and promoting technologies that enhanced food crop productivity (SAA, n.d.). Fan et al. (2013) states, "…smallholders' limited access to productivity-enhancing technologies is grounded in an environment where national research systems do not sufficiently prioritize smallholder-friendly technologies and extension systems fail to help smallholders gain access to and adopt such technologies" (p. 6).

CVPs used the influential roles of churches and pastors in the communities to disseminate information to farmers (Malima et al., 2014). The churches and pastors were considered beneficial for the program for the following reasons: "(a) the integrity of pastors implied credibility of project, (b) regular traffic to and from the church increased the visibility of the demonstration plots, and (c) they increased trust in the data collection" (Malima et al., 2014, p. 22).

The CVPs had a researcher from the Institute of Agriculture teach six educational interventions in each village throughout the first year (Malima et al., 2014). Anyone could attend these meetings, even if they were not involved with CVP (Malima et al., 2014). The results of the program showed there were major increases in the adoption of the new agricultural practices due to the farmers receiving personal instruction and witnessing first-hand the impacts of the improved practices on crop yields in the demonstration plots (Malima et al., 2014).

Acker and Gasperini (2008) discussed the progress of an educational program called Education for Rural People (ERP) that was created by partnerships of various international agencies in 2002. The program was created to provide all ages with access to education and its purpose was to meet Millennium Development Goals that sought to eradicate poverty and hunger and promote education, gender equity, and environmental sustainability (Acker & Gasperini, 2008). The program's focus on education resulted from a vision that "people—not institutions or technology—are the driving force of development" (Acker & Gasperini, 2008, p. 1). ERP's context of education included general education, training, and extension.

More education is needed in rural areas so that progress towards reducing poverty and eradicating hunger are not inhibited (Acker & Gasperini, 2008). Africa presents the greatest challenge in providing education in rural areas (Acker & Gasperini, 2008). ERP used its partnerships to establish a sharing of knowledge and application of practices as well as management and technical support to countries willing to meet program goals (Acker & Gasperini, 2008). One study they discuss by Carnoy (1992) revealed that the level of education farmers acquire and their level of farm productivity and income are closely related (Acker & Gasperini, 2008). Although ERP has been successful, impact has yet to be measured and providing rural areas with access to education still presents a huge challenge (Acker & Gasperini, 2008).

Current Agricultural Practices in Ghana

Current agricultural practices in developing countries must be known in order to develop interventions that consist of the best selection of farming practices. Asenso-Okyere (2009) states "local knowledge is crucial for survival" (p. 1), but it is insufficient

for those in poverty to further develop themselves. The majority of rural farmers in Ghana practice subsistence farming (Buadi et al. 2013; Feed the Future (FTF), n.d.; Ministry of Food and Agriculture (MoFA), 2010, 2012), which is characterized by their low use of modern farm inputs, insufficient extension services, and farming practices that are resilient but cause low yields (Buadi et al., 2013; Government of Ghana, 2010).

Rural subsistence farmers account for 56% of the work force in Ghana (International Fertilizer Development Center (IFDC), n.d.); and almost 90% of farmers in Ghana have less than two hectares of land (Buadi et al. 2013; MoFA, 2010, 2012). The other 10% are large farms and plantations, particularly for rubber, oil palm and coconut as well as rice, maize and pineapples (MoFA, 2010, 2012).

The dominate system of farming is traditional and some of the main farming tools are the hoe and cutlass, which is also known as a machete (Buadi et al. 2013; MoFA, 2010, 2012). Grivetti and Ogle (2000) indicate there is a need for more research on understanding these traditional farming practices. Lambert et al. (2005) indicates the World Bank supports this by stating, "Helping poor people use their traditional knowledge—along with modern agricultural methods and marketing techniques—to raise their incomes is in line with the World Bank's mission of sustainable poverty reduction" (p. 13).

Since mechanized farming is almost non-existent, draft animals are still used for farming land (i.e. plowing), particularly in northern Ghana (MoFA, 2010, 2012). Majority of small farms use a mixed cropping systems, a small percentage of farms use an intercropping system, and monocropping is mostly conducted by large commercial farms (Ghana Statistical Service, 2010).

Ghana is currently facing several environmental issues, such as drought, lack of drinkable water, deforestation, overgrazing, soil erosion, and water pollution (IFDC, n.d.; World Factbook, n.d.). Of the total land area, approximately 227,533 km^2 (87,851mi^2), or 20.12% is utilized for cultivating crops, while another 9% supports permanent crops such as fruit- and nut-bearing trees (IFDC, n.d.; World Factbook, n.d.). In comparison, Ghana is slightly smaller than the state of Oregon in the United States. Currently, only 309 km^2 (19.31mi^2) of land in Ghana is irrigated (World Factbook, n.d.).

Ghana's primary exports are gold and cocoa (IFDC, n.d.). They are also the largest contributors to the national Gross Domestic Product. Although the entire country is considered a tropical climate, the southeast and coastal regions are warm and dry, the southwest is hot and humid, and northern Ghana is hot and dry (World Factbook, n.d.). Agricultural products in Ghana include cocoa, rice, cassava, peanuts, maize, shea nuts, bananas and timber (IFDC, n.d.; World Factbook, n.d.). Some extremely important determinants of agricultural production in Ghana are soil and rainfall (Babu, 2000; MoFA, 2012). The amount and distribution of rainfall as well as the soil conditions determine how varied agricultural production will be each year (MoFA, 2012).

The Central Region of Ghana, where the workshops were located for this study, is only 4.%, or 9,830km^2 (3,795.4mi^2) of the total area in Ghana (MoFA, 2012; World Factbook, n.d.). According to GSS (2013), there were a total of 526,764 households in the Central Region in 2010. Of those households, 51.4% were listed as agricultural households (GSS, 2013). There were a reported number of 271,408 households in the rural areas of the Central Region and 73.2% of those households were agricultural households (GSS, 2013).

Current State of Health in Ghana

Currently, Ghana has an estimated population of 25,758,108 people (World Factbook, n.d.). Of this population, 38.6% are less than or equal to 14 years of age with the median age being 20.8 years (World Factbook, n.d.). Figure 2 illustrates Ghana's population by the distribution of genders and age estimated for 2014.

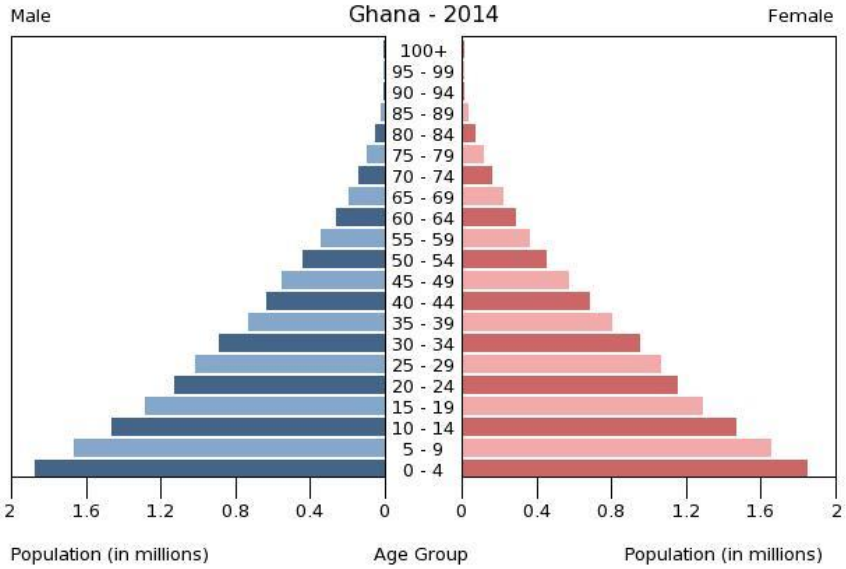

Figure 2 Population pyramid

Adapted from World Factbook (n.d.), by the *Central Intelligence Agency*.

Ghana's current position in transitioning from high to low fertility levels is causing less children to be born per household (GSS, 2013). In the past 30 years, Ghana has seen fertility levels drop from seven children to four children per woman (GSS, 2013). Children in comprise 40% of the agricultural households in Ghana (GSS, 2013). The national average in household size is 5.3 persons and the average household size in the Central Region is 4.4 persons (GSS, 2013).

In 2012, 5.2% of Ghana's GDP was spent on health expenditures (World Bank, n.d.). The global average of health expenditures was 10.1% based off of 2012 data (World Health Organization, 2014). There were 0.09 physicians for every 1,000 people in 2009 and 0.9 hospital beds per 1,000 people in 2011 (World Factbook, n.d.). Despite these estimates, the prevalence of underweight children fell from 25% in 1998 to 14% in 2008 (FTF, n.d.).

According to the Feed the Future Initiative, Ghana's overall poverty rates have fallen from 52% to 28% over the past 10 years. The primary reason for this reduction has been Ghana's agricultural growth (FTF, n.d.). The southern region of Ghana saw a larger decrease in poverty, while the northern region increased in poverty rates which are now double that of the south (FTF, n.d.).

The Central Region of Ghana was estimated to have approximately 2,201,863 people in 2010, based on the 2010 Population and Housing Census (MoFA, 2012). The total rural population in the area was estimated to be 52.9% in 2010 (MoFA, 2012). The region's population density in 2010 was 224.1 people per km^2 (MoFA, 2012).

In 2008/09, there were only 3,880 health care professionals of various occupations in the entire Central Region (Ministry of Health (MOH), 2010). The Central Region did not have any dental surgeons or technicians in 2008 (MOH, 2010). There was only one dietician, two physiotherapists, and five health educators (MOH, 2010). There were also 76 medical officers, 47 pharmacists, and 12 health services administrators in 2008 (MOH, 2010). In 2009, the area had a total of 84 doctors with the doctor to population ratio being one doctor for every 22,877 people (MOH, 2010). There

were also 2,369 nurses with there being one nurse for every 881 people in 2009 (MOH, 2010).

As of 2014, 800 million people are still suffering from malnutrition (Sale & Olujobi, 2014) and in most African countries, traditional medicines are heavily relied upon because of the lack of access to health care services (Lambert et al., 2005). Most of these traditional medicines are derived from indigenous plants (Grivetti & Ogle, 2000; Lambert et al., 2005), which many western agriculturalists seem to neglect and underutilize (Kone & Akeredolu, 2004; Wibberley, 2007).

Much research has studied the utilization of indigenous trees, shrubs, and herbs for medicinal purposes and some even for dual-purposes, such as farming and health (F/FRED, 1994; Lambert et al., 2005; Sale & Olujobi, 2014; van den Beldt, 1995). These plants, identified as multipurpose plants in this study, are defined by Winrock International Institute for Agricultural Development as, "Tree species that are grown to provide more than one significant crop or function or form. These may include soil conservation, shade, fuelwood, timber, fiber, fodder, food or medicine" (F/FRED, 1994).

Sale & Olujobi (2014) found "Multipurpose trees contribute directly to food security by providing fruits, nuts, and other edible foods. These contribute to people's diets in almost all rural areas by adding diversity and flavouring as well as providing essential minerals to the human diet" (p. 611). Sale and Olujobi's (2014) study in Nigeria revealed that a few of the major constraints to farmers planting multipurpose trees on their land were lack of technical know-how, land, inputs, time, labor, and decision makers. Since many farms in Africa are run by tenants who are seasonally hired by landowners to work the land, they do not have the authority or right to incorporate

new practices on the land, even if they see the benefit of planting multipurpose trees on the farms (Sale & Olujobi, 2014).

Fan et al. (2013) found "Agriculture, nutrition, and health are closely linked, and smallholders play an important role in this relationship (as both consumers and producers)" (p. 7). Studies have also reported many indigenous plants are heavily relied upon to provide energy and micronutrients in traditional agricultural societies (Grivetti & Ogle, 2000; Thurbey & Fahey, 2009). Many African societies suffer from diseases caused by micronutrient deficiencies which can be prevented by providing nutrition interventions that provide information on the existence and nutritional properties of indigenous plants (Babu, 2000). "The usefulness of indigenous knowledge on local foods can not be ignored in designing rural nutrition interventions" (Babu, 2000, p. 178). Babu (2000) also suggested that a pilot test should be conducted to introduce native plant species in a small area and evaluate its success.

Summary

Having a population obtain knowledge of an innovation is a very important first step for learners to begin the process to ultimately adopt or reject an innovation, such as the utilization of native plants and resources for farming and health. The examples provided in this chapter should assist outreach and extension program personnel in the development of programs that will benefit rural areas of developing countries in utilizing native plants. For outreach and extension programs to be successful in a developing country, culture, risks, local constraints, technology attributes, credibility, current agricultural practices, and current state of health must be taken into account. Programs

also need to understand the important role of indigenous knowledge on local resources in order to make the products of their program advantageous to learners.

CHAPTER III

METHODOLOGY

Introduction

The research for this study took place in the towns of Gomoa Enyeme and Agona Nyakrom in Ghana, West Africa. This study was part of an initiative to provide Ghanaian farmers with relevant information on practices in agriculture and human health. The purpose of this study was to determine the effectiveness of an educational workshop to increase participants' knowledge of farming and health practices and to encourage the adoption of agricultural practices in Ghana.

Research Objectives

The purpose of this study was to determine the effectiveness of an agricultural education program that sought to increase knowledge of farming and health practices among rural farmers in Ghana. The specific research objectives of this study were:

Objective 1: Describe the demographic characteristics of Ghanaian farmers who participated in an agricultural education workshop.

Objective 2: Assess rural farmers' knowledge of farming and health practices before and after an agricultural education workshop.

Objective 3: Determine farmers' current behavior and intent to implement farming and health practices.

Objective 4: Determine the level of implementation of farming practices by farmers at the time of the agricultural education workshop and three months after the agricultural education workshop.

Research Design

This research design is a quantitative, descriptive, cross-sectional survey case study. Singleton, Jr. and Straits (1999) define cross-sectional survey design as a collection of "data on a sample or "cross-section" of respondents chosen to represent a particular target population… gathered at essentially one point in time" (p.247). The purpose of the design was to describe the effects of an educational intervention on Ghanaian farmers' knowledge of farming and health as well as the influence it had on their behavior in implementing the practices taught.

"One point in time" is defined as "data collected in as short a time as is feasible" (Singleton Jr. & Straits, 1999, p.247). This method was selected because agricultural education workshops on farming and health practices were delivered to farmers wishing to participate. Data were collected using a census limited to the accessible population. The instruments used for data collection were developed by the researchers.

Participants completed pre- and post-tests to identify changes in knowledge and behavior. An observation assessment of local farming practices utilizing native plant species was conducted and collected by the researchers while on-site in Ghana. A follow-up observation assessment was to be conducted and collected by the Global Care Link Ghanaian coordinator three months following the agricultural education workshop.

Population and Sample

Since 1993, Global Care Link has partnered with the Methodist Church Ghana in choosing ten villages each year that are in need of community development, medical clinics, and Christian services (S. D. Seal, personal communication, August 13, 2014). The towns where the workshops were held were selected based on their centrality to the ten surrounding villages chosen by Methodist Church Ghana and its accessibility to farmers and researchers.

Local farmers were contacted by the pastoral leaders of the two locations to communicate the time and place of the workshops. The target population of this study were rural farmers in Ghana, while the accessible population for this study consisted of rural farmers who chose to attend and participate in the agricultural education workshops. A census of workshop participants was conducted. The following assumptions were made concerning the workshop participants:

1. Participants are willing to engage in the educational workshops.
2. Participants practice subsistence farming.
3. Participants have little to no formal agricultural education.
4. Workshop attendance indicated their willingness to learn more about agricultural practices.

Caution should be used in generalizing this study to a larger population due to the sampling method used.

Instrumentation

Three instruments were created by the researchers for this study. The instruments included a pre-test (APPENDIX B), post-test (APPENDIX C), and observational

assessment (APPENDIX D). The pre- and post-test were identical, except for one question, and were comprised of four sections. The pre-test consisted of 87 questions and the post-test consisted of 88 questions which were written to reflect the content taught in the workshops. The sections included demographic questions, true knowledge questions, current behavior, and planned behavior questions. The observation assessments consisted of a five-point Likert-type scale (1=Never, 5=Always) composed of ten selected farming practices. This study was a pilot test in using the instruments for data collection.

Section 1

Section one contained questions pertaining to the participants' demographics, including gender, age range, number of people living in the household, number of children, crops grown, primary reason for growing crops, and number of years farming. The post-test included one other question that asked participants if they had attended an agricultural education workshop prior to completing the post-tests.

Section 2

Section two consisted of true knowledge questions related to the workshop content, and in particular, the CAMP-AGGAMMAL acronym (Table 2). The acronym describes the uses of certain native plants and materials readily available in sub-Saharan Africa for use in farming and health practices. The acronym was developed by Dr. Mike Oye, director of Miratos Ventures, in order to help farmers "develop integral resource management strategies on their farm and disseminate them to others" (Wibberley 2007, p. 191).

Out of 56 true knowledge questions, 26 were true/false, 13 were fill-in-the-blank, 13 were multiple choice, and 4 were open-ended. Other true knowledge questions on the pre- and post-tests were drawn from a pre-existing document provided by Global Care Link.

Table 2 CAMP-AGGAMMAL

Resource	**Uses**
Crotolaria	a legume cover crop to alternate with cereals and other crops; erect seasonal nitrogen fixer; herb
Ash	add to compost, poultry feeds; supplies potassium and trace minerals
Moringa oleifera	tree; good live fence; supplier of NPK; food; medicinal plant; fodder; alley cropping; seeds purify water and help with constipation
Pueraria	cover crop which also gives good seed yield when grown on a supporting trellis; creeping nitrogen fixer; fodder
Acacia albida	erect nitrogen fixer; fodder; tree; alley cropping
Granite dust	nutrient source for compost and poultry rations; supplies phosphorus
Gliricidia	erect nitrogen fixer; live fence, termite resistant; durable; fuel-wood tree; fodder; rodenticide; alley cropping
Azadirachta	neem tree; timber; fodder; de-wormer; insect-repellent pesticide; medicinal plant for malaria and an antiseptic for healthy gums
Mulch	crop residues to protect soil from moisture loss & to suppress weed establishment
Manure	to replenish soil nutrients and to add to compost; supplies NPK
Ageratum	goatweed; natural pesticide and parasite-deterrent source; medicinal plant
Leucaena	valuable, fast-growing legume fodder, shade and fuel-wood tree

Adapted from "Vibrant agricultural management messages from Africa," by E.J. Wibberley, 2007, *International Farm Management Association*, *3*, p. 192.

Section 3

The third section consisted of 14 items measured on a five-point Likert scale (1 = Never, 5 = Always). This section asked participants to report their frequency of use of 10 selected native plants. There were two parts in this section. Part one pertained to participants' current behavior in using the native plants and materials in farming practices

(Figure 3). Part two focused on participants' current behavior in using the native plants for health practices (Figure 4).

How often do you use the following plants, minerals, and techniques in your farming practices?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

Figure 3 Part one: current behavior in utilizing selected farming practices

How often do you use the following plants for your health?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Ageratum	O	O	O	O	O

Figure 4 Part two: current behavior in utilizing selected native plants for health practices

Section 4

The fourth section consisted of 10 items measured on a five-point Likert scale (1 = Never, 5 = Always). This section asked participants to report their intent to implement 10 selected native plants by frequency (Figure 5).

How likely are you to use the following plants, minerals, and techniques in your future agricultural practices?					
	Very Unlikely	Unlikely	Not Sure	Likely	Very Likely
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

Figure 5 Planned behavior in the utilization of selected farming practices

Observation Assessments

The observation assessments sought to describe farmers' current observed use of selected native plants, materials, and cropping techniques in their farming practices collectively (Figure 6). The assessments consisted of 10 items measured on a five point Likert scale (1 = Never, 5 = Always). This sections asked pastoral leaders to report how frequently farmers were currently using the selected native plants in farming practices.

How often are farmers using the following plants, minerals, and techniques in their farming practices?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

Figure 6 Observations on overall utilization of selected farming practices

Validity and Reliability

IRB approval for the study and instruments was obtained prior to the collection and analysis of data. Content validity of each instrument was established by a panel of experts with knowledge of instrument development, agricultural extension education, agricultural and health practices in rural Ghana, as well as the cultural context of rural Ghana. The instruments were developed by the researchers and, to the researchers' knowledge, were the first instruments to use the CAMP-AGGAMMAL acronym as its basis. Pre-test reliability for true knowledge, current behavior, and planned behavior were r = .885, r = .865, and r = .943. Post-test reliability for true knowledge, current behavior, and planned behavior were r = .944, r = .898, and r = .941.

Indigenous Experts

Dr. Mike Oye

Dr. Mike Oye is an expert in naturopathy with doctorates in Rural Sociology and Agricultural Extension. He is a native of Ghana and now presides in the country of Nigeria. In Nigeria, Dr. Oye owns a small farm where he trains students and pastors in naturopathy and organic farming techniques. Dr. Oye has been working with Global Care Link for many years. For the past several years, he has been planning to conduct agricultural workshops that would be integrated with Global Care Link's annual ministry to Ghana and Nigeria. These workshops would teach farmers about native plants, materials, and resources and how to use them for farming and health purposes. The seeds given to farmers after the workshops were provided by Dr. Oye from his own farm.

This research studied the first round of workshops conducted in Ghana. The content used in the workshops was created and taught by Dr. Oye. In teaching the workshops, he was able to address cultural issues and barriers that may have not been perceived by the researchers. He also validated the instruments by revising and approving them prior to data collection.

Pastoral Leaders

An established network of pastors was used to conduct the workshops and collect data. Methodist Church Ghana has pastors located in and/or near the towns of Gomoa Enyeme and Agona Nyakrom where the workshops were located. The pastors were responsible for setting the time and place of the workshops.

There was one pastor at each location that had a background and expertise in agriculture. These pastors explained the observation assessment forms to the other

leaders in the area and all leaders completed the assessments together. There were four leaders in Gomoa Enyeme and seven leaders in Agona Nyakrom. The two pastors with agricultural backgrounds also had expertise and knowledge of the practices being taught in the workshops. With these two leaders present, the other pastors could better understand the observation assessments.

Data Collection

On March 3rd of 2014, the researchers, along with Dr. Oye, collected plants and materials to use as visuals for the workshops. Workshop one was conducted in Gomoa Enyeme on March 4th and 5th. On the first day, Dr. Oye, with the help of a native translator, explained to the participants the proceedings of the workshop and distributed pre-tests and pencils to all participants. To overcome language barriers, the instrument was read aloud and translated into the native language. A total of 94 pre-tests were collected by the researchers. After the pre-tests were collected, Dr. Oye covered a few topics that would be taught more in-depth the following day. The first day of workshop one took approximately two hours. A transcription of the workshop content is located in APPENDIX E.

The second day of workshop one took place on the morning of March 5th. All participants were provided with paper and pencils to take notes. The training session took approximately one hour and 45 minutes. After the training session, post-tests were distributed, completed, and collected using the same procedure as was used for pre-test collection. A total of 61 post-tests were collected.

Once data collection was complete, seed packets to the participants containing *Moringa oleifera* seed, a tree with many medicinal properties, and *Luecaena* seed, a tree

that fixes nitrogen in the soil. Planting instructions were included on the seed packets (APPENDIX F). The handing out of seeds was meant to encourage farmers to plant and use them in their farming practices.

Workshop two took place on March 7th and 8th in Agona Nyakrom. Identical procedures were used. A total of 92 pre-tests and 33 post-tests were collected by the researchers. Both days of workshop two were approximately two hours each day.

The third instrument was an observation assessment created to assess behavior change between the time of the workshops and three months after the workshops. The pastoral leaders were asked to complete the observation assessments either before or during the workshops. Four observational assessments were collected for Gomoa Enyeme and seven observational assessments for Agona Nyakrom.

The second round of observation assessments were sent electronically to Global Care Link's Ghanaian coordinator in June of 2014. The coordinator contacted the same leaders who had completed the first round of observation assessments. The leaders were asked to complete the second round of observation assessments, which would then be collected by the coordinator and sent to the researchers electronically by August of 2014. However, due to time and communication constraints, the coordinator was not able to return the assessments.

Data Analysis

Microsoft Excel® spreadsheets were used for entering data and then transferred to SPSS (version 21.0) for further analysis. All questions in the demographics, current behavior, and planned behavior sections where participants chose not to respond were

coded as missing data. All questions in the true knowledge section where participants chose not to answer were coded as incorrect.

Objective one collected demographics information from the participants. Frequencies were calculated for gender, age range, number of people living in household, number of children, and number of years farming. Question eight on the post-test was removed from the data analysis. The question asked was, "Did you attend an agricultural workshop?" The question was meant to determine if the post-test respondents had previously attended the agricultural education workshop given by Dr. Oye prior to the post-test.

Objective two of the pre- and post-tests assessed true knowledge. Means were calculated for the overall pre- and post-tests total number of correct answers. Independent t-tests compared means between the pre-tests of both workshops and between the post-tests of both workshops. Means were also calculated for the pre- and post-test of workshop one and workshop two. Question 16 on the pre-test, which is also question 17 on the post-test, was removed from the data analysis due to discrepancies between agricultural education experts on the definition of the word "pesticide". The questions asked was, "Ageratum is a pesticide, which means it kills what?"

Objective three was to describe the current and planned behavior of participants. Current and planned behavior was self-reported by participants. Means were calculated for the pre- and post-tests of current behavior and of planned behavior within each workshop. Paired samples t-tests reported the mean difference on the post-test only between current and planned behavior.

For objective four, the observation assessments reported behaviors observed among Ghanaian farmers in Gomoa Enyeme and Agona Nyakrom in utilizing selected farming practices. Means were calculated for this variable.

Limitations

Responses were acquired only from individuals who attended the workshop and were willingly to complete both the pre- and post-tests. Language barriers were a limitation in administering instruments and collecting complete data. Although the national language of Ghana is English, many farmers in the rural areas spoke and wrote in the local language. Missing data was a limitation in collecting complete data and the data analysis. A high rate of attrition was also encountered at the workshops which is a limitation in the interpretation of results.

Relying on others in another country outside of the research team to collect and return data results for the three months post-workshop observation assessments was a limitation. The time allotted for each workshop did not allow any further opportunities for non-respondents to complete the questionnaires. There was also no further opportunity for researchers to contact non-respondents. For these reasons, non-response error was not considered for this study.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter reports the results of the study and an interpretation of the data. The purpose of this study was to determine the effectiveness of an educational intervention to influence agricultural and health practices of Ghanaian rural farmers. The results of this research provide an analysis of Ghanaian farmers' knowledge of utilizing native plants for farming and health as well as their current and planned behavior with regards to farming practices.

Objective One Results

Workshop One Participants

Gender

Objective one was to describe the demographic characteristics of Ghanaian farmers who participated in an agricultural education workshop. Demographics were collected in section one of the pre- and post-test instruments. The first day of workshop one showed 50.0% of the respondents were female (n = 47), 46.8% were male (n = 44), and 3.2% chose not to report their gender (n = 3). The majority of respondents on the second day of workshop one were male (63.9%, n = 39) and 27.9% were female (n = 17). Five did not report their gender (8.2%) (Table 3).

Table 3 Gender of workshop one respondents

Gender	Pre-test Frequency	%	Post-test Frequency	%
Male	44	46.8	39	63.9
Female	47	50.0	17	27.9
Not Reported	3	3.2	5	8.2
Total	94	100.0	61	100.0

Age

Respondents were asked to report their age for objective one. The first day of workshop one resulted in having respondents mostly between 50 – 59 years of age (28.7%, $n = 27$), with 60+ years of age as a close second (25.5%, $n = 24$). The second day of workshop one also resulted in majority of respondents being between ages 50 – 59 years (24.6%, $n = 15$). There was also an equal number of respondents between 30 – 39 years of age (18.0%, $n = 11$) and 60+ years of age (18.0%, $n = 11$). The second day of workshop one was the only day with respondents under 20 years of age (3.3%, $n = 2$) (Table 4).

Table 4 Age of workshop one respondents

	Pre-test		Post-test	
Age Range	Frequency	%	Frequency	%
< 20 years	0	0.0	2	3.3
20 - 29 years	6	6.4	7	11.5
30 - 39 years	14	14.9	11	18.0
40 - 49 years	22	23.4	10	16.4
50 - 59 years	27	28.7	15	24.6
60 - 69 years	24	25.5	11	18.0
Not Reported	1	1.1	5	8.2
Total	94	100.0	61	100.0

Number in Household

Figure 7 indicates the number of people currently living in the respondents' households for workshop one. There was an overwhelming majority of respondents from all four days of the workshops indicating they had five or more people currently living in their household. The first day of workshop one resulted in 70 respondents having five or more people in their household (74.5%). There were 46 respondents (75.4%) who indicated they had five or more people in their household on the second day of workshop one.

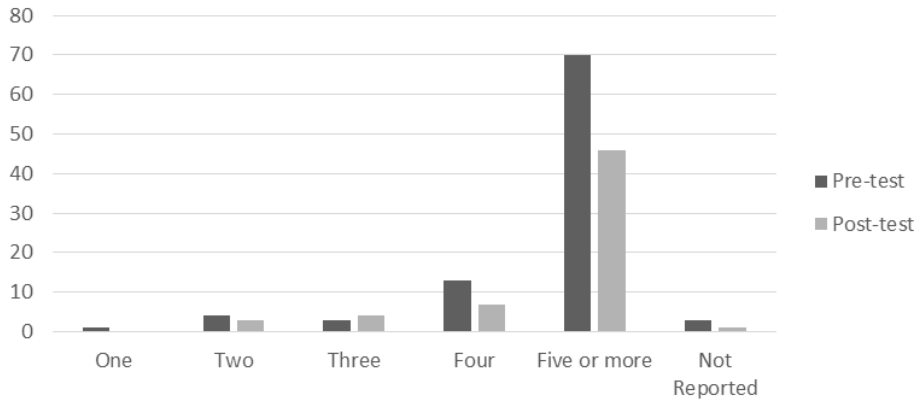

Figure 7 Number in household for workshop one

Number of Children

Figure 8 illustrates how many children repondents have currently. A large percentage of respondents from each day of the workshops indicated they had five or more children. There were 54 respondents (57.4%) on the first day and 29 respondents (47.5%) on the second day of workshop one who indicated they had five or more children.

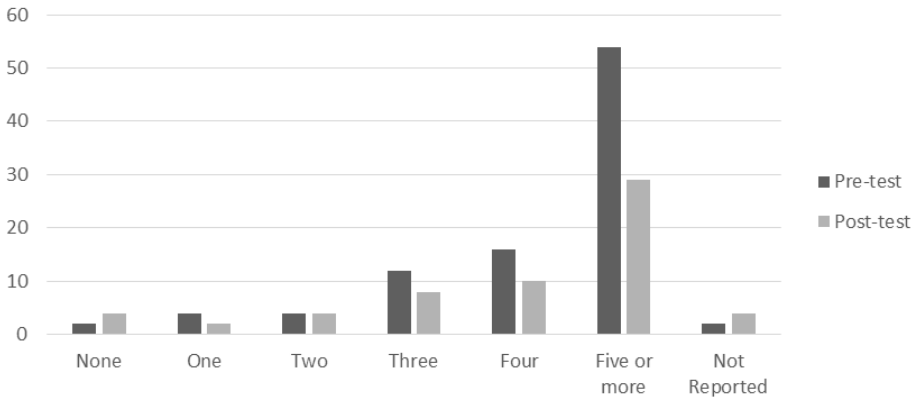

Figure 8 Number of children for workshop one

Number of Years Farming

Figure 9 illustrates how many years the respondents have been farming. Majority of respondents indicated they had five or more years' experience in farming. Workshop one showed on the first day 83% of respondents (n = 78) reported they had spent five or more years farming and 72.1% of respondents (n = 44) on the second day reported the same thing.

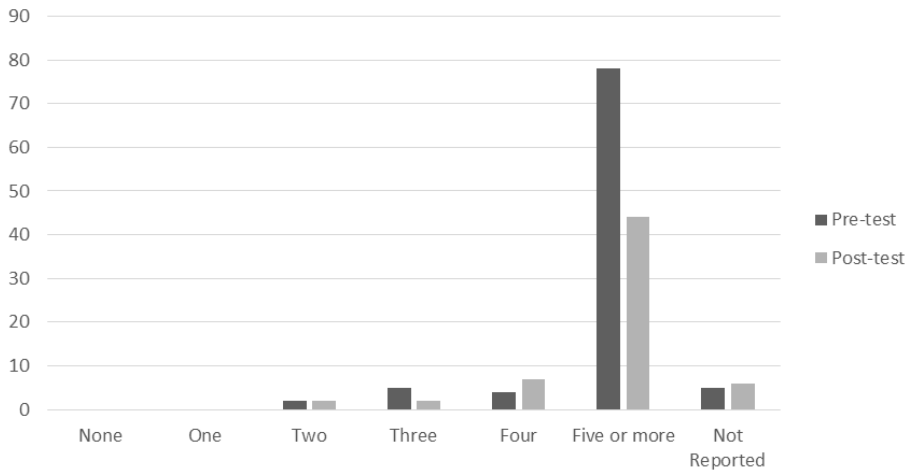

Figure 9 Number of years farming for workshop one

Crops

There were a wide variety of crops being grown in the area. Cassava, yam, maize, and cocoa yam were the primary starches reported being grown currently. The main fruits and vegetables currently being grown by respondents were pepper, sweet potato, okra, tomatoes, and garden eggs (type of eggplant), oranges, and cocoa. The majority of respondents from both workshops indicated they primarly grew crops for household consumption and to sell in the local markets.

Workshop Two Participants

Gender

Respondents on the first day of workshop two were mostly male (57.6%, *n* = 53), 37.0% were female (*n* = 34), and 3.0% did not report their gender (*n* = 1). On the second day of workshop two there were 19 males (57.6%), 13 females (39.4%), and one respondent chose not to report their gender (3.0%). Table 5 illustrates the gender of the participants represented at workshop two.

Table 5 Gender of workshop two respondents

	Pre-test		Post-test	
Gender	Frequency	%	Frequency	%
Male	53	57.6	19	57.6
Female	34	37.0	13	39.4
Not Reported	5	5.4	1	3.0
Total	92	100.0	33	100.0

Age

Respondents on the first day of workshop two reported being mostly between the ages of 40 – 49 years (30.4%, *n* = 28). The second day of workshop two resulted in an equal number of respondents between the ages of 50 – 59 years (27.3%, *n* = 9) and 60+ years (27.3%, *n* = 9). Table 6 shows all results for the age of respondents.

Table 6 Age of workshop two respondents

	Pre-test		Post-test	
Age	Frequency	%	Frequency	%
< 20 years	0	0.0	0	0.0
20 - 29 years	2	2.2	3	9.1
30 - 39 years	7	7.6	5	15.2
40 - 49 years	28	30.4	6	18.2
50 - 59 years	22	23.9	9	27.3
60 - 69 years	24	26.1	9	27.3
Not Reported	9	9.8	1	3.0
Total	92	100.0	33	100.0

Number in Household

The first day of workshop two indicated 78.3% of respondents (n = 72) had five or more people living their household. The second day of workshop two had 78.8% of respondents (n = 26) also indicate they had five or more people living in their household (Figure 10).

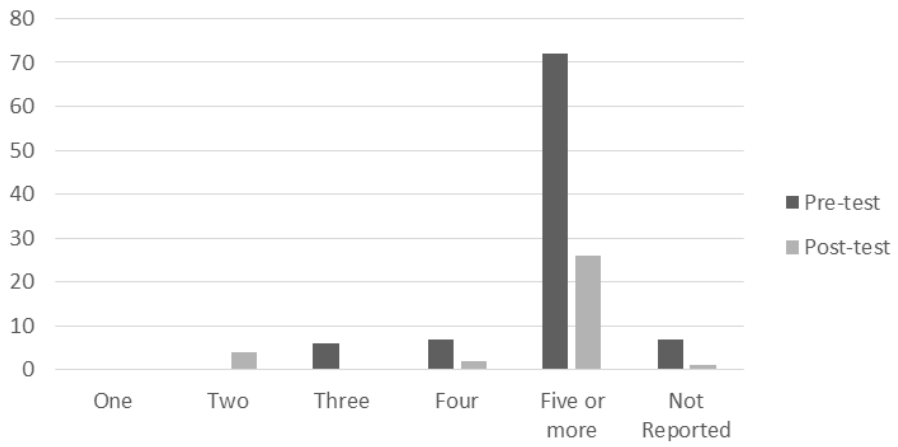

Figure 10 Number in household for workshop two

Number of Children

The first day of workshop two had 60 respondents (65.2%) indicate they had five or more children and the second day of workshop two had 26 respondents (78.8%) also indicate they had five or more children (Figure 11).

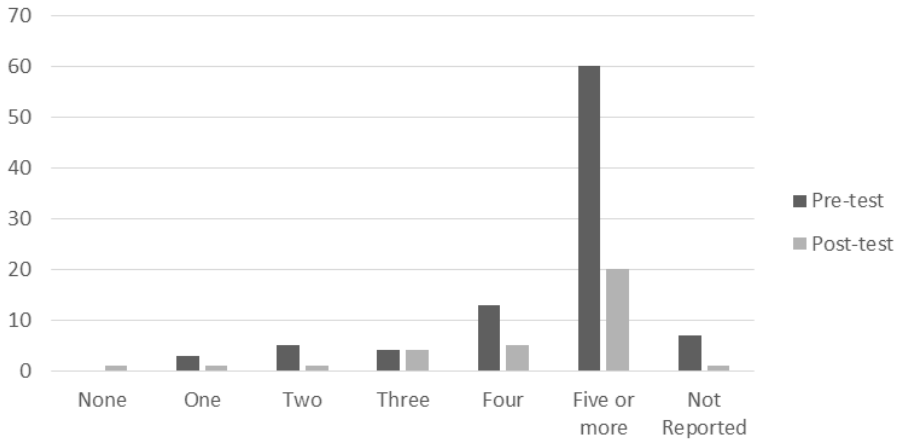

Figure 11 Number of children for workshop two

Number of Years Farming

Workshop two resulted in 92.4% of respondents (n = 85) from the first day and 72.7% of respondents (n = 24) from the second day indicate they had been farming for five or more years (Figure 12).

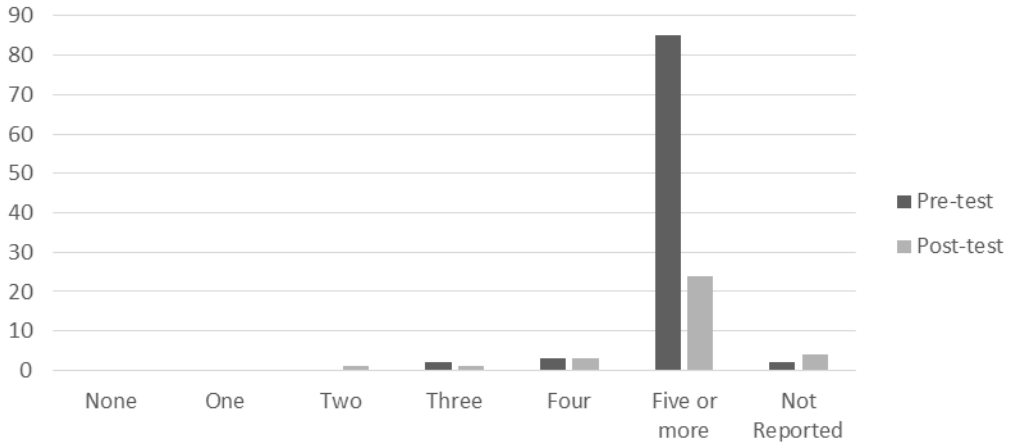

Figure 12 Number of years farming for workshop two

Crops

There were a wide variety of crops being grown in the area. Cassava, yam, maize, and cocoa yam were the primary starches reported being grown currently. The main fruits and vegetables currently being grown by respondents were pepper, sweet potato, okra, tomatoes, and garden eggs (type of eggplant), oranges and cocoa. Majority of respondents indicated they primarly grew crops for household consumption and to sell in the local markets.

Objective Two Results

The second objective of this study was to assess Ghanaian rural farmers' knowledge of farming and health practices before and after an agricultural education workshop. The mean percent correct on the pre-tests (n = 186) was 26.9% (M = 14.82, SD = 7.05) and the mean percent correct on the post-tests (n = 94) was 50.0% (M = 27.53, SD = 12.74). The post-tests yielded a higher number of correct answers than the pre-tests (Table 7).

Table 7 Mean of the pre- and post-tests for both workshops combined

Total Correct Answers: Workshops Combined			
	n	*M*	*SD*
Pre-test	186	14.82	7.05
Post-test	94	27.53	12.74

The mean number of correct scores on the pre-tests for workshop one (n = 94) was M = 12.31 (SD = 7.42) and the mean number of correct scores on the pre-tests for workshop two was 17.39 (SD = 5.62). An independent t-test indicated there was a statistically significant difference between the pre-tests of both workshops, $t(173.16) = -5.28$, $p < .05$, $r = .37$, (Table 8). The effect size (r = .37) indicates there was a medium effect.

Table 8 Mean comparison of pre-tests

Total Correct Answers: Pre-tests					
	n	*M*	*SD*	*t*-test	df
Workshop One	94	12.31	7.42	-5.28*	173.16
Workshop Two	92	17.39	5.62		

*$p < .05$

The mean number of correct scores on the post-tests for workshop one ($n = 61$) was 26.66 ($SD = 13.30$), while the mean number of correct scores on the post-tests for workshop two ($n = 33$) was 29.15 ($SD = 11.66$). An independent *t*-test showed there was not a statistically significant difference between the two post-test scores, $t(92) = -.91$, $p > .05$, $r = .09$, (Table 9).

Table 9 Mean comparison of post-tests

Total Correct Answers: Post-tests					
	n	*M*	*SD*	*t*-test	df
Workshop One	61	26.66	13.30	-9.06	92
Workshop Two	33	29.15	11.66		

Means and standard deviations were calculated for the pre-test and post-test of workshop one. The mean percent correct on the pre-tests ($n = 94$) was 22.4% ($M = 12.31$, $SD = 7.42$) and the mean percent correct on the post-tests ($n = 61$) was 48.5% ($M = 26.66$, $SD = 13.30$) (Table 10).

Table 10 Pre- and post-test means of workshop one

Workshop One			
	n	*M*	*SD*
Pre-test	94	12.31	7.42
Post-test	61	26.66	13.30

Means and standard deviations were calculated for the pre-test and post-test of workshop two. The mean percent correct on the pre-tests ($n = 92$) was 31.6% ($M = 17.39$, $SD = 5.62$) and the mean percent correct on the post-tests ($n = 33$) was 53.0% ($M = 29.15$, $SD = 11.66$) (Table 11).

Table 11 Pre- and post-test means of workshop two

Workshop Two			
	n	*M*	*SD*
Pre-test	92	17.39	5.62
Post-test	33	29.15	11.66

Objective Three Results

The third objective was to describe farmers' current and planned behavior concerning farming and health practices. Means were calculated to describe how often respondents were currently using and how likely they were to utilize the selected

practices taught in the workshops. Paired samples *t*-tests were used to describe the differences in means between current and planned behavior of the pre- and post-tests.

For current behavior, participants from workshop one reported *never*, *rarely*, *or sometimes* using the ten selected farming practices, with mean scores ranging from 1.17 to 3.22. Participants from workshop two reported *never* using eight of the ten selected practices and *rarely* using two, with mean scores ranging from 1.22 to 2.74. Table 12 shows respondents' current behaviors on the selected farming practices for both workshops.

Table 12 Current behavior of respondents in utilizing selected farming practices

		Workshop One			Workshop Two		
Farming Practice	Test	N	*M*	*SD*	N	*M*	*SD*
Pueraria	Pre	59	1.37	0.96	73	1.42	0.85
	Post	44	1.80	1.27	27	1.52	1.22
Moringa	Pre	58	2.29	1.28	68	2.22	1.24
	Post	42	2.52	1.66	27	2.74	1.29
Neem	Pre	59	2.34	1.45	62	2.21	1.07
	Post	38	2.58	1.45	27	2.70	1.17
Gliricidia	Pre	50	1.34	1.10	63	1.27	0.68
	Post	39	1.54	1.25	24	1.80	1.32
Ageratum	Pre	41	1.17	0.70	54	1.65	1.08
	Post	35	1.69	1.28	25	2.12	1.39

Table 12 (continued)

Wood Ash	Pre	45	3.22	1.73	61	1.90	1.18
	Post	41	2.61	1.51	24	2.58	1.28
Granite Dust	Pre	46	1.37	1.14	60	1.22	0.64
	Post	42	1.38	0.99	25	1.28	0.79
Mucuna	Pre	49	1.27	0.88	66	1.38	0.94
	Post	43	1.53	1.05	24	1.50	1.10
Leucaena	Pre	49	1.20	0.82	64	1.33	0.80
	Post	41	1.51	1.16	25	1.48	1.23
Alley Cropping	Pre	57	1.49	1.07	64	1.73	1.28
	Post	38	1.66	1.21	27	1.48	1.19

Note. 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

For workshop one, two medicinal plants were reported as *never* being used and two were reported as *rarely* or *sometimes* being used, with means ranging from 1.15 to 3.66. Participants of workshop two reported they *never* used one of the selected medicinal plants and *rarely* used three, with means ranging from 1.45 to 2.91. Table 13 shows respondents' current behavior in utilizing selected medicinal plants for human health practices.

Table 13 Current behavior of respondents in utilizing selected medicinal plants

		Workshop One			Workshop Two		
Plants	Test	N	*M*	*SD*	N	*M*	*SD*
Pueraria	Pre	56	1.38	1.05	71	1.51	1.11
	Post	41	1.85	1.30	29	1.45	1.09
Moringa	Pre	56	3.66	1.30	69	2.73	1.17
	Post	40	3.13	1.60	28	2.64	1.31
Neem	Pre	48	3.38	1.20	66	2.91	0.97
	Post	39	2.95	1.32	29	2.76	1.18
Ageratum	Pre	55	1.15	0.76	66	2.42	1.25
	Post	41	1.54	0.92	30	2.50	1.33

Note. 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

For planned behavior, workshop one respondents indicated that they planned to apply all ten farming practices *sometimes* or *often* in their farming practices, with mean scores ranging from 3.50 to 4.23. Workshop two respondents indicated they planned to apply all ten practices *sometimes* or *often* in their farming practices, with means ranging from 3.36 to 4.46. (Table 14).

Table 14 Planned behavior of respondents in utilizing selected farming practices

		Workshop One			Workshop Two		
Farming Practice	Test	N	*M*	*SD*	N	*M*	*SD*
Pueraria	Pre	65	4.83	0.57	70	3.49	1.75

Table 14 (continued)

	Post	37	3.70	1.61	30	4.13	1.14
Moringa	Pre	70	4.94	0.38	68	4.13	1.38
	Post	38	4.23	1.28	30	4.37	1.40
Neem	Pre	66	4.92	0.27	58	4.22	1.36
	Post	34	4.21	1.30	28	4.43	1.20
Gliricidia	Pre	69	4.78	0.80	51	3.43	1.20
	Post	37	3.57	1.46	23	4.39	1.23
Ageratum	Pre	65	4.82	0.75	47	4.06	1.31
	Post	34	3.65	1.59	26	4.46	1.24
Wood Ash	Pre	68	4.91	0.51	57	3.89	1.45
	Post	37	4.14	1.46	26	4.31	1.49
Granite Dust	Pre	66	4.85	0.61	46	3.30	1.52
	Post	34	3.76	1.50	25	3.36	1.32
Mucuna	Pre	69	4.86	0.55	54	3.65	1.53
	Post	36	3.56	1.52	26	3.77	1.48
Leucaena	Pre	65	4.82	0.61	49	3.49	1.52
	Post	30	3.50	1.59	27	3.70	1.54
Alley Cropping	Pre	70	4.91	0.5	58	3.52	1.58
	Post	36	3.61	1.57	26	4.23	1.34

Note. 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

Paired samples t-tests were used to compare mean differences between each selected practice from current to planned behavior for both workshops. For each workshop, a significant difference was found for each of the practices between participants' current and planned behavior.

Negative mean differences indicate the participants planned to implement the practices more often. When the post-test mean is subtracted from the pre-test mean, the difference between them would then become negative. Table 15 illustrates the results of paired samples t-tests for all ten practices.

Workshop one's smallest mean difference was reported for *wood ash*, (M = -1.45, $t(32) = -4.77$, $p < .05$). The greatest mean difference was *granite dust*, (M = -2.60, $t(32) = -9.85$, $p < .05$). Workshop two's smallest mean difference was for *neem*, (M = -1.60, $t(31) = -5.33$, $p < .05$), while the greatest mean difference was *alley cropping*, (M = -2.75, $t(23) = -6.95$, $p < .05$).

Table 15 Comparison of current and planned behavior of both workshops

		Workshop One					Workshop Two				
Farming Practice	Behavior	N	*M*	*SD*	*t*-test	df	N	*M*	*SD*	*t*-test	df
Pueraria	Current	35	1.83	1.25	-4.88*	34	26	1.54	1.24	-9.26*	25
	Planned	35	3.69	1.64			26	4.12	1.18		
Moringa	Current	35	2.54	1.65	-5.11*	34	26	2.77	1.31	-7.28*	25
	Planned	35	4.29	1.20			26	4.58	1.14		
Neem	Current	28	2.64	1.31	-5.33*	27	25	2.80	1.15	-5.66*	24
	Planned	28	4.25	1.32			25	4.40	1.26		
Gliricidia	Current	32	1.41	1.04	-7.55*	31	18	1.67	1.24	-7.21*	17
	Planned	32	3.66	1.45			18	4.22	1.35		
Ageratum	Current	27	1.37	0.84	-6.92*	26	21	2.14	1.46	-6.96*	20
	Planned	27	3.56	1.63			21	4.62	1.20		
Wood Ash	Current	33	2.70	1.47	-4.77*	32	21	2.76	1.26	-4.31*	20
	Planned	33	4.15	1.48			21	4.43	1.43		

Table 15 (continued)

Granite Dust	Current	33	1.15	0.51	-9.85*	32	23	1.30	0.82	-6.01*	22
	Planned	33	3.76	1.52			23	3.30	1.33		
Mucuna	Current	34	1.35	0.88	-7.88*	33	21	1.48	1.12	-6.26*	20
	Planned	34	3.65	1.50			21	3.90	1.41		
Leucaena	Current	29	1.31	0.89	-6.44*	28	22	1.41	1.18	-6.51*	21
	Planned	29	3.45	1.59			22	3.68	1.52		
Alley Cropping	Current	30	1.60	1.16	-6.98*	29	24	1.42	1.13	-6.95*	23
	Planned	30	3.70	1.56			24	4.17	1.37		

*$p < .05$

Note. 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

Objective Four Results

The fourth objective of the study was to determine the level of implementation of selected farming practices by farmers at the time of the agricultural education workshop and three months after the agricultural education workshop. There were a total of four observations completed for location one and seven observations completed for location two. The initial observations were completed at the time of the workshops with the follow-up observations planned to be completed three months post-workshop.

Table 14 shows the results of the first observation assessments. Results indicated that in location one, farmers were observed *never* using three practices, *rarely* using five, and *sometimes* using two practices, with means ranging from 1.25 to 3.00. Results also indicated that in location two, farmers were observed *never* using one practice, *rarely* using two, *sometimes* using four, and *often* using three practices, with means ranging from 1.83 to 4.43.

Table 16 Pre-workshop observation assessments

	Location One			Location Two		
Farming Practice	*n*	*M*	*SD*	*n*	*M*	*SD*
Pueraria	3	2.00	1.73	7	3.57	0.53
Moringa	4	3.00	1.41	7	4.43	0.98
Neem	4	2.00	0.82	7	4.14	0.90
Gliricidia	4	2.00	0.82	6	1.83	0.41
Ageratum	4	1.75	0.96	7	3.29	0.49
Wood Ash	4	2.50	1.00	6	4.00	0.89
Granite Dust	4	1.25	0.50	7	2.29	0.49
Mucuna	4	1.25	0.50	7	3.00	0.00
Leucaena	4	3.00	1.41	7	2.86	0.38
Alley Cropping	4	2.75	0.50	7	3.29	0.95

Note. 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always

The second part of this objective was to determine the farmers' level of implementation of the farming and health practices taught three months post-workshop. The observation assessments were sent electronically to Global Care Link's coordinator in Ghana in June of 2014. However, due to time and communication barriers, the coordinator was not able to return the observation assessments for analysis.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this study was to determine the effectiveness of an educational program in influencing the utilization of native plants for farming and health practices among rural farmers in Ghana. Ultimately, the study sought to determine change in knowledge among participating farmers and intended behavior change. The specific research objectives of this study were:

Objective 1: Describe the demographic characteristics of Ghanaian farmers who participated in an agricultural education workshop.

Objective 2: Assess rural farmers' knowledge of farming and health practices before and after an agricultural education workshop.

Objective 3: Determine farmers' current behavior and intent to implement farming and health practices.

Objective 4: Determine the level of implementation of farming practices by farmers at the time of the agricultural education workshop and three months after the agricultural education workshop.

Conclusions Related to Objective One

Objective one was to describe the demographic characteristics of Ghanaian farmers who participated in an agricultural education workshop. Demographics carry an important role in research, especially in agriculture (MoFA, 2011). Ghana Statistical Service (2013) indicates the 2010 Population and Housing Census was the first report to acquire national statistics on agricultural households. The 2010 census data was compared to the demographical data collected in this study. The questions created for demographic data collection were constructed by recommendations made in "Asking Questions" by Bradburn, Sudman, and Wansink (2004).

The majority of those who attended the workshops were male. According to GSS (2013), the heads of agricultural households are 71.4% male. Although males may be head of most households in Ghana, women are responsible for 87% of the farm work (GSS, 2008). This could be an indication that we reached the heads of many agricultural households in the Central Region of Ghana, but we may not have reached those in the households who are actually doing the majority of the manual labor. While conducting research on the effectiveness of extension systems, MoFA (2011) noticed the majority of respondents were male (73.5%). MoFA (2011) states, "Most contracts are made with male familiy heads while women – who do not receive adequate remuneration – often do the bulk of the work," (p. 21).

The majority of participants at both workshops were 40 years old and above. GSS (2013) indicates that the population as a whole in Ghana is gradually increasing in age. The population in the Central Region between the ages of 25-59 has increased from 31.7% in 2000 to 33.1% in 2010 (GSS, 2013). The population of those 60 years and

above in the Central Region has stayed relatively the same with 7.8% in 2000 and 7.4% in 2010 (GSS, 2013). GSS (2013) also states that the population will continue to age as advances are made in the country's transition from high to low fertility levels.

The majority of participants also had five or more children. GSS (2013) indicated that biological children constituted almost 40% of households in rural areas for 2010. Statistics also indicate agricultural households in Ghana "have proportionately more children…than in the total country" (GSS, 2013, p. 289).

Respondents also reported the majority had five or more people currently living in the household. Nationally, the average household size for agricultural households is 5.3 persons, but GSS (2013) indicated the average household size in the Central Region of Ghana is 4.4 persons. On average, agricultural households in Ghana tend to have more people than the national average (GSS, 2013). Also, according to GSS (2013) "the urban areas had relatively smaller agricultural households compared with rural areas" (p. 289).

Most of the respondents had been farming for five or more years and most grew their crops for the purposes of household consumption and to sale in the local market. Both groups of participants also indicated they were growing mostly vegetables and tropical fruits. All of the crops listed by the participants constitute the majority of the major crops grown in Ghana (GSS 2013). This is an indication that the participants were experienced in the field of agriculture.

The demographic data collected are representative of the rural Ghanaian population, more specifically the agricultural population in the Central Region of Ghana. Demographic data is important in data collection to help determine who is being reached with agricultural knowledge.

Conclusions Related to Objective Two

Objective two was to assess the participants' knowledge of farming and health practices before and after an agricultural education workshop. Analysis revealed a significant difference in pre-workshop knowledge levels between the two locations. Respondents from workshop two correctly answered a greater number of questions than workshop one respondents. Thus, workshop two participants' possessed greater beginning knowledge of the farming and health practices to be taught. Post-workshop knowledge levels were not significantly different between workshop one and workshop two, which may have been caused by the difference in demographics encountered between workshops. Despite the demographics, this is an indication that improvements were made in participants' knowledge regardless of their beginning level of knowledge.

Workshop one saw an increase of 26.1% in total number of correct answers from pre- to post-test and workshop two saw an increase of 21.4% in total number of correct answers form pre- to post-test. This may indicate that workshops participants' knowledge of selected farming practices increased; however, due to the high rate of attrition encountered at the workshops, caution should be taken in interpreting these results.

Despite attrition levels, participants' ability to correctly answer questions about the selected farming practices indicates their presence in the first stage of the innovation-decision process: knowledge (Rogers, 2003). Participants' ability to correctly answer questions also indicates that Rogers' (2003) awareness and how-to knowledge levels were reached. Furthermore, Asiabaka and Owens (2002) note that the higher the educational levels of farmers the more likely they are to seek out more information and

adopt an innovation. Thus, for farmers to make any necessary changes or to adopt technology, they must first be made aware of relevant information regarding these changes or technology (Lee, 2005).

Conclusions Related to Objective Three

Objective three was to determine farmers' current behavior and intent to implement farming and health practices. Participants self-reported the frequency with which they were currently using selected practices for farming and health purposes as well as their intentions of utilizing the practices before and after the workshops.

Participants from workshop one reported currently *never* or *rarely* using the ten selected farming practices. Participants from workshop two reported currently *never* using eight of the ten selected practices and *rarely* using two. Participants may not be utilizing the practices due to various constraints such as lack of technical know-how, inputs, land, time, labor, or decision makers as mentioned by Sale and Olujobi (2014).

For workshop one, two medicinal plants were reported as *never* being used and two were reported as *rarely* or *sometimes* being used. Participants of workshop two reported they *never* used one of the selected medicinal plants and *rarely* used three. Grivetti and Ogle (2000) and Thurbey and Fahey (2009) indicated many native plants are used to provide energy and micronutrients in the diets of agricultural households. However, that is not the case with the self-reported current behavior of the workshop participants. This could indicate the participants lacked awareness or how-to knowledge in utilizing the plants or there are other medicinal plants being used that were not selected for this study.

Respondents of both workshops indicated that they planned to apply all ten farming practices *sometimes* or *often* before and after the workshops. This indicates the the participants' intentions on utilizing the farming practices remained unchanged. This could be due to the level of credibility in the source of information already established among participants through the pastoral leaders which is a vital role as indicated by Rogers (2003) and Asiabaka and Owens (2002).

Workshop one's smallest mean difference was reported for *wood ash*, (M = -1.45). The greatest mean difference was *granite dust*, (M = -2.60). Workshop two's smallest mean difference was for *neem*, (M = -1.60), while the greatest mean difference was for *alley cropping*, (M = -2.75). The differences in means between self-reported current and planned behavior on the post-test are negative. This is an indication that the means of current behavior was lower than the means of planned behavior. This also indicates that the participants intend to utilize the practices taught in the workshops more frequently in their farming practices.

Acker and Gasperini (2008) found the levels of education, farm productivity, and income are all closely related. So, rural farmers in Ghana must first be educated in order to increase agricultural productivity, which will then increase household income. If workshop participants utilize the practices more frequently on their farm as reported there is possibility that farm productivity may increase in the area which will, in turn, increase household income.

According to Roger's (2003) innovation-decision process, this indicates the workshops communicated positive characteristics of the farming practices, thus moving participants through stage 2, persuasion. In the persuasion stage, farmers are provided the

five attributes of the farming practices taught in the workshops which are relative advantage, compatibility, complexity, observability, and trialability. In the workshops, participants were given information on relative advantage, compatibility, and complexity. Based on their intentions, the farmers obtained an accurate knowledge base of the farming practices and were more inclined to implement the practices rather than reject.

Conclusions Related to Objective Four

The fourth objective was to determine the level of implementation of farming practices by farmers at the time of the agricultural education workshop and three months after the agricultural education workshop. The first round of observations assessments revealed that overall farmers in Gomoa Enyeme were currently *never* using three practices, *rarely* using five, and *sometimes* using two selected practices. In Agona Nyakrom, the assessments indicated that overall farmers were currently *never* using one practice, *rarely* using two, *sometimes* using four, and *often* using three selected practices. This is an overall indication that farmers in location two, are currently using the selected practices more frequently than those in location one, which is very close to the current behavior that was self-reported by the workshop participants.

The second round of observation assessments were sent electronically to Global Care Link's coordinator in Ghana. The coordinator received the assessments and reported to be in the process of collecting them. However, due to time and communication limitations, was unable to collect and return the assessments to the researchers in a specified time frame.

Recommendations

There are several recommendations that can be made for researchers and practitioners. Since the majority of those who were taught in the workshops were male, practitioners should conduct workshops that target women. The workshops should also provide incentives for women and younger farmers, below 30 years of age (MoFA, 2011), for further encouragement to participate in the workshops. The level of education is also vital to the use of information and technology adoption (MoFA, 2011) and has been found to be related to farm productivity (Acker & Gasperini, 2008). This requires future researchers to collect demographical data on farmers' levels of education in order to compare to farmers' level of productivity.

Similar to the Companion Village Project in Tanzania, this educational intervention was able to utilize the local pastoral leaders and existing church infrastructure to disseminate information to farmers (Malima et al., 2014). The credibility of the pastoral leaders and their established relationship with members of the community played a critical role in communicating with the rural farmers. According to Rogers' (2003), the second stage in the role of those wanting to create change is to establish credibility, competency, and trustworthiness among potential adopters. Both Rogers' (2003) and Asiabaka and Owens (2002) indicate that credibility of the information source is vital to the role of those disseminating information.

The pastoral leaders should also be seen as taking the role of opinion leaders, which is defined by Rogers' (2003) as "individuals who lead in influencing others' opinions" (p. 300). These individuals are typically sought out for information or advice (Rogers, 2003). The pastoral leaders in Ghana participated in the workshops and were

provided with manuals from Global Care Link after the workshops in case they or other participants needed reminders of subject matter taught in the workshops. This will require workshop participants to seek out the pastoral leaders for further clarification and follow-up of workshop material. Because these roles are held by pastoral leaders, practitioners should hold separate trainings for the pastoral leaders.

Since the successful CVP was based on a combination of Farmer Field Schools (FFS) and Training and Visit (T&V) programs, the researchers recommend that extension agents and practitioners follow the initial workshops with additional experiential education, providing farmers opportunities to learn through hands-on methods. Malima et al. (2014) indicated an increase in the adoption of farming practices taught by CVP based on farmers receiving personal instruction. Farmers should also receive extended support as they implement the practices. This relates to Asiabaka and Owens (2002) study which revealed that farmers must receive the technical assistance necessary in order to adopt an innovation.

Sale and Olujobi's (2014) noted several constraints to farmers implementing selected farming practices in Nigeria. Indeed, even though farmers intend to implement practices, they may face barriers such as lack of technical know-how, land, time, inputs, and decision-makers. With this in mind, researchers suggest that future research include focus group interviews with farmers to gain a deeper and clearer understanding of the barriers they may face in implementing farming practices as well as additional educational needs. As Fan et al. (2013) noted, educational interventions should be tailored toward African farmers' needs and production practices.

Asenso-Okyere (2009) indicates that needs assessments must be conducted with farmers in order to determine what information is most relevant and useful to them. Although the practices in this study were applicable and relevant to the farmers, there may be external factors that need to be considered. Future research should conduct needs assessments based on community, farmers' needs, cultural and social norms, resources available as well as assess potential risks, and cultural preferences in the area which are indicated by MoFA (2011).

U.S. academic institutions can partner with Ghanaian extension systems to conduct future trainings. Ghanaian extension is working toward a more pluralistic approach (MoFA, 2011), which offers opportunities for NGOs, public, and private sector organizations to work alongside extension in Ghana.

Researchers and practitioners should also partner with agricultural institutions in Ghana in order to have greater access to educational resources and up-to-date information on improved farming practices. In this way, educational investments can be tailored more toward the needs of African farmers and their environments.

While knowledge and persuasion were assessed in this study, investigation did not extend to actual adoption of the practices taught. Therefore, researchers recommend that longitudinal data be collected through observations noting the level of implementation of the farming practices.

This research can be used to create more workshops which promote the utilization of native plants and materials in farming and health practices. The instruments in this study can be used for further data collection on farmers' knowledge of native plants and materials as well as their current and planned behavior in utilizing those plants and

materials. The instruments can also be adapted to fit the needs of researchers to collect farmer demographics in other rural areas of developing countries. The data collected in this study should be compared to future educational workshops that teach and encourage the utilization of native plants and materials to improve farming and health practices.

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APPENDIX A

IRB APPROVAL

February 19, 2014

Alyssa Barrett
School of Human Sciences
Mailstop 9745

RE: HRPP Study #14-035: Investigating Knowledge and Implementation of Best Farming Practices in Ghanaian Smallholder Farmers

Dear Ms. Barrett:

This email serves as official documentation that the above referenced project was reviewed and approved via administrative review on 2/19/2014 in accordance with 45 CFR 46.101(b)(2). Continuing review is not necessary for this project. However, in accordance with SOP 01-03 Administrative Review of Applications, a new application must be submitted if the study is ongoing after 5 years from the date of approval. Additionally, any modification to the project must be reviewed and approved by the HRPP prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The HRPP reserves the right, at anytime during the project period, to observe you and the a! dditional researchers on this project.

Please note that the MSU HRPP accreditation for our human subjects protection program requires an approval stamp for consent forms. The approval stamp will assist in ensuring the HRPP approved version of the consent form is used in the actual conduct of research. Your stamped consent form will be attached in a separate email. **You must use the stamped consent form for obtaining consent from participants.**

Please refer to your HRPP number (#14-035) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at jroberts@orc.msstate.edu or call 662-325-2238.

Finally, we would greatly appreciate your feedback on the HRPP approval process. Please take a few minutes to complete our survey at http://www.surveymonkey.com/s/YZC7QQD.

Sincerely,

!
Jodi Roberts, Ph.D.
IRB Officer

cc: Laura Lemons (Advisor)

APPENDIX B

PRE-TEST

Mississippi State University
Informed Consent Form for Participation in Research

Title of Research Study: Knowledge and Implementation of Best Agricultural Practices among smallholder farmers in Ghana

Study Site: Winneba, Ghana

Researchers: Dr. Laura Lemons and Ms. Alyssa Barrett, Mississippi State University

We would like to ask you to participate in a research study.

Your participation in this research is completely voluntary. If you choose to participate, you will be asked to answer questions related to your farming practices. A translator is available to help interpret any of the questions, if you need them. It should take no more than 15 minutes to answer these questions. You may choose not to participate. If you feel uncomfortable answering any of the questions, you may leave them blank, or discontinue your participation at any time. Your lack of participation will not result in any penalty or loss of benefits. Specifically, you are eligible to participate in the workshop today, whether or not you choose to participate in this study by answering the questions on the survey.

Questions
If you have any questions about this research project, please feel free to contact Dr. Laura Lemons or Ms. Alyssa Barrett at 662-325-1804.

Voluntary Participation
Please understand that your **participation is voluntary.** Your **refusal to participate will involve no penalty or loss** of benefits to which you are otherwise entitled. You **may discontinue your participation** at any time without penalty or loss of benefits.

Please take all the time you need to read through this document and decide whether you would like to participate in this research study.

If you decide to participate, your completion of the research procedures indicates your consent. Please keep this form for your records.

MSU HRPP

Approved:	Expires:
02/19/2014	02/19/2019

IRB # 14-035

DEMOGRAPHICS

1. What is your gender? Check one.
   - Male
   - Female

2. What is your age? Check one.
   - < 20 years
   - 20-29 years
   - 30-39 years
   - 40-49 years
   - 50-59 years
   - 60 or older

3. Including you, how many people live in your household?
   - 1
   - 2
   - 3
   - 4
   - 5+

4. How many children do you have?
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5+

5. List the crops you grow at home.

   _____ _____

   _____ _____

   _____ _____

6. What is the primary reason you grow these crops? (ex: to sell, to trade, to consume)

_____

_____

7. How many years have you been farming?
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5+

AGRICULTURAL KNOWLEDGE

8. What does the acronym CAMP-AGGAMMAL stand for? List at many as you can.

C: _____ A: _____

A: _____ G: _____

M: _____ G: _____

P: _____ A: _____

M: _____

M: _____

A: _____

L: _____

9. Why is the input formula CAMP – AGGUMAL useful?

_____

_____

_____

10. How is Neem made into a medicine?

_____

_____

_____

11. How can Gliricidia be used to kill rats?

_____

_____

_____

12. How is Ageratum made into a pesticide liquid?

_____

_____

_____

13. Pueraria is a type of plant that runs along the ground. This is known as a _____.

14. How many elements out of CAMP – AGGUMAL are needed for the formula to work?
    - 0
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6+

15. Ageratum is a(n):
    a. Herb
    b. Shrub
    c. Algae
    d. Invasive species

16. Ageratum is used as a pesticide, which means it kills what?
    a. Animals
    b. Invasive plants
    c. Bugs/pests
    d. Weeds

17. A legume adds what nutrient to the soil?
    a. Sulfur
    b. Potassium
    c. Phosphorus
    d. Nitrogen

18. Mucuna has properties similar to those of:
    a. Pueraria
    b. Neem
    c. Gliricidia
    d. Leucaena

19. Neem tree can be used to prevent and/or cure what disease?
    a. HIV/AIDS
    b. Sleeping Sickness
    c. Malaria
    d. River Blindness

20. Neem tree branches can be used as an antiseptic for:
    a. Healthy gums
    b. Cleaning wounds
    c. Treating burns
    d. Eye drops

21. In alley cropping, the rows are how many feet apart?
    a. Less than 10 ft
    b. 5 – 10 ft
    c. 10 – 20 ft
    d. 20 – 30 ft

22. Moringa can be used for the following: (check all that apply)
    □ Pesticide
    □ Feeding animals
    □ Water purifier
    □ Nutritional supplement
    □ Rat poison

Read the statements below and select if it is True or False.		
	TRUE	FALSE
23 Pueraria kills weeds when it forms a carpet.	O	O
24 Wood ash gathered from kitchens adds phosphorus to the soil.	O	O
25 Granite dust adds phosphorus to the soil.	O	O
26 Gliricidia supplies potassium to the soil through the roots.	O	O
27 Farm animals can live for a year off of Neem's leaves and branches.	O	O
28 Gliricidia is safe for human and animal consumption.	O	O
29 Ageratum can be used to make tea.	O	O
30 Azadirechta, or Neem tree, is a more effective pesticide than Ageratum.	O	O
31 Leucaena adds nitrogen to the soil.	O	O
32 Leucaena can be used as feed for animals.	O	O
33 Moringa is used to provide nitrogen to the soil.	O	O
34 Moringa can be planted at the edge of fields or near water sources to prevent soil erosion.	O	O
35 Neem produces a sticky substance called glue.	O	O
36 Neem is not an effective pesticide for crops.	O	O
37 Chewing Neem branches is good for your teeth and gums.	O	O
38 Ashes from wood fires cannot be used on farm land.	O	O
39 Wood ash is a good source of potassium for crops.	O	O
40 Granite dust is most commonly found in sites known as quarries.	O	O
41 Granite dust is a good source of nitrogen for crops.	O	O
42 Granite dust will dissolve quickly with rainfall.	O	O
43 Pueraria is an invasive plant that kills weeds.	O	O
44 Pueraria supplies nitrogen to the soil.	O	O
45 Pueraria is used mostly for permanent crops.	O	O
46 Eating 2-3 Pueraria beans can help relieve headaches.	O	O
47 Pueraria is used for permanent crops such as: cocoa, mango, cashew, and kola nuts.	O	O
48 Leaving Pueraria leaves on the ground is good for the soil.	O	O

CURRENT BEHAVIOR

How often do you use the following plants, minerals, and technques in your farming practices?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

PLANNED BEHAVIOR

How often do you use the following plants for your health?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Ageratum	O	O	O	O	O

How likely are you to use the following plants, minerals, and techniques in your future agricultural practices?					
	Very Unlikely	Unlikely	Not Sure	Likely	Very Likely
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

APPENDIX C

POST-TEST

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Please take all the time you need to read through this document and decide whether you would like to participate in this research study.

If you decide to participate, your completion of the research procedures indicates your consent. Please keep this form for your records.

MSU HRPP

Approved:	Expires:
02/19/2014	02/19/2019

IRB # 14-035

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   - 30-39 years
   - 40-49 years
   - 50-59 years
   - 60 or older

3. Including you, how many people live in your household?
   - 1
   - 2
   - 3
   - 4
   - 5+

4. How many children do you have?
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   - 2
   - 3
   - 4
   - 5+

5. List the crops you grow at home.

_____ _____

_____ _____

_____ _____

6. What is the primary reason you grow these crops? (ex: to sell, to trade, to consume)

_____

_____

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   - 3
   - 4
   - 5+

AGRICULTURAL KNOWLEDGE

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M: _____ G: _____

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M: _____

M: _____

A: _____

L: _____

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_____

_____

_____

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_____

_____

11. How can Gliricidia be used to kill rats?

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_____

_____

12. How is Ageratum made into a pesticide liquid?

_____

_____

_____

13. Pueraria is a type of plant that runs along the ground. This is known as a _____.

14. How many elements out of CAMP – AGGUMAL are needed for the formula to work?
    - 0
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6+

15. Ageratum is a(n):
    a. Herb
    b. Shrub
    c. Algae
    d. Invasive species

16. Ageratum is used as a pesticide, which means it kills what?
    a. Animals
    b. Invasive plants
    c. Bugs/pests
    d. Weeds

17. A legume adds what nutrient to the soil?
    a. Sulfur
    b. Potassium
    c. Phosphorus
    d. Nitrogen

18. Mucuna has properties similar to those of:
    a. Pueraria
    b. Neem
    c. Gliricidia
    d. Leucaena

19. Neem tree can be used to prevent and/or cure what disease?
    a. HIV/AIDS
    b. Sleeping Sickness
    c. Malaria
    d. River Blindness

20. Neem tree branches can be used as an antiseptic for:
    a. Healthy gums
    b. Cleaning wounds
    c. Treating burns
    d. Eye drops

21. In alley cropping, the rows are how many feet apart?
    a. Less than 10 ft
    b. 5 – 10 ft
    c. 10 – 20 ft
    d. 20 – 30 ft

22. Moringa can be used for the following: (check all that apply)
    □ Pesticide
    □ Feeding animals
    □ Water purifier
    □ Nutritional supplement
    □ Rat poison

Read the statements below and select if it is True or False.		
	TRUE	FALSE
23 Pueraria kills weeds when it forms a carpet.	O	O
24 Wood ash gathered from kitchens adds phosphorus to the soil.	O	O
25 Granite dust adds phosphorus to the soil.	O	O
26 Gliricidia supplies potassium to the soil through the roots.	O	O
27 Farm animals can live for a year off of Neem's leaves and branches.	O	O
28 Gliricidia is safe for human and animal consumption.	O	O
29 Ageratum can be used to make tea.	O	O
30 Azadirechta, or Neem tree, is a more effective pesticide than Ageratum.	O	O
31 Leucaena adds nitrogen to the soil.	O	O
32 Leucaena can be used as feed for animals.	O	O
33 Moringa is used to provide nitrogen to the soil.	O	O
34 Moringa can be planted at the edge of fields or near water sources to prevent soil erosion.	O	O
35 Neem produces a sticky substance called glue.	O	O
36 Neem is not an effective pesticide for crops.	O	O
37 Chewing Neem branches is good for your teeth and gums.	O	O
38 Ashes from wood fires cannot be used on farm land.	O	O
39 Wood ash is a good source of potassium for crops.	O	O
40 Granite dust is most commonly found in sites known as quarries.	O	O
41 Granite dust is a good source of nitrogen for crops.	O	O
42 Granite dust will dissolve quickly with rainfall.	O	O
43 Pueraria is an invasive plant that kills weeds.	O	O
44 Pueraria supplies nitrogen to the soil.	O	O
45 Pueraria is used mostly for permanent crops.	O	O
46 Eating 2-3 Pueraria beans can help relieve headaches.	O	O
47 Pueraria is used for permanent crops such as: cocoa, mango, cashew, and kola nuts.	O	O
48 Leaving Pueraria leaves on the ground is good for the soil.	O	O

CURRENT BEHAVIOR

How often do you use the following plants, minerals, and technques in your farming practices?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

PLANNED BEHAVIOR

How often do you use the following plants for your health?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Ageratum	O	O	O	O	O

How likely are you to use the following plants, minerals, and techniques in your future agricultural practices?					
	Very Unlikely	Unlikely	Not Sure	Likely	Very Likely
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

APPENDIX D

OBSERVATION ASSESSMENT

ACTUAL BEHAVIOR OBSERVED AGGREGATE*(to be completed as observation a day prior to workshop and at 3 months post workshop)*

How often are farmers using the following plants, minerals, and techniques in their farming practices?					
	Never	Rarely	Sometimes	Often	Always
Pueraria (Kudzu)	O	O	O	O	O
Moringa	O	O	O	O	O
Neem	O	O	O	O	O
Gliricidia	O	O	O	O	O
Ageratum	O	O	O	O	O
Wood Ash	O	O	O	O	O
Granite Dust	O	O	O	O	O
Mucuna	O	O	O	O	O
Leucaena	O	O	O	O	O
Alley Cropping	O	O	O	O	O

Observer:_____ Location:_____

Date:_____

Additional Comments:

APPENDIX E

WORKSHOP TRANSCRIPTIONS

Ghana Workshops
Note Transcriptions
Conducted by Dr. Oye
Location: Gomoa Enyeme

Day 1: March 4, 2014

1. When farmers grow yam and cassava in heaps, they surround it with things like groundnuts or beans, so that it will supply N to the crop and the tubers will become very big.
2. Wonderful thing about N, is that it is in the air and is about 78% of the air we breathe, so we catch it through those plants, put them in the soil and that is what we feed the plants to grow.
3. So tomorrow we will show some plants that are very common here that to that (legumes). Even if you don't get Pueraria or Mucuna, we will bring Centrosema, which they will see and know.
4. Ash from the kitchen is a wonderful fertilizer.
5. There are 3 important elements needed by the soil and the plants. They are NPK. Ash supplies K. Apart from that there are trace elements needed in tiny, tiny quantities which are found in the same ash.
6. There are some crops that women grow, that need only K and trace elements which means it would need only ash and nothing else. Crops are pepper, tomatoes, garden eggs, and sweet potatoes. Even if you only grown those crops in a small commercial way you will gain a lot in the market. We'll bring examples to show tomorrow.

Day 2: March 5, 2014
LEGUMES

1. It is important that we don't produce only crops but also animals that would give us crude animal protein.
2. Today, we will learn about plants we can feed our animals for a year without buying anything.
3. We will also learn about plants that can take care of most of our physical diseases so we can live healthy lives. (promotes the selling of his books)
4. CAMP-AGGAMMAL acronym (writing formula) (blackboard, pencil, paper)
5. 12 items on the board, each one is a possible input into the farm and each will improve productivity and you don't need to have all 12 on the spot, you can have 5 and you'll be okay, because each environment in the tropics will have each of these things.
6. Crotolaria (repeat 3x's)
    a. We find it to be a weed, but it has a fruit. Children shake it.
    b. The root is able to fix N from the air to the soil.

c. If you broadcast the seed on your prepared land when it begins to grow and you plant your corn or cassava, your crop is going to gain a lot of N for rapid growth and fruiting.
d. Grows to about 2ft. high while your maize or cassava will grow tall so it won't disturb your crop and it's not a weed on your farm, it's an asset/blessing.
e. When the plant dies, it becomes another type of fertilizer, NPK. Best for corn, cassava, coco yam, anything that grows for 6mos, even pepper.
f. Harvest and store seeds when the fruit dies. You can spread seeds to plant more.
g. N is very important for plants to grow well and bear fruit.
h.

7. Pueraria (repeat 3x's) (show plant example)
    a. Supplies N
    b. When you get the seeds, grow it the same way as Crotolaria.
    c. All the plants we're showing now are in the same bean family and groundnuts, this will fix N in the soil.
    d. Cannot use it for cassava, corn, pepper, groundnuts, or tomatoes, because it will cover the crops.
    e. Use this for plantations
8. Centrosema
    a. Used to show as a substitute for Pueraria.
    b. Pueraria has same traits as Mucuna, so if you don't have Pueraria you may get Mucuna.
    c. Mucuna has bigger leaves than Pueraria.
9. Mucuna
    a. One variety has fruit with velvet skin, when this skin gets close to your body it will scratch you.
    b. Using 2, 3, or 4 you can control weeds, will bring down cost of labor.
    c. They can also preserve water underground for a long time.
    d. 37:00 another advantage??
    e. You can have worms and soil to ?
    f. All parts of the plant will decay and supply NPK.
    g. The fruits you produce will be fresh, organic, and very good for your health.
    h. A few trees also produce N.

TREES THAT SUPPLY N

1) Leucaena
    a. Plant identification (example shown)
    b. Produces tiny, brown seeds

c. (draws fruit on the board)
d. Flower is like a small, white tennis ball
e. Supplies N to soil
f. Can spread very fast
g. It never dies, stays fresh in both wet and dry seasons
h. Fodder for goats, sheep, cattle, etc. They can live on Lucaena for a year.
i. Large advantage to those who want to raise small animals.
j. Can be used in alley cropping
k. Plant in a row left apart, 10-15 ft. between rows.
l. Plant crops between rows.
m. Roots of Lucaena grow toward the crops and will fid N
n. Don't allow it to become bushy, it will shade your crop, so prune and cut branches, give cut branches to animals.
o. Supplies fertilizer for crops and food for animals (mixed farming)
p. Two other trees can do the same thing, Gliricidia and Acacia

2) Gliricidia
   a. Use in alley cropping, same as Lucaena
   b. Advantage is seeds from fruits will kill rats and mice
      i. Grind dry seeds and add it to food
   c. Leaves help raise goats, sheep, and domestic animals
3) Acacia
   a. Mentioned last because it's not the best
   b. Supplies N to soil, but takes in many minerals
   c. If you don't have either of the top 2 you can use Acacia
   d. Used in alley cropping
   e. Must prune

---

1) Moringa
   a. Does not fix N, not a legume
   b. If used as an alley crop its only advantage is the leaves will provide NPK to the soil when they fall.
   c. One of the best plants for medicine
   d. Supplies amino acids, nutrients, and minerals needed by the body
   e. Can be used to prevent many diseases and heal others
   f. Great for pregnant women and unborn babies
   g. Children born are very strong from the beginning
   h. Recommend that every family have 1 tree
   i. If we depend on Moringa for food, we will not go to hospital at all
   j. One way for person to become rich is not going to hospital as much

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SUPPLY K

2) Ash

a. Provides K best
b. Pepper, tomatoes, garden eggs, sweet potatoes need K
c. Spread it all over if you have a lot
d. If only a little ash, place it in a ring around the base of the crops
e. K will dissolve with rain into soil

SUPPLY P

3) Granite Dust
    a. Supplies P
    b. Rocks used in road construction
    c. Very common
    d. Even if you have 1 acre of land and 1 bucket of granite, broadcast it on the land, when rain comes, it will dissolve into the soil
    e. The amount of P needed by plants isn't much
4) Manure
    a. In mixed farming, collect droppings from animals, contains NPK

PESTICIDES

5) Azadirachta (Neem)
    a. Take leaves (evergreen), bucket of water, squeeze leaves in bucket, leave overnight
    b. Cannot get fruit all the time
    c. Don't need sprayer, use branches with leaves of Neem to broadcast over crops/veggies
    d. Any liquid left on plants can help cure malaria (most bitter things heal, most sweet things harm) besides fruit
6) Ageratum
    a. Does same work as Neem
    b. Cannot kill as many insects as Neem
    c. Very seasonal, only plentiful during rainy season
    d. Powerful, versatile, medicine for human body
    e. Anit-viral, anti-fungal, will stop anything
    f. Drink as a tea
    g. Controls ____?
    h. Fixes menstrual problems
    i. Enhances fertility

APPENDIX F

SEED PACKETS

MORINGA OLEIFERA
INSTRUCTIONS FOR USE

1. Choose an area with light and sandy well drained soil - not heavy with clay and water logged.

2. Dig holes 30cm square and 1 meter deep. Back fill the holes with 3 parts river sand and 1 part compost. Make the hole up to 90cm wide if the soil is heavy.

3. Plant 3 to 5 seeds per hole, 5cm apart. Plant the seeds no deeper than three times the width of the seed +- 1.5cm.

4. Keep the soil moist enough so that the top soil will not dry and choke the emerging sapling, but not too wet or else the seeds can drown and rot. A light sprinkling of dry grass makes an excellent mulch. The seeds take between one and two weeks to germinate.

5. When the saplings are 10cm to 15cm tall, keep the healthiest sapling in the ground and remove the rest.

Instructions for Use. Leaves can be eaten fresh, cooked, or dried and crushed. Provides source of Vitamin B6, Vitamin C, Vitamin A, Calcium, Magnesium, Potassium, Protein, and more.

Moringa leaf contains:
- 7 Times the Vitamin C of oranges
- 4 Times the Vitamin A of carrots
- 4 Times the Calcium of milk
- 3 Times the Potassium of bananas
- 2 Times the Protein of yogurt

Seeds can be eaten like peas or roasted like nuts, contain high levels of vitamin C. Can be crushed and used to purify contaminated water.

And my God will meet all your needs according to the riches of his glory in Christ Jesus.
~ Philippians 4:19