Spatial and Gender Dimensions of IPM Adoption in Uganda

Kellyn Paige Montgomery

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science
In
Geography

Lawrence S. Grossman
Maria Elisa Christie
James B. Campbell

May 23, 2011
Blacksburg, VA

Keywords: gender, distance, transportation, IPM, GIS

Spatial and Gender Dimensions of IPM Adoption in Uganda

Kellyn Paige Montgomery

ABSTRACT

This research on gender and tomato production in rural sub-county of Busukuma in Uganda explores the roles that distance and mobility play in adoption of environmentally friendly crop protection practices. Uganda's National Agricultural Research Organization (NARO) prioritized blight and bacterial wilt as significant detrimental crop diseases for tomatoes, an important high-value horticulture crop. Tomato farmers have also identified these diseases as primary constraints for crop production and have employed chemical pesticides to reduce crop losses. One focus of the Integrated Pest Management Collaborative Research Support Program (IPM CRSP), which is managed by Virginia Tech, has been the development of an IPM package to lower the use of pesticides in tomato production while reducing the incidence of such crop diseases. Recommended practices increase yields, save money on inputs, and improve health conditions.

Women are responsible for the majority of food production in sub-Saharan Africa; therefore, an understanding of women's issues is critical for the success of agricultural projects, such as the IPM program in Uganda. This research seeks to determine problems women farmers face in adopting the farming practices recommended by the IPM CRSP. Gender-specific constraints make adopting IPM more costly and time-consuming for women. Surveys, interviews, focus group discussions and GIS analysis were completed to determine if adoption of the recommended IPM package is affected by gender constraints in mobility and distances to inputs.

Table of Contents

List of Figures

List of Tables

Page

Chapter 1: Introduction and Statement of Purpose

1.1 Introduction

African leaders recognize that the problems of poverty and hunger that persist among the people of sub-Saharan Africa must be ameliorated through economic growth based upon agriculture. Global partnerships, such as the United States Agency for International Development's (USAID) Initiative to End Hunger in Africa (IEHA) and the U.S. Government initiative, Feed the Future (FTF), are focused on ensuring that income generation through agriculture is a viable and secure option. It is estimated that one in three Africans are undernourished (USAID 2007). Basic nutritional needs must be met before people can effectively contribute to the economy and broad improvements in wellbeing can be experienced. Additionally, increasing agricultural productivity will benefit countless households in African countries where the agricultural sector encompasses a large majority of the work force; for example, approximately 80 percent of the workforce in Uganda is involved in agriculture (Kalley 2006).

To achieve the goals of the IEHA and FTF, there has been a large investment in research and development projects to implement technologies to improve agricultural productivity. The success of these projects is dependent on an adequate focus on women smallholder farmers for two reasons. First, women play an important role in agriculture. In a survey of Kenyan farmers, 61 percent of women cited farming as their primary occupation, compared to only 24 percent of men (Saito, Makonnen, and Spurling 1994). Furthermore, women across sub-Saharan Africa make up approximately half of agricultural labor and produce the large majority of food crops (FAO 2011). Women in Kenya, for example, "are responsible for over eighty percent of the food crops and contribute substantially to cash crop production" (Davison 1988, 157). The second reason is that women are often highly marginalized. Despite their critical role in food production, women generally have less access to resources, such as land, labor, technology, extension, and credit (Gladwin and McMillan 1989; Quisumbing 1995; Jiggins, Samanta, and Olawoye 1997; Doss 1999, 2001; Flora 2001; Torkelsson 2007; FAO 2011). These two concerns point to the "food insecurity paradox in sub-Saharan Africa" (Saito, Makonnen, and Spurling 1994, 15). Women farmers make up the majority of the food insecure population yet they are responsible for a large portion of food production. Women's participation must be prioritized as critical for the success of programs since women are invariably a vital part of crop production and often make important agricultural decisions. Despite the active effort of program developers to integrate women through participatory research techniques, women continue to be constrained by numerous factors, such as limited access to resources and information, the division of household labor, and social roles.

One of the key issues for both male and female farmers in Africa and elsewhere is coping with losses in agriculture due to pests. The Integrated Pest Management Collaborative Research Support Program (IPM CRSP) is a USAID-sponsored program that is designed to develop and implement sustainable pest management methods. In relation to sustainable pest management systems, integrated pest management has universally become "the paradigm of choice" for holistic crop management aimed at reducing the use of chemical inputs during crop production while also increasing economic productivity (Kogan and Bajwa 1999, 2). The many benefits of IPM range from environmental to social. IPM raises individual farmers' crop productivity, reduces expenditures on pesticides, and improves conditions for human and environmental health.

The IPM CRSP has been working in Uganda in collaboration with Makerere University since 1994 to implement IPM techniques for use on high value horticultural crops, such as tomato. The tomato IPM package has proven to be very effective in increasing farmer productivity and reducing pesticide usage. The package consists of several components: use of a tomato variety developed at Makerere University, MT56, which is resistant to bacterial wilt; reduced pesticide application; use of mulch; and use of staking. Farmer Field Schools (FFS) have been used to introduce the package to a small group of about twenty farmers in Busukuma sub-county. Various constraints, such as limited availability of MT56 seed, lack of staking materials, and poor accessibility to markets, have prevented complete adoption of the package. Despite an effort to disseminate the package to other farmers, there has been almost no adoption outside of this FFS group (IPM CRSP 2008).

Many of the constraints faced by the IPM tomato project in Uganda are distinctively spatial. Farmer access to markets, improved seeds, staking and mulching material, and information about IPM all require the movement and transport of items and ideas. Distance from the source of these resources can be the limiting factor that determines if an individual farmer will adopt IPM. Analysis of the spatial factors and patterns related to IPM adoption can foster a deeper understanding of the processes behind pest management decisions. Additionally, spatial technology, such as a GIS, can allow analysis of more complex factors, such as gendered access to these resources.

1.2 Statement of Purpose

Gender is an integral factor that must be considered in agricultural research and development. While gender is becoming increasingly “mainstreamed” in current development projects, spatial dimensions are generally overlooked. Spatial patterns in tomato grower behavior, such as in pest management, may not be perceived by researchers. Mapping pest management practices and associated factors in relation to gender allows analysis of spatial patterns to improve understanding of how decisions about pest management are made.

The purpose of this research is to explore the gender and spatial dimensions of the adoption of a tomato IPM package developed by the IPM CRSP for use by small-scale farmers in Busukuma sub-county, Uganda. Research methodologies include the use of surveys, focus group discussions, key informant interviews, and basic GIS analysis. The integration of quantitative and qualitative methodologies will help determine if adoption of the recommended techniques is constrained by differences in men and women tomato farmers' distances to required inputs and modes of transportation. A better understanding of gender differences in growing tomatoes may help the IPM CRSP address existing constraints to IPM adoption and achieve project objectives. Additionally, this research will help determine if spatial techniques and analyses are useful for identifying gendered differences in space and distance within agricultural production.

This thesis has two additional chapters. Chapter 2 is a review of previous research concerning IPM adoption and related gender factors. Chapter 3 presents results of my study, which explores the spatial factors related to pest management practices used by men and women tomato growers in Uganda. It is written in preparation for submission to the journal *African Geographical Review*.

1.3 References

Doss, C. R. 1999. *Twenty-Five Years of Research on Women Farmers in Africa: Lessons and Implications for Agricultural Research Institutions; with an Annotated Bibliography*. CIMMTY Economics Program Paper No. 99-02. Mexico D. F.: CIMMYT.

———. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29(12):2075-2092.

Flora, C. 2001. "Access and Control of Resources: Lessons from the SANREM CRSP."*Agriculture and Human Values* 18:41-48.

Food and Agriculture Organization. 2011. Women in Agriculture: Closing the Gender Gap for Development. In *The State of Food and Agriculture.* Rome.

Gladwin, C. H. and D. McMillan. 1989. "Is a Turnaround in Africa Possible without Helping Women to Farm?" *Economic Development and Cultural Change* 37(2):345-369.

IPM CRSP. 2008. *Integrated Pest Management Collaborative Research Support Program Annual Report.* Blacksburg: OIRED Virginia Tech.

Jiggins, J., R. K. Samanta, and J. E. Olawoye. 1997. Improving Women Farmers' Access to Extension Services. In *Improving Agricultural Extension*, eds. B. E. Swanson, R. P. Bentz and A. J. Sofranko. Rome: Food and Agriculture Organization of the United Nations.

Kalley, K. 2006. "Uganda." *Uganda Country Monitor.* Global Insight Inc.

Kogan, M. and W. I. Bajwa. 1999. "Integrated Pest Management: A Global Reality?" *Anais da Sociedade Entomologica do Brasil* 28(1):1-25.

Quisumbing, A. R. 1995. *Gender Differences in Agricultural Productivity: A Survey of Empirical Evidence.* Food Consumption and Nutrition Division Discussion Paper No. 5. Washington, D.C.: International Food Policy Research Institute.

Saito, K. A., H. Mekonen, and D. Spurling. 1994. *Raising the Productivity of Women Farmers in Sub-Saharan Africa*. World Bank Discussion Papers 230. Washington, D.C.: The World Bank.

Torkelsson, A. 2007. "Resources, Not Capital: A Case Study of the Gendered Distribution and Productivity of Social Network Ties in Rural Ethiopia." *Rural Sociology* 74(4):583-607.

USAID. 2007. "Sub-Saharan Africa: Initiative to End Hunger in Africa (IEHA)." United States Agency for International Development, March 20, 2008 Available from: http://www.usaid.gov/locations/sub-saharan_africa/initiatives/ieha.html.

The World Bank, Food and Agriculture Organization, and International Fund for Agricultural Development. 2009. *Gender in Agriculture Sourcebook.* Washington, D.C.: The World Bank.

Chapter 2: Literature Review

2.1 Introduction

Increasing agricultural productivity throughout Africa in order to achieve the broad economic development and poverty reduction goals of global partnerships, such as the United States Agency for International Development's (USAID) Initiative to End Hunger in Africa (IEHA) and the U.S. Government initiative, Feed the Future (FTF), has been the focus of countless studies and research efforts. In pursuit of these goals, IPM has universally become "the paradigm of choice" for holistic crop management focused on reducing the use of chemical inputs during crop production while also increasing economic productivity (Kogan and Bajwa 1999).The many benefits of IPM range from environmental to social. Despite its advantages, practical IPM implementation has been limited by constraints found especially in developing countries (Galt 2007).

IPM packages are transferred to farmers through modes of diffusion, such as agricultural extension services, researchers, Farmer Field Schools (FFS), community and focus group meetings, and informal networks amongst farmers (Doss 2001). Previous studies have highlighted evidence that suggests that a focus on technology transfer to women is an efficient and effective strategy for knowledge dissemination because women play a significant role in agricultural production systems (Boserup 1970; Bryson 1981; Poats 1991; Ezumah and Di Domenico 1995; Doss and Morris 2001). Reaching women farmers requires an understanding of the complex gendered nature of spaces, resources, and knowledge.

Small farmers in developing countries use a variety of strategies for pest management. Sources of information about pest control are highly variable, including indigenous, local, and institutional sources. Interaction among individuals is a key process influencing what pest controls are used. Extension services play an important role in distributing institutional information about recommended agricultural practices to small farmers. There are many studies that focus on the correlation between presence of extension services and IPM adoption by small farmers (Byerlee 1987; Igodan, Ohaji, and Ekpere 1988; Bagchee 1994). Operationalizing the degree of IPM adoption, however, is a difficult and disagreed-upon issue in IPM research and development (Kogan and Bajwa 1999; Orr 2003; Norton et al. 2005; Ehler 2006).

Distribution of necessary resources to small farmers, women in particular, is a critical step towards making IPM a viable choice for pest control. Distribution and spatial organization of agricultural inputs are variables that have generally been overlooked in IPM research. Technologies for spatial analysis, such as geographic information systems and global positioning systems, could help to optimize extension services by providing a spatial framework for planning and identifying areas in need. Geographic technology can help answer why and how agricultural ideas and resources move in relation to IPM.

Key geographic concepts relevant to IPM adoption research include distance decay, modes of information dispersal, diffusion of innovations, and spatial patterns. A significant focus of this research is on the observation of modes of transfer taken by IPM information. The process of change amongst small farmers from pesticide dependency to using IPM manifests itself in a spatial form or pattern. The spatial pattern of IPM implementation might fit a distance decay function with relation to increasing distance from centers of innovation. Measuring IPM adoption, however, is an especially difficult challenge of operationalization.

Agricultural research has identified many themes that are relevant for IPM adoption and gender. There are many constraints and factors that influence decisions about pest management and the adoption of IPM. Among the most critical of these factors are diffusion of information and the sources of information used by farmers, agricultural extension in particular. There is extensive literature that highlights the importance of women in agriculture and the potential benefits of targeting women in agricultural development projects, including projects that promote IPM. Mobility also plays a role in the diffusion of agricultural innovations. The impact that gender differences in mobility have on adoption of improved agricultural methods is not well understood, however. Research has been completed to further the understanding of gender in relation to IPM adoption; however, the interaction between spatial factors and gender in IPM adoption has not been addressed.

2.2 Women and Agriculture

Programs in developing countries meant to generate economic growth through increased agricultural production have been active for many years. These programs included distribution of fertilizers, higher-yielding and disease resistant seeds, and other technological innovations. These efforts, however, have not been successful in solving the problems of poverty and hunger in rural Africa partly because mostly men farmers have been targeted. Countless reports have noted that new technologies were introduced to men while women were left out of agricultural training, credit, extension, and land reform policies (Picard 1995). Increased food production is dependent upon an understanding of gender roles and constraints. Women in Kenya, for example, “are responsible for over eighty percent of the food crops and contribute substantially to cash crop production” (Davison 1988, 157). Despite renewed efforts at national and international levels, development programs have still not reformed in response to women’s primacy in food production enough to empower women as farmers (The World Bank, FAO, and IFAD 2009; United States Government 2010).

The household remains the primary unit of production in agriculture in most parts of the developing world. In patriarchal social systems, men often have ownership and control over land while women provide the majority of labor. The recent growth of agro-industries and patterns of male migration to urban areas make it imperative to reexamine gender relations as the structure of family farms is rapidly changing (Saito, Makonnen, and Spurling 1994; Sachs 1996). Privatization, commercialization, and capitalization of agriculture contribute to unequal access to resources between genders.

Failure of agricultural development programs is partly due to lack of consideration of gender issues in program planning. An illustrative example of this tendency to overlook women comes from Mali, where IPM CRSP introduced a "no-host" period in tomato production to combat the whitefly (*Bemisia tabaci*) that was destroying tomatoes (IPM-CRSP 2007). A "no-host" period involves a collective decision by farmers to wait a few months before planting in order to minimize the opportunity for the white fly to reproduce. For this technique to be effective, all farmers must participate. If project managers overlook women's gardens, the white fly is free to reproduce in these spaces, which will lead to the infestation of other tomato crops planted after the "no-host" period is completed. Women have a very important role in pest management. Scientists and planners must take women's knowledge into account. Otherwise, they lose vital information and, as shown in the "no-host" example, reduce their chances of success.

The realization of the importance of women for economic development project success initiated a massive emergence of multidisciplinary research about women in agriculture. Ester

Boserup's (1970) book *Women's Role in Economic Development* was one of the first to recognize women's important role in agricultural development. In spite of the popularity of gender research in agriculture, mainstream practices in agricultural development projects and research have not been sufficiently reformed to take into account women's perspectives (Doss 2001).

The USAID-funded IPM Collaborative Research Support Program (IPM CRSP) is committed to prioritizing women's needs in research projects around the world. Previous research by IPM CRSP has shown that women do participate in pest control and have considerable influence over outcomes. An example from Mali has shown that when IPM training is limited to men, women continue to apply chemical pesticides even while their husbands use IPM techniques (Christie 2007). IPM CRSP has developed methods for integrating women into research and IPM training (Hamilton et al. 2005).

Women play a distinct and important role in agriculture. Women farmers have been found to have more influence in decision-making than expected by researchers and have less access to resources than their male counterparts (Tanzo 2005). Women are engaged in production of food crops for subsistence, as well as for sale in local and export markets. Women comprise 43 percent of agricultural labor worldwide (FAO 2011). In Uganda, studies have shown that as much as 75 percent of agricultural producers are women (The World Bank, FAO, and IFAD 2009). It makes sense then that programs for agricultural development should incorporate those who do the most work if they are to be effective, and take account of the gendered division of labor if they are to be equitable.

A significant issue addressed in gender and agriculture literature is the time shortage that women face due to their dual reproductive and productive responsibilities within rural households. Women account for the majority of food production in addition to being responsible for child-care, maintaining the home, and in the case of mixed farming systems, tending to livestock. Research indicates that women work one and a half times as much as men do. Additionally, the limited access to resources faced by women reduces their agricultural productivity by 20 percent (Bagchee 1994; FAO 2011). In Kenya, for example, a study found that even though the output from men's plots was 8 percent higher than that from women's plots, if women used the same amount and quality of inputs as men did, their output would increase by about 22 percent (Saito, Makonnen, and Spurling 1994). Additionally, women are particularly vulnerable to negative consequences of agricultural activities that increase productivity because they are often the first to experience increased labor and time demands (Agricultural Development Program 2008). The combination of limited time and access to quality resources puts women farmers at a disadvantage for adopting new technologies and increasing productivity.

Men and women do not farm under identical conditions. Differences along lines of gender create constraints to IPM adoption. Lack of social recognition of women as farmers prevents them from participating in organizations that offer technical and marketing assistance. Women are also constrained by poor access to hired labor (Doss 2001). Many IPM techniques are more labor-intensive than traditional pest management, which relies on pesticides, and require control over and means to hire labor that women often do not have. Women farmers receive greatest benefit from technologies that save labor and time (Hamilton et al. 2005).

2.3 Sources of Information

Roger's (2003) diffusion of innovation model has been applied extensively to the adoption of new agricultural technology (Miller, Mariola, and Hansen 2007). Rogers (2003, 5) defines diffusion of innovation as "the process by which an innovation is communicated through certain channels over time among the members of a social system." There are debates in the literature about whether it is appropriate to apply the model to environmental technologies, such as those in IPM, rather than the usual commercial technologies. Unlike commercial innovations that generally result in an increase of profits, environmental innovations often lead to a decrease in profits. In the case of the latter, "costs of adoption are borne by the individual farmer, while the benefits accrue to society at large" (Miller, Mariola, and Hansen 2007, 3). Also, there are arguments about what role institutions and formal sciences play in innovation adoption in the developing world (Ahmad and Ruttan 1988; Miller, Mariola, and Hansen 2007).

Institutional factors in IPM adoption, such as mode of contact between farmers and extension agents, have been understudied although "in the long run, institutional factors may have the greatest impact on adoption and use of conservation practices" (Clearfield and Osgood 1986, 9). There is research in Kenya, however, that has shown that contact with extension agents has a positive impact on men's plots but not on women's. Differences in effectiveness of extension services for men and women may be impacted by the low proportion of women extension agents (Saito, Makonnen, and Spurling 1994). Debates throughout the literature illustrate that the diffusion of knowledge about IPM innovation is complex and difficult to analyze.

Farmers' awareness of methods for controlling pests comes from various sources. An important source is extension services that contact and interact directly with farmers. The knowledge gained from direct exposure to an authoritative source, such as an extension officer, is then passed on to other farmers through community interactions (Wyckhuys and O'Neil 2007). Agricultural program developers often ignore cultural or traditional knowledge, which is also an important resource to consider in relation to pest control. Many researchers support a participatory process that involves understanding and being sensitive to indigenous knowledge systems (Chambers 1979; Morales and Perfecto 2000; van Mele et al. 2002; Williamson et al. 2003; Ortiz 2006; Wyckhuys and Neil 2007). Robert Chambers (1979, 1) has claimed that “[t]he interests of those who are weaker would be better served if more of the powerful professionals would step down off their pedestals, seek out the poorer people, and sit down, listen and learn.” Farmers may also gain knowledge through individual experimentation and observation (Grossman 1992). Understanding small-scale farmers’ existing knowledge about pest management is a critical step in the effort to extend IPM implementation.

There are gender differences in sources of information about agricultural activities. In Africa, women comprise about 20 percent of those in formal agricultural training programs (Bagchee 1994). Agricultural extension has traditionally been focused on cash crop activities, which have been dominated by men. Also, women are burdened by a heavy workload at home, including child-care, and are less likely to attend training programs far from their homes. Considerable research has been done to explore solutions to unequal access to training programs (Jiggins, Samanta and Olawoye 1997). Women also experience limited access to many social networks that expand beyond their own village, partly due to transportation constraints (Calvo 1994). Social hubs, such as bars and recreational halls, which are more often frequented by men than women, provide occasion to listen to news and other information, such as that concerning market conditions and prices. Research indicates that those outside of social networks are often the poorest and most vulnerable (Torkelsson 2007). In general, men have greater access than women to formal sources of information (Erbaugh et al. 2003; Torkelsson 2007).

2.4 Decision Making and the Role of Extension Services

Researchers have identified many environmental, cultural, institutional, and socioeconomic factors that influence farmers' decisions about pesticides use (Igodan, Ohaji, and Ekpere 1988; Zalom 1993; Patterson 1996; Elsey and Sirichoti 2001; Grossman 2004). Factors include access to necessary resources, such as land or extension services, individual perception of effectiveness or safety of pest management methods, gender, type of crop being grown, market characteristics, physical geography, and infrastructure conditions (Patterson 1996). Also, lack of labor can be a significant constraint in IPM adoption as IPM is often labor intensive (Hasnah, Fleming, and Coelli 2004). Ultimately, individuality and experimentation among farmers make pesticide-use patterns highly variable and difficult to predict (Grossman 2004).

Contact with extension services has consistently been identified throughout the literature as highly influential in small farmer pest management practices and knowledge (Voh 1982; Byerlee 1987; Igodan, Ohaji, and Ekpere 1988; Elsey and Sirichoti 2001; van Mele et al. 2002; Nathaniels et al. 2003; Williamson et al. 2003; Ortiz 2006; Miller, Mariola, and Hansen 2007; Wyckhuys and O'Neil 2007). In their study of growers in Thailand, Elsey and Sirichoti (2001, 7) found that "the most important factors influencing the adoption of IPM was the amount of satisfaction growers had with the quality of IPM information and explanation." Extension services have often provided to farmers recommended techniques that are oversimplified and summed up in a "recipe for crop production" (Byerlee 1987, 232). IPM is complex and difficult to implement without auxiliary information about how the farm ecosystem works and site specific variables, such as the type of crop and pest (Ehler 2006). Extension officers are therefore challenged to provide farmers with access to resources necessary for IPM adoption (Byerlee 1987).

The complexity and difficulty of implementing IPM require a shift away from extension efforts based on “transfer of technology” (TOT) in which farmer perspectives are not taken into account and farmers are expected to follow recommendations without understanding the reasons for them. Knowledge transfer should happen in both directions between farmer and extension services to provide adequate knowledge for farmers to make decisions in coping with everyday problems that arise (Williamson et al. 2003). Unfortunately, extension services in developing countries are often non-existent or underfunded and poorly trained in relation to IPM (Patterson 1996).

The making and prioritization of extension services are influenced by a variety of factors. For example, agricultural areas that are closer to urban areas may be less vulnerable to poverty due to an increase in occupational diversity (Schlosser 2000). Extension services involving transfer of agricultural recommendations and advice must therefore be directed outward to more remote rural areas where agriculture is the primary source of income (Christoplos and Farrington 2004). Some researchers point to the need for extension services that are “capable of negotiating solutions to cultural differences among research and development professional and between external actors and communities” (Sherwood, Cole, and Crissman 2007, 192). The role of extension officers demands a high degree of flexibility. Farmers learn about IPM most effectively through participatory research, Farmer Field Schools (FFS), and well-rounded institutional training (Wyckhuys and O'Neil 2007). Participatory research in this context is the collaboration of farmers and researchers in the research and development of agriculture (Bentley

1994). Extension services are expected to facilitate access to information as well as the socio-political context of the market (Christoplos and Farrington 2004).

2.5 Spatial Patterns in IPM Adoption

Using a GIS for spatial analysis is advantageous because it provides the capacity to analyze the spatial variability of many factors simultaneously. The success of agriculture is influenced by many factors that can be observed in a GIS, such as climate, soil, terrain, infrastructure, and location of markets. Application of GIS analysis for agricultural research adds the ability to integrate qualitative and quantitative site-specific variables (Coulson 1992). In spite of the insights promised by spatial analysis, integration of spatial information and analytical tools in agricultural assessment has been understudied (Wood and Chamberlin 2003). Spatial analysis is limited because of the lack of relevant data sets at a useful scale. Most agricultural data are only available for a highly aggregated geographic coverage. However, the use of remote sensing has facilitated the construction of more complete vegetation cover data sets (Wood and Chamberlin 2003). The development of worldwide comprehensive, disaggregated spatial datasets is a critical first step in the incorporation of spatial analysis for agricultural research and development.

Strategies used for pest management may vary spatially with respect to urban centers and extension offices. Schlosser (2000) noted in his research in Jamaica that there is a decrease in the importance of agriculture as an economic activity with increased proximity to urban areas. The economic diversity of communities closer to urban centers was found to be greater than those in very rural, remote areas where people are dependent on agricultural income. The vulnerability of farmers to agricultural issues, such as pest management, therefore, varies spatially. The decrease in economic diversity with increased distance to urban areas may be described as distance decay. Distance and distance decay are concepts central to the discipline of geography. “Distance plays a role in the distribution of ideas, technology, population, and interaction of various types” (Eldridge and Jones 1991, 1). The spatial pattern of increasing economic primacy of agriculture with distance from urban centers suggests that the places most in need of agricultural extension are the ones farthest from centers from innovation.

Mobility is an important spatial factor that affects the exposure to and adoption of new agricultural technologies. Women’s personal mobility is limited by their responsibilities at home, most significantly their role as child caretaker. Even when another woman is present within the home and can take on some of the child-care responsibilities, women do not necessarily increase their mobility due to social norms and fear of being ostracized for disregarding their role within the household (Mandel 2004). Torkelsson (2007, 21) aptly described the limitations of women’s mobility by their responsibilities in the home as a “Cinderella-paradox” because they *de jure* have the freedom to move about as they wish and participate in social activities outside the home but are so heavily burdened by reproductive responsibilities and societal stigmas present throughout sub-Saharan Africa associated with highly-mobile women, that they find themselves without the time or desire to do so.

Bicycles are the most important form of transportation for rural Ugandans. In most areas of the country, however, they are rarely used for transportation by women, however, because of cultural, educational, and economic constraints (Calvo 1994). Bicycles are commonly used for activities such as going to a market, visiting neighboring villages, and making social calls. Women encounter fewer opportunities than men for exposure to new ideas and technologies because of the constrained use of this critical form of transportation.

2.6 Issues in IPM Adoption

Development of technologies that are relevant to farmers' needs and can be easily adopted by small-scale, resource-poor farmers is critical for the success of agricultural development projects. Often, however, there is a large gap between researchers and farmers (Bagchee 1994). Research has tended to occur primarily in areas where agricultural development projects are underway and with the more influential and less-poor rural people (Chambers 1981). These biases limit the visibility of the actual status of poverty and lead to ineffective development programs. New technologies will not be adopted until related issues, such as poor infrastructure, unreliable markets, or unfair pricing policies are addressed and ameliorated (Lado 1998). Consequently, new technologies are often poorly adopted, resulting in low yields, crop diseases and pests, as well as indiscriminate use of chemicals (Ssonko et al. 2005).

The degree of IPM adoption by farmers is difficult to determine. IPM involves many techniques that may be used in varying degrees. In order to assess IPM adoption, a consensus on a definition of IPM must be reached (Kogan and Bajwa 1999). Prokopy (2003, 299) has defined IPM as "a decision-based process involving coordinated use of multiple tactics for optimizing the control of all classes of pests in an ecologically and economically sound manner." Kogan and Bajwa (1999, 6) found sixty-seven definitions of IPM throughout the literature proposed between 1959-1998, but all of them include similar concepts, such as decision-making and minimizing environmental impact.

There are no established criteria for operationalizing IPM or distinguishing it from other cultural pest controls. Among the criteria currently used for identifying IPM are use of crop and pest monitoring procedures, access to appropriate information in order to support decision-making, use of control tactics that follow IPM principles, consideration of environmental impacts of control actions, and consideration of the total ecosystem (Kogan and Bajwa 1999). Measurement of IPM adoption has been the subject of much debate because IPM programs currently in place need to be evaluated for effectiveness. Some criteria used for measuring performance of an IPM program include reduction of pest populations and their impact on crop production, reduction of pesticide input, preservation of local environment, increased safety for farm workers, and increased consumer confidence in safety of products.

Various techniques for quantifying IPM adoption have been used by researchers. Many studies rely on farmer responses to surveys about their management practices (Morales and Perfecto 2000; Blake et al. 2007). More qualitative studies use techniques involving individual interviews of farmers and participatory group analysis to assess IPM adoption (Murray and Hoppin 1992; Williamson et al. 2003). Qualitative research techniques, such as participant observation and conducting interviews, are particularly influenced by the social and cultural backgrounds of the individuals involved. Positionality of researchers, therefore, must be considered as a factor influencing methodology and data collection (Kitchin 2006).

The unit of analysis used in IPM research is variable as well. Household-level surveys are common but some research highlights the importance of understanding variability that can occur within households, especially between men and women (Atreya 2007).

2.7 IPM in Uganda

Small-scale farming is well suited for farmer participation in IPM development. In sub-Saharan Africa, approaches combine indigenous farmer knowledge with scientific knowledge to develop site-specific IPM systems. This approach is called “knowledge-intensive” because it requires in-depth understanding of specific site variables in order for implementation to be successful (Erbaugh et al. 2005). Development and implementation of site-specific IPM systems requires participatory research and extension.

IPM CRSP has applied a participatory IPM (PIPM) approach for small-scale farmers in East and West Africa. This approach involves collaboration with farmers at each step of the research process. A PIPM approach seeks to identify priority crops, pests, and constraints on IPM adoption. A baseline survey conducted for IPM CRSP research sites in Uganda has produced in-depth descriptions of local farmer characteristics (Erbaugh et al. 2005).

According to a baseline survey, Ugandan farmers employ pesticides as the primary form of pest control (Erbaugh et al. 2005). Pesticide use is associated with cash-crop production. Knowledge of other pest control methods as well as knowledge of beneficial insects is limited. This fact requires the introduction of knowledge-based technologies in order to raise knowledge of pests and diseases. This knowledge is vital for making appropriate, informed pest-management decisions. In addition, both male and female farmers at the research sites in Uganda identify pests and labor as the most important constraints on agricultural production (Erbaugh et al. 2005).

Gender issues in the adoption of improved farming methods, such as IPM, are complex. It is important to understand these issues, however, in order for alternative agriculture technologies to be viable, relevant, and successful. In the sub-Saharan Africa context, disparities in transportation and mobility between men and women should be considered more thoroughly as these factors may have a significant impact on women’s ability to adopt certain farming methods. Also, distribution and spatial organization of agricultural inputs are important variables that have generally been overlooked in IPM research. Additionally, geospatial technologies, such as geographic information systems (GIS), have been underutilized as a tool for analyzing the factors associated with small-scale farmer decision-making and use of improved farming methods.

2.8 References

Agricultural Development Program. 2008. *Gender Impact Strategy for Agricultural Development.* Bill & Melinda Gates Foundation. Available from: http://www.gatesfoundation.org/learning/Documents/gender-impact-strategy.pdf.

Ahmad, I and V. W. Ruttan, eds. 1988. *Generation and Diffusion of Agricultural Innovations: The Role of Institutional Factors*. Brookfield: Gower Pub. Co.

Atreya, K. 2007. "Pesticide Use Knowledge and Practices: A Gender Differences in Nepal." *Environmental Research* 104(2):305-311.

Bagchee, A. 1994. *Agricultural Extension in Africa*. World Bank Discussion Papers 231. Washington, D.C.: The World Bank.

Bentley, J. W. 1994. "Facts, Fantasies, and Failures of Farmer Participatory Research." *Agriculture and Human Values* 11(2):140-150.

Blake, G., H. A. Sandler, W. Coli, D. M. Pober, and C. Coggins. 2007. "An Assessment of Grower Perceptions and Factors Influencing Adoption of IPM in Commercial Cranberry Production." *Renewable Agriculture and Food Systems* 22(2):134-144.

Boserup, E. 1970. *Woman's Role in Economic Development*. London: Earthscan.

Bryson, J. C. 1981. "Women and Agriculture in Sub-Saharan Africa: Implications for Development (an Exploratory Study)." *Journal of Development Studies* 17(3):29-46.

Byerlee, D. 1987. "From Adaptive Research to Farmer Recommendations and Extension Advice." *Agricultural Administration and Extension* 27(4):231-244.

Calvo, C. M. 1994. *Case Study on Intermediate Means of Transport : Bicycles and Rural Women in Uganda*. Sub-Saharan Africa Transport Policy Program Working Paper No. 12. Washington, D.C.: The World Bank.

Chambers, R. 1979. "Editorial." *The IDS Bulletin* 10(2):1-3.

Chambers, R. 1981. "Rural Poverty Unperceived: Problems and Remedies." *World Development* 9(1):1-19.

Christie, M. E. 2007. *Final Gender Report for IPM Phase Two*. unpublished report, IPM CRSP.

Christoplos, I and J. Farrington, eds. 2004. *Poverty, Vulnerability, and Agricultural Extension: Policy Reforms in a Globalizing World*. New York: Oxford University Press.

Clearfield, F., and B. Osgood. 1986. *Sociological Aspects of the Adoption of Conservation Practices.* Washington, D.C.: Natural Resources Conservation Service.

Coulson, R. N. 1992. "Intelligent Geographic Information Systems and Integrated Pest Management." *Crop Protection* 11(6):507-516.

Davison, J. 1988. "Who Owns What? Land Registration and Tensions in Gender Relations of Production in Kenya." In *Agriculture, Women, and Land : The African Experience,* ed. J. Davison, pp. 157-176. Boulder: Westview Press.

Doss, C. R. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29(12):2075-2092.

Doss, C. R. and M. L. Morris. 2001. "How Does Gender Affect the Adoption of Agricultural Innovations?: The Case of Improved Maize Technology in Ghana." *Agricultural Economics* 25(1):27-39.

Ehler, L. E. 2006. "Integrated Pest Management (IPM): Definition, Historical Development and Implementation, and the Other IPM." *Pest Management Science* 62(9):787-789.

Eldridge, J. D. and J. P. Jones. 1991. "Warped Space: A Geography of Distance Decay." *Professional Geographer* 43(4):500-511.

Elsey, B., and K. Sirichoti. 2001. "The Adoption of Integrated Pest Management (IPM) by Tropical Fruit Growers in Thailand as an Example of Change Management Theory and Practice." *Intergrated Pest Management Reviews* 6:1-14.

Erbaugh, J. M., J. Caldwell, S. Kyamanywa, K. T. Gamby, and K. Moore. 2005. Developing IPM Packages in Africa. In *Globalizing Integrated Pest Management a Participatory Research Process*, eds. G. W. Norton, E. A. Heinrichs, G. C. Luther and M. E. Irwin, pp 51-69. Ames: Blackwell Publishing.

Erbaugh, J. M., J. Donnermeyer, M. Amujal, and S. Kyamanywa. 2003. "The Role of Women in Pest Management Decision Making in Eastern Uganda." *Journal of International Agriculture and Extension Education* 10(3):71-81.

Ezumah, N. N., and C. M. Di Domenico. 1995. "Enhancing the Role of Women in Crop Production: A Case Study of Igbo Women in Nigeria." *World Development* 23(10):1731-1744.

Food and Agriculture Organization. 2011. Women in Agriculture: Closing the Gender Gap for Development. In *The State of Food and Agriculture.* Rome.

Galt, R. E. 2007. "Regulatory Risk and Farmers Caution with Pesticides in Costa Rica." *Transactions of the Institute of British Geographers* 32(3):377-394.

Grossman, L. S. 1992. "Pesticides, Caution, and Experimentation in St. Vincent, Eastern Caribbean." *Human Ecology* 20(3):315-336.

———. 2004. Understanding Pesticide Misuse in Developing Countries. In *Worldminds: Geographical Perspectives on 100 Problems,* eds. B. W. Donald, G. Janelle, and K. Hansen, pp 425-429. Boston: Dordrecht.

Hamilton, S., K. Moore, C. Harris, M. Erbaugh, I. Tanzo, C. Sachs, and L. A. de Bariios. 2005. Gender and IPM. In *Globalizing Integrated Pest Management a Participatory Research Process*, eds. G. W. Norton, E. A. Heinrichs, G. C. Luther and M. E. Irwin, pp 263-289. Ames: Blackwell Publishing.

Hasnah, E. Fleming, and T.J. Coelli. 2004. "Assessing the Performance of a Nucleus Estate and Smallholder Scheme for Oil Palm Production in West Sumatra: A Stochastic Frontier Analysis." *Agricultural Systems* 79(1):17-30.

Igodan, C. O., P. E. Ohaji, and J. A. Ekpere. 1988. "Factors Associated with the Adoption of Recommended Practices for Maize Production in the Kainji Lake Basin of Nigeria." *Agricultural Administration and Extension* 29(2):149-156.

IPM CRSP. 2007. "Gender and IPM." IPM CRSP, April 1, 2008. Available from: http://www.oired.vt.edu/ipmcrsp/what_we_do/gender%20continued.htm.

Jiggins, J., R. K. Samanta, and J. E. Olawoye. 1997. Improving Women Farmers' Access to Extension Services. In *Improving Agricultural Extension*, eds. B. E. Swanson, R. P. Bentz and A. J. Sofranko. Rome: Food and Agriculture Organization of the United Nations.

Kitchin, R. 2006. Positivistic Goegraphies and Spatial Science. In *Approaches to Human Geography*, eds. S. C. Aitken and G. Valentine. London: SAGE.

Kogan, M. and W. I. Bajwa. 1999. "Integrated Pest Management: A Global Reality?" *Anais da Sociedade Entomologica do Brasil* 28(1):1-25.

Lado, C. 1998. "The Transfer of Agricultural Technology and the Development of Small-Scale Farming in Rural Africa: Case Studies from Ghana, Sudan, Uganda, Zambia and South Africa." *GeoJournal* 45(3):165-176.

Mandel, J.L. 2004. "Mobility Matters: Women's Livelihood Strategies in Porto Novo, Benin." *Gender, Place and Culture* 11(2):257-287.

Miller, M. J., M. J. Mariola, and D. O. Hansen. 2007. "Earth to Farmers: Extension and the Adoption of Environmental Technologies in the Humid Tropics of Costa Rica." *Ecological Engineering* 34(4):349-357.

Morales, H., and I. Perfecto. 2000. "Traditional Knowledge and Pest Management in the Guatemalan Highlands." *Agricultural and Human Values* 17(1):49-63.

Murray, D. L., and P. Hoppin. 1992. "Recurring Contradictions in Agrarian Development: Pesticide Problems in Caribbean Basin Nontraditional Agriculture." *World Development* 20(4):597-608.

Nathaniels, N. Q. R., M. E. R. Sijaona, J. A. E. Shoo, and N. Katinila. 2003. "IPM for Control of Cashew Powdery Mildew in Tanzania. I: Farmers Crop Protection Practices, Perceptions and Sources of Information." *International Journal for Pest Management* 49(1):25-36.

Norton, G. W., E. A. Heinrichs, G. C. Luther, and M. E. Irwin, eds. 2005. *Globalizing Integrated Pest Management, a Participatory Research Process*. Ames, Iowa: Blackwell Publishing.

Orr, A. 2003. "Integrated Pest Management for Resource-Poor African Farmers: Is the Emperor Naked?" *World Development* 31(5):831-845.

Ortiz, O. 2006. "Evolution of Agricultural Extension and Information Dissemination in Peru: An Historical Perspective Focusing on Potato-Related Pest Control." *Agriculture and Human Values* 23(4):477-489.

Patterson, K. A. 1996. *The Political Ecology of Nontraditional Agricultural Exports and an IPM Project in Jamaica*, unpublished thesis (M.S.), Virginia Polytechnic Institute and State University.

Prokopy, R. J. 2003. "Two Decades of Bottom-Up, Ecologically Based Pest Management in a Small Commercial Apple Orchard in Massachusetts." *Agriculture, Ecosystems and Environment* 94(3):299-309.

Picard, M. T. 1995. Listening to and Learning from African Women Farmers. In *Women and Sustainable Development in Africa*, ed. V. U. James, pp 35-62. Westport: Praeger.

Poats, S. V. 1991. *The Role of Gender in Agricultural Development*. Issues in Agriculture Paper 3. Washington, D.C.: Consultative Group on International Agricultural Research.

Rogers, E. M. 2003. *Diffusion of Innovations.* 5th ed. New York: Free Press.

Sachs, C. E. 1996. *Gendered Fields: Rural Women, Agriculture, and Environment*. Boulder: Westview Press.

Saito, K. A., H. Mekonen, and D. Spurling. 1994. *Raising the Productivity of Women Farmers in Sub-Saharan Africa*. World Bank Discussion Papers 230. Washington, D.C.: The World Bank.

Schlosser, G. L. 2000. *Gendered Production Roles and Integrated Pest Management in Three Jamaican Farming Communities*, unpublished thesis (M.S.), Virginia Polytechnic Institute and State University.

Sherwood, S., D. Cole, and C. Crissman. 2007. "Cultural Encounters: Learning from Cross-Disciplinary Science and Development Practice in Ecosystem Health." *Development in Practice* 17(2):179-195.

Ssonko, R., E. Njue, J. M. Ssebuliba and A. de Jager. 2005. *Pro-Poor Horticulture in East Africa and South East Asia: The Horticulture Sector in Uganda.* Scripta Horticulture No. 1. Belgium: International Society for Horticultural Science.

Tanzo, I. R. 2005. *Women and Pesticide Management in the Philippines: An Assessment of Roles and Knowledge*, unpublished thesis (PhD), Pennsylvania State University.

Torkelsson, A. 2007. “Resources, Not Capital: A Case Study of the Gendered Distribution and Productivity of Social Network Ties in Rural Ethiopia.” *Rural Sociology* 74(4):583-607.

United States Government. 2010. "Feed the Future Guide." January 26, 2011. Available from: http://www.feedthefuture.gov/guide.html.

USAID. 2007. "Sub-Saharan Africa: Initiative to End Hunger in Africa (IEHA)." United States Agency for International Development, March 20, 2008 Available from: http://www.usaid.gov/locations/sub-saharan_africa/initiatives/ieha.html.

van Mele, P., T. V. Hai, O. Thas, and A. van Huis. 2002. "Influence of Pesticide Information Sources on Citrus Farmers' Knowledge, Perception and Practices in Pest Management, Mekong Delta, Vietnam." *International Journal of Pest Management* 48(2):169-177.

Voh, J. P. 1982. "A Study of Factors Associated with the Adoption of Recommended Farm Practices in a Nigerian Village." *Agricultural Administration* 9(1):17-27.

Williamson, S., A. Little, M. Arif Ali, M. Kimani, C. Meir, and L. Oruko. 2003. "Aspects of Cotton and Vegetable Farmers' Pest Management Decision-Making in India and Kenya." *International journal of Pest Management* 49(3):187-198.

Wood, S. and J. Chamberlin. 2003. "Enhancing the Role of Spatial Analysis in Strategic Impact Assessment: Improving Data Resolution for Regional Studies." *Quarterly Journal of International Agriculture* 42(2):167-187.

The World Bank, Food and Agriculture Organization, and International Fund for Agricultural Development. 2009. *Gender in Agriculture Sourcebook.* Washington, D.C.: The World Bank.

Wyckhuys, K. A. G., and R. J. O'Neil. 2007. "Role of Opinion Leadership, Social Connectedness and Information Sources in the Diffusion of IPM in Honduran Subsistence Maize Agriculture." *International Journal of Pest Management* 53(1):35-44.

Zalom, F. G. 1993. "Reorganizing to Facilitate the Development and Use of Integrated Pest Management." *Agriculture, Ecosystems and Environment* 46:245-256.

Chapter 3: Spatial and Gender Dimensions of IPM Adoption in Uganda

Abstract

This research on gender and tomato production in rural sub-county of Busukuma in Uganda explores the roles that distance and mobility play in adoption of environmentally friendly crop protection practices. Uganda's National Agricultural Research Organization (NARO) prioritized blight and bacterial wilt as significant detrimental crop diseases for tomatoes, an important high-value horticulture crop. Tomato farmers have also identified these diseases as primary constraints for crop production and have employed chemical pesticides to reduce crop losses. One focus of the Integrated Pest Management Collaborative Research Support Program (IPM CRSP), which is managed by Virginia Tech, has been the development of an IPM package to lower the use of pesticides in tomato production while reducing the incidence of such crop diseases. Recommended practices increase yields, save money on inputs, and improve health conditions.

Women are responsible for the majority of food production in sub-Saharan Africa; therefore, an understanding of women's issues is critical for the success of agricultural projects, such as the IPM program in Uganda. This research seeks to determine problems women farmers face in adopting the farming practices recommended by the IPM CRSP. Gender-specific constraints make adopting IPM more costly and time-consuming for women. Surveys, interviews, focus group discussions and GIS analysis were completed to determine if adoption of the recommended IPM package is affected by gender constraints in mobility and distances to inputs.

3.1 Introduction to Research

African leaders recognize that the problems of poverty and hunger that persist among the people of sub-Sahara Africa must be ameliorated through economic growth based upon agriculture. Global partnerships, such as the United States Agency for International Development's (USAID) Initiative to End Hunger in Africa (IEHA) and the U.S. Government initiative, Feed the Future (FTF), are focused on ensuring that income generation through agriculture is a viable and secure option. It is estimated that one in three Africans are undernourished (USAID 2007). Basic nutritional needs must be met before people can effectively contribute to the economy and broad improvements in wellbeing can be experienced. Additionally, increasing agricultural productivity will benefit countless households in African countries where the agricultural sector encompasses a large majority of the work force; for example, approximately 80 percent of the workforce in Uganda is involved in agriculture (Kalley 2006).

To achieve the goals of the IEHA and FTF, there has been a large investment in research and development projects to implement technologies to improve agricultural productivity. The success of these projects is dependent on an adequate focus on women smallholder farmers for two reasons. First, women play an important role in agriculture. In a survey of Kenyan farmers, 61 percent of women cited farming as their primary occupation, compared to only 24 percent of men (Saito, Makonnen, and Spurling 1994). Furthermore, women across sub-Saharan Africa make up approximately half of agricultural labor and produce the large majority of food crops (FAO 2011). Women in Kenya, for example, "are responsible for over eighty percent of the food crops and contribute substantially to cash crop production" (Davison 1988, 157). The second reason is that women are often highly marginalized. Despite their critical role in food production, women generally have less access to resources, such as land, labor, technology, extension, and credit (Gladwin and McMillan 1989; Quisumbing 1995; Jiggins, Samanta, and Olawoye 1997; Doss 1999, 2001; Flora 2001; Torkelsson 2007; FAO 2011). These two concerns point to the "food insecurity paradox in sub-Saharan Africa" (Saito, Makonnen, and Spurling 1994, 15). Women farmers make up the majority of the food insecure population yet they are responsible for a large portion of food production. Women's participation must be prioritized as critical for the success of programs since women are invariably a vital part of crop production and often make important agricultural decisions. Despite the active effort of program developers to integrate women through participatory research techniques, women continue to be constrained by numerous factors, such as limited access to resources and information, the division of household labor, and social roles.

One of the key issues for both male and female farmers in Africa and elsewhere is coping with losses in agriculture due to pests. The Integrated Pest Management Collaborative Research Support Program (IPM CRSP) is a USAID-sponsored program that is designed to develop and implement sustainable pest management methods. In relation to sustainable pest management systems, integrated pest management has universally become "the paradigm of choice" for holistic crop management aimed at reducing the use of chemical inputs during crop production while also increasing economic productivity (Kogan and Bajwa 1999, 2). The many benefits of IPM range from environmental to social. IPM raises individual farmers' crop productivity, reduces expenditures on pesticides, and improves conditions for human and environmental health.

3.2 Uganda Context

The IPM CRSP, in a project led by the Ohio State University, has been working in Uganda (Figure 1) since 1994 in collaboration with Makerere University to implement IPM techniques for use with high-value horticultural crops, such as tomatoes. The tomato IPM package has proven to be very effective in increasing farmer productivity and reducing pesticide usage. The package consists of several components: use of a tomato variety resistant to bacterial wilt (MT56); reduced pesticide application; use of mulch; and use of staking. Farmer Field Schools (FFS) have been used to introduce the package to a small group of about twenty farmers in Busukuma sub-county, located in the Wakiso district of southeastern Uganda (Figures 2 and 3). Despite an effort to disseminate the package to other farmers, there has been almost no adoption outside of this FFS group (IPM CRSP 2008).

Many of the constraints faced by the IPM tomato project in Uganda are distinctively spatial. Farmer access to markets, improved seeds, staking and mulching material, and information about IPM all require the movement and transport of items and ideas. Distance from the source of these resources can be the limiting factor that determines if an individual farmer will adopt IPM. Analysis of the spatial factors and patterns related to IPM adoption can foster a deeper understanding of the processes behind pest management decisions. Additionally, spatial technology, such as a GIS, can allow analysis of more complex factors, such as gendered access to these resources.

This research aims to explore constraints facing tomato farmers in Busukuma sub-county in the adoption of IPM. Specifically, I am interested in identifying any differences in the constraints that women and men experience in relation to IPM adoption. Additionally, this research investigates spatial factors, such as distance and modes of transportation in the production and marketing of tomatoes, and the implications they have for the adoption of IPM.

Finally, I make recommendations based on the findings of this research for the IPM CRSP to help meet its project objectives.

3.3 Study Site

Busukuma sub-county is part of Kyadondo County in Wakiso District and covers approximately 45 square miles. It is located 15 miles from the capital city of Kampala. The sub-county is comprised of eight parishes and thirty-eight villages. As of the 2002 Population and Housing Census, the sub-county had a population of 27,207 people (Busukuma Technical Planning Committee 2007). The majority of the residents are from the Baganda tribe and speak the language of Luganda. The major religions are Catholicism, Protestantism, and Islam.

Busukuma has a mild tropical climate with monthly temperatures ranging from 59°F to 82°F. Due to its location near the equator, the region experiences very little change in average temperatures throughout the year. There are two distinct wet seasons from April to May and October to November. Annual rainfall is approximately 46 inches. The elevation of the sub-county ranges from 2,952 to 4,396 ft.

Similar to patterns in most of central Uganda, the mailo system of land tenure is used in Busukuma sub-county. In this system, a few elite residents own titles to the land but tenants do most of the farming. Tenant farmers have rights to farm the land and cannot be evicted without compensation.

Busukuma sub-county experiences a high rate of rural-urban migration to the nearby capital of Kampala. Most of the residents who remain in Busukuma engage in subsistence agriculture and sell produce for income generation. There is a high rate of poverty amongst the sub-county residents. The main cash crops grown are coffee and cotton (Busukuma Technical Planning Committee 2007).

The IPM CRSP has been working to encourage farmers in Busukuma sub-county to adopt an IPM package for growing tomatoes. The IPM CRSP project's objective is to develop a regional model for IPM research and training for improving crop productivity while reducing the use of pesticides. I chose Busukuma sub-county as the study site for this research because it is one of IPM CRSP's numerous project locations. Existing infrastructure for research created by the work done by the IPM CRSP, such as relationships with local extension workers and farmers, made it ideal as a study site in the context of limited funds and time available for this research. Also, the efforts in Busukuma to disseminate information about IPM have been largely unsuccessful, and this research concludes with recommendations for improving the project's success and achieving project objectives.

3.4 Literature Review

Agricultural research has identified many themes that are relevant for IPM adoption and gender. There are many constraints and factors that influence decisions about pest management and the adoption of IPM. Among the most critical of these factors are the sources of information used by farmers, agricultural extension in particular. Additionally, there is extensive literature that highlights the importance of women in agriculture and the potential benefits of targeting women in agricultural development projects, including projects that promote IPM. Mobility also plays a role in the diffusion of agricultural innovations. The impact that gender differences in mobility have on adoption of improved agricultural methods is not well understood, however. Research has been completed to further the understanding of gender in relation to IPM adoption;

however, the interaction between spatial factors and gender in IPM adoption has not been addressed.

IPM has universally become “the paradigm of choice” for holistic crop management aimed at reducing the use of agrochemical inputs during crop production while also increasing economic productivity (Kogan and Bajwa 1999, 2). The many benefits of IPM range from environmental to social. Despite its advantages, practical IPM implementation has been limited by constraints found especially in developing countries (Galt 2007).

Researchers have identified many environmental, cultural, institutional, and socioeconomic factors that influence farmers’ decisions about pesticides use (Igodan, Ohaji, and Ekpere 1988; Zalom 1993; Patterson 1996; Elsey and Sirichoti 2001; Grossman 2004). Factors include access to necessary resources, such as land or extension services, individual perception of effectiveness or safety of pest management methods, gender, type of crop being grown, market characteristics, physical geography, and infrastructure conditions (Patterson 1996). Also, lack of labor can be a significant constraint in IPM adoption as IPM is often labor intensive (Hasnah, Fleming, and Coelli 2004). Ultimately, individuality and experimentation among farmers make pesticide-use patterns highly variable and difficult to predict (Grossman 2004).

Small farmers in developing countries use a variety of strategies for pest management. Sources of information about these strategies vary and may be indigenous, local, or institutional. Extension services play an important role in distributing institutional information about recommended agricultural practices to small farmers. There are many studies that focus on the correlation between presence of extension services and IPM adoption by small farmers (Byerlee 1987; Igodan, Ohaji, and Ekpere 1988; Bagchee 1994). Operationalizing the degree of IPM adoption, however, is a difficult issue disagreed upon in IPM research and development (Kogan and Bajwa 1999; Orr 2003; Norton et al. 2005; Ehler 2006).

IPM packages are transferred to farmers through modes of diffusion, such as agricultural extension services, researchers, Farmer Field Schools (FFS), community and focus group meetings, and informal networks amongst farmers (Doss 2001). Institutional factors in IPM adoption, such as modes of contact between farmers and extension agents, have been understudied although “in the long run, institutional factors may have the greatest impact on adoption and use of conservation practices” (Clearfield and Osgood 1986, 9). There is research in Kenya, however, that has shown that contact with extension agents has a positive impact on men’s plots but not on women’s. Differences in effectiveness of extension services for men and women may be impacted by the low proportion of women extension agents (Saito, Makonnen, and Spurling 1994). Debates throughout the literature illustrate that the diffusion of knowledge about IPM innovation is complex and difficult to analyze.

Previous studies have highlighted evidence that suggests that a focus on technology transfer to women is an efficient and effective strategy for knowledge dissemination because of the significant role that women play in agricultural production systems (Boserup 1970; Bryson 1981; Poats 1991; Ezumah and Di Domenico 1995; Doss and Morris 2001). Specifically, research has found that women have a greater understanding of the harmful effects of pesticides; therefore, targeting women farmers may expedite the adoption of health-conscious pest management, such as IPM (Erbaugh 2003). The realization of the importance of women for economic development project success initiated a massive emergence of multidisciplinary research about women in agriculture. Ester Boserup’s (1970) book, *Women’s Role in Economic Development*, was one of the first to recognize women’s important role in agricultural development. Despite popularity of gender research in agriculture, mainstream practices in agricultural development projects and research have not been sufficiently reformed to take into account women's perspectives (Doss 2001). Reaching women farmers requires an understanding of the complex gendered nature of spaces, resources, and knowledge.

Women play a distinct and important role in agriculture. Women farmers have been found to have more influence in decision-making than expected by researchers, and they have less access to resources than their male counterparts (Tanzo 2005). Women are engaged in production of food crops for subsistence, as well as for sale in local and export markets. Women comprise 43 percent of agricultural labor worldwide (FAO 2011). In Uganda, studies have shown that as much as 75 percent of agricultural producers are women (The World Bank, FAO, and IFAD 2009). It makes sense then that programs for agricultural development should incorporate those who do the most work if they are to be effective, and take account of the gendered division of labor if they are to be equitable.

Mobility is an important spatial factor that affects the exposure to and adoption of new agricultural technologies. Women's personal mobility is limited by their responsibilities at home, most significantly their role as child caretakers. Even when another woman is present within the home and can take on some of the child-care responsibilities, women do not necessarily increase their mobility due to social norms and fear of being ostracized for disregarding their role within the household (Mandel 2004).

As with much of sub-Saharan Africa, bicycles are the most important form of transportation in rural Uganda. However, in most areas of the country they are rarely used for transportation by women because of cultural, educational, and economic constraints (Calvo 1994). Bicycles are commonly used for activities such as travel to markets, visiting neighboring villages, and making social calls. Women encounter fewer opportunities than men for exposure to new ideas and technologies because of their constrained mobility.

Equitable and effective distribution of agricultural information and educational resources to small-scale farmers, especially women farmers, is a critical step towards making IPM a viable choice for pest control. Distribution and spatial organization of agricultural inputs are variables that have generally been overlooked in IPM research. Furthermore, in the sub-Saharan African context, disparities in transportation and mobility between men and women should be considered more thoroughly as these factors may have a significant impact on women's ability to adopt certain farming methods, including IPM. Technologies for spatial analysis, such as geographic information systems and global positioning systems, could help to optimize extension services by providing a spatial framework for planning and identifying areas in need. Geographic technology can help answer why and how agricultural ideas and resources move.

3.5 Methodology

I collected the data for this research during three weeks in July and August 2008 with the help of several assistants in Busukuma sub-county. A combination of many methodologies was used to explore research questions and reach objectives.

3.5.1 Sample and Application of Survey

I conducted a survey of 19 male and 22 female tomato farmers in Busukuma sub-county with the help of two research assistants. One research assistant was a graduate student at Makerere University in Agricultural Economics who was native to Uganda and fluent in Luganda, the local language spoken by the research population. The second assistant was the male extension agent for Busukuma sub-county, who also was a native Ugandan and fluent in the local language. The extension agent was integral for expediting the data gathering process. He had established relationships with the farmers in Busukuma sub-county and was able to easily locate them. He also provided introductions between researchers and farmers.

Prior to the fieldwork, I developed a preliminary survey through collaboration with IPM CRSP researchers. The survey incorporated the following variables: modes of transportation of inputs and produce; travel time to tomato garden and water source; pest management techniques used; household gender composition; level of education; amount of land used to farm; and extent of contact with extension agent[1]. At the study site, I tested the survey instrument with two farmers. I then made revisions in order to improve the clarity and effectiveness of the survey based on the results of the test (Appendix A).

No adequate sampling frame was available that would include the target population of all adults in Busukuma sub-county who grow tomatoes. In order to establish a sample of the population, a snowball sample methodology was used. Although the snowball sampling method does not produce a random sample, it was necessary in order to acquire data in the short period of time available for fieldwork. Twenty male and 20 female tomato farmers were targeted from ten villages within the sub-county. The ten villages were chosen in a manner that increased geographic coverage across the sub-county. The agricultural extension agent was asked to identify which villages had at least one tomato grower who he knew of and could locate. These villages were stratified by parish and one village was randomly chosen from each parish. Only seven of the eight parishes in the sub-county contained villages with tomato growers that could be identified by the extension agent. Three of these seven parishes were then chosen randomly,

[1]Extent of contact with extension services was determined by number of visits from extension agent to farmer's home and number of extension meetings attended by a farmer.

and one additional village was randomly chosen from each, which produced a list of ten villages from which to sample. Stratifying the villages by parish provided a more uniform geographically distributed sample of the sub-county and facilitated exploration of the effects of distance to IPM training locations and sources of inputs on IPM adoption (Figure 4).

In each village, a tomato farmer was identified by the extension agent and was surveyed by the two research assistants and myself. The farmer then directed us to another tomato grower within the village who was surveyed. This method was used to find two male and two female participants from each of the ten villages.

I read each survey question aloud to the participants in English and either the extension agent or graduate student research assistant then translated them into Luganda. The participants' responses were translated aloud, and I transcribed them in English. The surveys generally took 15-25 minutes. They were not administered in private, and for most participants, there were several people watching and listening.

3.5.2 Collection of Geospatial Data

I took the GPS coordinate location at each survey participant's place of residence using a handheld GPS unit. I also took GPS data at key locations, including markets that were referenced in the survey responses, health centers nearby, farmer supply areas (for such inputs as seeds, fertilizers, pesticides, and sprayers), Makerere University agriculture department where the IPM researchers were based, the sub-county headquarters where meetings were held to teach IPM techniques, and the IPM demonstration plot (Figure 5). I used these data to create a GIS application for analysis of spatial factors involved in tomato production and pest management.

3.5.3 Focus Group Discussions and Interviews

I held two focus group discussions (FGD) with the help of research assistants to explore gender issues related to tomato production and pest management that are present in the study area. The first FGD was conducted before the survey was administered and provided details about the IPM practices being introduced to farmers and their perceptions of the project. The FGD lasted about two hours and was conducted with farmers who participated in the IPM group meetings held monthly. This group of farmers is very familiar with IPM and most employ IPM to grow their tomatoes. The FGD was held at the sub-county headquarters where the IPM meetings were usually held and IPM demonstration plot was located. The graduate student research assistant led the FGD in the local language and the extension agent transcribed notes in English. Six women and 13 men attended the first FGD.

Discussions followed an outline of questions prepared prior to the meeting. The group collectively completed a mobility map exercise to create a map of the closest village and provide information about the extent of mobility the farmers generally have (Appendix B). Next, the group was split by gender. Each gender group completed another exercise to create a daily activity calendar for a typical week (Appendix C). The mobility map exercise and the activity calendar exercise were adapted from *Tools of Gender Analysis: A Guide to Field Methods for Bringing Gender into Sustainable Resource Management* (Thomas-Slayter, Esser, and Shields 1993).

A second FGD was held that consisted of 15 women and two men farmers. Some attendees were part of the IPM group, and others had never heard of the project. A female graduate student in extension education from Makerere University assisted with the meeting by leading the discussion in the local language. She and another female farmer who spoke English translated the discussion, which I transcribed in English. The discussion was guided by a list of follow-up questions that had arisen during the initial survey and were intended to further explore the gender differences in constraints faced during tomato production. The group represented a wide range of awareness levels about IPM. This meeting lasted about two hours.

Dr. Maria Elisa Christie, Gender Equity Coordinator for IPM CRSP, and I interviewed Dr. Florence Kyazze of Agricultural Extension Education and Dr. Robinah Ssonkko of Crop Science at Makerere University as key informants due to their familiarity with the IPM CRSP project. Each interview lasted about 30 minutes. Dr. Christie helped with formation of questions and facilitated the discussion. Both of these key informants spoke English, which allowed a direct exchange between the interviewees and myself. The guiding questions used were open ended, which allowed for greater elaboration on topics. Follow-up questions were developed “on the fly” based on answers to previous questions.

Dr. Christie and I also interviewed one of the female farmers in Busukuma sub-county as another key informant. She was a young farmer who grew many different crops for market sale and was very familiar with IPM and the IPM CRSP project. She was a valuable source of insight into the gender constraints of IPM adoption and tomato farming. This interview lasted about one hour. She spoke English so no translator was needed for this interview. The guiding questions used were open-ended, allowing for greater elaboration on topics. Follow-up questions were developed “on the fly” based on answers to previous questions.

I also interviewed the extension agent for Busukuma sub-county. He was the only extension agent for the study area and had been working with researchers at Makerere University to implement the IPM project in Busukuma sub-county. He also spoke English, so no translator was used. This interview process was less formal than with the other key informants. Short interviews with the extension agent lasting about 10-20 minutes were conducted many times during the three-week research period. The guiding questions used were open ended, allowing for greater elaboration on topics. Follow-up questions were developed on the fly based on answers to previous questions.

The graduate student who assisted with the second FGD also conducted three brief formal farmer interviews with two women and one man. The interview participants were farmers who were part of the initial survey and volunteered to be interviewed further. These interviews lasted about 15 minutes. They were conducted in Luganda and transcribed in English by the assistant. These interviews addressed some of the discussion questions that were raised by the initial survey and the key informant interviews (Appendix D). The discussion questions were developed in collaboration between the female student assistant, Dr. Christie, and myself.

3.5.4 Farmer-to-Farmer Exchange

The research assistants, Dr. Christie, and I held a gathering with all of the farmers who participated in the survey along with their families. At the gathering, an IPM farmer led a group discussion about IPM farming. She gave detailed descriptions of the practices recommended by the IPM project. She also facilitated a group dialogue about the various constraints faced in tomato production. Most of the farmers in attendance were not aware of the improved tomato variety MT56 and had never heard of IPM. This was a highly effective way of sharing information about IPM and facilitating exchange among farmers about constraints to growing tomatoes. The exchange also provided an opportunity to assess the local farmers' knowledge of tomato growing techniques.

3.5.5 Follow-up Survey

The extension agent applied a brief follow-up survey with all 41 of the original survey participants (Appendix E). I did not have adequate time to implement this survey while in the field, so this was completed during the fall of 2008. Each survey lasted approximately five minutes. The extension agent conducted the survey in Luganda and transcribed the responses in English.

3.5.6 Statistical Analysis

The data collected in this research are not normally distributed because a snowball sampling method was used. Several nonparametric statistical tests were applied to the survey data to determine significant relationships. Tests most appropriate for the small sample size and sampling methodology were chosen. Minitab software and online calculators hosted by Vassar College were used. A 5% (p=0.05) level of significance was used for all statistical tests results.

The Chi-square test of association was applied to categorical variables to identify significant relationships. Fisher's Exact test was used to identify significant relationships in 2x2 contingency tables with expected values less than 5. The Fisher-Freeman-Halton test was used for contingency tables with expected values less than 5 that were larger than 2x2.

The Mann-Whitney U test was used to compare numerical data between two categories, such as male and female. When more than two categories were compared, the Kruskal–Wallis one-way analysis of variance was used. Finally, Spearman's rank correlation coefficient was calculated to measure the dependency between variables that were identified as significant by the Mann-Whitney or Kruskal-Wallis tests.

3.6 Results

The characteristics of the sample of 41 farmers are detailed in Table 1. The age of the farmers ranged from 18 to 56 years. Most of the farmers were married with an average of approximately 2 children. The farmers had an average of seven years of formal education. Land used for farming is commonly rented.

Very few farmers were familiar with IPM, and pesticides and fertilizer are used by nearly all of the survey participants. Most farmed 2-4 acres of land with a mix of subsistence and market crops, such as cassava, sweet potato, beans, corn, bananas, eggplant, and coffee. It was common to hire some extra labor for farming. Typical perceived constraints to increased tomato production included disease, expensive inputs, unreliable markets, and distance from markets.

Several time and distance factors are relevant for the sample of farmers in this research. Bicycles are the most common form of transportation for the sample of farmers, and are either owned and operated by the farmers themselves or hired as a taxi. Less than half of the women sampled use a bicycle independently, while all of the men sampled do. There are several small village markets within a short distance of most farmers in the sample. The closest substantial markets, Bombo and Gayaza, are an average of 6.21 miles and 8.08 miles away, respectively. The average time farmers need to travel to their gardens is 32 minutes, using various modes of transportation. The time needed to collect water varies widely from 3 minutes to 180 minutes.

3.6.1 Gender Comparison

The gender comparison shows several statistically significant differences between men and women tomato growers in Busukuma sub-county (Tables 2, 3 and 4). Head of household status, determined by farmers' responses in the survey, differed between men and women. Women were the head of their households only when they were divorced or widowed.

Fewer women used bicycles for agriculture-related transportation than men. There was also a significant difference in the mode of transportation used by women and men for traveling to their tomato gardens and for collecting water. Again, women tended to walk, whereas men tend to use bicycles.

There was a significant gender difference in the place of sale of tomatoes. Women tended to sell their tomatoes at farmgate, and men tended to sell their tomatoes directly to traders at the market. Similarly, there was a significant difference in the distance that women and men travel to the place of sale. The difference in distance traveled for agricultural-related tasks other than sale of tomatoes, however, did not differ significantly between genders.

Sources of information did not differ between genders according to the statistical analysis either. The responses for source of information about tomato production were classified into two groups, formal and informal sources, in order to apply a Chi-Square test. Formal sources included extension agents, researchers, farmer associations, and agricultural radio and television productions. Informal sources were friends, family, markets, and agricultural stores. Whether grouped this way or not, there was no significant difference between genders. However, when the raw data were analyzed without the grouping, there was a slight trend in the type of informal information source used by men and women (Table 5). It appeared that more men than women obtained information from agricultural stores or markets, while women were more likely to get information from family and friends.

Knowledge of the improved seed variety, MT56, did not differ between genders. The source of information about MT56 was not statistically significant due to a very small sample size. However, when the raw data were analyzed, there was a trend (Table 6). Men appear to be more likely to get information about improved seed varieties from extension agents or researchers, while women appear to get this information from family or friends.

There was no significant gender difference in ownership of the land used for tomato growing. It should be noted, however, that participants were not asked if the land owned was in their name or in the name of a family member. Therefore, the individual may not actually own the land. Ownership of the tomatoes is a more important factor, however, as this may indicate who controls the income earned. There was not a significant gender difference in the ownership of the tomatoes grown. With a larger sample size, however, the difference may be significant. None of the men reported that their spouse was the owner of the tomatoes, whereas approximately eighteen percent of the women did (Table 7).

A number of variables related to IPM addressed in the survey were not statistically different between genders. They include vehicle ownership, sprayer ownership, frequency of extension visits, number of extension events attended, use of hired labor for farming, use of tomatoes grown for home consumption, and the use of the four components of the IPM package: improved seed (MT56), mulching, staking, and a recommended frequency for spraying tomatoes with pesticides.

3.6.2 Distance Class Comparison

The sample was divided into four distance classes based on road distance from the farmers' homes to the sub-county headquarters. The classes were divided using natural breaks (Figure 6 and Table 8). The distance classes were compared statistically and several relationships were identified.

In general, those residing in the distance classes farthest from the sub-county headquarters were less involved in IPM (Tables 9 and 10). There was a significant difference in the number of IPM members in each class. IPM farmers tended to be located in classes closest to the headquarters. Similarly, farmers in classes closer to the headquarters used more IPM components than did those in classes farther from the headquarters. Those in classes closer to the headquarters were more likely to use MT56 and staking. Farmers farther from the headquarters were less likely to know about MT56.

Farmers in distance classes farther from the sub-county headquarters used more acres of land for tomatoes and used a larger percentage of their total farmland for tomatoes (Table 10). Also, farmers in distance classes farther from the headquarters required more time to collect water, most likely due to the central location of boreholes near headquarters.

3.6.3 Additional Comparisons Between Variables

Follow-up statistical tests were performed to further investigate the relationships between variables that were identified as significant in the gender and distance class comparisons. Several relationships were identified as significant.

Sources of information and contact with extension services were related to several variables. Those who cited formal sources of information as the most important were more likely to know about MT56 (Table 11). Similarly, those with the most frequent extension visits used a higher number of IPM components to grow tomatoes (Table 12). Also, those with the most frequent visits from extension agents and those who had participated in a higher number of extension events tended to use a smaller percentage of their total farmland for tomato production.

Distance from the sub-county headquarters was also an important factor for farmers. Farmers who lived closer to the headquarters were more likely to know about MT56 and employ more IPM components for growing tomatoes (Table12 and 13 and Figures 7, 8, 9 and 10). Also, farmers closer to the headquarters received more frequent visits from the extension agent and attended more extension events (Table 12). However, despite the negative correlation of distance from headquarters with frequency of extension visits and use and knowledge of IPM components, distance from the headquarters was not correlated with the source of information for tomato production cited by the farmers (Table 13). Farmers located farther from the sub-county headquarters required more time to collect water (Table 12). Greater distance from the headquarters was also correlated with a greater percentage of farmland used for tomatoes.

Distance to the place of sale for tomatoes was correlated with several factors. Distance traveled to place of sale increased with distance of farmer from the sub-county headquarters (Table 12). Farmers with a higher percentage of farmland used for tomatoes traveled farther to sell their tomatoes. Also, those who used bicycles or other vehicles traveled farther to sell their tomatoes (Table 13). Similarly, the farmers who sold their tomatoes at farmgate instead of at markets were much less likely to use a bicycle for any agriculture-related tasks (Table 11).

The time required to travel to tomato gardens was correlated with a few variables (Table 12). Farmers with higher travel times to gardens tended to have a larger percentage of farmland used for tomatoes. Also, those with higher travel times to gardens used fewer IPM components for tomato production.

The total amount of land farmed was correlated with several other factors. Farmers who used more acres for farming also used more acres for tomato production (Table 12). Those who required a greater amount of time to collect water tended to have smaller farms. Farmers with more years of formal education used more acres for farming. Finally, households headed by a man had larger farms than those headed by a woman (Table 13).

The total amount of land used for tomato production was also correlated with several factors (Table 12). Older farmers tended to have smaller tomato gardens and use a smaller percentage of their total farmland for tomatoes than younger farmers. Also, farmers with bigger tomato gardens tended to travel farther to sell them and used fewer IPM components. Similarly, farmers who used more IPM components for tomato production used a smaller percentage of their farmland for tomatoes.

Chemical sprayer and vehicle ownership were related to several other factors (Table 11). Farmers who used MT56 were less likely to own a chemical sprayer. Farmers in female-headed households were also less likely to own a bicycle or other vehicle. There was not a significant relationship between tomato ownership and the other variables, however (Table 14).

Age and tomato growing experience were also important factors (Table 12). More experienced tomato farmers tended to have fewer years of formal education and received extension visits more frequently. Also, more experienced tomato farmers used more IPM components for tomato growing than less experienced farmers. Similarly, older farmers had fewer years of formal education but received extension visits and attended extension events more frequently. Finally, older farmers tended to use more IPM components for tomato growing.

3.7 Discussion

Both men and women farmers face constraints to adopting IPM; however, many constraints are gender specific. Women farmers experience gender-based constraints related to distances and modes of transportation.

3.7.1 Distance and Modes of Transportation

Gendered differences in modes of transportation are the cause of the majority of observed differences between men and women farmers in constraints to adopting IPM. Most obvious is the difference in the place of sale of tomatoes for men and women. Nearly all women in the sample sell their produce at farmgate either to a non-kin middleman or to a male relative, such as a husband or uncle. Men take produce directly to markets via bicycles or motorbikes and sell them to market vendors. One key informant stated, “The only women at the market, are the market vendors themselves.” Men leverage bargaining power at markets and use knowledge of pricing fluctuations to gain optimal profit. Women, however, sell at farmgate with limited knowledge of the actual market price. Selling to a middleman results in a smaller profit margin for women. Further research should be completed to explore how place of sale and mode of transportation of tomatoes impact amount of income generated by farmers.

Although women walk to water sources while men generally ride a bicycle, there was no significant difference in the time needed to collect water reported by men and women. This contradicts statements made at the focus group discussion that indicate that men are able to collect much more water than women in “half the time.”

Distance from the sub-county headquarters was a significant factor related to the use of IPM practices. All of the survey participants who were members of the IPM group were located close to the sub-county headquarters. A spatial pattern of distance decay is evident as the number of IPM components adopted decreased with distance from the headquarters, which is considered the main source of IPM information. The extension agent for the sub-county and IPM project confirmed that the majority of IPM farmers live near the headquarters, with the exception of a few farmers.

Farmers closer to the sub-county headquarters used a smaller proportion of their land for growing tomatoes than those farther away. This suggests that farmers who use more IPM components have a smaller amount of tomatoes. It may be that those with larger tomato plots are commercial farmers who have no interest in producing value-added crops. It is also possible that the labor-intensive nature of IPM practices, such as staking tomatoes, discourages cultivation of larger tomato plots. Farmers at the focus group discussion indicated that they are not interested in using staking because it is not practical for larger plots. Stakes are difficult to find, time consuming to put in place, and must be replaced throughout the season due to termite damage. Furthermore, the farmers in the discussion group said that they do not have time to space out their plants as instructed by IPM. Most use broadcasting of seeds for planting. IPM is not an attractive option for farmers with larger tomato plots. Further research should be undertaken to determine the size of tomato plot for which IPM is most appropriate.

3.7.2 Integrated Pest Management Usage

There was no significant gender difference in the overall adoption of IPM practices. This suggests that the constraints that limit farmers' ability to adopt IPM affect both men and women.

As mentioned previously, the use of IPM practices decreases with distance from the sub-county headquarters for both men and women farmers. Limitations in IPM knowledge diffusion to areas far from the demonstration plot and meetings held at the headquarters have a significant impact on the success of the IPM project.

3.7.3 Sources of Information

Contact with the extension agent and participation in IPM project events were important factors influencing the adoption of IPM. Farmers who did not attend any extension workshops or events employed fewer IPM techniques to grow tomatoes than those who did.

There was no statistically significant difference in the frequency of extension agent visits for men and women; however, the raw data show a trend toward women receiving fewer visits. This is noteworthy because frequent extension visits for women can have a large impact. Extension agents provide accurate information about IPM and can help develop farmers' confidence in themselves and IPM techniques. It also should be noted that there is only one male extension agent working in Busukuma sub-county. This may impact the usefulness of extension services for women (see Saito, Makonnen, and Spurling 1994). Similarly, source of information was not significantly different between men and women; however, the data show a trend towards women getting information from friends and family and men getting information from markets and agricultural stores. This difference may be due, in part, to the dominant role of men as the marketer of crops and women's limited mobility and access to public spaces. According to the focus group discussion, women do not market their crop; a man always does this because he will ride a bicycle.

3.7.4 Agricultural Inputs

There were no statistically significant differences in ownership of the resources addressed in this study between men and women. Ownership of a bicycle, chemical sprayer, and land, as well as use of hired labor, were comparable between men and women. It is important to note, however, that it was not clarified during the survey who actually pays for these assets and if household members have equal access to them. Further research would be required to determine how assets are used within households. It is evident from this research, however, that even though a household owns a bicycle, women farmers within the household are not using them for farm-related travel. Additionally, women at the second focus group stated that they would not take their produce to market even if they owned their own bicycle. Societal constraints impact women's ability to fully utilize resources, even when they have access to them.

3.7.5 Farm and Household Characteristics

The only farm and household characteristic that differed significantly between men and women was head of household status. Women were not heads of their household unless they were divorced or widowed.

No men reported using their tomatoes for household consumption whereas several women did. Despite the *a priori* assumption that women would focus farming efforts into food crops, men and women farmers did not use a different proportion of their farmed land for tomatoes. Tomatoes, however, served the dual role of food and cash crop for women only. Also, according to one of the key informants, women farmers just recently started participating in income-generating activities and decision-making.

There was no significant gender difference in the ownership of tomatoes grown. Four of the women, however, reported that their spouse owned the tomatoes they grew, whereas none of the men did. Further research is required to determine how the farmers in the sample define ownership of tomatoes. It was originally hypothesized that the owner would control the income generated from sale of the tomatoes; however, according to one of the key informants interviewed, men sell the tomatoes grown by women in their household and keep the money. The key informant stated that women are compensated by gifts, such as new clothing, but do not control the income generated by sale of their tomatoes.

3.8 Conclusions

There are several spatial patterns identified by this research that suggest that distance is an important factor in the adoption of the IPM package presented by IPM CRSP. This supports the literature, which states that “distance plays a role in the distribution of ideas, technology, population, and interaction of various types” (Eldridge and Jones 1991, 1). The farmers who participate in the IPM meetings and apply IPM for tomato growing live in areas surrounding the sub-county headquarters. There is a pattern of distance decay in which knowledge about and use of IPM decreases as distance from the sub-county headquarters increases. This may be due to limitations in transportation for farmers, especially women.

The IPM CRSP has attempted to eliminate the constraint of transportation costs by providing compensation to each farmer who attends an IPM group event based on the distance they traveled to get there. It is possible, though, that women, in particular, continue to be limited for several reasons despite the compensation provided. Women generally do not ride bicycles when they travel independently due to societal norms and, therefore, would have to hire a motorcycle taxi in order to attend the events. The cost of a taxi may be higher than the compensation offered. Also, women have a higher workload at home, which limits the time available for pursuing outside interests. Lastly, since women tend to grow tomatoes in conjunction with their husbands, men may be more likely than women to attend the meetings as a representative of their household, since they are the ones who ride bicycles. This may limit the diffusion of IPM information to other household members.

The spatial pattern of distance decay from the sub-county headquarters, which acts as the main hub for IPM information, suggests that IPM CRSP should explore different vehicles for disseminating information across longer distances. It may not be feasible for farmers to travel to the headquarters. The use of village-level demonstration plots, farmer-to-farmer discussion groups, and other small farmer organizations may be appropriate. Numerous sources of information about IPM should be placed at destinations common to men and women farmers across the sub-county. Additionally, efforts should be made to extend extension services to those who are less visible in the community than the farmers who regularly attend events at the sub-county headquarters.

A key informant observed that women have been quick to organize resource and information sharing groups. One of the key informants has organized such a group for women farmers and distributed the improved seed, MT56, to the participants. IPM CRSP could use this enthusiasm to encourage women to adopt IPM. Such enthusiasm was demonstrated during the farmer-to-farmer discussion held during this research. Many farmers who would not otherwise be exposed to IPM gathered to listen to and share stories about growing and marketing tomatoes. These groups also present an opportunity for IPM CRSP to provide much needed small-business training, such as record keeping and marketing, to women farmers.

According to the focus group discussions and a key informant, reasons for and frequency of travel differ between men and women. These differences may affect exposure to new technologies and ideas. Men make frequent visits to social gatherings at local cantinas and shops, while women tend to travel for shopping or health needs. Also, men commonly take their produce to markets to sell directly to vendors. This allows for an opportunity to observe other produce and communicate with other farmers about the best tomato growing techniques. Women are very dependent on friends and family for information about farming.

The source of information about tomato growing used by farmers also differs between men and women. Although not statistically significant, there was a trend in the data that indicated that women received fewer visits from extension officers than men. This is in agreement with gender and agriculture research, which suggests that women tend to rely on less formal sources of information than men (Erbaugh et al. 2003; Torkelsson 2007). Further research should be completed to determine if this is the case and to distinguish between an extension visit made to a household and a visit made to the farmer specifically, as it was not clear if women were benefiting from visits they reported having received. Furthermore, research should be conducted to determine if the gender of the extension agent in the study area influences the number of visits received by men and women.

A few of the women farmers surveyed who were wives of IPM farmers had access to the improved seed variety, MT56, through their husbands. Diffusion of information about IPM to women may be partially effective through spouses. It is likely, however, that women who do not receive IPM training directly will not be taught the reasoning behind IPM, which according to the literature leads to low adoption rates (Ehler 2006). IPM is complex and difficult to implement without auxiliary information about how the farm ecosystem works and site-specific variables, such as the type of crop and pest. Women in focus group discussions indicated that their husbands do not explain why they should use a particular method or seed variety. In fact, most of the farmers in the second focus group discussion knew of the improved tomato variety and that it produces large, healthy fruit but were not aware that it is successful because it is resistant to bacterial wilt. IPM CRSP should focus on educating farmers about what is important in selecting seed varieties and why they may or may not be successful. This is important so that it is clear to farmers what decisions about tomato growing are the most critical for a successful harvest.

Women and men use similar proportions of their farmland for tomatoes. This contradicts much of the previous research on African agriculture (Doss 2002). In the case of this research, tomatoes played a dual role of food and cash crop for women, however. Only the women farmers indicated that they used part of their crop for household consumption. As expected, women retained the role of food providers. The farmers at the first focus group discussion pointed out that in many cases, men grow tomatoes and the women in their household exclusively grow food crops. Further research should be done in order to determine if the proportion of farmers who grow tomatoes differs by gender as this research only targeted farmers who grow tomatoes.

Although it was not statistically significant, there seems to be a gender difference in ownership of tomatoes. Most of the women surveyed reported that they share ownership of their tomatoes with their husbands. Only a small portion of the men said they shared ownership, however. A difference in perception of ownership may exist between men and women. It is unclear based on this research if ownership means control over the income generated from sale of tomatoes. Further research is required to determine how ownership is defined and what influence it has in the adoption of IPM. If the owner of the tomatoes is the decision-maker in regards to what farming methods are used and how to distribute the income generated, ownership would have a significant impact on the adoption of IPM for women in particular (Flora 2001; Torkelsson 2007). Women who do not own the tomatoes they grow would have very little incentive to adopt new technologies that will improve the harvest, especially if the technologies are more labor intensive.

According to a key informant, if a woman farmer's husband sells her tomatoes for her, she will not be given the cash generated. Instead, her husband will give her a special gift, such as a new dress. If a woman sells her tomatoes herself and controls the income generated, her husband will be less likely to give her money for household expenses as he may have done before. When a woman produces her own income, it does not necessarily result in increased money under her control. A key informant observed that "when [a woman] has money, [her husband] wouldn't even give [her] soap."

Increasing production and adopting time-consuming methods, such as planting seeds at accurately measured intervals versus broadcasting seed, may not be feasible due to the work load outside of farming that women carry, which includes cooking, cleaning, tending livestock, and taking care of children. The activity calendar indicated that women spent approximately 34 to 42 hours per week on gardening and related tasks, while men spent approximately 81 hours per week on the same (Appendix B). Women, therefore, have less access than men to their own labor as a farming resource.

According to the focus group discussion, women do not think IPM methods, especially staking, are valuable or even feasible for a relatively large-scale tomato plot of one acre due to the extra time and resources required. The labor-intensive nature of IPM can be a hindrance to adoption (Hasnah, Fleming, and Coelli 2004). IPM CRSP must make using stakes more practical for farmers growing relatively large plots of tomatoes and effectively demonstrate the benefits, which include more efficient use of chemicals, facilitated pruning, and less rotting. It is difficult to convince women farmers, who carry a large work load already, to invest more effort into growing tomatoes without making the benefits very apparent. Additionally, women may have less incentive to increase their labor input and improve their crops because they have less control over the income generated.

In order for farmers to see the value in using IPM, they should be taught and encouraged to keep accurate records of their investments and income. It was evident from the FGD that many of the farmers are unsure of how much profit they are getting from their crop. Since IPM requires an increased investment of time, labor, and capital, IPM CRSP will need to better demonstrate that the return on investment for IPM will be substantial in order for farmers to feel that it is worth their attention. The IPM group members are the innovators and early adopters that are characteristic of the Roger's Bell Curve (Rogers 2003, 281). The general population will resist IPM until they are convinced that the resultant profits will exceed their investments.

Several disincentives exist for women in increasing tomato production and applying IPM that may outweigh the incentives. Inputs for IPM and tomato growing, such as mulch, stakes, and cleared land, require physical labor that is generally done by men. According to the focus group discussions, for example, women always pay someone to cut mulch for their gardens, while men do it for themselves. Additionally, stakes must be replaced throughout the growing season due to termite damage. IPM CSRP has proposed a solution to this by encouraging farmers to grow a small bamboo plot to provide termite resistant stakes.

One key informant made it clear that "women receive less money for their tomatoes, but it costs more money for them to produce the crop." Women generally hire someone to clear land for their plots and make mulch, whereas men do these tasks themselves. If a woman decides to transport her produce to the market, she must hire a motorcycle taxi to transport her, as well as a second one to transport her boxes of tomatoes. According to women at the focus group discussion, women who do take their tomatoes to market to sell receive a lower price than men regardless. As hiring two motorcycle taxis is generally cost prohibitive, most women choose to sell to middlemen at farmgate. Women have very little bargaining power in this situation, because tomatoes have a short shelf life and must be sold immediately after harvest. This lack of leverage is exacerbated by the supply and demand issue which occurs when everyone's tomatoes ripen at once. IPM CRSP should endeavor to teach women methods for negotiating the highest price possible for their tomatoes even when they sell to a middleman.

Market insecurity is a primary concern for both men and women farmers, even more so than pests and crop diseases. The IPM CRSP project should address this concern as part of IPM training and highlight IPM tomatoes as a value-added product. IPM may be a more attractive option to farmers if they are educated about how "organic" techniques or the use of fewer agrochemicals can be marketed to appeal to middle class, chemical-conscious consumers who reside in urban areas, such as nearby Kampala. Women farmers who experience reduced bargaining power because of limited mobility and use of a middleman may especially benefit from a value-added product. Consumer perceptions about tomatoes play an important role in decisions about pest management and should be addressed by the IPM CRSP program.

Labor-intensive and time-consuming water collection may be a constraint for women in increasing tomato production. In a focus group discussion, it was stated that, in general, women and children are responsible for collecting water for both men's and women's gardens. Water collection without a bicycle is very time-consuming, which contributes to the time shortage faced by most women. Participants in the second focus group discussion stated that when men do collect water, they can carry up to six jerrycans at once using a bicycle and it takes them "half the time" than it does for women to carry just one jerrycan by foot. Furthermore, the farmers in the discussion emphasized that men do not fetch water for the plots tended by the women in their household even though it would be much more efficient. Further research should be undertaken to determine how water collection issues affect decisions related to IPM adoption. Women may choose garden locations and sizes based on their proximity to water sources. They may be less likely to adopt farming practices that require increased labor, such as IPM, if they are far from a water source.

Even though women traditionally do not ride bicycles, it is apparent that they choose to not use them for many reasons beyond cultural ones. Some women do use bicycles; therefore, societal norms are not totally restrictive. During a focus group discussion with fifteen women, the researcher proposed a scenario where the women all owned bicycles and were free to use them and then asked if they would use them to take their tomatoes to the market to sell. Only two of the fifteen women present said they would. Women say that they would not take the produce themselves because the trip is very physically demanding, takes several hours, and it is unsafe for women to travel alone for long distances. Also, they do not believe the increased profit from sale at market will be high enough to make the trip worth it due to unreliable markets and the time required to transport the tomatoes. It is unrealistic for women to take their produce to markets via bicycles. Men and women perceive the same distance from farmers' homes to the market differently. Alternative solutions to the problem of lower price received for tomatoes sold at farmgate should be explored.

According to the results of the survey, there is no difference in the availability of agricultural inputs for men and women, which included land, sprayers, bicycles, and hired labor. This is in contrast to much of the gender and agriculture research, which states that women have more limited access to resources than men (Doss 2001; Tanzo 2005; FAO 2011). Caution must be used when interpreting this result, however, because the survey did not distinguish between household ownership of resources and personal ownership. Additionally, it should be noted that although women may have access to bicycles, they do not use them for agricultural tasks. Further research should be done to determine how resources are shared within households and how this affects decisions about farming practices.

This research incorporated several methodologies in order to develop a more complete picture with which to address the research questions and objectives. Literature has praised the use of multiple methodologies as a way to develop a valuable narrative through the combination of the various results (Rocheleau 2005). Each method used in this research produced an incomplete dataset on its own; however, when combined, a better understanding of the reality on the ground was achieved. Although the integration of methods was useful for engaging the research questions, it proved most significant for identifying gaps in the information each method was able to extract. The information produced from the quantitative survey methods often contradicted observations made through the qualitative discussion and interview methods. This research provides an example of how methodologies can produce silences and reflect positionalities in the literature (Nightingale 2003).

The adoption of the IPM package is constrained by gender differences in mobility and distance to inputs. This research identifies several factors that create constraints in IPM adoption, particularly for women. The relationship between distance and IPM adoption is complicated, however.

Most importantly, there is a lack of widespread, common knowledge about IPM and environmentally friendly farming techniques. Most farmers in the community have not heard of IPM. Those who have seen or heard of the project demonstrations are uninterested because the most visible plots have been relatively unsuccessful and unimpressive. Farmers at the second focus group discussion, which was attended by both IPM and non-IPM farmers, specifically stated that they have not been interested in asking other farmers about IPM because they "have not seen any great results." IPM CRSP should focus on creating more visible and convincing sources of information about IPM and encourage farmer-to-farmer exchange of knowledge through women's groups, demonstration plots, and village-level workshops.

3.9 Acknowledgements

This research was made possible through support provided by gender research funds of the Integrated Pest Management Collaborative Research Support Program (CRSP). The CRSP is funded by the U.S. Agency for International Development, under the terms of Cooperative Agreement No. EPP-A-00-04-00016-00. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development.

This research was also supported by the Sidman P. Poole Scholarship fund from the Department of Geography at Virginia Tech.

Thank you to the farmers, extension agents, and Makerere University faculty to who participated in this research and played an essential role in the success of the field research. Thank you to Dr. Sam Kyamanywa, Dean of the Faculty of Agriculture at Makerere University, in particular, for his invaluable assistance in coordinating this research.

I would also like to express my gratitude to Dr. Mark Erbaugh, Principal Investigator for the IPM CRSP East Africa Program and director of International Programs in Agriculture at the Ohio State University, for supporting this research.

Dr. Maria Elisa Christie provided unending inspiration, guidance, and support throughout the entire research process. Her contribution to this research has been significant and invaluable.

Dr. Lawrence Grossman also played an essential role in the evolution of this research. His introduction to geographic theory and research provided the foundation for this study. Thank you also for your editing expertise.

Thank you to Dr. Jim Campbell as well for guidance and advice in applying the statistical analysis and preparing the final manuscript.

Finally, thank you to my family and friends for their limitless support and encouragement.

3.10 References

Bagchee, A. 1994. *Agricultural Extension in Africa*. World Bank Discussion Papers 231. Washington, D.C.: The World Bank.

Boserup, E. 1970. *Woman's Role in Economic Development*. London: Earthscan.

Bryson, J. C. 1981. "Women and Agriculture in Sub-Saharan Africa: Implications for Development (an Exploratory Study)." *Journal of Development Studies* 17(3):29-46.

Busukuma Technical Planning Committee. 2007. *Busukuma Sub County Council Three Year Development Plan 2007-2010*.

Byerlee, D. 1987. "From Adaptive Research to Farmer Recommendations and Extension Advice." *Agricultural Administration and Extension* 27(4):231-244.

Calvo, C. M. 1994. *Case Study on Intermediate Means of Transport : Bicycles and Rural Women in Uganda*. Sub-Saharan Africa Transport Policy Program Working Paper No. 12. Washington, D.C.: The World Bank.

Clearfield, F., and B. Osgood. 1986. *Sociological Aspects of the Adoption of Conservation Practices.* Washington, D.C.: Natural Resources Conservation Service.

Davison, J. 1988. "Who Owns What? Land Registration and Tensions in Gender Relations of Production in Kenya." In *Agriculture, Women, and Land : The African Experience,* ed. J. Davison, pp. 157-176. Boulder: Westview Press.

Doss, C. R. 1999. *Twenty-Five Years of Research on Women Farmers in Africa: Lessons and Implications for Agricultural Research Institutions; with an Annotated Bibliography*. CIMMTY Economics Program Paper No. 99-02. Mexico D. F.: CIMMYT.

———. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29(12):2075-2092.

———. 2002. "Men's Crops? Women's Crops? The Gender Patterns of Cropping in Ghana." *World Development* 30(11):1987-2000.

Doss, C. R. and M. L. Morris. 2001. "How Does Gender Affect the Adoption of Agricultural Innovations?: The Case of Improved Maize Technology in Ghana." *Agricultural Economics* 25(1):27-39.

Ehler, L. E. 2006. "Integrated Pest Management (IPM): Definition, Historical Development and Implementation, and the Other IPM." *Pest Management Science* 62(9):787-789.

Eldridge, J. D. and J. P. Jones. 1991. "Warped Space: A Geography of Distance Decay." *Professional Geographer* 43(4):500-511.

Elsey, B., and K. Sirichoti. 2001. "The Adoption of Integrated Pest Management (IPM) by Tropical Fruit Growers in Thailand as an Example of Change Management Theory and Practice." *Intergrated Pest Management Reviews* 6:1-14.

Erbaugh, J. M., J. Donnermeyer, M. Amujal, and S. Kyamanywa. 2003. "The Role of Women in Pest Management Decision Making in Eastern Uganda." *Journal of International Agriculture and Extension Education* 10(3):71-81.

Ezumah, N. N., and C. M. Di Domenico. 1995. "Enhancing the Role of Women in Crop Production: A Case Study of Igbo Women in Nigeria." *World Development* 23(10):1731-1744.

Flora, C. 2001. "Access and Control of Resources: Lessons from the SANREM CRSP."*Agriculture and Human Values* 18:41-48.

Food and Agriculture Organization. 2011. Women in Agriculture: Closing the Gender Gap for Development. In *The State of Food and Agriculture.* Rome.

Galt, R. E. 2007. "Regulatory Risk and Farmers Caution with Pesticides in Costa Rica." *Transactions of the Institute of British Geographers* 32(3):377-394.

Gladwin, C. H. and D. McMillan. 1989. "Is a Turnaround in Africa Possible without Helping Women to Farm?" *Economic Development and Cultural Change* 37(2):345-369.

Grossman, L. S. 2004. Understanding Pesticide Misuse in Developing Countries. In *Worldminds: Geographical Perspectives on 100 Problems*, eds. B. W. Donald, G. Janelle, and K. Hansen, pp 425-429. Boston: Dordrecht.

Hasnah, E. Fleming, and T.J. Coelli. 2004. "Assessing the Performance of a Nucleus Estate and Smallholder Scheme for Oil Palm Production in West Sumatra: A Stochastic Frontier Analysis." *Agricultural Systems* 79(1):17-30.

Igodan, C. O., P. E. Ohaji, and J. A. Ekpere. 1988. "Factors Associated with the Adoption of Recommended Practices for Maize Production in the Kainji Lake Basin of Nigeria." *Agricultural Administration and Extension* 29(2):149-156.

IPM CRSP. 2008. *Integrated Pest Management Collaborative Research Support Program Annual Report.* Blacksburg: OIRED Virginia Tech.

Jiggins, J., R. K. Samanta, and J. E. Olawoye. 1997. Improving Women Farmers' Access to Extension Services. In *Improving Agricultural Extension*, eds. B. E. Swanson, R. P. Bentz and A. J. Sofranko. Rome: Food and Agriculture Organization of the United Nations.

Kalley, K. 2006. "Uganda." *Uganda Country Monitor.* Global Insight Inc.

Kogan, M. and W. I. Bajwa. 1999. "Integrated Pest Management: A Global Reality?" *Anais da Sociedade Entomologica do Brasil* 28(1):1-25.

Mandel, J.L. 2004. "Mobility Matters: Women's Livelihood Strategies in Porto Novo, Benin." *Gender, Place and Culture* 11(2):257-287.

Nightingale, A. 2003. "A Feminist in the Forest: Situated Knowledges and Mixing Methods in Natural Resource Management." *ACMEL An International E-Journal for Critical Geographies* 2(1):77-90.

Norton, G. W., E. A. Heinrichs, G. C. Luther, and M. E. Irwin, eds. 2005. *Globalizing Integrated Pest Management, a Participatory Research Process*. Ames, Iowa: Blackwell Publishing.

Orr, A. 2003. "Integrated Pest Management for Resource-Poor African Farmers: Is the Emperor Naked?" *World Development* 31(5):831-845.

Patterson, K. A. 1996. *The Political Ecology of Nontraditional Agricultural Exports and an IPM Project in Jamaica*, unpublished thesis (M.S.), Virginia Polytechnic Institute and State University.

Poats, S. V. 1991. *The Role of Gender in Agricultural Development*. Issues in Agriculture Paper 3. Washington, D.C.: Consultative Group on International Agricultural Research.

Quisumbing, A. R. 1995. *Gender Differences in Agricultural Productivity: A Survey of Empirical Evidence.* Food Consumption and Nutrition Division Discussion Paper No. 5. Washington, D.C.: International Food Policy Research Institute.

Rocheleau, Dianne. 1995. "Maps, Numbers, Text and Context: Mixing Methods in Feminist Political Ecology." *Professional Geographer* 47(4):458-466.

Rogers, E. M. 2003. *Diffusion of Innovations.* 5th ed. New York: Free Press.

Saito, K. A., H. Mekonen, and D. Spurling. 1994. *Raising the Productivity of Women Farmers in Sub-Saharan Africa*. World Bank Discussion Papers 230. Washington, D.C.: The World Bank.

Tanzo, I. R. 2005. *Women and Pesticide Management in the Philippines: An Assessment of Roles and Knowledge*, unpublished thesis (PhD), Pennsylvania State University.

The World Bank, Food and Agriculture Organization, and International Fund for Agricultural Development. 2009. *Gender in Agriculture Sourcebook.* Washington, D.C.: The World Bank.

Thomas-Slayter, B., A. L. Esser, and M. D. Shields. 1993. *Tools of Gender Analysis: A Guide to Field Methods for Bringing Gender into Sustainable Resource Management*. Worchester: Clark University.

Torkelsson, A. 2007. “Resources, Not Capital: A Case Study of the Gendered Distribution and Productivity of Social Network Ties in Rural Ethiopia.” *Rural Sociology* 74(4):583-607.

USAID. 2007. "Sub-Saharan Africa: Initiative to End Hunger in Africa (IEHA)." United States Agency for International Development, March 20, 2008 Available from: http://www.usaid.gov/locations/sub-saharan_africa/initiatives/ieha.html.

Zalom, F. G. 1993. "Reorganizing to Facilitate the Development and Use of Integrated Pest Management." *Agriculture, Ecosystems and Environment* 46:245-256.

3.11 Figures

Figure 1 – Uganda in Africa

Figure 2 - Wakiso District in Uganda

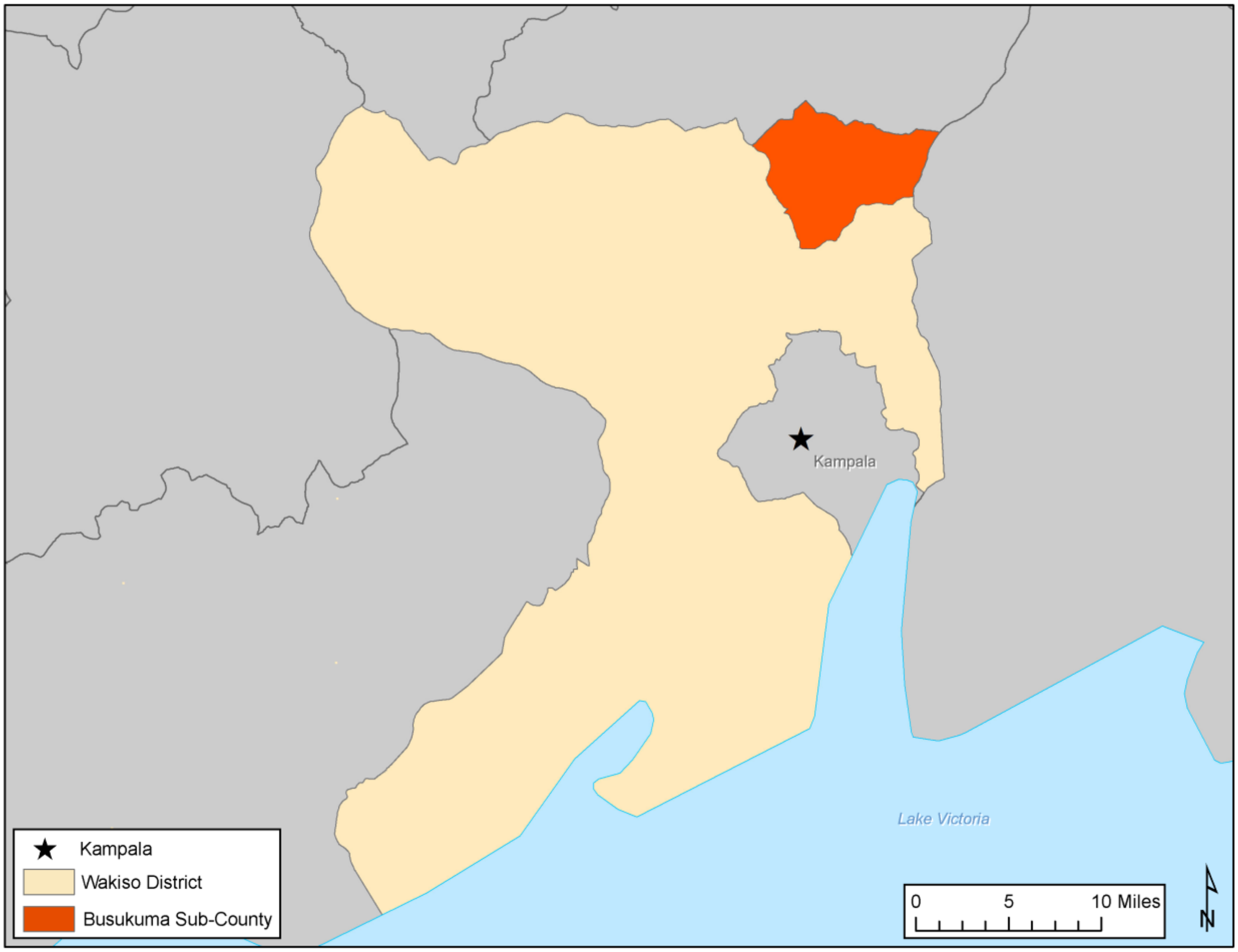


Figure 3 - Busukuma Sub-County in Wakiso District

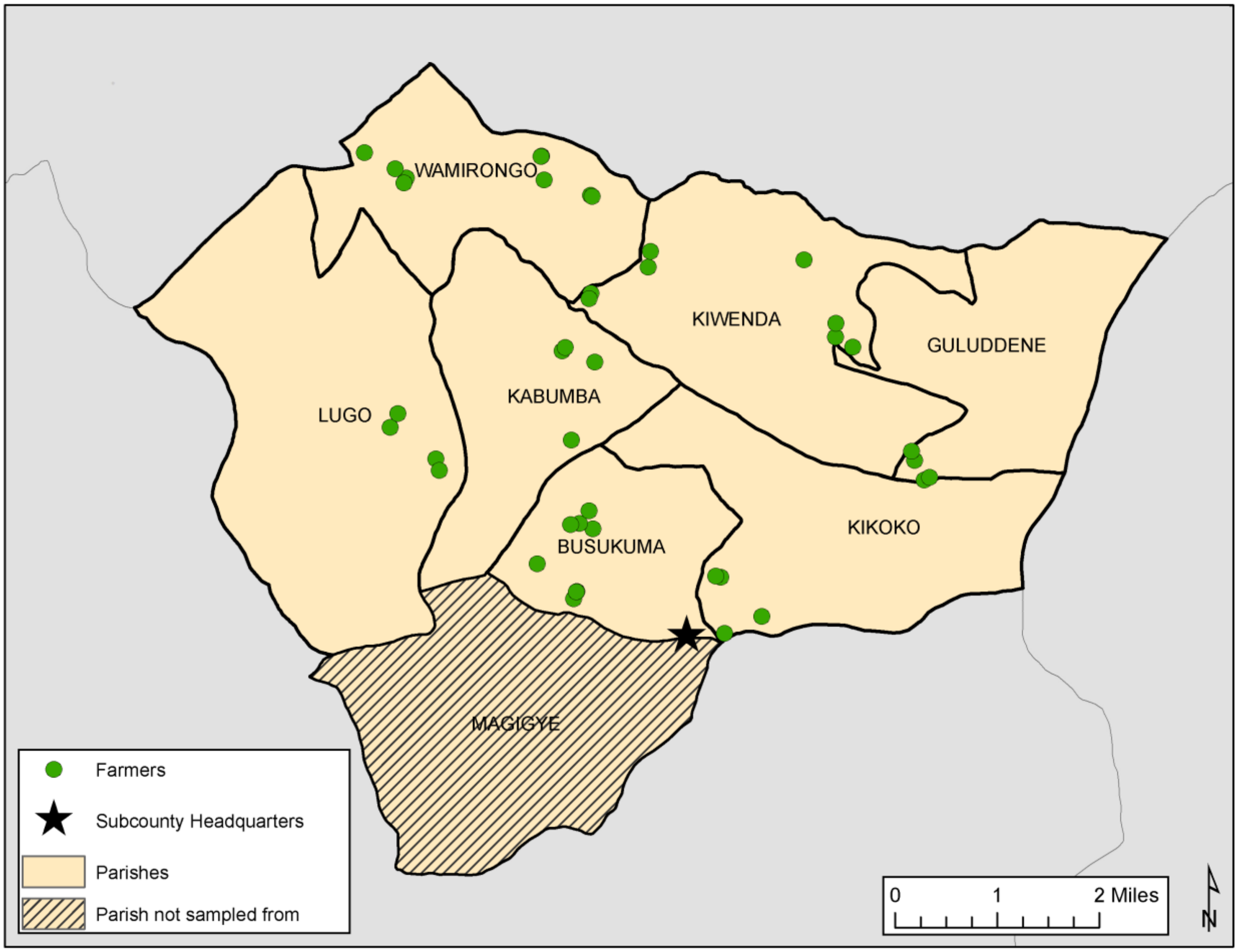


Figure 4 - Sample Distribution in Busukuma Sub-County

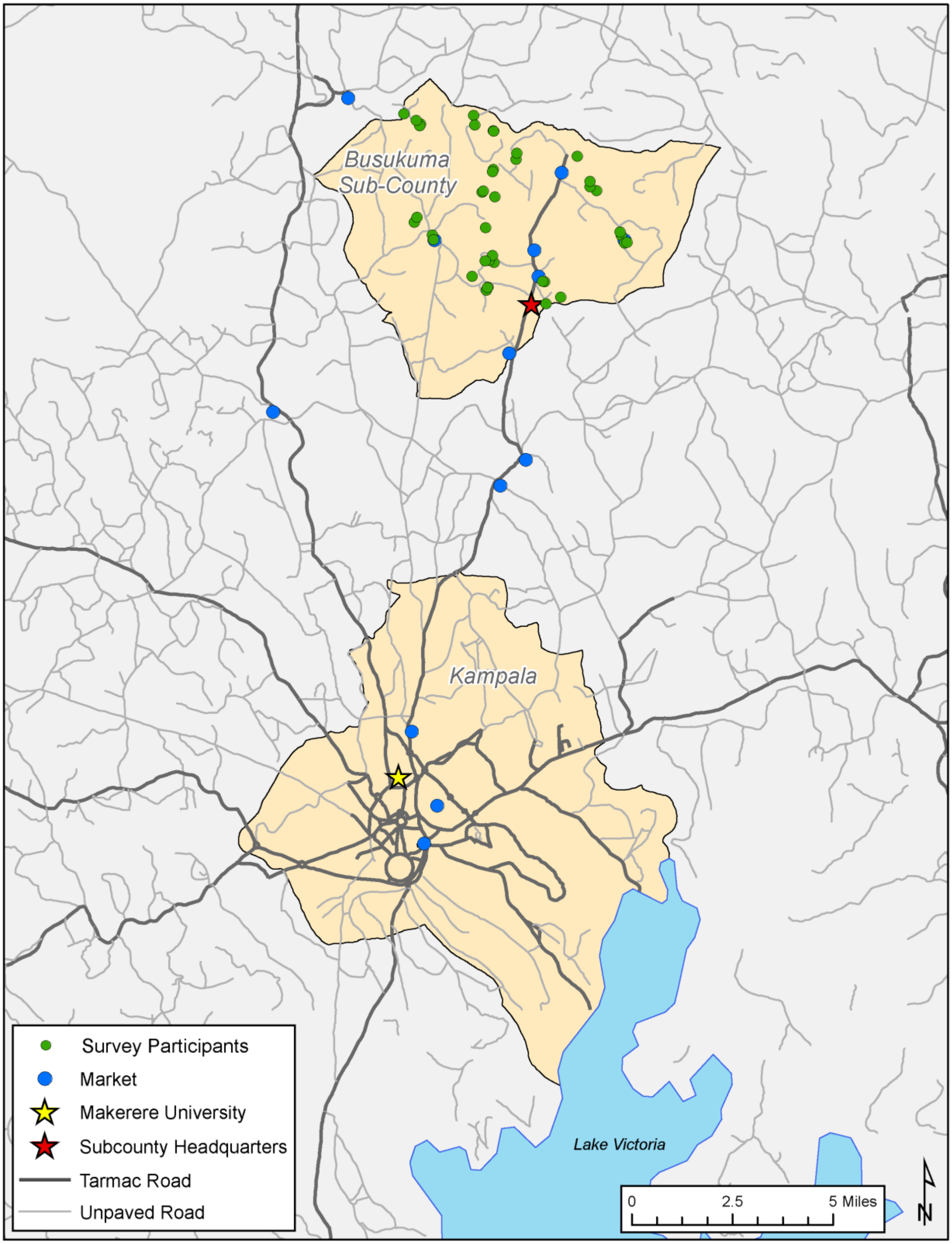


Figure 5 - Study Area

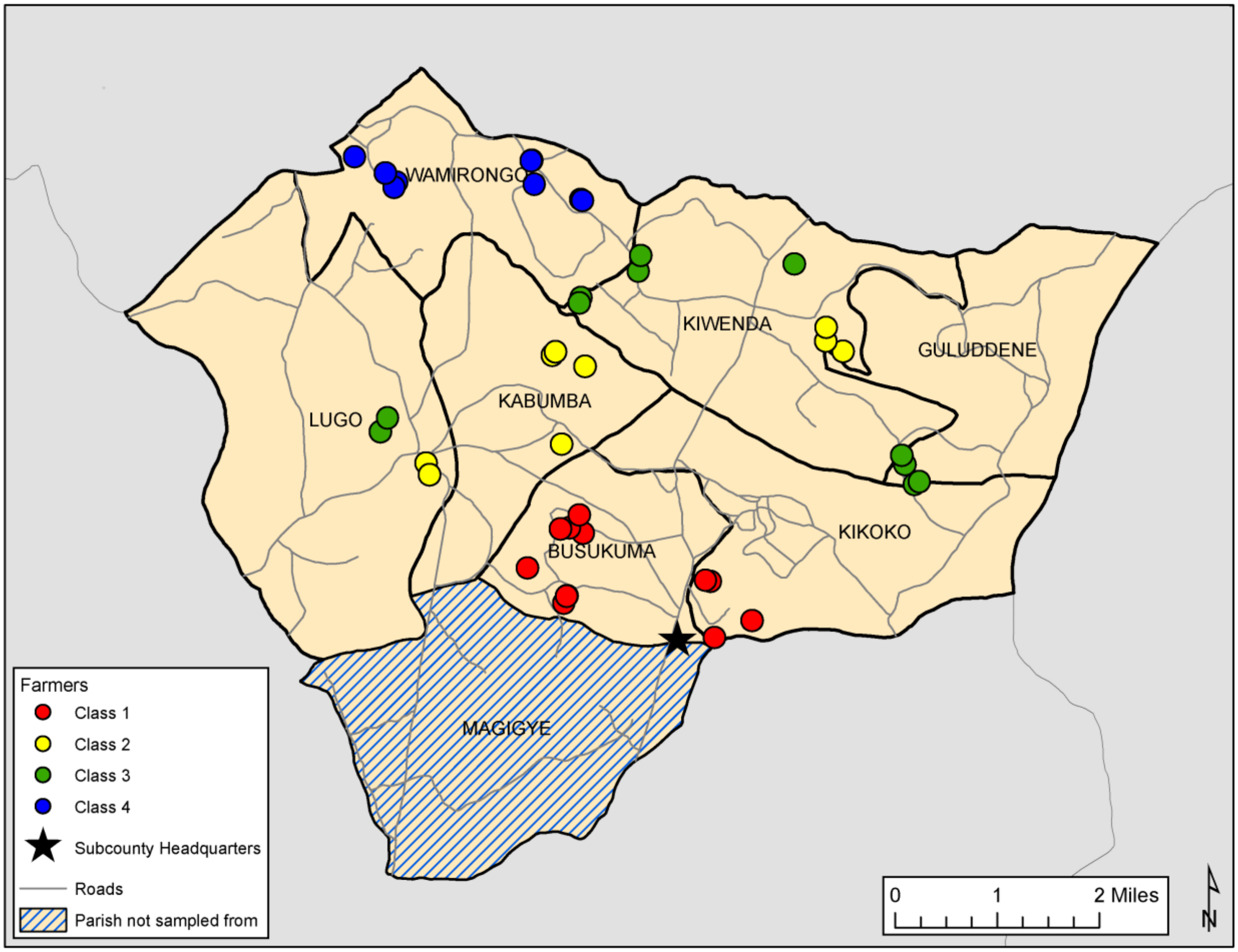


Figure 6 - Distance Classes- Natural breaks were used to divide the sample into four distance classes based on road distance from the farmers' homes to the sub-county headquarters (Table 8).

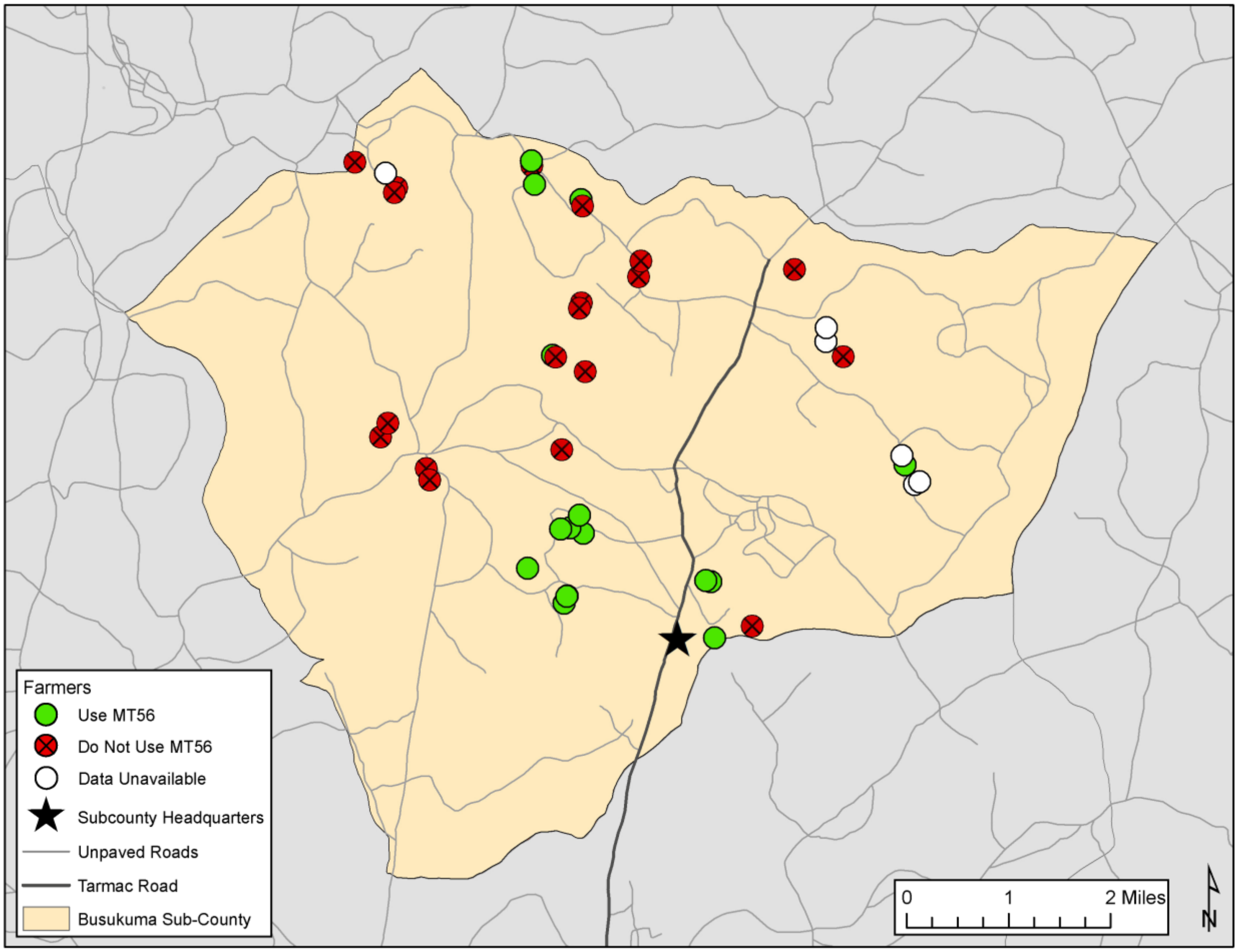


Figure 7 - Use of Improved Tomato Variety (MT56)

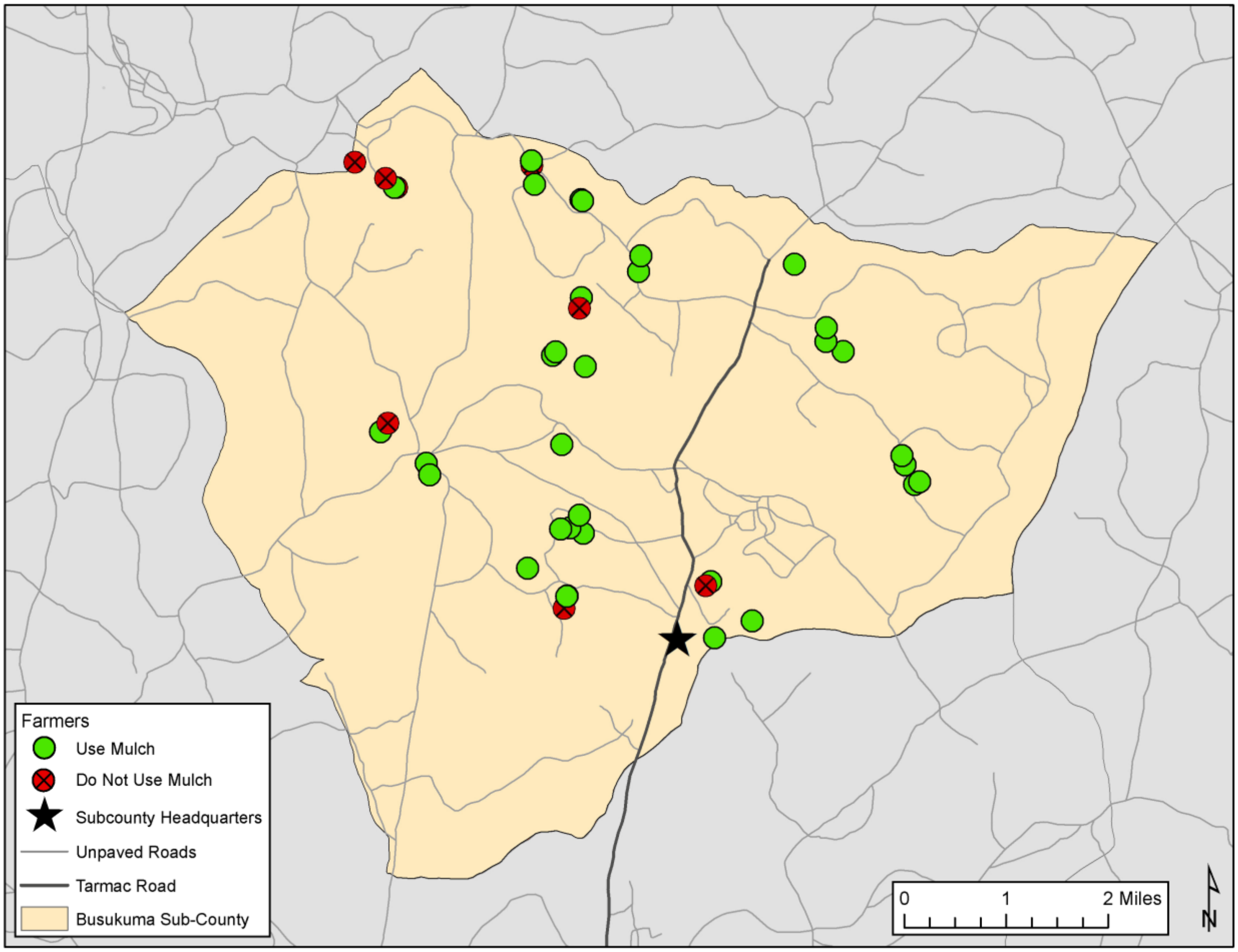


Figure 8 - Use of Mulch

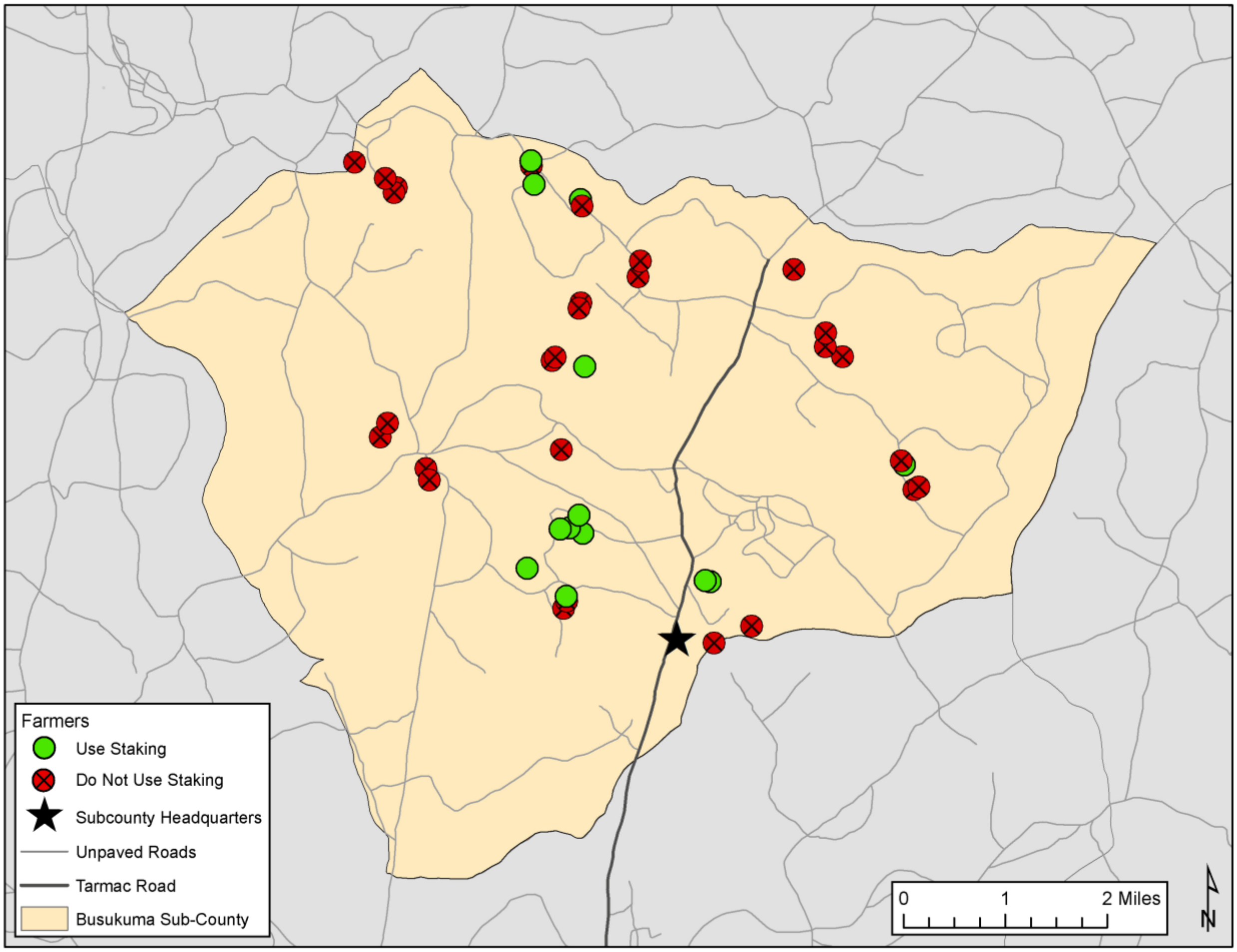


Figure 9 - Use of Staking

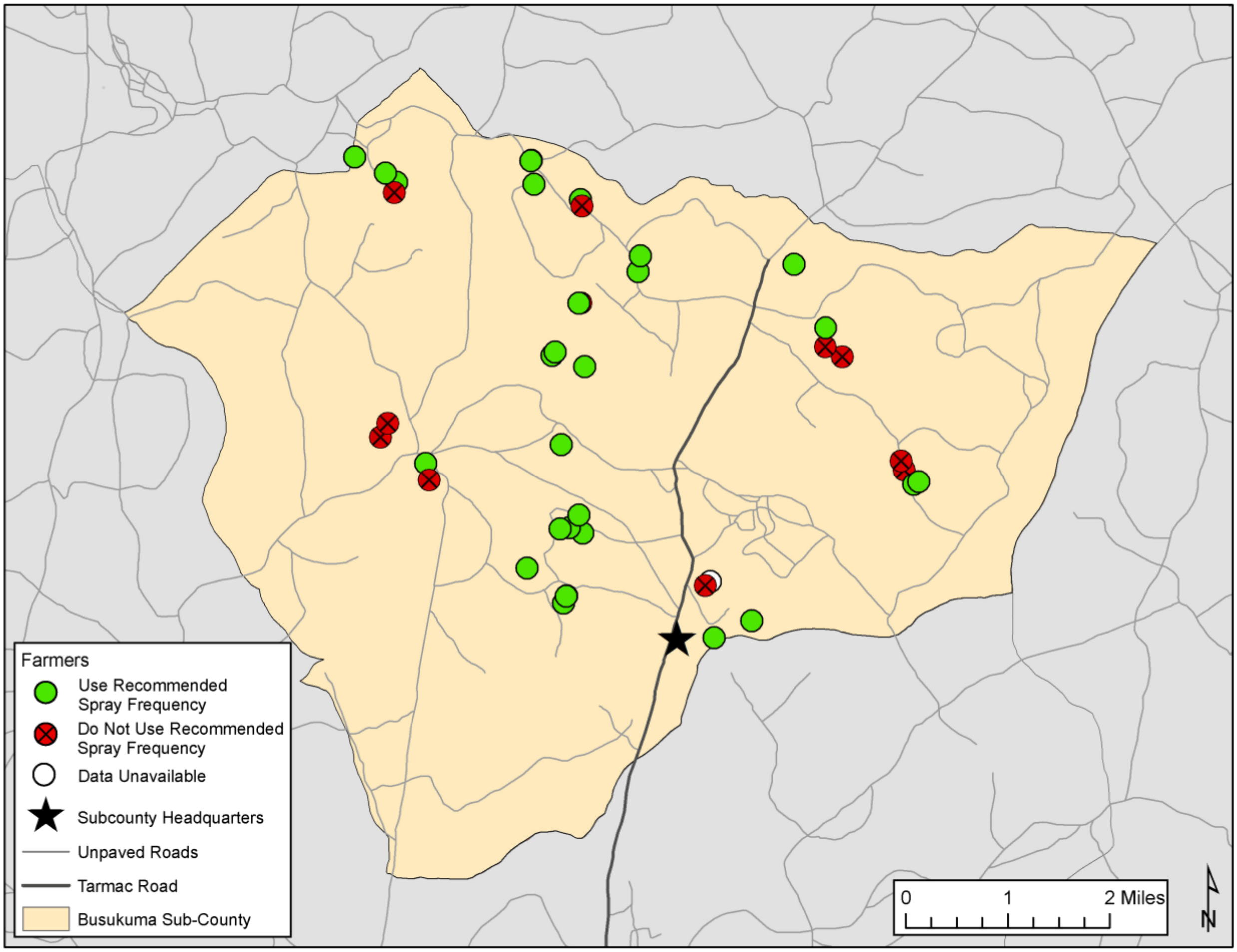


Figure 10 - Use of Recommended Chemical Application Frequency

3.12 Tables

Table 1 - Sample Characteristics

(n=41)

Variable	Range	Average
Age (yr)	18-56	37.39
Distance to fertilizer (miles)	0-20.35	2.00
Distance to pesticide (miles)	0-21.17	9.66
Distance to place of sale (miles)	0-17.68	4.30
Distance to seed (miles)	0-20.81	6.73
Distance to sub-county headquarters (miles)	0.83-8.08	4.19
Education (yr)	0-14	6.93
Farm size (ac)	0.5-15	3.63
Number in household	0-12	3.98
Number of extension events attended in past 12 months	0-12	2.56
Number of extension visits received in past 12 months	0-24	4.39
Number of IPM components used	0-4	2
Percent of land used for tomatoes	4.17-100	23.61
Tomato growing experience (yr)	1-21	9.73
Tomato growing experience (yr)	1-21	9.73
Tomato plot size (ac)	0.13-2.5	0.62
Travel time to collect water (mins)	3-180	41.73
Travel time to garden (mins)	2-120	32.38

Table 2 – Gender Comparison: Categorical Variables

Pearson's Chi Square Test of Independence (n=41)

Variable	Size of table	Chi square (X^2)	Probability (p)	Significant at p=0.05?
Head of household	2x2	17.790	0.000	Yes
Knowledge of MT56	2x2	0.141	0.707	No
Mode of transportation to collect water	2x2	6.078	0.014	Yes
Mode of transportation to garden	2x2	15.314	0.000	Yes
Ownership of chemical sprayer	2x2	2.815	0.093	No
Ownership of land used	2x2	0.56	0.454	No
Place of sale of tomatoes	2x2	20.421	0.000	Yes
Source of information about tomato production (simplified)	2x2	0.001	0.982	No

Use bicycle	2x2	9.856	0.002	Yes
Use of hired labor	2x2	0.407	0.524	No
Use of MT56	2x2	0.465	0.495	No
Use of mulch	2x2	0.312	0.576	No
Use of recommended spray frequency	2x2	0.755	0.385	No
Use of staking	2x2	0.000	0.987	No

Table 3 - Gender Comparison: Categorical Variables

Fisher's Exact Test/Fisher-Freeman-Halton Test (n=41)

Variable	Size of table	Probability (p)	Significant at p=0.05?
Ownership of bicycle or other vehicle	2x2	0.099	No
Ownership of tomatoes	2x3	0.175	No
Source of information about MT56	2x2	0.315	No
Source of information about tomato production (not simplified)	2x4	0.389	No
Use of fertilizer	2x2	0.588	No
Use of tomatoes for home consumption	2x2	0.111	No

Table 4 - Gender Comparison: Numerical Variables

Mann-Whitney Test (n=41)

Variable	Median (women)	Median (men)	Probability (p)	Significant at p=0.05?
Acreage used for tomatoes	0.5	0.5	0.989	No
Age	37.0	42.0	0.070	No
Distance to place of sale (miles)	0.0	6.2	0.000	Yes
Distance traveled to get fertilizer (miles)	0.0	0.0	0.192	No
Distance traveled to get pesticide (miles)	5.0	6.1	0.381	No
Distance traveled to get seed (miles)	1.2	3.4	0.445	No
Number of extension events attended in past 12 months	0.0	0.0	0.745	No
Number of IPM components applied	2.0	2.0	0.413	No
Number of visits from extension in past 12 months	0.0	5.0	0.089	No
Percentage of land farmed used for tomatoes	16.6	12.5	0.823	No
Total acreage farmed	2.5	2.0	0.681	No
Total in HH involved in agriculture	4.5	3.0	0.058	No

Total time to collect water (minutes)	30.0	30.0	0.551	No
Travel time to garden (minutes)	30.0	27.5	0.391	No
Years of formal education	7.0	7.0	0.978	No
Years of tomato growing experience	9.0	10.0	0.157	No

Table 5 - Gender Comparison: Primary Source of Information about Tomato Production

(n=41)

	Agricultural stores or markets	Book or Radio	Extension Agent, Farmer Associations or Researchers	Family or Friends
Male (% of responses)	15.79	5.26	47.37	31.58
Female (% of responses)	4.76	4.76	47.62	42.86

Table 6 - Gender Comparison: Source of Information about MT56

(n=41)

	Friends or Family	Researchers or Extension
Male (% of responses)	25.00	75.00
Female (% of responses)	62.50	37.50

Table 7 - Gender Comparison: Ownership of Tomatoes

(n=41)

	Self	Spouse	Spouse and Self
Male (% of responses)	73.68	0.00	26.32
Female (% of responses)	59.09	18.18	22.73

Table 8 - Distance Classes, Home to Sub-County Headquarters

(n=41)

Class	Road Distance Range (miles)	Number of Samples in Class
1	0 – 2.10	12
2	2.11 – 4.22	9
3	4.23 – 6.10	11
4	6.11 – 8.08	9

Table 9 – Distance Class Comparison: Categorical Variables

Fisher-Freeman-Halton (n=41)

Variable	Size of table	Probability (p)	Significant at p=0.05?
IPM membership	2x4	0.004	Yes
Knowledge of MT56	2x4	0.024	Yes
Ownership of bicycle or other vehicle	2x4	0.078	No
Ownership of chemical sprayer	2x4	0.177	No
Place of sale of tomatoes	2x4	0.557	No
Source of information about tomato production (simplified)	2x4	0.590	No
Use of bicycle	2x4	0.877	No
Use of MT56	2x4	0.000	Yes
Use of mulch	2x4	0.138	No
Use of recommended spray frequency	2x4	0.259	No
Use of staking	2x4	0.013	Yes
Use of tomatoes for home consumption	2x4	0.125	No

Table 10 - Distance Class Comparison: Numerical Variables

Kruskall-Wallis Test (n=41)

Variable	Probability (p)	Significant at p=0.05?
Acreage used for tomatoes	0.001	Yes
Distance to place of sale	0.282	No
Number of IPM components applied	0.012	Yes
Number of visits from extension in past 12 months	0.161	No
Percentage of land farmed used for tomatoes	0.011	Yes
Tomato growing experience	0.346	No
Total time to collect water	0.049	Yes
Travel time to garden	0.163	No

Table 11 – Follow-Up Statistics: Categorical Variables

Fisher's Exact Test/Fisher-Freeman-Halton (n=41)

Variable 1	Variable 2	Size of table	Probability (p)	Significant at p=0.05?
Gender of head of household	Ownership of land used	2x2	0.703	No

Gender of head of household	Use of MT56	2x2	1.000	No
Gender of head of household	Use of staking	2x2	1.000	No
Gender of head of household	Use of mulch	2x2	1.000	No
Gender of head of household	Ownership of chemical sprayer	2x2	0.059	No
Gender of head of household	Use of recommended spray frequency	2x2	1.000	No
Gender of head of household	Use of hired labor	2x2	0.412	No
Gender of head of household	Use of bicycle	2x2	0.202	No
Gender of head of household	Ownership of bicycle or other vehicle	2x2	0.000	Yes
Gender of head of household	Ownership of tomatoes	2x3	0.568	No
Head of household	Ownership of tomatoes	2x3	0.111	No
Marital status	Ownership of land used	2x2	0.436	No
Marital status	Ownership of chemical sprayer	2x2	0.429	No
Marital status	Use of hired labor	2x2	0.658	No
Marital status	Ownership of bicycle or other vehicle	2x2	0.077	No
Ownership of chemical sprayer	Use of recommended spray frequency	2x2	0.073	No
Ownership of chemical sprayer	Source of info about MT56 (simplified)	2x2	0.302	No
Ownership of land used	Use of staking	2x2	0.737	No
Ownership of land used	Use of mulch	2x2	0.436	No
Ownership of land used	Use of recommended spray frequency	2x2	0.723	No
Place of sale of tomatoes	Ownership of bicycle or other vehicle	2x2	0.668	No
Source of information about tomato production (simplified)	Knowledge of MT56	2x2	0.000	Yes
Spouse living at home	Use of hired labor	2x2	1.000	No
Tomato ownership	Knowledge of MT56	2x3	0.595	No

Use of bicycle	Head of household	2x2	0.306	No
Use of bicycle	Marital status	2x2	0.672	No
Use of bicycle	Ownership of land used	2x2	0.325	No
Use of bicycle	Use of MT56	2x2	0.480	No
Use of bicycle	Use of staking	2x2	0.719	No
Use of bicycle	Use of mulch	2x2	1.000	No
Use of bicycle	Ownership of chemical sprayer	2x2	1.000	No
Use of bicycle	Use of recommended spray frequency	2x2	0.704	No
Use of bicycle	Use of hired labor	2x2	1.000	No
Use of bicycle	Place of sale of tomatoes	2x2	0.019	Yes
Use of bicycle	Source of information about tomato production (simplified)	2x2	0.810	No
Use of bicycle	Ownership of tomatoes	2x3	0.868	No
Use of bicycle	Knowledge of MT56	2x2	1.000	No
Use of MT56	Ownership of chemical sprayer	2x2	0.025	Yes
Use of MT56	Use of recommended spray frequency	2x2	0.270	No
Use of mulch	Use of recommended spray frequency	2x2	1.000	No
Use of mulch	Use of hired labor	2x2	0.658	No
Use of staking	Use of recommended spray frequency	2x2	0.450	No
Use of staking	Use of hired labor	2x2	0.280	No
Use of tomatoes for home consumption	Use of MT56	2x2	0.278	No
Use of tomatoes for home consumption	Use of staking	2x2	0.288	No
Use of tomatoes for home consumption	Use of mulch	2x2	0.569	No
Use of tomatoes for home consumption	Use of recommended spray frequency	2x2	1.000	No
Use of tomatoes for home consumption	Ownership of tomatoes	2x3	0.709	No

Table 12 - Follow-Up Statistics: Numerical Variables

Spearman's Correlation Coefficient (n=41)

Variable 1	Variable 2	*Rho*	Interpretation
Acreage used for tomatoes	Distance to place of sale	0.319	Weak Positive
Acreage used for tomatoes	Total acreage farmed	0.438	Moderate Positive
Acreage used for tomatoes	Years of formal education	-0.037	Negligible Negative
Acreage used for tomatoes	Number IPM components used	-0.393	Weak Negative
Acreage used for tomatoes	Number of visits from extension in past 12 months	-0.149	Negligible Negative
Acreage used for tomatoes	Years of tomato growing experience	0.004	Negligible Positive
Age	Acreage used for tomatoes	-0.242	Weak Negative
Age	Number IPM components used	0.429	Moderate Positive
Age	Number of visits from extension in past 12 months	0.325	Weak Positive
Age	Number of extension events attended in past 12 months	0.299	Weak Positive
Age	Years of formal education	-0.293	Weak Negative
Age	Total acreage farmed	-0.018	Negligible Negative
Age	Distance to place of sale	-0.012	Negligible Negative
Age	Percentage of land farmed used for tomatoes	-0.241	Weak Negative
Distance to place of sale	Percentage of land farmed used for tomatoes	0.245	Weak Positive
Distance to sub-County Headquarters	Percentage of land farmed used for tomatoes	0.328	Weak Positive
Distance to sub-County Headquarters	Distance to place of sale	0.251	Weak Positive
Number of extension events attended in past 12 months	Distance to cub-County Headquarters	-0.400	Moderate Negative
Number of extension events attended in past 12 months	Total acreage farmed	-0.080	Negligible Negative
Number of extension events	Percentage of land farmed used	-0.384	Weak Negative

attended in past 12 months	for tomatoes		
Number of extension events attended in past 12 months	Years of formal education	0.185	Negligible Positive
Number of females in HH involved in agriculture	Number IPM components used	0.092	Negligible Positive
Number of IPM components used	Years of formal education	-0.039	Negligible Negative
Number of IPM components used	Travel time to tomato garden (one way)	-0.209	Weak Negative
Number of IPM components used	Total acreage farmed	-0.090	Negligible Negative
Number of IPM components used	Distance to Sub-County Headquarters	-0.434	Negligible Negative
Number of IPM components used	Distance to place of sale	-0.016	Negligible Negative
Number of IPM components used	Percentage of land farmed used for tomatoes	-0.243	Weak Negative
Number of IPM components used	Number of visits from extension in past 12 months	0.580	Moderate Positive
Number of males in HH involved in agriculture	Number IPM components used	0.037	Negligible Positive
Number of visits from extension in past 12 months	Years of formal education	-0.001	Negligible Negative
Number of visits from extension in past 12 months	Total acreage farmed	0.143	Negligible Positive
Number of visits from extension in past 12 months	Distance to Sub-County Headquarters	-0.208	Weak Negative
Number of visits from extension in past 12 months	Percentage of land farmed used for tomatoes	-0.264	Weak Negative
Total in HH involved in agriculture	Number IPM components used	0.088	Negligible Positive
Total in HH involved in agriculture	Amount of land used for tomatoes	0.028	Negligible Positive
Total in HH involved in agriculture	Number of visits from extension in past 12 months	0.099	Negligible Positive
Total in HH involved in agriculture	Years of formal education	0.067	Negligible Positive
Total in HH involved in agriculture	Total acreage farmed	0.102	Negligible Positive
Total in HH involved in	Percentage of land farmed used	-0.071	Negligible

agriculture	for tomatoes		Negative
Total time needed to fetch water	Distance to Sub-County Headquarters	0.355	Moderate Positive
Total time needed to fetch water	Total acreage farmed	-0.297	Weak Negative
Travel time to tomato garden (one way)	Distance to Sub-County Headquarters	0.186	Negligible Positive
Travel time to tomato garden (one way)	Distance to place of sale	0.287	Negligible Positive
Travel time to tomato garden (one way)	Percentage of land farmed used for tomatoes	0.273	Weak Positive
Travel time to tomato garden (one way)	Total acreage farmed	-0.021	Negligible Negative
Years of formal education	Total acreage farmed	0.273	Weak Positive
Years of formal education	Percentage of land farmed used for tomatoes	-0.185	Negligible Negative
Years of formal education	Distance to place of sale	0.034	Negligible Positive
Years of tomato growing experience	Number of IPM components used	0.340	Weak Positive
Years of tomato growing experience	Number of visits from extension in past 12 months	0.285	Weak Positive
Years of tomato growing experience	Years of formal education	-0.277	Weak Negative
Years of tomato growing experience	Total acreage farmed	-0.080	Negligible Negative
Years of tomato growing experience	Distance to place of sale	0.104	Negligible Positive
Years of tomato growing experience	Percentage of land farmed used for tomatoes	0.045	Negligible Positive

Table 13 - Follow-Up Statistics: Numerical Variables

Mann-Whitney Test (n=41)

$Sample_1$	$Sample_2$	$Median_1$	$Median_2$	Probability (p)	Significant at p=0.05?
Do use bicycle; Years of tomato growing experience	Do not use bicycle; Years of tomato growing experience	10.0	9.0	0.643	No
Do use bicycle; Years	Do not use bicycle;	6.5	7.0	0.610	No

of formal education	Years of formal education				
Do use bicycle; Distance to sub-county headquarters (m)	Do not use bicycle; Distance to sub-county headquarters (m)	6786.0	7347.0	0.920	No
Sell at farmgate; Years of tomato growing experience	Sell at market; Years of tomato growing experience	10.0	10.0	0.348	No
Formal source of information; Distance to sub-county headquarters (m)	Informal source of information; Distance to sub-county headquarters (m)	6510.2	7074.1	0.553	No
Do use bicycle; Distance to place of sale (m)	Do not use bicycle; Distance to place of sale (m)	0.0	8133.6	0.041	Yes
Female headed household; Total in HH involved in agriculture	Male headed household; Total in HH involved in agriculture	3.5	4.0	0.454	No
Do use staking; Total in HH involved in agriculture	Do not use staking; Total in HH involved in agriculture	5.0	3.0	0.140	No
Do use mulch; Total in HH involved in agriculture	Do not use mulch; Total in HH involved in agriculture	4.5	3.0	0.424	No
Do use staking; Number of females in HH involved in agriculture	Do not use staking; Number of females in HH involved in agriculture	2.0	2.0	0.304	No
Do use staking; Number of males in HH involved in agriculture	Do not use staking; Number of males in HH involved in agriculture	2.0	1.0	0.373	No
Female headed household; Total acreage farmed	Male headed household; Total acreage farmed	2.0	3.0	0.045	Yes
Fenale headed household; Acreage used for tomatoes	Male headed household; Acreage used for tomatoes	0.4	0.5	0.372	No

Female headed household; Number of visits from extension in past 12 months	Male headed household; Number of visits from extension in past 12 months	0.0	4.0	0.139	No
Head of household; Number of visits from extension in past 12 months	Not head of household; Number of visits from extension in past 12 months	2.0	3.0	0.882	No
Single; Number of visits from extension in past 12 months	Married; Number of visits from extension in past 12 months	0.0	2.0	0.124	No
Do know of MT56; Distance to sub-county headquarters (m)	Do not know of MT56; Distance to sub-county headquarters (m)	3072.5	7997.9	0.004	Yes
Do use MT56; Distance traveled to get pesticide (m)	Do use MT56; Distance traveled to get pesticide (m)	7947.0	27050.0	0.365	No
Do use recommended spray frequency; Distance traveled to get pesticide (m)	Do not use recommended spray frequency; Distance traveled to get pesticide (m)	8269.0	25874.0	0.785	No
Do use bicycle; Years of tomato growing experience	Do not use bicycle; Years of tomato growing experience	10.0	9.0	0.643	No
Do use bicycle; Years of formal education	Do not use bicycle; Years of formal education	6.5	7.0	0.610	No

Table 14 - Follow-Up Statistics: Numerical Variables

Kruskall-Wallis Test (n=41)

Variable$_1$	Variable$_2$	Variable$_3$	Probability (p)	Significant at p=0.05?
Tomatoes owned by self; Years of formal education	Tomatoes owned by self and spouse; Years of formal education	Tomatoes owned by spouse; Years of formal education	0.826	No
Tomatoes owned by	Tomatoes owned by	Tomatoes owned by	0.411	No

self; Number of IPM components used	self and spouse; Number of IPM components used	spouse; Number of IPM components used		
Tomatoes owned by self; Years of tomato growing experience	Tomatoes owned by self and spouse; Years of tomato growing experience	Tomatoes owned by spouse; Years of tomato growing experience	0.714	No
Tomatoes owned by self; Age	Tomatoes owned by self and spouse; Age	Tomatoes owned by spouse; Age	0.257	No
Tomatoes owned by self; Distance to place of sale (m)	Tomatoes owned by self and spouse; Distance to place of sale (m)	Tomatoes owned by spouse; Distance to place of sale (m)	0.172	No

Appendix A- Survey Questions

Individual Data:

1. Respondent's name:
2. Village:
3. Gender of person being interviewed:
4. Are you the head of household?
   . If no, what is your relationship to the head of household?
5. Age of person being interviewed:
6. Age of spouse:
7. If spouse if deceased, divorced, or living elsewhere, please note:
8. Number of people in household actively engaged in agriculture:
   . Male: Female:
9. Religion (Protestant, Catholic, Muslim, African traditional):

Individual plot characteristics:

10. How much land do you cultivate for tomato production?
11. What is your relationship to the land used for tomato production? (Rent? Own? Please explain.)
12. How long have you been growing tomatoes?
13. Why do you grow this amount of tomatoes and not more? What constrains increased tomato crop production?
14. What other crops do you grow?
15. What is the intended use of other crops grown?

Tomato crop production:

16. Do you use an improved variety of tomato?

- Why or why not?

17. Where do you get the seeds used for planting your tomato plots?

18. Do you use staking?

    - Why or why not?

19. Are you using mulch?

    - Why or why not?

20. Do you use fertilizer?

    - Why or why not?
    - If yes, what kind do you use?
    - If yes, where do you get the fertilizer?

21. Do you use chemical pesticides?

    - Why or why not?
    - If yes, what kind(s) do you use?
    - Why did you choose to use this kind of pesticide?

22. Do you own a knapsack sprayer? Do you rent or borrow one?

23. Where do you get the pesticides?

24. What pest are you trying to control in this field?

25. How many times in a tomato-growing season do you spray your crops with pesticides?

    - What influences how often you spray?

26. How do you transport inputs such as fertilizers or pesticides from where they are purchased to your tomato plots?

27. What are the three major constraints faced in tomato production?

Labor:

28. How do you cultivate your tomato fields?

Any of the following?

- Family members use hand hoe
- Hired labor use land hoe
- Use own plough or oxen
- Use borrowed plough or oxen
- Use rented plough or oxen
- Use own tractor
- Use rented or hire tractor

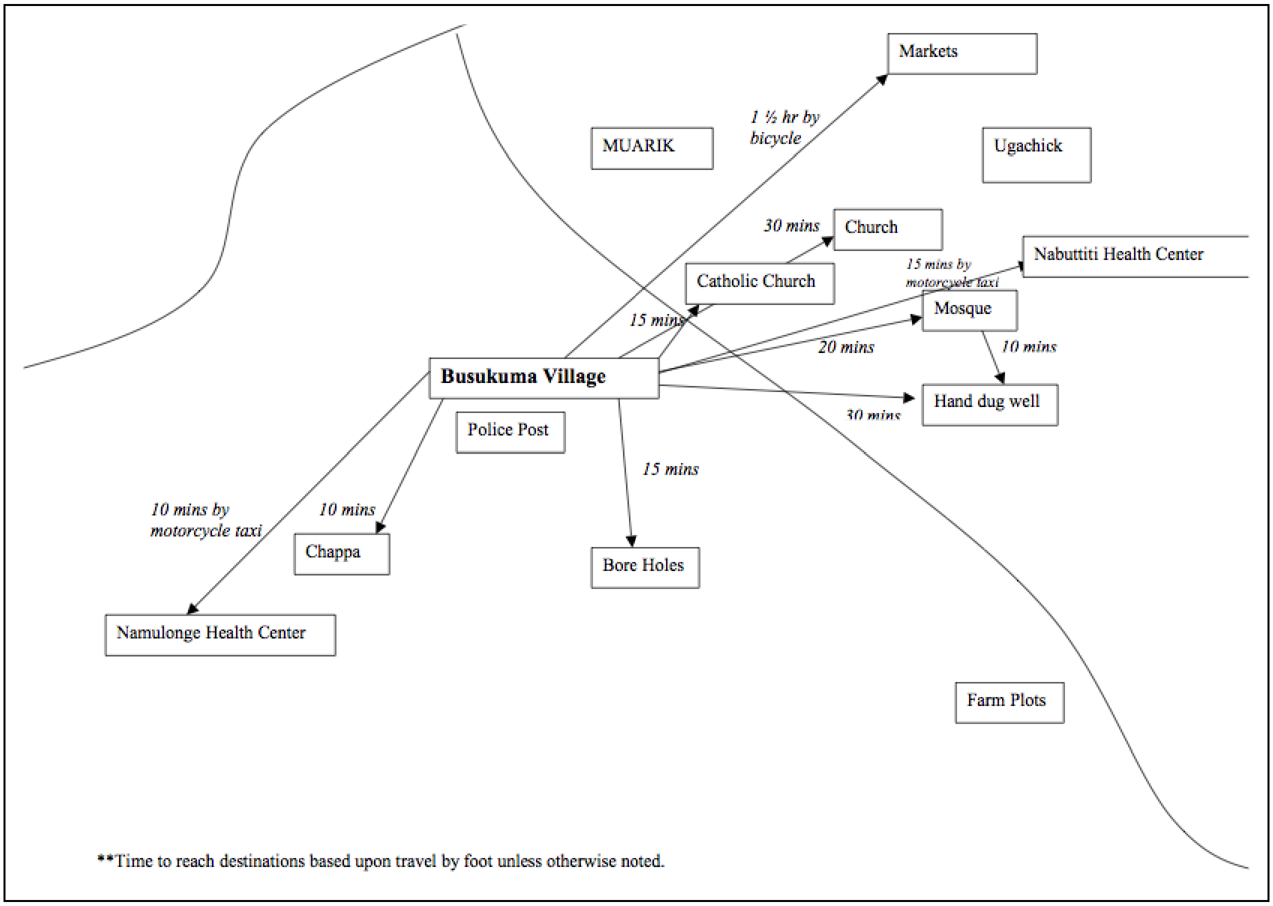
29. What is the intended use of tomato crops produced?
    - If for market, where do you sell product?
    - To whom to you sell your tomatoes?
    - How is crop transported to market? (Walking, motorbike, bicycle?)
30. Do you own a bicycle or motorbike? (Explain)

Experience with extension services:

31. How many times in the last 12 months did an extension agent visit you?
32. Do you find extension officers' visits helpful?
33. How many times in the last 12 months did you participate in meeting or demonstration (FFS) hosted by extension?
34. What are two most important sources of new information on how to improve your crop production?
    - Might include:
        - Newspaper
        - Radio
        - Books
        - Agriculture store
        - Extension agents
        - NARO research scientists

- Farmer association
- Friends
- Family
- Makerere research scientists
- Local market

Appendix B- Mobility Map



Appendix C- Activity Calendars

Men's Activity Calendar

Day	Morning	Afternoon	Evening
Monday	Take products to market (4AM), Farm work	Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Tuesday	Take products to market (4AM), Farm work	Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Wednesday	Take products to market (4AM), Farm work	Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Thursday	Take products to market (4AM), Farm work	Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Friday	Take products to market (4AM), Farm work	Worshiping (for Muslims) Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Saturday	Take products to market (4AM), Farm work	Farm work, Lunch, Leisure, Tethering Animals	Shopping, Recreation, Supper, Sleep
Sunday	Wake at 8am, Breakfast, Prayers, Farm work	Lunch, Recreation (Board games)	Recreation, drinking, listening to radio, sleep

Women's Activity Calendar

Day	Morning	Afternoon	Evening
Monday	Wake at 6AM, Prayers, Cleaning house and utensils, Preparing breakfast, Teathering cattle and feeding pigs, Farmwork (8AM-noon, in dry season they stay in field until 11AM)	Lunch, preparing supper, Care for animals, Fetching water, Washing, Farmwork (only in wet season)	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep
Tuesday	Wake at 6AM, Prayers, Cleaning house and utensils, Preparing breakfast, Teathering cattle and feeding pigs, Farmwork (8AM-noon, in dry season they stay in field until 11AM)	Lunch, preparing supper, Care for animals, Fetching water, Washing, Farmwork (only in wet season)	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep
Wednesday	Wake at 6AM, Prayers, Cleaning house and utensils, Preparing breakfast, Teathering cattle and feeding pigs, Farmwork (8AM-noon, in dry season they stay in field until 11AM)	Lunch, preparing supper, Care for animals, Fetching water, Washing, Farmwork (only in wet season)	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep
Thursday	Wake at 6AM, Prayers, Cleaning house and utensils, Preparing breakfast, Teathering cattle and feeding pigs, Farmwork (8AM-noon, in dry season they stay in field until 11AM)	Lunch, preparing supper, Care for animals, Fetching water, Washing (for Muslims), Farmwork (only in wet season)	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep
Friday	Ironing, prayers (for Muslims), washing, preparing food	Washing (for Seventh Day Adventists), Salon, preparing food, crafts	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep

Saturday	Washing, routine work, Ceremonies, Church (Seventh Day Adventists)	Ceremonies, weddings, salon	Watering (during dry season only), bathing, supper, prayers, bringing animals, "make-up for husband", sleep
Sunday	Worshiping (non-Muslims)	Lunch, resting, visiting	ironing uniforms for children and husband, preparing supper

Appendix D- In Depth Survey Questions

1. How many years of formal education do you have?
2. Who in the household decides to grow tomatoes and why?
3. Who owns the tomato gardens and why?
4. How many tomato fields do you have?
5. Which of these fields works best for you?
6. If you use staking and mulching, where do you get the materials?
7. Who decides the land on which tomatoes are grown and why?
8. How is labor divided in tomato production?
9. How far is your tomato garden from your home?
10. How do you get to your tomato garden and how long does it take?
11. Who sells the tomatoes and why?
12. Who decides how to use the income generated from sale of tomatoes? How is the income distributed?
13. What are the sources of information about IPM?
14. How far is the information source from your home?
15. If the information source is far away from your home (5km), would you seek it?
16. If it is the woman who owns the tomatoes, what does the man do for income generation?
17. Have you heard about improved tomato varieties?
18. Do you have access to improved tomato varieties?
19. How do they differ from local varieties?
20. What is the most important market where you sell your tomatoes?
21. How far is the market from your home?

22. What is the total acreage of land used for farming?

23. How many other people have you convinced to join the IPM project?

Appendix E- Follow-Up Survey Questions

1. How many years of formal education have you completed?

2. Who in the household owns the tomatoes that you grow?

3. What do you know about the MT-56 tomato variety and how did you learn about it?

4. How do you get to your tomato garden and how long does it take (estimated time of one-way journey)?

5. How do you fetch water and how long does it take (estimated time of round trip to water source plus time to fill cans)?

6. What is the total acreage of land used for farming?