12-2018

Climate Change Perceptions and Adaptation Among Small-Scale Farmers in Uganda: A Community-Based Participatory Approach

Thomas Derr
Utah State University

CLIMATE CHANGE PERCEPTIONS AND ADAPTATION AMONG SMALL-SCALE FARMERS IN UGANDA: A COMMUNITY-BASED PARTICIPATORY APPROACH

by

Thomas Derr

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Geography

Approved:

_____	_____
D. Layne Coppock, Ph.D. Major Professor	Claudia Radel, Ph.D. Committee Member
_____	_____
Roger Kjelgren, Ph.D. Committee Member	Richard S. Inouye, Ph.D. School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2018

ABSTRACT

Climate Change Perceptions and Adaptation Among Small-Scale Farmers in Uganda: A Community-Based Participatory Approach

by

Thomas Derr

Utah State University, 2018

Major Professor: D. Layne Coppock
Department: Environment and Society

Climate change in Uganda is characterized by unpredictable severe weather and shifts in the once-stable bimodal pattern of annual precipitation that traditional farming systems depended on. This, in combination with ongoing compounding socioeconomic challenges, has significantly increased the vulnerability of small-scale farmers who comprise the majority of Uganda's population. Evidence suggests that Ugandan farmers may be passive or slow to adapt to the diverse changes they perceive. Communication and intervention strategies are therefore needed to better identify emerging problems and sustainable solutions. This research used a novel combination of participatory rural appraisal (PRA) and participatory action research (PAR) over seven months with two communities in Hoima District of western Uganda. One represented a rural area and the other a peri-urban area. The PRA methods were used to identify and prioritize solvable problems and generate community action plans. The PAR methods were used to reveal

implementation details of problem-solving interventions. Overall, the main problems identified included degraded water resources, poor agricultural performance, gender issues, and health challenges. In some cases these problems were indirectly linked to climate change, but in most instances they occurred due to socioeconomic challenges like poverty and lack of institutional support. In both communities, sustainable solutions to major problems were developed involving a combination of human capacity-building and improving access to local services. These actions resulted in the successful implementation of a pilot project in the rural community focused on improving water resources. Overall, this approach was effective because the communities were empowered to act as self-advocates for creating lasting change. This research echoes a rapidly growing body of literature demonstrating the practicality and effectiveness of community-based adaptation to poverty mitigation and climate change in the field of sustainable rural development. Ultimately, these findings also challenge the typical narrative of donor-driven development that unnecessarily force the implementation of external solutions without substantial community involvement or commitment.

(163 pages)

PUBLIC ABSTRACT

Climate Change Perceptions and Adaptation Among Small-Scale Farmers in Uganda: A Community-Based Participatory Approach

Thomas Derr

Climate change in the East African country of Uganda is causing severe variations in the once predictable seasonal weather patterns that farmers had come to depend on. This, in combination with social and economic challenges, has significantly increased the vulnerability of farmers who make up the majority of Uganda's population. Previous knowledge and observations suggest that Ugandan farmers may be reluctant or slow to change their practices in response to the changing climate. Strategies are therefore needed to identify challenges and sustainable solutions. This research used qualitative data collection methods known as participatory rural appraisal (PRA) and participatory action research (PAR) over a seven-month period with two communities in western Uganda. One community was located in an urban area while the other was rural. Research methods were used to first identify real challenges specific to the community before developing strategies to solve them. Both of these steps were conducted in a bottom-up community-based way, utilizing the expertise of community participants. Overall, the main problems identified included degraded water resources, poor farm performance, gender issues, and health challenges. Most of these problems were not directly a result of climate change, but rather a combination of social and economic challenges like poverty and a lack of support from the government and other organizations. In both communities,

sustainable solutions to major problems were created by increasing the overall knowledge, expertise, and cooperation among community participants in addition to improving access to local services. The actions taken resulted in a pilot project that improved water resources for the rural community. The approach was effective because it allowed the communities to advocate for themselves to create lasting change. This research builds upon a rapidly growing body of literature on the effectiveness of community-based efforts to solve real-life problems in struggling communities. Furthermore, these findings also challenge more traditional donor-driven approaches to development.

ACKNOWLEDGMENTS

My thanks go to Layne Coppock for his constant support and guidance throughout this project. His thoughtful insights and encouragement helped to put challenges in perspective and kept me focused on my goals. I also thank my other committee members, Claudia Radel and Roger Kjelgren, for their support and expertise. It has been a pleasure to work with all of you.

I thank Peace Corps for giving me the opportunity and supporting me to work in Uganda. The gratitude I feel towards the Peace Corps Uganda family at large, and particularly my fellow volunteers whom I could always count on to lend a hand when in need, cannot be overemphasized.

I also acknowledge my host organization and staff at Eco-Agric Uganda for sticking with me and making me a part of your family. A special thank you goes out to my counterpart, Atugonza Nicholus, for spending long hours in the field with me to help conduct this research. You are a true friend, and this project could not have been completed without you.

Thanks to the villages of Kihigwa and Itara for participating in this project and making me feel welcome and at home in your communities. Your ability to come together and solve problems for the greater good has truly impressed me. Also, thanks to my home village of Kasingo for integrating me into your community so that we could learn from one another.

Finally, thanks to my family for your unwavering support in all of my endeavors.

I cannot begin to properly express how much your love and support has meant to me.

Tom Derr

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In the fields of geography and human-environment research, small-scale or smallholder farmers remain critically important today (Vadjunec et al., 2016). Commonly defined as farmers who cultivate on no more than ten hectares of land and usually with some reliance on subsistence production (FAO, 2012), small-scale farmers comprise between 2 and 2.5 billion people (Zimmerer & Vanek, 2016). More so, small-scale farmers occupy the majority of total agricultural lands globally (Lowder et al., 2016). Consequently, it is logical that they have a profound impact on land use and biodiversity (Vadjunec, 2016).

Their size and scale alone is not the primary reason for why they remain so relevant, partly because the term 'smallholder' can no longer be defined solely by land holding size or production. The term now needs to be more fluid and situation-dependent so that it does not limit researchers or practitioners (Vadjunec, Radel, & Turner, 2016). This shift in the definition of what a small-scale farmer is reflects the increasingly dynamic challenges that they face, such as finite resources, poverty, gender gaps, poor political representation, economic globalization, and others. Ultimately, the success or failure of small-scale farmers can be linked to the prosperity or downfall of communities and nations across the social, political, and economic spectrum (FAO, 2012).

Small-scale farmers in the world's least developed countries are vulnerable to a multitude of social, economic, and environmental stressors (Morton, 2007). The resiliency of small-scale farmers and their ability to overcome challenges wanes as stressors become increasingly compounded (Smit & Wandel, 2006). In relevance to climate change, Morton (2007) states that smallholder vulnerability to climate change is

compounded because of the "socioeconomic, demographic, and policy trends that limit their capacity to adapt to change." This thesis analyzes many of these stressors but ultimately aims to interconnect them to determine how they influence the challenge of small-scale adaptation to climate change. More specifically, this thesis presents the findings of community-based research conducted within two communities of western Uganda. The goal of these projects was to utilize participatory rural appraisal (PRA; Chambers, 1994, 2004) and participatory action research (PAR; Whyte, 1989) methods to identify feasible and sustainable pathways to adaptation.

This research focuses specifically on climate change, as opposed to other key stressors, because of its prominence as a relatively recent emerging issue with rapidly shifting impacts. For example, in Uganda the main challenge of climate change has been an alteration in the bimodal pattern of seasonal rains. Dry seasons are now becoming longer and hotter while wet seasons are shorter with more intense rainfall events. These changes severely impact how Ugandan smallholders have traditionally practiced farming (Orlove, Roncoli, & Kabugo, 2010). Considering that smallholders make up 80% of the Ugandan population, how they perceive and adapt to climate change is significant.

The predicament for developing feasible solutions to this problem lies in the reality that no single community in Uganda or elsewhere faces the same set of challenges, whether they are climate related or not. Consequently, a cure-all across the board solution, like those more commonly conceived in top-down strategies, will likely not result in a successful outcome in promoting sustainable adaption to climate change (Reid & Huq, 2007). Because of this reasoning, this research elected to take on a bottom-up

community-based approach in which community participation would be key to the completion of the project.

Of the two communities where research projects took place, one was in a peri-urban setting while the other was in a rural setting. This was done intentionally to exemplify how differences in community resource access may or may not promote or hinder adaptation. Within each of the targeted communities, research practitioners worked and established relationships with community members over a seven-month period. During this time, PRA methods were used to reveal implementation details of problem solving interventions. Specific PRA tools utilized interactive activities that drew from the shared experience and knowledge of community members. The tangible results of the PRA process were the collection of ethnographic data seen in the form of community maps, seasonal calendars, historical timelines, and through community and key informant discussions, culminating in an eclectic set of qualitative data. This data would determine the priority challenges and opportunities to be addressed.

PAR methods were then used to reveal implementation details of problem-solving interventions. This involved the collaboration of research practitioners and community members to develop community action plans. Through further collaboration, these plans were implemented via the efforts and funds raised by the communities themselves, practitioners, and outside sources when necessary.

Many key challenges and opportunities were identified, but those that stood out the most included degraded water resources, poor agricultural performance, gender issues, and health challenges. All of these challenges were in some way linked to climate change but likely occurred more directly as a result of socioeconomic challenges like

poverty and a lack of institutional support. In both communities, sustainable solutions to major challenges involved a combination of human capacity-building and improving access to local services.

This consequently demonstrates that the most efficient way to promote climate change adaptation is rarely the most obvious, particularly from an outsider's perspective. This research reveals that in reality, the challenges that communities face are wicked, ever changing, and compounding. Identifying and implementing community-driven solutions are therefore found to be the most feasible and effective strategy for enhancing resilience to climate change and other challenges.

BACKGROUND AND LITERATURE REVIEW

Climate Change and Ugandan Smallholder Agriculture

Climate change, a phenomenon that the IPCC finds "beyond reasonable doubt" to be true, will likely impact the continent of Africa more than any other. In fact, excerpts from IPCC (2007) reports on climate change in Africa state, "no continent will be struck as severely by the impacts of climate change as Africa." It is extremely important to note that it is not the physical impacts of climate change themselves that make Africa so vulnerable, since other regions face similar if not worse threats. Rather, it is the existing problems in Africa such as poverty, lack of infrastructure, and reliance on subsistence agriculture that will be amplified by climate change stressors (IPCC, 2007).

Agriculture in Africa is singled out by many studies to be most negatively impacted by climate change (McCarthy, Canziani, Leary, Dokken, & White, 2001). In the Great Lakes region of East Africa, Uganda—a country heavily dominated by small-scale farming (UBS, 2014)—will undoubtedly feel the compounded impacts of climate change in addition to pre-existing stressors like rapid population growth, a population with a very young age structure (Daumerie & Madsen, 2010), declining ecosystem services, and recurrent economic crisis. In the proposed research, perceptions of and adaption to climate change among small-scale farmers in Uganda will be investigated to identify needs, resources, and capabilities at the community level.

Uganda's geography results in an exceptionally diverse climate. A combination of large lakes, tall mountain ranges, deserts, savannahs, and forests makes the climate literally vary village by village. It is because of this astounding variation that a USAID

assessment (Caffrey et al., 2013) segmented the nation into six distinct eco-climatic regions. This is remarkable considering that Uganda only covers 241,038 square kilometers, roughly the size of Oregon.

For Uganda overall, the analysis by Caffrey et al. (2013) noted that there has not been any significant change in annual rainfall in recent years, nor is any change projected for the next 30 years, i.e., 2015–2045. What the report did reveal, however, was change in duration and intensity of rainy and dry seasons. The onset of rainy seasons is now likely to shift from 15 to 30 days from the traditional dates; the rainy seasons may also end sooner or be extended an additional 20 to 40 days. This is significant because farmers rely on rain-fed agriculture and plant their crops around the traditional expectations concerning the onset of the rains, and in the past this was easier to predict.

The main rainy seasons have historically occurred between March to May and September to November with intervening dry seasons, but Caffrey et al. (2013) show that this is no longer the case. Furthermore, an analysis of average annual temperatures from 1951 to 2010 show a substantial increase of 0.5 to 1.2 degrees Celsius for minimum temperatures, and 0.6 to 0.9 degrees Celsius for maximum temperatures; other projections suggest an overall increase of 2.0 degrees Celsius by 2030. Lastly, extreme weather events like floods, hailstorms, and droughts may occur more frequently (Caffrey et al., 2013).

Orlove et al. (2010) point out that farmers in Uganda have traditionally relied on their indigenous knowledge to help navigate natural climate variations that occur in any given year. The four main components of this knowledge are: (1) Longstanding familiarity with the seasonal patterns of precipitation and temperature; (2) a set of local

traditional climate indicators; (3) observation of meteorological events; and (4) information about the progress of the seasons elsewhere in the region. This indigenous knowledge is slowly beginning to fail Ugandan farmers as climate change takes hold (Orlove et al., 2010).

For example, several studies have shown that farmers generally like to plant during the month leading up to the rainy season to have a better chance of producing a higher crop yield, but this once common practice is now riskier given the onset of the rains is less predictable (Caffrey et al., 2013; Hepworth & Goulden, 2010; Hisail, Birungi, & Buyinza, 2011; Orlove et al., 2010; Osbahr, Dorward, Stern, & Cooper, 2010). Most farmers will now only plant when they are sure the rains have arrived, which lowers harvest quantity. Additionally, rising temperatures will cause problems for farmers by slowing the development of key crops like coffee, rice, maize, and bananas by hindering their seed and leaf development (Caffrey et al., 2013). Arabica coffee in particular, a key cash-crop grown at higher altitudes where it thrives in cooler conditions, is undoubtedly under the biggest threat as warmer temperatures ascend Uganda's mountain slopes (Caffrey et al., 2013). Higher temperatures at higher elevations will also increase the likelihood of pests in mountainous regions where temperatures have been traditionally too cold for them to survive, and this can now cause new problems for crops besides coffee (GOU, 2004). Even mosquitoes can now move to higher elevations, leading to outbreaks of malaria in villages that never experienced the disease before (Wandiga et al., 2010).

Perhaps most significant, however, is the conclusion by Caffrey et al. (2013) that rising temperatures will lead to an increased rate of evaporation and a decline in soil

moisture, creating an even greater need for irrigation. Without easy access to water, increasing irrigation becomes a major time and energy stressor on many farming households. Lastly, the occurrence of more extreme weather events like droughts and floods will increase the prevalence of pests and diseases that thrive in harsher conditions while physical damage to crops from rain and hailstorms will be more common as well (Caffrey et al., 2013; GOU 2004).

These climatic changes will impact some crops more than others. According to Caffrey et al. (2013), eight of the most widely grown crops and their value chains were analyzed to determine which would be the most or least vulnerable. These crops—listed as most to least vulnerable—include: coffee, rice, maize, banana, beans, sorghum, sweet potatoes, and cassava. Coffee will be extremely vulnerable due to rising temperatures; this is crucial because coffee is the major cash crop in Uganda [Uganda recently overtook Ethiopia as the leading exporter of coffee in Africa (ICO, 2015)].

Rice and maize are two major food crops, and these are similarly at a heightened risk from pests and disease as a result of rising temperatures. Sweet potatoes and cassava are the two least vulnerable crops, and they may actually thrive in warmer temperatures. Cassava, and to a lesser extent sweet potatoes, are considered to be primarily subsistence or "hunger" crops that are only eaten when other crops have not yet been harvested or are scarce in any given year (Orlove et al., 2010). Furthermore, the nutritional value of cassava and sweet potatoes is low and alone cannot provide a healthy diet. Efforts are being made to promote orange-fleshed sweet potatoes which have a higher nutritive value over traditional varieties (Low et al., 2001).

Overall, Caffey et al. (2013) show that crops in Uganda, even those considered to be the least vulnerable, will be negatively impacted in some way as a result of climate change. Okonya et al. (2013) point out that not all climate impacts will necessarily be negative. For example, those farmers who can utilize large amounts of rainfall over short periods of time or use newly flooded lands to grow rice may benefit from climate change. Undoubtedly though, climate change and the role of agriculture in adaptation and mitigation is incredibly complex. For more information, see Appendix C.

The Ugandan Ministry of Water and Environment has been assigned the task of taking on issues pertaining to climate change. Consequently, this ministry has recently created a Climate Change Department (CCD). The United Nations Frameworks Convention on Climate Change have had very influential roles in shaping the operations of the CCD. The sense of urgency is due to concern that the least developed countries (LDCs) will be most vulnerable to climate change (UNFCCC, 2009). The CCD gives much attention to mitigating the production of greenhouse gases (GHG) in Uganda, despite that such production is miniscule on a global scale. This outcome may be encouraged by Uganda's political commitments to the UNFCCC and the Kyoto Protocol.

Efforts to mitigate GHG emissions in Uganda fit well with Uganda's National Development Plan (NDP) that aims for sustainable national development (GOU, 2010). Furthermore, Uganda's government is involved in projects that utilize carbon market mechanisms (CMMs) and carbon development mechanisms (CDMs). This can earn certified emission reductions (CERs) that in turn can be sold to offset emissions produced in other parts of the world. For example, one popular project concerns the use of energy efficient, small-scale stoves that burn charcoal and firewood more slowly than traditional

stoves. This program is a registered CDM that earns CERs bought by other entities (IPCC, 2007).

Overall, GHG mitigation practices promoted by the government help put Uganda on a path for sustainable development but does relatively little to support small-scale rural farmers. In some cases such efforts can even hurt farmers when the government sells large portions of land to foreign countries or private investors who use the land to plant trees and receive carbon credits. Literature has shown that such top-down actions have largely been unsuccessful in helping local people (Adger, Barnett, Brown, Marshall, & O'Brien, 2013).

Alternatively, in 2007 the Ugandan CCD released their National Adaptation Program of Action (NAPA), which includes programs being created by LDCs worldwide to identify "urgent and immediate" priorities for climate adaptation (UNFCCC, 2009). Uganda's NAPA takes a bottom-up approach, focusing on development at the community level, connecting climate adaptation with issues like poverty alleviation and population growth. It did this by identifying interventions at the community level and then matching them against three levels of criteria that are national development priorities, implications at community and ecosystem levels, and urgency and immediacy (GOU, 2007). Consequently, eight areas of intervention were prioritized including: (1) land use; (2) farm forestry; (3) water resources; (4) health; (5) weather and climate information; (6) indigenous knowledge documentation and awareness creation; (7) policy and legislation; and (8) infrastructure. The importance of making any data collected in these areas of intervention easily available to the Ugandan public at the village level has been stressed (Corner, 2011).

The Government of Uganda (GOU) has called upon the international community to provide funding in tens of millions of dollars to develop projects in these eight areas of intervention, but not all funding has come to fruition. In a report by OXFAM (2008), Paul Isabirye, Uganda's principal meteorological officer, is quoted saying in reference to this lack of funding that "We must get well prepared before we get the funds if we want to make an impact." The report further claims that while other LDCs have looked to consultants to develop their plans for them, "the Ugandan government established a real country process that was driven from below" (OXFAM, 2008). The GOU's efforts can be admired, but without funding to apply their plans for promoting climate adaption, there will be little or no impact.

It is not just the GOU and others in power that are recognizing the threats of climate change. Ugandan farmers, as well as other African farmers across the continent, are recognizing the threats and perceive them to be very real (Maddison, 2007). While farmers usually fail to understand the science behind climate change or why it is happening, they do recognize changes in the long-term weather patterns. In a survey study across 10 African nations by Maddison (2007), it was found that older farmers or those with more experience were able to perceive changes in the climate better than younger farmers or better than those with less farming experience. For example, of all farmers surveyed, 42% having up to 19 years of experience stated they perceived warmer temperatures, while 60% of farmers with 40-plus years of experience perceived warming. Similarly, 44% of those with up to 19 years of experience stated they perceived a decrease in precipitation, while 62% of those with 40-plus years of experience perceived

a decrease. This indicates a logical relationship between number of years farming and the ability to perceive long-term climate patterns.

As Maddison (2007) points out, simply perceiving a climate shift does not mean that one will act on it by taking some sort of adaptive measure. Maddison states, "Adaptation to climate change actually involves a two-stage process: First perceiving that climate change has occurred, and then deciding whether or not to adopt a particular measure." He also noted that, "Although experienced farmers are more likely to perceive climate change, it is educated farmers who are more likely to respond by making at least one adaptation." The findings of Maddison (2007) are consistent with others throughout Africa (Bryan, Deressa, Gbetibous, & Ringler, 2009; Conway & Schipper, 2011; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009), that found that farmers often only complete the first step of adaptation—namely perceiving that it has occurred—but then either fail to choose a particular adaptation measure or choose to do nothing.

There are many reasons that might explain why farmers fail to try to adapt to climate change. There has been a disconnect in the literature as to which barriers are most prominent and why. For example, the study by Maddison (2007) claims that insecure property rights, lack of market access, transportation problems, and lack of inputs were rarely the main issues. Rather, it was the lack of financial capital and knowledge or information that were cited as the primary barriers (Maddison, 2007). By comparison, key informants in research conducted by OXFAM (2008) claimed that an absence of markets and a lack of property rights—especially for women—were important barriers. Other studies suggest that gender of the household head and size of owned land holdings are primary determinants of or barriers for adaptation (Okonya et al., 2013). Conflicting

findings are also present when analyzing age in relationship to adaptation. Shiferaw and Holden (1998) claimed that older farmers are less likely to embrace adaptation methods, but Deressa et al. (2009) claimed that they are very likely to do so. These conflicting findings perhaps illustrate a high degree of place-based variability of spatial and temporal factors that determine how individual communities or households respond to climate change. Overall, most small-scale farmers seem to either be failing to adapt completely or are failing to significantly implement an adaptation practice that is consequential enough to reduce their vulnerability.

Of the small-scale farmers that do choose to try to adapt to climate change, there are many different ways the process is attempted both locally and through more general socio-economic and political systems (Smit &Wandel, 2006). Adaptation is defined as making adjustments in the natural or human system in response to actual or expected climatic stimuli, or their effects, to moderate harm or exploit beneficial opportunities (Smit & Pilisova, 2001). Some of the more common adaptation practices include making basic changes to farming systems by planting different crop varieties that may be more resistant to change, increasing the use of irrigation, or planting trees to create more shade and a cooler environment for crops that may be heat-stressed (Lal et al., 2015). Other adaptation measures focus on making changes divorced from the farming system; adaptation measures via social systems can include utilization of village savings and loan associations (VSLA), opening a shop to diversify livelihoods, migrating to a new area, or leaving farming all together to pursue a different livelihood (Lowicki-Zucca, Walugembe, Ogaba, & Langol, 2014). In Uganda, farmers often rely on the formation of social groups like VSLAs and other microfinance operations, which create a new culture

of saving and provides access to loans for farming inputs and emergencies that poor farmers usually cannot receive from banks (Lowicki-Zucca et al., 2014). Farming cooperatives allow farmers to bulk together their crop yields and get better prices from middlemen, who in turn sell the crops in the more lucrative Kampala markets (Kwapong & Korugyendo, 2010). Additionally, community crop-storage units, almost never available to an individual farmer, enhance post-harvest handling practices and therefore improve the overall quality of the stored crop.

Bryan et al. (2009) analyzed factors influencing the decision to adapt to climate change by breaking adaptation into four main components. These components included: (1) the characteristic of the stressor; (2) the characteristics of the system; (3) multiple scales that the stressor and system spread to; and (4) the adaptive response itself. Responses to stressors can be either reactive—taking action once the stress is felt—or proactive—predicting the stressor and taking action before it occurs (Bryan et al., 2009; Smithers & Smit, 1997). Other research has argued that factors like experience and the risk tolerance of individuals influence adaptive decision-making as well (Burton, 1997). As Adger et al. (2003) point out, it is necessary to distinguish adaptation with regards to who is undertaking it because, even though all societies are fundamentally adaptive, some sectors are more sensitive or vulnerable than others. Furthermore, personal beliefs based on perceptions, values, and norms can also encourage or limit adaptation (Adger, Lorenzoni, & O'Brien 2009).

The adaptation measures a farmer chooses or does not choose to take are dependent on many things, perhaps most importantly, his or her level of vulnerability. Defined by Bohle, Downing, and Watts (1994), vulnerability is "an aggregate measure of

human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations." This definition of vulnerability connects to the idea of multiple stressors from various sources environmentally, socially, economically, and politically that build on top of one another to increase vulnerability overall. This is a critical point and highlights the importance of not overemphasizing climate-based problems that detract attention from other equally important, if not greater, problems because never will there be a single challenge not interconnected with several others in a socio-ecological setting (Nyantakyi-Frimpong & Bezner-Kerr, 2015).

Adger (2006) defines vulnerability as "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt." Like Bohle et al. (1994), Adger (2006) also mentions multiple stressors but also includes the "capacity to adapt" as a key feature determining vulnerability. Caffrey et al. (2013) use the following equation to measure vulnerability:

$$V \text{ (vulnerability)} = f \text{ (exposure x sensitivity x adaptive capacity)}$$

In this equation, exposure represents a multiple set of changes to climate, sensitivity represents a connection of exposure elements to human systems integrated with natural systems, and adaptive capacity is the inherent ability of a livelihood system or a household to absorb climate change shocks or buffer their impacts. This equation summarizes all of the factors that go into vulnerability that make it such a complex topic.

Another key word, often referred to as the opposite of vulnerability, is resilience. The concept of resilience began with ecological systems as a characteristic of their ability to maintain themselves during a disturbance (Folke, 2006; Holling, 1973;). This theory

spread to social systems as well, and Adger (2000) defines social resilience as "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change." For rural and small-scale farm communities like those found all over Uganda, there is a link between resilient ecosystems and resilient communities. In other words, a resilient ecosystem usually means a resilient community due to the support a community receives from natural resources and ecosystem services. While it can be assumed that ecosystems in Uganda were never completely stable or resilient, they were resilient enough to support many rural communities. With the onset of climate change, ecosystem resilience will break down and further erode social resilience that is already suffering from social and political deterioration (Adger, 2000). As social systems become more vulnerable they further degrade environmental systems to support their own needs, but in doing so create a vicious cycle that eventually will not be able to support itself (Adger, 2000).

Challenges of Development Assistance

How to best promote resiliency while reducing vulnerability has been a convoluted topic of discussion within development studies. Top-down donor-driven efforts have been the generally accepted paradigm in international development since its inception in the post WWII and postcolonial era when it was perhaps better known as aid (Rist, 2014). In hindsight, and maybe unsurprisingly, these efforts have not been as effective as those who implemented them may have hoped. As undoubtedly an extremely complex topic, challenges in international development cannot be solved by quick fixes typically implemented in many top-down donor-driven development schemes. In

actuality, these efforts have arguably hindered development and contributed to a vicious cycle of poverty and dependence (Moyo, 2009).

The shortcomings of development have been analyzed by Ferguson (Moyo, 2009) who states, "It has long seemed to me problematic, and even a little embarrassing, that so much of the public debate about Africa's economic problems should be conducted by non-African white men." Ferguson goes on to pose the question, why is it that poverty has increased despite increased aid efforts? This theme is further analyzed and discussed by Moyo (2009), Tandon (2008), and Glennie (2008), who argue that Africans should be responsible for their own development and that foreign development initiatives have created aid dependency among the supposed beneficiaries. Prior to this relatively recent literature on the subject, Hayter (1976) discussed the use of development as a political weapon, demonstrating that the shortcomings and misuse of development assistance was apparent nearly 50 years ago.

In response to the increasingly apparent downfalls of top-down, donor-driven development/aid, the paradigm has gradually been shifting to a more inclusive bottom-up, community-based approach (Moyo, 2009). The field of community-based adaptation (CBA) has recently emerged as one of the more prominent methods for combining climate change adaptation and development from a practical and applied perspective.

Reid and Huq (2007) discuss six key CBA lessons, beginning with the importance of establishing trust between community members and outsiders/researchers by spending long periods of time together and utilizing intermediaries to help bridge gaps. Second, climate change is a confusing concept and therefore should be explained in locally relevant languages and terms that can be understood. Third, once trust is established and

terminologies are understood, the process of identifying appropriate adaptations can begin. Fourth, the difference between successful and unsuccessful interventions is not in the intervention itself but rather the inputs to the intervention. In other words, it is not about what the community is doing but, more practically, why they are doing it and with what knowledge. Fifth, early findings also show that CBA practices are not learned in a formal training setting but are instead learned by practicing them in the field. Lastly, early findings show that CBA is still new but has the potential to grow very rapidly in the development community.

Major development organizations have recognized these points and are finding ways to incorporate CBA projects into their activities (Ayers & Forsyth, 2009). These include the Food and Agriculture Organization (FAO) of the United Nations, the World Bank, and the United Nations Development Program (UNDP) (Leopold & Mead, 2009). The organizations implementing CBA approaches the most effectively are on-the-ground local NGOs who recognized the benefits of these approaches long ago and are now getting their chance (Derr, personal observation). Locally based NGOs are often the most motivated and have the best understanding of local issues, culture, and connections. Providing them with funding and resources to implement their own projects and ideas, as opposed to the ideas of commonly irrelevant outsiders, needs to be considered more.

Funding for development projects is usually granted based on the promise of a well-designed and structured proposal with set indicators and objectives that are predetermined. The CBA projects, by their nature, are generally much less structured than this. For example, Coppock (2016) discusses the disconnect between researchers and the communities they aim to support and speaks to the creative and organic flow of

participatory action research as it happens iteratively by observing, acting, adjusting, and then repeating. Having predetermined objectives or agendas significantly hinders the natural progression of a project but, unfortunately, they are deeply ingrained in the culture of academia and are primary determinants of funding and supposed credibility.

Nonetheless, a wide variety of creative community-based methodologies are emerging. For example, Beh, Bruyere, and Lolosoli (2013) utilize a photovoice approach, allowing locals to legitimize their perspectives on conservation in Kenya through photography. Coppock, Desta, Tezera, and Gebru (2011) discuss how connecting vulnerable pastoral women in Ethiopia to successful peers in northern Kenya helped to inspire action and change among them. Other practitioners are proponents of participatory resource mapping, which can be used in multiple ways to help communities articulate their knowledge to outsiders (Greene & Hesse, 2017). Experimental learning, the use of games and other activities, has also proven itself to be a useful CBA field tool for revealing valuable community knowledge (Suarez, de Suarez, Koelle, & Boykoff, 2012).

The CBA and development efforts focused around climate change have no doubt grown rapidly and produced powerful results. They have not been without their flaws though. Burnham and Ma (2015) find that in many climate adaptation development projects, researchers tend to focus too much on the climate specific impacts and ignore the equally if not more important nonclimatic stressor. By untangling and separating climate impacts from the even more complex livelihood systems, researchers fail to fully understand the entirety of the situations they are analyzing.

Community-based development projects have also been criticized as being poorly designed and implemented and have the appearance of being messy and haphazard. Mansuri and Rao (2004), for example, find that project implementers are too naïve when it comes to complex topics like participation, social capital, and empowerment. They find facilitators are often poorly trained in participatory methodologies, and external agents often have too much influence on project outcomes, despite their intentions. Furthermore, there is always a substantial risk that participatory projects can be taken advantage of by certain community individuals or bodies.

The field of development is being examined under a critical lens now more than ever and rightfully so. In a discussion on the ethics of development, Gasper (2015) states, "Different choices and ways of thinking about development bring greatly different outcomes for different people. We should try to think openly, carefully and fairly about the priorities and principles that guide these choices, about which groups are favored, neglected, or even sacrificed, and about the choices involved also in the related ways of thinking." This statement speaks to human values as a means of motivation and as a means for understanding others. While many development practitioners hold values that motivate them to help vulnerable populations, it is pertinent to critically examine how this is achieved.

Development practitioners need to ask themselves if their outside expertise and resources are practical for developing sustainable solutions in local communities. More importantly, they need to ask themselves if their interventions are doing more harm than good. Ultimately, community-based methods may not prove to be the best pathway for

the conundrum of international development. Nonetheless, it is a step in the right direction, promoting the continued evolution of international development.

Summary Remarks: A Case for Bottom-Up Development

As the literature has illustrated thus far, and in relation to the ideas of vulnerability and resilience, it is fair to say that in the face of climate change, the livelihoods of many Ugandan farmers are severely threatened (Adger, 2006). Meteorological reports have projected serious changes in the historically stable climate patterns; this means that indigenous knowledge will become increasingly ineffective. Several articles have demonstrated the gap that exists between perceptions of, and adaptations to, climate change (Bryan et al., 2009; Conway & Schipper, 2011; Deressa et al., 2009; Maddison, 2007). Efforts by the GOU in promoting adaptation have not yet been applied. Adaptation methods undertaken by farmers thus far have been insignificant. All signs, consequently, seem to indicate that the vulnerability of Ugandan farmers is increasing while resilience is declining (Derr, personal observation). The literature suggests that the most effective way forward is to build capacity at the local level to empower farmers from the bottom-up.

RESEARCH QUESTIONS

Based on the topics presented in the background information and literature review, a set of four research questions were developed. To begin, this research seeks to answer if (1) small-scale Ugandan farmers perceive the climate to be changing and, if so, how? Based on findings in the literature, specifically from Caffrey et al. (2013), it is already known that climate change in Uganda is exemplified by a shifting in the bimodal patterns of seasonal rains with higher temperatures and more extreme weather events occurring more frequently. Findings from this research utilizing ethnographic methods will be compared to previous findings that have relied on meteorological data. Ultimately this will demonstrate whether or not there is a disconnect between perceptions and hard meteorological data within the targeted study sites.

Second, (2) are farmers and community members within the study sites taking any adaptive actions in response to the changes they perceive? In the literature review it is discussed how Maddison (2007) sees adaptation to climate change as a two-step process. First one must perceive the impact prior to taking any adaptive action towards it. This research aims to analyze what, if any, adaptive actions are being taken and what their potential impact is in regard to reducing vulnerability or enhancing resilience to climate change.

This research then seeks to explore how current or new adaptive actions can be developed, which poses the question, (3) what resources do farmers need to enhance their resilience? More specifically, in what sectors (health, agriculture, infrastructure, institutional support, etc.) do participants need the most support? Where is it most

feasible to conduct interventions with the target communities given that resources and funding are limited?

Lastly, this research aims to determine if (4) climate change perceptions, adaptive actions, and resource needs vary with location. In other words, how do these factors and the target communities influence each other in rural versus peri-urban locations given that each location has its own unique set of challenges? The physical environment, social dynamics, local government, access to resources, and other factors vary drastically by community. This research therefore seeks to determine what this means when it comes to developing adaptation strategies.

In summary, the following four research questions are posed:

(1) Do small-scale Ugandan farmers perceive the climate to be changing, and if so, how?

(2) Are farmers taking adaptive actions in response to the perceived changes?

(3) What resources do farmers need to enhance their resilience?

(4) Do climate change perceptions, adaptive actions, and resource needs vary with location?

RESEARCH APPROACH AND METHODS

The main body of research for this project utilized a two-phased approach for two separate study sites. Phase 1 utilized Participatory Rural Appraisal (PRA) methods while phase 2 utilized Participatory Action Research (PAR) methods. Both of these approaches rely heavily upon an eclectic collection of ethnographic methods to create a large body of qualitative data. They also rely heavily upon the immersion of the researchers into the community. Consequently, the status of the primary field researcher as a Peace Corps Volunteer (PCV) who lived and worked in the study area full-time was beneficial to the research methods. For more details regarding the background of the primary field researcher as a PCV and for their description of service, reference Appendices A and B. While the origins and details of PRA and PAR are discussed here, it is worth noting that specific methods followed a similar format to those of Coppock et al. (2014).

Phase I: Community Problem Diagnosis and Planning Solutions

As noted in the literature review, farming systems in Uganda are extremely complex and face multiple climatic and social stressors. Additionally, individual farming households are faced with their own specific stressors, making them each unique. Consequently, the research employed took on a participatory-based approach and utilized PRA methods to collect data and implement community action plans (CAPs) at the local level from the bottom-up. Climate change adaptation programs implemented in Uganda using a top-down model, like the National Adaptation Program for Action (NAPA), have been mostly unsuccessful due to funding barriers (OXFAM, 2008). By building off of the

resources and knowledge already present in a community, this methodology helps demonstrate that community members can improve their lives and adapt to climate change without large amounts of outside funding.

Participatory methods, originating in the 1980s, are always progressing. And as stated by Chambers (1994), these methods are "evolving so fast that to propose one secure and final definition would be unhelpful." Consequently, Chambers has altered his own definition of Participatory Rural Appraisal (PRA) over the years. Chambers (2004) defined PRA as "A growing family of approaches, methods, attitudes, and behaviors to enable and empower people to share, analyze and enhance their knowledge of life and conditions, and to plan, act, monitor, evaluate and reflect."

The origins of PRA stem from several other domains including Rapid Rural Appraisal (RRA), applied anthropology, and activist participatory research. Participatory methods were first used in the developing world as early as the 1960s. In regard to rural development, Cohen and Uphoff (1977) noted, "Participation includes people's involvements in decision-making processes, in implementing programs, their sharing in the benefits of development programs and their involvement in efforts to evaluate such programs." Saxena (1998) states, "Participation is exercising voice and choice and developing the human, organizational and management capacity to solve problems as they arise in order to sustain the improvements."

Overall, the main idea of techniques such as PRA is to empower people at the local level to build their capacity and create behavior changes that are sustainable. It does this by identifying local strengths already present within the community and then builds off them. With most PRA projects there tends to be no organized road map as the local

community participants are the ones who bend and shape the project as it progresses. Consequently, rushing through a project is a danger to a PRA process. Many disciplines have benefitted from the use of PRA methods in rural development. This includes resource economics (Pretty & Scoones, 1989), community forestry (Messerschmidt, 1991; Molnar, 1989), natural resource planning (Scoones and McCracken, 1989), and public health (Maalim, 2006).

Chambers (1994) emphasizes three major components to PRA. These include: (1) methods; (2) behavior and attitudes; and (3) sharing. Methods refer to the various tools and activities used to facilitate analysis by rural people to demonstrate their needs and capabilities. This component represents the major information-gathering stage used to identify resources, barriers, and strategies to move forward. The PRA tools/activities used by this research include the following:

- Social Resource Map: These are maps prepared by communities themselves using local knowledge that show social and physical features within a community. They also show the geographical distribution of households and name the heads of key households. These maps are primarily used to identify key agricultural resources.
- Transect Walks: As the name of this tool suggests, key community members lead team members on a specific path/walk through a community. During the walk, vegetation coverage, soil types, land use coverage patterns, cropping strategies, and opportunities for other agricultural practices or related activities are identified. Physically seeing the resources and opportunities in a community allows participants to better understand challenges and opportunities.

- Sketches of Representative Farms: A variety of key households in a community are visited and toured while team members sketch out a pictorial representation of land and natural resource use. Family members are also interviewed during this time to determine socio-economic status of the family and key income-generating activities. This allows team members to better understand what the average household in a community is like.
- DAG (Disadvantaged Group) Mapping: This activity is completed by community members to identify differing levels of wealth in their community. The differing levels of wealth are characterized and then analyzed within a community.
- Historical Timeline: This exercise can be done in a focus-group type setting for a community to discuss and map out on a timeline key trends, points, and major events that have happened in the past. This tool is especially useful for identifying climatic trends and large-scale weather events that are particularly noticeable.
- Seasonal Farming Calendars: This is an exercise undertaken by a community to record on a calendar the yearly seasonal changes that occur and the activities that go along with the change of the seasons. This is used to identify when certain agricultural activities like planting specific crops occurs, to identify times of vulnerability, stress, and food shortage, and to identify when social and cultural activities occur.
- Gender Daily Calendars: This exercise allows groups of males and females to record their daily routines, which are then compared to identify differences in gender. Identifying these differences and recognizing them at the community-level is important to do before undertaking any development strategy.

- Livelihoods Mapping: This tool is used to identify the different resources that are needed within a community on a daily basis. Resources that are fully available in a community, partially available in a community, and available only outside a community are identified.
- Stakeholder/Institutional Analysis: This tool uses methods like the creation of Venn diagrams by a community to investigate linkages and relationships that occur or could potentially occur between them and institutions or community groups. This allows communities to identify specific partners in development.
- Community Wide Discussions: These are used to discuss key issues in the community or issues that call for further investigation. Climate change is one topic that should be discussed during these sessions to identify perceptions and beliefs related to climate change and to identify any adaptations measures being undertaken.

The second component of PRA refers to the behavior and attitudes of the external change agents, not the community participants (Chambers, 1994). In using PRA effectively, change agents are encouraged to step back, listen to and learn from the community participants to ensure that the project is not biased by external agendas and to build rapport with the target community. This component is key to the success of the project to ensure that participants are not misinformed about what the "outsider" may be trying to do. In all PRAs, change agents are only there to help participants help themselves by facilitating and guiding them through the methods.

The third and last component is sharing, which emphasizes the importance of local people sharing knowledge among themselves, local people sharing knowledge with

outsiders, and outsiders sharing what they learn with each other and with the local people (Chambers, 1994). This helps to diffuse the findings of the PRA process to other relevant community members who may also benefit from the information or any follow-up projects.

Among these components there are three common elements to PRA (Chambers, 2007; Chandra, 2010). The first is self-awareness responsibility, meaning that participants must hold themselves accountable, be self-critical, and embrace error while facilitators exercise judgment where needed. The second is the promotion of equity and empowerment among those in the community who may be marginalized or deprived—this often includes women. The third element is diversity, which should be recognized and celebrated. These elements are necessary to reduce bias and encourage fairness throughout the entire PRA process (Chandra, 2010).

This research uses the PRA methodology with two small-scale farming communities to assist a process of climate change adaptation. While there are a variety of ways to implement PRAs in the field, this research elected to use a simple three-step approach as reviewed below:

(1) Project introduction and initial challenges listing: After extensive community mobilization, requiring the collaboration of researchers and village leaders, a community-wide plenary meeting was held at each site to introduce the project. During this time, participants were told up front what to expect and not expect out of the project as clearly as possible so that no false expectations were created. This was done via a Letter of Information (LOI) developed in consultation with the Institutional Review Boards (IRBs) at Utah State University and within

Uganda (see Appendix D). The LOI was read aloud to community members at the start of the engagement process, and people were allowed to participate once they had understood and agreed to the benefits, risks, and commitments involved in the research. Once these logistical steps were completed, a broad discussion on any and all challenges present in the community was initiated. This discussion allowed researchers to get a general understanding of the community before delving into the details. To conclude the opening plenary meetings at each site, participants and researchers created a schedule for carrying out the PRA activities.

(2) PRA activities: The bulk of the PRA process took place during this step. Researchers met with groups and individuals in various capacities to complete the PRA activities listed and described above. The activities generally took a month to complete in full for each site. Because of the circumstances, participants and researchers elected to meet in a community-wide plenary setting to conduct some of the activities. Most of the activities were conducted in small group settings. Throughout this step, participants and researchers worked together to identify the priority challenges/opportunities within each community.

(3) Ranking of identified priority problems: A final plenary meeting was organized for each site to complete the PRA process. Using a matrix-ranking diagram, participants discussed and then voted upon the seven challenges/opportunities that they perceived to be the greatest. The matrix diagram pairs each challenge/opportunity against each other to create a clear ranking of all seven identified challenges/opportunities. The completed ranking for each site was the culmination of the entire PRA process.

Phase 2: Action Research and Pilot Projects

While Phase 1 of the research focused on analyzing, diagnosing, and identifying challenges and opportunities within the two study-sites, Phase 2 utilized this information to create and implement action plans. This was done through the use of PAR. The PAR approach, as stated by Whyte (1989), "Contrasts sharply with the conventional models of pure research, in which members of organizations and communities are treated as passive subjects, with some of them participating only to the extent of authorizing the project, being its subjects, and receiving the results. The PAR approach is applied research, but it also contrasts sharply with the most common types of applied research in which researchers serve as professional experts, designing the project, gathering the data, interpreting the findings, and recommending action." Alternatively, PAR differs from common applied research because researchers work closely with participants in group discussions, focus groups, and key informant interview settings to push a project towards success via some sort of innovation (Whyte, 1989). In PAR, researchers do not act as experts but instead work hand-in-hand with local community participants to build authentic relationships with stakeholders to solve problems and develop solutions.

The PAR process is iterative in nature as researchers and stakeholders observe the problems, act on them, adjust where needed, and then observe again (Coppock, 2016). This process allows researchers and stakeholders to clarify details that are important to facilitate innovative adaptations necessary to solve the problems identified in the PRA. Researchers can use focus groups and key informant interviews to complement the finding from the PRA to determine more specific pathways to implement innovations.

The PRA and PAR approaches complement each other in this way. Coppock (2016) states, "A PRA provides a problem diagnosis, whereas a PAR can provide the research details (often via conventional means) that support the creation of new technology, management systems, or policy interventions needed to solve the problem."

Literature by Short (2006) and DiCicco-Bloom and Crabtree (2006) show that qualitative data-collection methods, primarily focus group discussions (FGDs) and key informant interviews (KIIs), are the best ways for researchers to build a rapport with study subjects while also collecting valuable information. These methods, consequently, were ideal for the PAR process because they allowed researchers to collect useful qualitative data while also working with participants to create pathways for change. Standard FGD techniques, as described by Short (2006), were used during the PARs. The FGDs were comprised of eight to 15 participants and took place at central locations within each study site. Standard techniques for semi-structured KIIs, as described by DiCicco-Bloom and Crabtree (2006), were also utilized for the PARs. Community elders, leaders, and government representatives were the primary targets for these interviews, in addition to regular community members. The KIIs were semi-structured in that they were "organized around a set of predetermined open-ended questions, with other questions emerging from the dialogue between interviewer and interviewee" (DiCicco-Bloom & Crabtree, 2006).

Similar to phase 1, the PRA process, study-site participants and researchers began phase 2 with a community-wide plenary meeting. Here, researchers explained to participants that the aim of the project was to now utilize the information collected during the PRA phase to develop and implement community action plans (CAPs). When

developing these CAPs, participants and researchers aimed to construct feasible programs to address identified challenges and opportunities. A successful CAP required participants to identify where the program/project would take place, what materials/resources would be needed, who would be responsible for implementing the program/project, how much money would be needed, and when it would start and finish. Participants were encouraged to use the acronym SMART (as seen below) to develop their CAPs.

- Specific: Action plans should be as specific as possible in terms of the resources/ materials, people, location, and funding needed to implement the proposed program/ project.
- Measurable: The results of the proposed program/project should be measurable so that it can be monitored and evaluated effectively.
- Attainable: The proposed program/project must be attainable and feasible to implement. If the resources needed to complete the program/project are not available then it should not be pursued.
- Relative: The proposed program/project must have the potential to achieve a goal that is relative to the needs of the community. If the program/project is not relative or applicable to the needs of the community then it should not be pursued.
- Time-bound: The proposed program/project should have set dates as to when it is expected to start, finish, and reach important milestones. This is key for measuring the progress of programs/projects.

Follow-up plenary meetings, FGDs, and KII were conducted until researchers and participants had all of the details necessary to create a finalized CAP. This took anywhere

from a few weeks to a month to complete, depending on the site. Actual implementation of CAPs would take much longer to complete.

Study Area

This research was conducted at the village level in Hoima District of Western Uganda (Figure 1). Of the 111 districts that make up Uganda, Hoima is one of the larger districts in both size and population; it is the eighth largest in human population (573,903 residents) according to the Uganda Bureau of Statistics (UBS, 2014). The largest urban center in Hoima District is Hoima Town, which is currently the ninth largest town in Uganda with a population of 100,625 in 2014 and a growth rate of 10.7% (UBS, 2014). Hoima Town had a population of only 30,000 in 2010, making it one of the fastest growing municipalities in the country (UBS, 2014).

Hoima Town's rapid growth rate can be attributed to the recently created plans to soon begin oil drilling off the shores of Lake Albert, promising to provide jobs for many people (OIES, 2015). Like the rest of Uganda, however, Hoima District's economic backbone has been dependent on agriculture, primarily food crops. As previously noted, 80% of Uganda's population is made up of farmers, and this is no different for Hoima District. In fact, Western Uganda prides itself on having the best soils for growing crops in the country (Derr, personal observation). A high population combined with a rapid growth rate (the national average annual growth rate was 3% in 2014) (UBS, 2014) means there is little available land for farmers to expand their operations and even less land for new farmers to cultivate in the area surrounding Hoima Town. These combined

Figure 1. Map of Uganda showing Hoima District. Source: USAID

problems of population growth, land scarcity, and climate change make Hoima an ideal place for this research as it is already firmly set in a pattern of development that the rest of the country is expected to follow.

Two villages within Hoima District were targeted for this research. Itara Village (less than five kilometers from Hoima Town) represented a peri-urban population, while Kihigwa Village (35 kilometers from Hoima Town) represented a rural population. These two villages were chosen because the non-profit called Environmental Conservation and Agricultural Enhancement, Uganda (Eco-Agric)—a primary partner affiliated with this research—was familiar with these areas already and had connections to village leaders,

households, and farming groups. Community members in each village were also interested in collaborating on this particular project (Derr, personal observation).

Community members within Itara were situated near Hoima Town and therefore had access to the services and amenities of a major town, including several markets, grocery stores, agricultural input suppliers, banks, extension services, and government offices. Most people in this area still depend on farming as their main livelihood, but many also work in town where they own a small business or work for others. Furthermore, farmers in Itara were more likely to refer to themselves as commercial farmers and not just strictly subsistence or peasant farmers. The population in Itara has been growing as farming households gravitate towards the services and amenities in town but also have been attracted to open land available for farming, even if just a small parcel. The farming systems in Itara are of various types, with most households dealing in both crop production and livestock rearing (i.e., chickens, goats, and cattle). Some of the more popular crops grown include matooke (*Musa acuminata)*, cassava *(Manihot esculenta)*, sweet potatoes (*Ipomoea batatas)*, groundnuts (*Arachis hypogaea)*, and maize (*Zea mays)*. Vegetables like tomatoes, peppers, and eggplants are grown to a lesser extent because they require more maintenance and inputs and are generally less successful. Coffee is commonly grown at the household level as a cash crop (Derr, personal observation).

By comparison, Kihigwa Village is more rural than Itara. Hoima Town is accessible to Kihigwa only by a poorly maintained dirt road and the use of irregular public transportation. An average one-way trip to Hoima Town via public transport generally takes two hours (Derr, personal observation). Small-scale farming is the

primary livelihood of almost every person in Kihigwa, although a few operate on a commercial scale. Most community members consider themselves subsistence or peasant farmers and practice agricultural activities only to meet their most basic needs. Farming systems of a mixed variety like those described in Itara are common in Kihigwa as well, but with more of an emphasis on subsistence crops like cassava and less emphasis on vegetables or cash crops. With access to larger areas of land, the few wealthier farmers here develop plantations for coffee, tea, sugar cane, and trees for timber. Poorer farmers can sometimes find work as paid laborers on these plantations (Derr, personal observation).

Participant Recruitment

As many participants as possible were recruited from each of the two respective study areas to take part in the project. This was the aim given that a larger number of participants would reflect a more accurate representation of community issues and needs. Participants were volunteers over 18 years of age. Eco-Agric assisted with participant recruitment via the use of previously established community mobilizers and village leaders. No formal recruitment materials such as flyers or radio announcements were used. Participating community members learned about the project only by word-of-mouth. All participants were presented with a letter of information (LOI) in both English and the local language at every plenary meeting held. The LOI discussed the basic details of the project, project duration and time requested from participants, potential risks and benefits, privacy and confidentiality, compensation, and the specific details of the researchers (see Appendix D).

RESULTS

Kihigwa Rural Community Results

PRA Plenary 1: Project introduction and initial challenge listing

The opening plenary meeting was held to introduce the community to the PRA process and the overall aim of the project. Participants were told up front what to expect and what not to expect out of the project as clearly as possible so that no false hopes would be created. During this time the LOI was also presented, which the participants verbally agreed to after an extensive question and answer session.

This was followed by a group discussion on perceived challenges in the community. Participants were encouraged to list any and all challenges they faced, no matter how big or small. The purpose of this exercise was to allow researchers to acquire an initial feel for community challenges and, more importantly, to initiate a dialogue between community members, researchers, and other stakeholders to begin developing pathways to solutions. See Appendix E for a detailed listing of the initial challenges.

Fifty-three community members participated in the group discussion. Participants were mostly comprised of older individuals who would likely be considered key people in the community and within their households. Thirty-three of them were men and twenty of them were women. As expected, they voiced their concerns on a broad range of challenges that were condensed into seven broad unranked categories, as follows:

- Agriculture: Participants cited low agricultural production as a key challenge due to a prevalence of pests, crop diseases, and livestock diseases. The shifting and shortening of seasonal rain patterns, creating challenges when planning for

farming activities, was also commonly cited. Participants called for the acquisition of inputs (fertilizer, pesticides, tractors, labor, land, and money) to solve these problems.

- Infrastructure: Poor roads were a challenge commonly raised but without any apparent seriousness, likely because significant government support that could not feasibly be acquired would be needed. Still, it is a challenge worth addressing since chronic poor road conditions restricts access to larger markets not present in Kihigwa.
- Poverty: All participants agreed that deep-rooted poverty was a major challenge throughout the community. A reliance almost exclusively on subsistence farming as the primary livelihood for nearly all community members combined with a lack of natural and institutional resources were given as the main reasons for rampant poverty.
- Water resources*:* Participants reported having a shortage of safe and easily accessible drinking water due to having no functional protected water sources (i.e., protected springs, boreholes, or shallow wells). Alternatively, the community reported having to rely mostly on open unprotected sources, leading to a high prevalence of waterborne diseases. A need for improved crop irrigation was also expressed to cope with shifting rain patterns.
- Health: Challenges related to health were raised repeatedly by elderly female participants, citing a need for better and more affordable health services. This was of prime importance to them so that they could meet farm and household needs

without being set back by various ailments. Additionally, waterborne illnesses like typhoid were commonly reported.

- Gender inequality: The issue of gender-based violence was brought up by one elderly female participant but not discussed further by anyone else. This was likely because of the public setting in which discussions were taking place, meaning that sensitive topics were mostly avoided. Private discussions held with various women in the community at a later time ultimately proved that the challenges of gender-based violence and general gender inequality were commonplace.
- Institutional: Any sort of institutional presence (governmental or NGO) was reported to be low and cited as a challenge to the overall development of the community. Specific challenges were raised as to the performance of local government officials from the village to the district level. Issues of corruption and inactivity were commonly reported. NGOs have some presence in the community, but generally their activity is insignificant.

Before the meeting was officially closed, a schedule of all PRA activities and plenary meetings was created. It was decided that two more plenary meetings would be held during which the bulk of PRA activities would be held. The researchers would separately organize PRA activities that did not require the attendance of a large group (i.e., transect walks, sketches of representative farms, institutional analyses, KIIs, and smaller FGDs). This was determined to be the most efficient way to move forward since community mobilization and scheduling were expected to be significant barriers to progress.

Overall, the opening plenary meeting was deemed successful. Participant turnout was relatively high. There was a genuine feeling of engagement and interest in the PRA process.

PRA Plenary 2: Community sketch map, seasonal calendar, and historical timeline

Three key PRA activities were conducted during this plenary with approximately 70 participants, of which one-third were female. The high attendance allowed for a plethora of views and personal experiences to be shared.

Community sketch map

During this exercise participants worked together to make a representative map of their community using markers and flip-chart paper. They were instructed to provide as much detail as possible by denoting key features in the landscape, important structures, water sources, and natural resources. The finished map helped researchers and participants to identify key resources and see how they were distributed throughout the community. See Appendix F for a photo of the completed sketch map.

The finished map told the story of a physical landscape in constant change, indicative of a vulnerable community's reliance on agriculture. In the process of making the map, participants described how much of the land they were marking as farmland had relatively recently been forests and wetlands. Land conversion was reportedly happening due to a growing population and the perceived need by many to expand croplands (potentially as a safety net form of adaptation when other crops fail). The map also showed that while households generally owned large pieces of land (10 to 20 acres on

average), they are heavily fragmented, likely representing the existence of social imbalances. For example, it was found that wealthier men in the community would rent out their surplus lands, usually to disadvantaged women, for farming.

Changes in the landscape were acknowledged again as farmers in Kihigwa are commonly being hired by a newly established sugar processing plant to grow sugarcane on their own land. Participants claimed that farmers were willing to shift to growing sugarcane because it is generally more successful than other cash crops and, more importantly, they have a guaranteed buyer. Overall, participants reported that the land has not been as productive as it once was. The landscape changes highlighted in the sketch map offered some reasoning for this.

Despite all of these recent changes, some physical features have remained as fixtures in Kihigwa. Most notably is the series of streams lacing through the lowlands of the village and representing Kihigwa's main source of water. At various points, water is diverted from the stream or captured in ponds as a collection of 16 open-water sources indicated on the map. Participants discussed how all of these ponds were once surrounded by forests that acted as buffers and filters to prevent soil runoff and other contaminants from entering them. Because of cropland expansion though, most of these forest buffers are now gone, causing the ponds to become highly contaminated as a result. Participants highlighted four protected water sources on their map that had all been established within the last decade as a logical response to this. All four sources have fallen into disrepair, leaving Kihigwa with no easy access to clean drinking water.

Another key feature of the map is that it lacks many important structures, most notably a school, health center, or marketplace. Besides houses, the only structures

present are a few churches and a small collection of stores and bars selling basic things like sugar and tea. All other amenities and services must be found in neighboring villages between five- and 10-kilometers away. This includes markets for those who wish to sell their crops, but even then, market days only occur on a weekly basis, forcing farmers to sell through a middleman at a lower price on many occasions (Derr, personal observation).

Seasonal calendar

A seasonal calendar exercise was conducted to analyze the influence of weather patterns, timing of farming activities, times of food scarcity, the incidents of human and animal diseases, and the occurrence of cultural events. To get a better feel for how participants perceived changes in the climate, they were asked to make two calendars. Calendar 1 would represent a time before major shifts in the climate occurred, which participants claimed was about 10 years ago. Calendar 2 would represent recent years under the changing climate regime, widely perceived within the last five years. See Appendix G for the seasonal calendars.

Weather patterns in calendar 1 were shown as expected for a tropical climate, with participants reporting bimodal wet and dry seasons. Consistently heavy rains and colder temperatures would occur from March to May and from August to October. In between these times temperatures would rise, and very little rainfall would occur. Community members claimed that these seasonal patterns were so consistent that the beginning and end of each season could be predicted with a high degree of accuracy.

Calendar 2 told the story of how this steady climate shifted to being much more unpredictable. The general consensus among the participants was that in recent years the rainy seasons have been shorter but with more severe storms, while the dry season has become longer and hotter. There was some contention among participants as to the exact extent and specific details of these changes, possibly indicating the extreme variability of recent weather patterns. Nonetheless, there was no doubt among any participant that changes were occurring.

More importantly, these changes were perceived to be having a major impact on farm production. Calendar 1 demonstrated how in the past, farmers would follow a specific regimen of activities closely corresponding to the time of year and weather. Land preparation (clearing and tilling) would occur in the months leading up to the rainy season followed by the planting of seeds, which would be completed just before the first rains in order to maximize yields. Land maintenance and weeding would occur throughout the wet season until it was time to harvest at the beginning of the dry season.

The shifting weather patterns have made it impossible for farmers to follow this regimen any longer. Without the ability to plan their farming activities accordingly, they have been forced to rely on an erratic system of constant preparedness. Calendar 2 showed that farmers are now preparing their lands up to three months in advance in case rains come early. They are also more cautious about planting and will only plant once there is significant moisture in the soil from at least two or three heavy rainfall events. Even then, there is still a possibility that the rains will be insufficient. This means that a community that has historically relied heavily on rain-fed agriculture may have to shift to irrigation as a safety net for inconsistent rains.

Additionally, participants reported on calendar 2 that weeding activities are now more extensive and occur more frequently, along with the prevalence of pests and crop/livestock diseases. This is likely a result of more extreme weather as weeds, pests, and crop/animal diseases tend to thrive in more extreme conditions, whether it is hotter temperatures or more rain.

Lastly, times of food scarcity commonly occurred in January and February as seen in calendar 1. This was because the second growing season of the year is generally not as productive and the end of the year dry season tends to be longer and more severe. During these times the community depends more on what they refer to as "hunger crops" like cassava, which can be grown year-round. Calendar 2 shows that climate change is lengthening times of food scarcity, primarily because of crop failures. Overall, the seasonal calendars have demonstrated the increased vulnerability of Kihigwa as a result of climate change.

Historical timeline

A historical timeline exercise was conducted to initiate dialogue on past times of vulnerability and to analyze the progression of certain trends in the community. Older participants were key to this activity and consequently led much of the discussion by drawing from an abundance of past experiences as far back as 1956. Major points in Uganda's national history, like gaining independence and Idi Amin's reign, served as reference points for local events. See Appendix H for the completed historical timeline.

The finished timeline demonstrates that the population of Kihigwa is familiar with coping to adverse situations, as natural disasters have commonly occurred throughout

their history. Most notably is the frequency of drought events, which participants recalled happening in 1980, 1988, 1992, and 1996. These droughts correlated with hunger and famine in many of these years. Some participants told stories of how they were forced to forage for food and, in some extreme cases, attempt to eat the leather off of shoes or other seemingly inedible things in an attempt to satisfy their hunger. Interestingly, no major drought event was recalled within the past 20 years (i.e., since 1996). This begs the question, did droughts not occur during this stretch, or was the community just better equipped to cope with them?

In addition to drought and famine, a few other major environmental disasters were noted. In 1962, extensive flooding took place in Kihigwa and throughout most of Uganda, likely indicating heavy rainfall events for that year. And in 1956, a major outbreak of mosquitoes occurred, dramatically increasing cases of malaria. Other major health events to note include the introduction of HIV/AIDS to the community in 1987, which correlates with the spread of the disease from West to East Africa in the 1980s. Also recorded was as outbreak of meningitis in 1992.

Participants also discussed important trends within the community. For example, participants agreed that forests gradually began disappearing in the 1990s when they were cleared to create more croplands. Community elders who described a time when forests were once abundant confirmed this. The disappearance of the forests correlates with the disappearance of certain wildlife, mostly notably olive baboons (*Papio anubis)*, vervet monkeys (*Chlorocebus pygerythrus)*, and black and white colobus monkeys (*Colobus guereza)*, which are now rarely seen in the area. Additionally, participants discussed an overall decline of land productivity in agriculture. Other trends likely hurting agricultural

productivity include the gradual expansion and fragmentation of farmland to meet the needs of a growing population.

Non-plenary activities

Non-plenary activities were conducted to give researchers the chance to work with smaller groups or individuals to hone in on specific topics and objectives. Three activities were completed including creating sketches of representative farms, hosting FGDs on climate change, and conducting an institutional analysis.

Sketches of representative farms. Researchers visited three households (HHs) where they toured the surrounding area, interviewed the head of each HH, and ultimately sketched a representation of the land and natural resource use. The HHs visited were representative of high (HH1), middle (HH2), and low (HH3) income status HHs within Kihigwa. This was done to better understand how HHs in Kihigwa differ from each other. Sketches of the farms can be found in Appendix I.

The sketch of HH1 is representative of a high-income HH in Kihigwa. The head of this HH is an older man, well respected in Kihigwa as a key mobilizer for community action. The HH supports 15 people living in four houses. The main house is made of cement and has a corrugated metal roof with makeshift gutters for water catchment. The remaining three houses, used by extended family, are walled with mud and have thatched roofs. The men in the family have begun making bricks nearby for the construction of a fifth house. A covered space near the main house serves as a cooking area where the women of the HH use firewood, or occasionally charcoal, to fuel local stoves (*sigiris*) and

open pits for cooking. The HH's closest water source is an unprotected catchment pond less than one-kilometer away.

The farming activities of HH1, spread across approximately 15 acres of land, can be described as incredibly diverse. Food crops grown include maize, beans, sweet potatoes, cassava, matooke, and a variety of fruit trees. Cash crops include rice, coffee, three acres of sugarcane, and one acre of eucalyptus trees for timber and firewood. The HH also owns a variety of livestock including two goats of an improved breed, a dozen chickens, and five head of cattle, with structures for the animals built near the main house.

The HH2 is representative of middle income HHs, which make up most of Kihigwa. The family is composed of a younger husband and wife, with three children, who reside in one brick house with a corrugated metal roof. The HH owns nine acres of land but does not use all of it for farming. They grow a diverse variety of food and cash crops including cassava, sweet potatoes, beans, groundnuts, pineapples, fruits, rice, and coffee. The husband reported that his wife is responsible for tending to the food crops while he tends to the cash crops. The HH's closest water source is an unprotected catchment one-kilometer away.

The HH3 is representative of the lower income HHs in Kihigwa who are the most vulnerable. The head of HH3 is a middle-aged woman with no husband who supports her four children and three grandchildren. Her eldest son struggles with severe chronic health problems and cannot contribute to the HH significantly, while her younger son attends primary school. Her two daughters have their own children who they take care of mostly on their own without support from the fathers, and they do not attend school. All eight

members of the HH live in a small, mud-walled house with a corrugated metal roof used for water catchment. Their primary water source is an unprotected catchment pond two-kilometers away. The HH owns less than two acres of land, but they also rent additional land when possible or travel a long distance to another small piece of land that they own. The HH grows cassava and sweet potatoes as their primary food crops for home consumption and maize and rice as their main cash crops. They do not own livestock.

Focus group discussions on climate change. Climate change has been a major topic of discussion in the international development sector. The government of Uganda has followed this trend, spending considerable time and resources studying climate change and its impacts across Uganda to develop adaptation strategies (NAPA). Whether this national level interest and urgency to respond to climate change has effectively trickled down to the local level is unclear (Derr, personal observation). Three FGDs were therefore held to gauge Kihigwa's level of interest and understanding of climate change. Eight to 15 people participated in each discussion where they were posed a wide variety of questions pertaining to how they understood, perceived, and responded to climate change.

Despite there being no easy or direct translation in the local language for the term *climate change*, all participants were still familiar with it, usually from radio and television broadcasts. They perceived climate change to be happening in Kihigwa. When asked what was causing it to happen, however, participants were less certain. There was no scientifically-based understanding that climate change is a global phenomenon collectively caused by human action. Rather, many participants expressed that they

believed climate change to be happening because of the community's own direct actions. For example, a recurring theme in discussions was the belief that local deforestation was the root cause of shifting seasonal patterns and less rain. This is interesting given that forests provide important ecosystem services that provide many local benefits, but deforestation in Kihigwa does not directly contribute to climate change. Alternatively, the presence of forests may serve a substantial role in reducing vulnerability to climate change in Kihigwa, explaining why some community members directly correlate local deforestation to climate change.

Specific individual accounts and perceptions of how the climate is changing were widely variable, indicating that the actual impacts themselves are extremely diverse. The impacts listed include changing seasonal patterns, heavier rainfall events, too much rain, not enough rain, drought and longer dry seasons, and extreme sun. These accounts suggest that the overall climate is becoming more extreme in all aspects, which participants unanimously agreed is having a negative impact on agricultural production.

When asked how they are responding/adapting to these changes, most participants claimed to be doing nothing. In actuality, farmers have already been forced to adapt their agricultural practices in some way as a natural reactive response. For example, most farmers have already adjusted their planting times in response to seasonal changes and have also increased their total time spent weeding as a response to more extreme weather that weeds thrive on. This is also demonstrated in the seasonal calendars. These types of reactive adaptations can often be taken for granted, but farmers could not hope to get by without them. On the other hand, proactive adaptations, which focus on long-term

strategies to reduce future impacts and are more effective overall, were nonexistent in Kihigwa.

Institutional analysis. An institutional analysis was conducted with a group of four main community mobilizers to identify organizations and institutions that could serve key roles in Kihigwa's development. Several institutions were identified, but ultimately only four were deemed feasible community partners based on services provided and level of interest.

Water resource committees (WRCs) were considered by participants to be the most important institution in Kihigwa. In total there are 10 WRCs in Kihigwa, with seven to twelve members each, most of which are inactive or disbanded for various reasons. The WRCs are responsible for collecting user fees and maintaining the integrity of their sources. Unsurprisingly, the quality of water sources throughout Kihigwa have fallen into disrepair without consistent leadership from the WRCs.

Local government bodies, most notably the parish chief and local councils 1 and 2 (LC1 and LC2), were identified as the next most important institution. As a group of local level leaders with the most influence over acquiring government funding and resources, participants felt that building stronger community partnerships with them would be key.

The parent teacher association (PTA) of the local primary school was ranked third. Participants believed this group to have a history of success in their endeavors to improve the school. Overall, the PTA has a vested interest in all community issues for the

sake of their children, making them not just a PTA but also a powerful community advocacy group.

The fourth most important institution is the local health center, actually located in a neighboring village where it is small and lacking resources, but it still acts as the best health care option for Kihigwa. Participants felt that people in Kihigwa need not only better health care but also more information of key health topics through outreach and extension that could be provided by this health center.

PRA Plenary 3: Final ranking of priority problems and analysis

Approximately 70 community members attended the final PRA plenary where, using a pairwise ranking matrix (found in Appendix J), participants completed a final ranking of their challenges (Table 1). Water resources were overwhelmingly ranked as the most important challenge. This was somewhat surprising to the researchers who expected challenges related to agriculture or finance to be ranked more important. Still, it is logical that water resources would be ranked the highest given the extreme rural nature and vulnerability of Kihigwa. The residents viewed clean water to be a basic necessity that was lacking due to the degradation of common pool resources. Consequently, improvements in the accessibility of clean water could lead to the greatest possible benefits for everyone. Furthermore, it is a relatively straightforward and feasible challenge to take on.

Researchers were surprised again to see that health challenges were ranked as the second highest priority. Similar to water resource issues, however, a lack of access to better health services is likely viewed as an all-encompassing community problem that

Table 1

Final Challenge Rankings for Kihigwa from Highest (1) to Lowest (7)

RANK	**CHALLENGE**
1	**Water Resources** Contaminated water sources leading to a high rate of water borne illnesses
2	**Health** High prevalence of illnesses making work difficult. Lack of affordable care.
3	**Finance** High rate of poverty. No money for agriculture inputs/investments.
4	**Agriculture** Changing climate. Poor crop and animal performance. Land degradation.
5	**Institutional** Little government support. NGOs offer some help but unsustainable
6	**Infrastructure** Poor roads. Lack of a nearby market.
7	**Social/Gender** Large burden on women. High prevalence of alcoholism. Youth portrayed negatively.

should be a basic necessity. Improving the overall health of the community could therefore drastically improve agricultural production and quality of life.

Financial challenges were ranked somewhat high, as expected, occurring as the third highest priority. This is likely because living in poverty has been commonplace for many HHs in Kihigwa, and improving one's financial status is the most straightforward way to escape it. But even though poverty can be considered a community-wide problem, there are no simple or direct pathways for eradicating it at the community level. Alternatively, poverty eradication pathways are pursued more effectively at the HH level.

Agricultural challenges were ranked fourth. This lower ranking was unanticipated given that Kihigwa is a subsistence farming community coping with the impacts of climate change. It can therefore be hypothesized that while agricultural challenges exist, community members felt that their farming systems were resilient enough to support them for the time being. Additionally, developing pathways for enhancing agricultural production or adaptation can be complicated and may not be feasible for Kihigwa at this time.

Institutional challenges, ranked fifth, were related primarily to a lack of or inefficiency concerning government and NGO support. The community recognized these institutions as key partners in development but were not optimistic that they could be relied upon as a primary pathway for improving lives. Challenges in infrastructure like poor roads, ranked sixth, also have a low feasibility rate because of the government support that would be needed to accomplish these objectives.

Social and gender challenges were ranked as the last priority, but it is likely that this is a misrepresentation of true community needs. During the FGDs, social and gender issues were brought up infrequently by few individuals who alluded to problems like alcohol abuse and inactive youth not attending school. These issues were likely not discussed more explicitly due to the public nature of the FGDs. Private KIIs, however, revealed much more. Many female respondents discussed the abusive nature of their husbands and the heavy burden placed upon them to run their households. Unfortunately, breakout group discussions comprised of women-only were not held to further analyze this problem or potential pathways. Had these sessions been held, it is likely that social and gender challenges would have been ranked higher.

PAR Plenary 1: Preliminary action planning

Based on the results from the final priority ranking, community members decided to mobilize their efforts to improve their water resources. This officially initiated the PAR phase of the project, and an opening plenary meeting was held to develop an action plan for a pilot project. Attendance for this meeting was high, with over 70 participants. This was expected given that the community was now making tangible plans to be put into action after completing the month-long PRA.

Too often development projects fail because of a lack of community ownership in project planning, implementation, and financial burden. Therefore, from the start of the PAR it was reiterated that this was to be a community-driven project and that at least 25% of total project funds and resources would ultimately come from the community. This was key to make sure the community would consider the financial costs of the project while planning it and to encourage overall sustainability and community ownership.

Participants decided that before they could accurately plan for the implementation of a fair and unbiased project, they would first need more information on specific details not covered in the PRA. To begin, all water sources would need to be surveyed by experts and engineers to assess damages and to estimate the cost of repairs and replacements. Funding and other resources from within and outside of Kihigwa would also need to be identified.

Two community-based investigative committees were therefore formed. One committee would be responsible for surveying Kihigwa's water sources to create a final

report on costs, primary sources, and barriers to implementation. The other committee would be responsible for identifying potential funding and caches of natural resources that could be used in Kihigwa. Researchers would work closely with both committees while also being responsible for identifying funding sources from outside of Kihigwa. Two weeks were allotted to complete these tasks and upon that time a second plenary would be held to create a final action plan.

Final report on water resources in Kihigwa

A community investigative committee worked with engineers contracted out of Hoima Town to create a final report on Kihigwa's water resources. Key findings of the report are listed below:

- There were 11 total water sources in Kihigwa. Two were damaged shallow wells that produced heavily silted water at a slow rate. The remaining nine were open catchment ponds or springs that were highly contaminated with silt and bacteria. Some of these sources served just a few HHs while others served up to 60 HHs.
- Water treatment by boiling or filtering was very rare. Some HHs reported to occasionally treat their water before consumption, but overall the practice was found to be too time-consuming.
- Community members claimed that contaminated water sources were one of the leading causes of health problems in Kihigwa. Water-borne diseases like typhoid were commonly reported.

- There has been no government support to improve water resources in the community. According to the government, it is the responsibility of the community to establish their own water sources.
- Engineers, contracted out of Hoima Town, reported that the two established shallow wells could be repaired at affordable costs. The best way to improve open sources would be to convert them into protected sources (shallow wells or protected springs), at a much higher cost.

Resources and funding in Kihigwa

The community committee responsible for identifying funding and other resources within Kihigwa met barriers to their efforts. Direct community monetary donations to the project would not be legitimate given the extreme poverty in Kihigwa. The committee did find that natural resources were abundant and could be used for source construction. Specifically, caches of gravel, clay, and sand would prove to be extremely useful. Additionally, community members would be willing to provide the labor necessary for source construction. A small project assistance grant from the U.S. Peace Corps and World Wildlife Fund was acquired to meet the monetary needs of the project (Derr, personal observation).

PAR Plenary 2: Final action planning

With additional information provided by the investigative committees, a large meeting was held to finalize a pilot-project action plan. By this time, it was apparent that immediate funds and resources would be insufficient to fully improve all resources in Kihigwa. Consequently, participants decided to target sources that could be repaired at

low costs and that could benefit the greatest number of people. The two previously established shallow wells were obvious targets since they only needed minor repairs and were already situated in prime locations. The remaining bulk of the funds and resources would be used to establish two additional protected sources in replacement of open pond sources. The ponds already served over 50 HHs each, making them the ideal candidates for full protection.

It was clear that some HHs would benefit more than others from the establishment of these sources. The final decision was therefore made after lengthy community-wide discussions exploring all possible options. Ultimately, participants felt confident in their choices.

These would not be the only actions pursued, though. Measures could still be put in place to at least partially protect the remaining sources and at no direct monetary cost. This would have to be done primarily through the restoration of lands surrounding the sources by planting trees and other native vegetation. Additionally, farmland would have to be moved away from the sources, and terracing would need to be implemented where necessary to prevent erosion. If completed, restoration could prove to be a very successful strategy for purifying and protecting sources. Unfortunately, land restoration programs would also be much more difficult to implement considering the level of community cooperation that would be needed. Nonetheless, these strategies would be included in the final action plan.

Lastly, the sustainability of the pilot project had to be considered. Reinstituting the operations of the WRCs to maintain the sources and collect user fees would be paramount to the longevity of the project. Training from government experts on how to

initiate and preserve successful WRCs was therefore scheduled. A completed action plan for Kihigwa can be found in Appendix K.

Preliminary implementation outcomes

A team of engineers was hired to repair and direct the construction of the new sources. Community members provided much of the labor and resources needed for construction, while the bulk of project funding went towards paying the engineering team and for the technical components of the sources. Upon completion, trees and shrubs were immediately planted to act as protective buffers, and fences were built around the sources. The benefits of the new sources, providing clean and accessible water to over 200 HHs, were apparent immediately.

Restoration activities for the remaining unprotected sources will take much longer to implement before positive results are achieved. Overall, the community is less motivated to engage this part of their action plan, likely because the results will not be immediate and will require a lot of community cooperation and commitment.

Training was held by local government experts on the reestablishment and preservation of WRCs. Water-source users elected new WRCs for some of the sources, while others were lagging behind. The success of the pilot project will largely depend on its sustainability, which will not be witnessed for a minimum of two to three more years. Local partners will continue to monitor the project as time progresses.

Itara Peri-Urban Community Results

PRA Plenary 1: Project introduction and initial challenge listing

The opening plenary for Itara was conducted following the same methods as Kihigwa. Participants were first introduced to the project, presented with the LOI, and then took part in a group discussion to list all challenges perceived in the community. Unfortunately, participant attendance was not as high as would be preferred for a community-wide meeting. Instead, participants were comprised of 15 women (part of a local women's group) who would ultimately be the main drivers of the PRA activities. Researchers used this to their advantage, recognizing that women often are the most vulnerable demographic in the community and may therefore have the best understanding of community problems. Still, substantial bias was present since gender and youth demographics were so skewed towards older women.

Participants voiced their concerns on a broad range of challenges (compiled in Appendix L) that were condensed into the seven unranked categories. This was done during the community-wide meeting where participants were able to speak freely and offer their suggestions as to what problems were of particular importance to them. Researchers grouped individual problems into seven broader categories as follows.

- Agriculture: Participants discussed many challenges within their farming systems, but low production did not seem to be a significant issue. This suggests that recent production trends have been consistent with those from the past. Additionally, shifting seasonal patterns, less rain, and too much sun were cited, but participants seemed to be coping with these climatic changes. Nonetheless, agriculture was

perceived to be a key challenge mainly because of a lack of inputs that participants felt were preventing them from increasing their incomes and overall standard of living.

- Health: Challenges related to physical wellbeing were of major importance to participants. They felt that the chronic health problems they were experiencing restricted them from running productive households and from working their fields. Major public and private health centers could be accessed fairly easily in Hoima town, but these were usually not affordable and services were viewed as marginal.
- Gender: Because participants were exclusively women, they seemed to be more open about discussing gender problems in the community. Most participants agreed that they would like to have more of a role in making critical decisions related primarily to agricultural production and sales. Furthermore, they felt that men in their households were not taking on enough responsibility, could be violent, and abused alcohol too frequently.
- Youth: Participants felt that youths were unwilling to take on farming as their primary livelihood once they finished school. Instead, they would become idle or leave the community to seek work elsewhere. This has led to a high population of unproductive and complacent youth in Itara, abusing drugs and alcohol in some cases.
- Infrastructure: Poor road conditions were listed as a challenge primarily because they restricted accessibility to Hoima town and other nearby trading centers.

Participants believed that with improved roads they could easily access important resources necessary for improving their standing.

- Finance: Participants felt that their livelihoods exclusively as small-scale farmers restricted their financial opportunities. They discussed how diversifying their income sources through other jobs, such as catering or tailoring, could help them to earn more.
- Water: The participants did not view challenges related to water resources as a major issue. Clean water from protected sources throughout the village was generally accessible but not always consistent because of drought or mechanical issues. Water needed for irrigation purposes was seen as the bigger issue in order to improve agricultural performance.

Before the official closure of the meeting, participants were encouraged to act as community mobilizers to more effectively recruit a broader demographic of participants and promote village-wide participation. Participants then agreed to try and meet on a weekly basis to continue on with the remaining PRA activities. Other activities not requiring the attendance of a large group would be organized separately by the researchers (i.e., sketches of representative farms, institutional analyses, KIIs, and smaller FGDs).

PRA Plenary 2: Community sketch map and seasonal calendar

Two key PRA activities were conducted during this second meeting. In total there were 21 participants. Eighteen were women and the remaining three were men. The low attendance rates early on, particularly among men, were indicative of a lack of

community-wide participation. Consequently, it was at this point that researchers felt it would be in the best interest of the project to work almost exclusively with the Itara women's group instead of the community at large. This would substantially narrow the target population so that efforts could be focused on the most motivated and, arguably most vulnerable, group in the community to create the most realistic approaches to initiate change.

Community sketch map

The completed sketch map can be seen in Appendix M. Itara's community map depicted a complex and diverse patchwork of farming systems. Seen on the map were large subsistence plots for producing staple foods like cassava, maize, beans, matooke, groundnuts, and sweet potatoes. Most of these fields were located on a shallow valley slope leading down to a stream where soils were poor, likely because of erosion and nutrient leaching from overuse. Smaller vegetable gardens were marked near many of the scattered households where they could be managed intensively using different permagardening techniques. The main purpose of these gardens was to promote better household nutrition by incorporating more vegetables into their diets. Commonly grown vegetables included tomatoes, eggplants, peppers, and different types of greens. Lastly, pasture areas and corrals were marked across the map, suggesting extensive livestock production for at least some households, which generally indicates wealth.

Nursery bed operations for producing vegetable seedlings were marked on the map near the stream where they could be irrigated easily and shaded by the forests running along the banks of the stream. The nurseries were established by the women's

group who worked together to manage them. When ready, the seedlings would be evenly distributed among the women to be planted in their permagardens.

Also located near the stream were multiple brick-making operations, which offered a viable way for teenaged and middle-aged men to make an income. Participants seemed to associate a negative connotation towards these operations due to their negative impact on the land in such close proximity to their fields. Furthermore, brick-making drew young men away from school. A few dukas (small shops) also dot the map, further demonstrating that farming is not the only livelihood present in the community.

Access to water for domestic purposes (i.e., drinking, cooking, cleaning, etc.) in Itara comes primarily from three separate boreholes found across the village in low-lying areas near the stream. Itara is fairly small, so most HHs are no more than one kilometer away from any given source. Still, some households rely on the stream as their main source of domestic water.

Seasonal calendar

Similar to the methods used in Kihigwa, two calendars were created by participants to show the timing of seasonal farming activities before climate change was widely perceived about 10 years ago (calendar 1) compared to the timing of current seasonal farming activities (calendar 2). The completed calendars can be seen in Appendix N. As expected, calendar 1 described a steady bimodal seasonal pattern. Consistent rainfall would occur from February to April and then again from August to October, with dry seasons occurring in between. By comparison, climate change shifts

recorded in calendar 2 described heavier rainfall events during the wet season mixed with intermittent spells of very hot and humid weather with no precipitation.

According to calendar 2, participants perceived total rainfall to be higher with climate change because of increased storm intensity. Unfortunately, this failed to lead to tangible benefits in crop production for several reasons. For example, soil moisture was rapidly lost due to increased evapotranspiration rates from more frequent dry spells. Furthermore, community members failed to harvest or channel rain to catchment areas or to their fields for irrigation purposes. Heavier storms also destroyed crops and increased the prevalence of pests and diseases, which thrived in the extreme weather conditions.

To cope with these changes, participants reported that they had to significantly alter their seasonal farming schedules. Land preparation and weeding activities now occur year-round instead of just the months leading up to the wet seasons. Farmers did this because they felt they had to always be prepared for unexpected rainfall events, even during the dry season. Planting would take place only once enough moisture had accumulated in the soil so that farmers could have some assurance that their seeds or seedlings would successfully germinate. Planting during traditional time frames before rains arrived was now far too risky a behavior.

Calendar 1 shows harvest times typically ran from after the first rainy season in June through January, which would allow households to harvest and store enough to make it to the start of the next harvest. Despite new farming challenges because of climate change, harvest times were reported in calendar 2 to be the same. This suggests that farmers were coping with the changes to their farming systems and still producing

enough food to get through the non-harvest season. Or, it could be indicative that many households had other sources of income, allowing them to buy food during times of need.

Non-plenary activities

As was also done in Kihigwa, non-plenary activities were conducted to give researchers the chance to work with smaller groups or individuals to hone in on specific topics and objectives. Two of these activities were completed, including creating sketches of representative farms and conducting an institutional analysis.

Sketches of representative farms. Researchers visited three HHs in Itara, owned by members of the women's group, where they were taken on tours of HH lands to examine specific farming activities more closely. The women were interviewed during the tour and answered questions about their daily lives, farming practices, family structure and dynamics, and climate change. The HHs chosen were representative of middle to low income HHs in Itara. Sketches can be seen in Appendix O.

The HH1 is a middle income HH headed by an older widowed woman who supports four younger grandchildren. They reside in an average sized brick home with a corrugated metal roof and approximately four acres of land adjacent to the house for farming. The closest water source is a community borehole a quarter-mile away. Considering the vulnerable position of the woman as a widow, she has done exceptionally well to support herself and her grandchildren, who all attend primary school. All four acres of the land is farmed intensively to grow a wide diversity of food and cash crops for home consumption and sale. Enough money has been earned by the HH to hire the services of a tractor to cultivate three acres of land used for staple crops

like beans, maize, and sweet potatoes. An additional acre of land is used for growing vegetables through permagardening techniques, including tomatoes, eggplants, peppers, and greens. The HH also has about a dozen chickens and one pig.

When asked what her HH's biggest challenge is, the woman responded that it was health issues. As the primary source of labor, her physical wellbeing was critical to the continued productivity of her gardens. Health centers were accessible, but she felt they did not provide the level of service necessary to help her. Additional challenges reported were related to impacts on farming from unpredictable rains, harsher dry seasons, and more pests and diseases. Still, the HH was successfully coping with this challenge primarily because of their well established and managed gardens.

The HH2 was representative of another middle income HH, but substantially larger as it supported 14 members. Researchers worked with the mother/wife of the family to draw a sketch of the HH and conduct an interview. The family resides in two average sized brick houses and an additional two mud houses all grouped together. The closest water source was a community borehole just 100 meters away. Directly behind the houses was a corral that held 15 head of cattle and 11 sheep. There were also 17 chickens. The HH claimed seven acres of land but did not utilize all of it. Eucalyptus trees were recently planted on a one-acre plot demonstrative of a long-term investment made by the HH. Two acres of land were used for crop production. Similar to HH1, a series of raised beds were managed closely and intensively using permagardening techniques to grow vegetables like tomatoes, eggplants, cabbages, peppers, and greens to promote HH nutrition. Staple crops like beans, maize, and matooke were also grown as the HH's main source of calories.

Climate change was believed to be a significant challenge, forcing the HH to spend more time on farming activities. The main impacts reported were less rain and longer droughts. The informant believed these impacts were occurring because of deforestation in the community. This suggested that, while local deforestation is not directly correlated to climate impacts, the presence of trees and forests benefitted agriculture by providing shade to reduce soil moisture evaporation and by adding much needed organic matter to the soil. Livestock diseases were also believed to be more prevalent as a result of hotter weather. Veterinary services are now needed much more frequently as a result.

The HH3 is representative of more vulnerable, low-income HHs in Itara. Once again, researchers worked with the mother/wife of the HH to create a sketch and conduct an interview. The husband and his wife support five younger children in a smaller mud house. They farm approximately three acres of land to grow mostly staple crops, although they also have a very small vegetable garden. All of their croplands, with the exception of their vegetable garden, were on shallow slopes leading down to a stream. A catchment pond next to the stream was their closest water source, but they did not use it for drinking water. Instead they used a community borehole one kilometer away to collect drinking water.

The informant believed that climate change was impacting the quality of the soil in addition to bringing about more drought and less rain, ultimately lowering the HH's total output. As a HH dependent almost entirely on subsistence farming, this is considered a major challenge to them. More specifically, caring for her children and paying for their school fees was considered to be the informant's greatest challenge. She

reported that more support was needed from her husband to cope with these challenges, as too much of the HH domestic and farming burden was placed on her. She further felt that she should have a greater role in making HH decisions as the primary laborer.

Institutional analysis. Researchers worked with two members of the woman's group to conduct an institutional analysis that would identify and assess key organizations or institutions that could play a role in Itara's development. The most obvious of these institutions was the woman's group itself. The group is well established with approximately 40 members and has been consistently active since 2011. The group's goal is to provide training for its members in different capacity-building activities so that they can effectively work together to improve their lives. For example, the group has its own village savings and loan association (VSLA), giving them a medium to save money and take out loans. They have also collaborated to establish and manage nursery beds for vegetable seedlings that they distributed among themselves to plant in their gardens to promote better HH nutrition.

A few different NGOs have been active in Itara off and on for over a decade. The international NGO World Vision, for example, established an orphanage for vulnerable children in the community in 2012 and provided other youths with resources like scholastic materials and school fees. The project also trained community members to be village health trainers responsible for conducting community-level training on relevant health topics. Eco-Agric has also been active in the community since 2014, providing agricultural extension services at the HH level.

Government projects are also prevalent, likely because of Itara's close proximity to a major town. In 2016 alone, major infrastructure projects like the establishment of new electrical lines providing power to the entire village and construction of a more direct road to Hoima Town were underway. The government has also funded the establishment of boreholes throughout Itara, providing access to clean water. Other government programs have sponsored children to go to school.

PRA Plenary 3: Final ranking of priority problems and analysis

A group of twenty women participated in the final PRA plenary where a pairwise matrix was used to complete a final ranking of priority problems (Table 2). Since all PRA community participants were almost exclusively women, this final ranking is representative of the challenges faced by women in Itara. The completed matrix can be found in Appendix O.

Agriculture was ranked as the number one challenge. This is likely not indicative of poor agricultural performance, but rather shows just how important agriculture is as the main livelihood in Itara. It can be speculated that the participants may have felt trapped in their current socioeconomic status and that their reliance on agriculture for their primary income source was preventing them from improving their lives. Increasing agricultural production with the resources available to them is, of course, possible. However, with the impacts of climate change making farming an ever more high-risk

Table 2

Final Priority Challenge Rankings for Itara from Highest (1) to Lowest (7)

RANK	CHALLENGE
1	**Agriculture** Need for expanding production so there is less reliance on subsistence farming and more on selling crops.
2	**Gender** Too much burden on women. Women are excluded from making key decisions.
3	**Health** Health problems restrict ability to work. Health centers are unhelpful.
4	**Finance** Need for livelihood diversification. There is a lack of finance for farming inputs. School fees need to be paid.
5	**Youth** High number of unemployed and complacent youth in the community.
6	**Infrastructure** Better roads are needed so that access to town is not restricted.
7	**Water Resources** Some HHs require better access to clean drinking water.

venture, it is likely that participants were seeking to diversify their livelihoods instead of continuing to rely upon marginal and potentially declining returns from farming.

Perhaps most unsurprising given the participant demographics, challenges related to gender were ranked second. Participants believed that they should be receiving more support from their husbands and that they are entitled to have a more active role in making important HH decisions. They felt if HH responsibilities could be divided more evenly, overall agricultural production could substantially increase. Unfortunately, as a well-established cultural construct, solutions to change this HH dynamic are limited. It

therefore may be more feasible to empower women as individuals to overcome such challenges in their own individual ways.

Health challenges were ranked third, although there was no single health issue that the participants discussed. Rather, a long list of unspecified ailments was brought up that restricted the ability of community members to work. Health centers were accessible, but their services were often reported to be unhelpful. As a community-wide problem, health challenges needed to be addressed, but solutions were ambiguous given the overwhelming nature of the challenge.

Ranked fourth were financial challenges. In Itara, financial challenges were primarily related to a need for community members to diversify their livelihoods away from agriculture towards other income-generating activities. Agriculture has provided a financial base for the community, but many participants felt that other activities would ultimately be necessary to improve their financial standing.

Challenges related to inactive and complacent youth were ranked fifth. It is possible that this challenge would not have received any serious consideration had men been involved in the ranking process. Participants believed that the establishment of youth groups could be key to solving this problem.

Challenges related to infrastructure and water resources were ranked last. While problems within these categories exist, they are mostly minor and in some cases are already being addressed (i.e., government programs to improve infrastructure).

PAR Plenary 1: Action planning

Twenty-eight members of the woman's group met to develop an action plan based on findings from the PRA. No specific project was implemented immediately due to a lack of funding and minimal community-wide participation. The completed community action plan for Itara can be seen in Appendix Q.

ANALYSIS AND DISCUSSION

The outcomes of the PRA and PAR processes identified challenges and opportunities that were translated into tangible actions that improved the capacity of the two communities. The following main research questions were also answered:

(1) Do small-scale Ugandan farmers perceive the climate to be changing, and if so, how?

(2) Are farmers taking adaptive actions in response to the perceived changes?

(3) What interventions do farmers need to enhance their resilience?

(4) Do climate change perceptions, adaptive actions, and interventions vary with location?

In addition, associated issues including gender and development process were encountered, and these will also be addressed in this section.

Results revealed that climate change impacts were being perceived at both the Kihigwa and Itara communities. Impacts were generally described as fluctuations in seasonal patterns. Wet seasons were reported to be shorter, with less consistent rain and more severe storms, while dry seasons were reported to be becoming longer with more extreme high temperatures. This translated to a decline in total agricultural productivity because farmers were unable to accurately predict when rainfall events would occur, therefore disrupting traditional farming patterns. Furthermore, a more extreme climate in terms of higher temperatures and heavier storms increased the prevalence of weeds, crop pests, human diseases, and animal diseases. Specific descriptions varied, but this was the commonly accepted perception regardless of age, sex, or social status of the participants.

These perceptions mostly align with actual climate data for Uganda. For example, average annual temperatures are up 0.5 to 1.2 degrees Celsius for minimum temperatures and 0.6 to 0.9 degrees Celsius for maximum temperatures in the period of 1951 to 2010 (Caffrey et al., 2013). Historical rainfall data also indicate that the occurrence of rainfall events within the last 20 years are more condensed and not as evenly distributed as they once were (Climate Knowledge Portal, 2016). Total average rainfall has remained consistent over time, which contradicts participant perceptions that they are receiving less rain. This can be explained by the onset of more pronounced seasonal change where heavier rainfall events are condensed into a shorter period of time instead of being more evenly distributed over the course of a year. Consequently, there probably is a higher rate of water loss via runoff and evapotranspiration due to the limited water holding capacity of soil.

The perception that climate change was occurring at all was limited to a local or, at best, regional level. In other words, community participants did not view or understand climate change as a global issue or phenomenon. In more than one case, participants reasoned that climate change was happening because of local deforestation. In some cases, participants correlated it to local rubbish littering. This was unsurprising given the limited scientific knowledge community members had about climate change.

Additionally, no direct translation existed for the term climate change in the local language. Instead, the local impacts of climate change had to be described by participants and researchers to convey what climate change was. For example, the most accurate local saying for describing climate change was *obwire kuba butakyaisanasana nkoku bwali eira,* best translated to mean changes in the occurrence of rain and sun. Consequently,

explaining the root causes of climate change as a global process was a major challenge but would ultimately pose no apparent threat to adaptation efforts. These findings therefore suggest that understanding climate change from a scientific perspective is not a prerequisite for successful adaptation as long as its local context is understood.

Results also showed that participants were responding and altering their behaviors to the changes they perceived. At the very least, all participants were making adjustments in the timing of certain farming activities like land preparation and planting in correspondence to shifting seasonal patterns. This was very apparent during the seasonal calendar activity of the PRAs, which explicitly compared the timing of farming activities before and after the onset of the perceived changes. In the case of Itara, permagardening practices were being utilized prior to project interventions, primarily because they had greater access to agricultural extension services in a peri-urban setting. Kihigwa, on the other hand, was not utilizing permagardening methods but was, in the case of some households, beginning to expand farming activities into wetlands and other uncultivated areas that were well endowed with moisture and nutrients.

Whether or not these adaptive actions can be deemed successful cannot be determined at this time, mostly because there is currently no consensus on how to define "successful adaptation" (Olazabal, Galarraga, Ford, Lesnikowski, & de Murieta, 2017). In some cases, the definition of successful adaptation can have competing interpretations in both research and practice (Ford et al., 2015; Sherman et al., 2016). The IPCC states that adaptation is "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm and exploit beneficial opportunities" (IPCC, 2014). Under this definition, it is obvious that both Kihigwa and

Itara are adapting because they are adjusting their farming systems (altering the timing of farming practices) in response to actual changes in the climate (shifting seasonal patterns) to moderate effects and avoid harm. Moreover, both communities exploit beneficial opportunities, like permagardening or land expansion, to further mitigate harm.

Under other, more specific definitions of adaptation, it is less clear if the study sites were adapting. For example, Adger, Arnell, and Tompkins (2005) state that 'successful adaptation' must "balance effectiveness, efficiency, and equity through decision-making structures that promote learning and are perceived to be legitimate." Tomkpins et al. (2010) discuss 'anticipatory adaptation planning,' which ensures "that the vulnerable are prepared, risk information is distributed, risk management plans developed, and public goods are managed to account for climatic changes." The IPCC (2014) uses the term 'adaptation management' to describe the "process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change" and "involves adjusting approaches in response to observations of their effect and changes in the system."

Using the definition by Adger et al. (2005), it could be argued that the study-sites were not 'successfully adapting.' For example, altering the timing of farming activities in response to shifting weather patterns is likely not efficient and arguably not effective or legitimate over time, because it requires farmers to utilize haphazard and unplanned strategies that may be unsustainable. In the case of Kihigwa, land expansion is not efficient because it requires more labor, and it is not equitable because not every farmer has the option to do this. Permagardening in Itara, on the other hand, may be the only

regularly observed adaptation that could be deemed successful under the Adger et al. (2005) definition.

'Anticipatory adaptation planning,' as defined by Tompkins et al. (2010), suggests a more formal and proactive form of adaptation that was not substantially occurring at either study-site. Risk information and management plans were not available since no institutional body was actively working to provide them. The Itara women's group was managing their public goods on some level with their permagardening efforts by utilizing wetlands for nursery bed operations, but full community participation was minimal. 'Adaptation management,' as defined by the IPCC (2014), was arguably occurring at both study-sites, but more so at the household level than the community level. For example, individual farmers regularly adjusted their land management approaches (like certain farming activities) both in the face of uncertainty and in response to observed changes in climate.

It can be stated with confidence that prior to interventions, study-site participants were taking adaptive action in response to perceived climate change impacts according the IPCC definition. According to Adger et al. (2005) though, most of the adaptive actions could not be considered 'successful adaptations.' Nor could it be stated that 'anticipatory adaptation planning,' as defined by Tompkins et al. (2010), was regularly occurring. But on a basic level, 'adaptation management,' as defined by the IPCC (2014), was occurring.

Given this analysis on the level of adaptation taking place at the study-sites, it is logical to justify that farmers need to be upgrading the quality of their adaptations to be more proactive and anticipatory in order to enhance their resilience. In other words,

interventions should focus on collaborative and iterative planning among the entire community to identify opportunities that can be feasibly implemented in an effective, efficient, and fair manner. This is essentially what the PRA and PAR component of the study accomplished, by providing a channel for participants to develop adaptation solutions. Each study-site community consequently created their own development pathway based on their needs and resources.

As the culminating exercise of the PRAs, the matrix ranking activity identified which challenges and opportunities could be most effectively pursued. For the rural study-site of Kihigwa, water resources were the most obvious challenge but also the greatest opportunity for development. Of the other challenges and opportunities present, none were as pressing and none could lead to the greatest cumulative gain for the community as water resources could. Consequently, the action plan developed during the PAR phase focused solely on enhancing water resources as the most feasible and effective way to enhance Kihigwa's resilience to climate change.

This was telling in that it demonstrated how basic resources and infrastructure are critical for building resilience to climate change for rural communities. For example, it may have been considered unwarranted for the researchers of this project to try and implement an improved agriculture program in a community without access to clean water, had they chosen to do so. This can be confusing given that within rural subsistence farming communities, agriculture often has the greatest influence on that community's success and is likely to be impacted the most by climate change. As a development practitioner, this could be a grave oversight. If a community can first firmly establish

their most basic needs, further and more complex development may happen more effectively and efficiently.

Matrix ranking results for the peri-urban community of Itara told a much different story compared to that for Kihigwa. These results indicated that a more diverse set of challenges and opportunities needed to be addressed to enhance Itara's resilience to climate change. Agriculture was ranked as the greatest challenge and opportunity, but gender, health, and finance topics seemed to be almost of equal importance to participants. This was apparent throughout PRA activities where a broad range of challenges were revealed, unlike in Kihigwa where water resources were almost always the most apparent challenge. Therefore, the PAR process for Itara took on a more eclectic approach, culminating in a CAP that acknowledged all seven identified priority challenges/opportunities. While no component of the CAP was implemented at Itara during this research project (due to a lack of time, funding, and resources), the plans do provide the community a blueprint for addressing priority problems in the future. The Itara action plan demonstrates that there are many feasible pathways for the community to improve their resilience to climate change.

Another interesting trait of the Itara study-site was that activities were conducted almost exclusively with women. This was not by design but was rather because men showed very little interest in participating. The reasoning for this was not fully ascertained, but it can be speculated that many men in the community were migrant workers who traveled daily to work in Hoima Town. Women in the community, on the other hand, had already mobilized themselves into a group focused on collaborative

projects aimed at improving their lives. Consequently, women were much more motivated and willing to participate in PRA activities.

The female-focused aspect of the Itara study-site did reveal a great deal about the nature of gender and climate change adaptation in Uganda. Demetriades and Esplen (2008) state, "climate change can exacerbate *existing* inequalities between and among women and men and intensify gendered experiences of poverty." This statement holds true for both the Kihigwa and Itara study-sites but was more actively discussed in Itara given that women participants were more willing to talk about these issues in the absence of men. For example, men in Uganda are commonly responsible for the decision-making and planning aspects of farming while women are responsible for much of the actual farm labor, like land maintenance/preparation and weeding. Climate change impacts like seasonal variation puts a greater labor and time burden on women to complete these tasks. Additionally, the burden of domestic labor for women and girls, like fetching water and fuel for cooking, becomes more time consuming as climate change further contributes to the scarcity of these resources. These findings on how women in Itara are disproportionately impacted by climate change compared to their male counterparts are consistent with the literature on this subject (Araujo, Quesada-Aguilar, & Pearl, 2007; Arora-Jonsson, 2011; Demetriades & Esplen, 2008; Flato, Muttarak, & Pelser, 2017; Mitchell, Tanner, & Lussier, 2007).

Women participants in Itara regularly discussed throughout the PRA and PAR processes their desire to have more control over the decision-making and planning aspects of farming in their households. In fact, many women participants who were household heads—and had total control over the decision-making aspects of their

farming—often had very productive agricultural systems despite being disconnected from the cultural privileges (i.e., land rights, political clout, and family benefits) commonly received by male headed households in Uganda. This suggests that farming systems could be more productive if Ugandan women were empowered to have a greater role in the decision-making and planning aspects of agriculture, particularly in households where the power dynamic is skewed towards men. Consequently, it is logical that study participants in Itara ranked gender as the second greatest challenge and opportunity.

These findings should not downplay the fact that men and boys in Itara and elsewhere are vulnerable to climate change in addition to social and economic oppression, despite the benefits of male privilege (Esplen & Greig, 2008). These findings are also not meant to contribute to what Djoudi et al. (2016) refer to as the 'feminization of vulnerability,' which can contribute to the victimization of women within the climate change discourse. Nor do they aim to generalize or "conceptualize women everywhere as a homogenous, subjugated group," as is often the case in much of the literature on gender and development (Demetriades & Esplen, 2008). Rather, the findings on gender dynamics and adaptation in Itara should highlight the need to focus on the root causes of female vulnerability to climate change like, for example, preexisting social injustices. This is supported by MacGregor (2010), who argues that climate change adaptation will only be sufficient and sustainable if it acknowledges these gender dynamics.

Regardless of gender, the differences in CAP design for each study-site indicate that needed interventions do vary with location. Kihigwa's decision to focus efforts solely on their water resources seems to suggest that rural communities may benefit the most by addressing basic needs that they commonly lack (i.e., clean water and health care

services) before addressing more complex challenges (i.e., agriculture productivity, gender analyses, and poor government/ institutional support). Itara's focus on a more diversified set of challenges suggests that peri-urban communities have a greater capacity to take on more complex challenges (i.e., agricultural productivity and gender analyses). This is a logical theory given that peri-urban communities generally have greater access to resources and therefore greater adaptive capacity compared to rural communities. Regardless of rural, peri-urban, or urban setting, it is also logical that intervention needs will vary dramatically by location due to the site-specific challenges that different areas face.

Ultimately, the use of a PRA and PAR approach successfully answered the research questions posed, but barriers were common throughout the duration of the project. The original barrier that researchers faced was getting commitments from the communities to buy into the PRA process. Extensive conversations with community leaders in Kihigwa and Itara were necessary to ultimately convince them that the PRA process was worth trying. When they were eventually introduced to the PRA process, participants were taken aback by its participatory and community-driven nature. Participants were more accustomed to traditional development/aid projects focused around handouts and outside interventions. Community participation consequently started slowly and gradually gained momentum as projects progressed. This was especially true in Kihigwa, where community attendance at plenary meetings reached close to 100 participants by the end of the project after an initially slow start. Comparatively, community participation in Itara was problematic throughout and severely limited the ultimate impact of the project. This was speculated to be because many men in Itara went

into Hoima Town to work on a daily basis. Also, it is likely that wealthier households in Itara felt they did not need to participate in the study because of their already stable standing.

Logistics also proved to be a major barrier. Participants had to set aside time for meetings and activities that they were not always willing to give. This was understandable given that community members had other priorities to address like their farms and families. The total duration of the project at both sites ultimately took longer than anticipated due to difficulties with scheduling.

Overall, the use of a community-based participatory approach for this project successfully revealed development pathways for both communities. For the case of Kihigwa specifically, interventions were carried out to improve water resources using an action research approach.

CONCLUSIONS

Results from this project revealed findings on the nature of climate change adaptation for small-scale farmers in Uganda through the use of a community-based approach (PRA and PAR methods). As a benefit of this research approach, both study site communities were able to develop action plans and, in the case of the Kihgwa study site, implement pilot projects. The overall research process promoted collaborative planning among community participants to enhance adaptation by making it more anticipatory and proactive. Ultimately, the hope is that this will make adaptation efforts more successful over time.

Key findings showed that small-scale farmers in Uganda do perceive the climate to be changing, primarily in the form of variations in the timing of seasonal patterns (i.e., longer and hotter dry seasons and shorter and more intense rainy seasons). Despite this perception, findings also showed farmers do not understand the mechanism (global warming) causing the change, instead believing in many cases that local-level events (deforestation, littering, and environmental degradation) are the primary reasons for the changes.

Results also showed that participants at both study-sites were adapting to the perceived changes prior to interventions primarily by making adjustments in the timing of certain farming activities. Whether this adaptation could be deemed 'successful' depends on one's interpretation of the literature. Regardless, findings also indicated that interventions could be utilized to further enhance the resilience of participants.

Consequently, the rural site of Kihigwa was found to need interventions in water resource development while the peri-urban site of Itara was found to need interventions in agriculture, gender analyses, health, and finance. This suggests that rural communities in Uganda could most benefit from resource and infrastructure development, while peri-urban communities could most benefit from social, financial, and institutional development. Climate change perceptions for each site were found to be the same. Adaptive actions for each site prior to interventions did vary since it was found that Itara was also implementing permagardening methods in addition to adjusting the timing of certain farming activities. These observations suggest the hypothesis that peri-urban communities in Uganda have a greater adaptive capacity to climate change than rural communities.

Results from this research project also contribute to our overall understanding of climate change adaptation among vulnerable communities. To begin, project results demonstrated how findings on indigenous farmer knowledge can interface with science and actual climate data to influence decision-making. In the case of this study, farmer perceptions of climate change were examined and compared to actual climate data to determine how they may or may not influence adaptation. Perceptions correlated well with actual climate data and were a primary factor influencing adaptation. Alternatively, perceptions on how and why climate change occurs as a scientific phenomenon was not understood but did not seem to influence adaptation. This suggests that understanding the scientific mechanisms of climate change is not a prerequisite for adaptation.

This study also contributes to the discussion of what qualifies as successful adaptation. Results show that study participants were adapting to the changes they

perceived, but there was potential to improve upon these efforts through interventions. This suggests that while vulnerable communities are capable of carrying out adaptation efforts on their own, there is often a need to enhance these adaptations when appropriate through outside interventions aimed at making them more proactive, equitable, and effective. Additionally, there is a need to recognize the prerequisites often needed to achieve this type of adaptation. For example, the study site of Kihigwa could not fairly or effectively foster more complex adaptation efforts without first establishing water resource infrastructure.

This research also contributes to the growing body of literature on CBA. More specifically, the PRA and PAR methods used in this study effectively fostered or laid the groundwork for more anticipatory and proactive adaption in study-site communities. This was achieved through collaboration among community members and researchers as they participated in various activities and discussions. The entire process happened organically, and researchers did their best to not force the project into any particular direction. This would ultimately be key to ensuring that study-sites focused on their own self-interests and not the interests of the researchers.

Overall, this project helps to shift the narrative away from traditional donor-driven development and aid in the context of small-holder adaptation to climate change. It focuses on creative problem-solving approaches to tackle real and applicable challenges that are often overlooked. Most importantly, the methods used promoted collaborative efforts through shared cultural experiences that empowered both the researchers and community participants.

REFERENCES

Abeysinghe, A., Dambacher, B. M.,& R. Byrnes. (2017). National adaptation plans: Understanding mandates and sharing experiences. IIED, London.

Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography 24*(3), 347–364.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change 16*(3), 268–81.

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change 15*, 77–86.

Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2013). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change 3*, 112–117.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D.R., Otto Naess, L., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? *Climate Change 93*, 335-354.

Adger, W. N., Huq, S., Brown, K., Conway, D., & Hulme, M. (2003). Adaptation to climate change in the developing world. *Progress in Development Studies 3*(3), 179–195.

Adger, W. N., Lorenzoni, I., & O'Brien, K. L. (2009). *Adapting to climate change: Thresholds, values, governance*. Cambridge, MA: Cambridge University Press.

Adhikari, B., & Taylor, K. (2012). Vulnerability and adaptation to climate change: A review of local actions and national policy response. *Climate and Development 4*(1), 54–65.

Altieri, M. A., & Nicholls, C. I. (2017). The adaptation and mitigation potential of traditional agriculture in a changing climate. *Climatic Change 140(1),* 33-45.

Araujo, A., Quesada-Aguilar, A., & Pearl, R. (2007). *Gender equality and adaptation*. Women's Environment and Development Organization (WEDO) and The International Union for the Conservation of Nature (IUCN).

Arora-Jonsson, S. 2011. Virtue and vulnerability: discourses on women, gender and climate change. *Global Environmental Change 21*, 744–751.

Ayers, J. and T. Forsyth. 2009. Community-Based Adaptation to Climate Change. *Environment: Science and Policy for Sustainable Development 51*(4), 22–31.

Bajzelj, B., Richards, K. S., Allwood, J. M., Smith, P., Dennis, J. S., Curmi, E., & Gilligan, C. A. (2014). Importance of food-demand management for climate mitigation. *Nature Climate Change 4,* 924–929.

Beh, A., Bruyere, B.L., & Lolosoli, S. (2013). Legitimizing local perspectives in conservation through community-based research: A photovoice study in Samburu, Kenya. *Society and Natural Resources 26*(12), 1390–1406.

Bindi, M., & Olesen, J. E. (2011). The responses of agriculture in Europe to climate change. *Regional Environmental Change 11*, 151–158.

Blanke, M.M., & Burdick, B. (2005). Food (miles) for thought: Energy balance for locally-grown versus imported apple fruit. *Environmental Science and Pollution Research 12*, 125–127.

Bohle, H.G., Downing, T. E., & Watts, M. J. (1994). Climate change and social vulnerability: toward a sociology and geography of food insecurity. *Global Environmental Change 4*, 37–48.

Bryan, E., Deressa, T. T., Gbetibous, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science and Policy 12*, 413–26.

Burnham, M., & Ma, Z. (2015). Linking smallholder farmer climate change adaptation decisions to development. *Climate and Development 8*(4), 289–311.

Burton, I. (1997). Vulnerability and adaptive response in the context of climate change. *Climatic Change 36*, 185–196.

Caffrey, P., Finan, T., Trzaska, S., Miller, D., Laker-Ojok, R., & Huston, S. (2013). *Uganda climate change vulnerability assessment report*. United States Agency for International Development.

Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World Development 22*(7): 953–69.

Chambers, R. (2004). *Notes for participants in PRA/PLA-related familiarization workshops in first half of the year 2001*. Institute of Development Studies, UK.

Chambers, R. (2007). *Who counts? The quiet revolution of participation and numbers*. Institute of Development Studies, Brighton, UK.

Chandra, G. (2010). *Participatory Rural Appraisal*. North Eastern Regional Center, Central Inland Fisheries Research Institute, Assam, India.

Chowdhury, R.B., & Moore, G. A. (2017). Floating agriculture: A potential cleaner production technique for climate change adaptation and sustainable community development in Bangladesh. *Journal of Cleaner Production 150*, 371–389.

Climate Knowledge Portal. (2016). *Average monthly temperature and rainfall for Uganda from 1901–2015*. The World Bank Group.

Cohen, J., & Uphoff, N. (1977). *Rural development participation: Concepts and measures for project design*. Rural Development Committee, Cornell University, Ithaca, New York.

Conway, D., & Schipper, E.L.F. (2011). Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. *Global Environmental Change 21*: 227–237.

Coppock, D. L. (2016). Cast off the shackles of academia! Use participatory approaches to tackle real-world problems with underserved populations. *Rangelands 38*(1), 5–13.

Coppock, D.L., Desta, S., Tezera, S., & Gebru, G. 2011. Capacity building helps pastoral women transform impoverished communities in Ethiopia. *Science 334*, 1394–1398.

Coppock, D. L., Shrestha, M., Pandey, N., Basnet, A., Duwal, D., & Davis, D. (2014). Adapting small-farm systems to climate change: Preliminary results from participatory community assessments in Bajura District, Nepal. *Research Brief-17-2014,* Feed the Future-Adapting Livestock systems to Climate Change, Colorado State University, Fort Collins, CO, USA.

Corner, A. (2011). *Hidden heat*. Pano Eastern Africa, Kampala, Uganda.

Daumerie, B., & Madsen, E. L. (2010). *The effects of a very young age structure in Uganda: Country case study*. Population Action International, Washington, D.C.

Demetriades, J., & Esplen, E. (2008). The gender dimensions of poverty and climate change adaptation. *Institute of Development Studies Bulletin 39*, 4.

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change 19*: 248–55.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education 40*(4): 314–321.

Djoudi, H., B. Locatelli, C. Vaast, K. Asher, M. Brockhaus, and B.B. Sijapati. 2016. Beyond dichotomies: gender and intersecting inequalities in climate change studies. *Ambio*. 45, 248–262.

Duffy, D. (2015). Conservation stewardship program. *Ag Decision Newsletter* Vol. 13: Issue 12, Article 3.

Dumaru, P. (2010). Community-based adaptation: Enhancing community adaptive capacity in Druadrua Island, Fiji. *Climate Change 1*, 751–763.

Esplen, E., & Greig, A. (2008). *Politicizing masculinities: Beyond the personal*. Institute for Development Studies. Lethbridge, AB: Warwick Printing.

European Environment Agency (2015, February 18). *Agriculture*. Retrieved from: http://www.easybib.com/reference/guide/apa/website.

Flato, M., Muttarak, R., & Pelser, A. (2017). Women, weather, and woes: The triangular dynamics of female-headed households, economic vulnerability, and climate variability in South Africa. *World Development 90*, 41–62.

Folke, C. (2006). Resilience: The emergence of a perspective from social-ecological systems analyses. *Global Environmental Change 16*: 253–267.

FAO (Food and Agriculture Organization). (2012). *Smallholders and family farmer factsheet*. Food and Agricultural Organization of the United Nations. Rome, Italy.

Ford, J. D., Berrand-Ford, L., Biesdroek, R., Araos, M., Austin, S. E., & Lesnikowski, A. (2015). Adaptation tracking for a post-2015 climate agreement. *Nature Climate Change 5*, 967.

Francis, C. A., Hansen, T. E., Fox, A. A., Hesje, P. J., Nelson, H. E., & Lawseth, A. E. (2012). Farmland conversion to non-agricultural uses in the US and Canada: Current impacts and concerns for the future. *International Journal of Agricultural Sustainability 10(1),* 8–24.

Franzluebbers, A. J., & Follett, R. F. (2005). Greenhouse gas contributions and mitigation potential in agricultural regions of North America: Introduction. *Soil and Tillage Research 83*, 1–8.

Gasper, D. (2015). Ethics of development. In *An Introduction to International Development, 3rd edition*. Oxford University Press.

Glennie, J. (2008).*The trouble with aid: Why less could mean more for Africa*. New York: Zed Books.

GOU (Government of Uganda). (2004). *Climate change, the environment and human welfare: Lessons learned from the Lake Kyoga catchment area*. UNDP-UNEP Poverty-Environment Initiative.

GOU. (2007). *Climate change: Uganda national adaptation program of action (NAPA).* Department of Meteorology, Government of Uganda. Kampala.

GOU. (2010). *National development plan 2010/2011–2014/2015*. The Republic of Uganda, Kampala, Uganda.

Greene, S., & Hesse, C. (2017). Participatory resource mapping: Better evidence in action. London, UK: *International Institute for Environment and Development*.

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). Global food losses and food waste. *Food and Agricultural Organization of the United Nations*.

Haines, A, & Patz, J. A. (2004). Health effects of climate change. *US National Library of Medicine 29*(1), 99–103.

Hayter, T. (1976). Aid as imperialism. *Social Scientist 5*, 77–80.

Hepworth, N., & Goulden, M. (2008). *Climate change in Uganda: Understanding the implications and appraising the response*. Edinburgh: LTS International.

Hickman, J. E., Scholes, R. J., Rosenstock, T. S., Garcia-Pando, C. P., & Nyamangara, J. (2014). Assessing non-CO_2 climate-forcing emissions and mitigation in sub-Saharan Africa. *Environmental Sustainability 10*, 65–72.

Hisail, E, Birungi, P., & Buyinza, F. (2011). Adaptation to climate change in Uganda: Evidence from micro level data. *Global Environmental Change 21*: 1245–1261.

Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics 4*(1): 1–23.

IPCC (Intergovernmental Panel on Climate Change). (2007). *Impacts, adaptation, and vulnerability*. Fourth Assessment Report. Cambridge, UK: Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change). (2014). *Impacts, adaptation, and vulnerability*. Fifth Assessment Report. Cambridge, UK: Cambridge University Press.

ICO (International Coffee Organization). *Historical Data on the Global Coffee Trade*. Retrieved from: http://www.ico.org/new_historical.asp?section=Statistics

Kansiime, M. K. (2012). Community-based adaptation for improved rural livelihoods: A case study in eastern Uganda. *Climate and Development 4*:4, 275–287.

Kwapong, N. A., & Korugyendo, P.L. (2010). *Revival of agricultural cooperatives in Uganda*. International Food Policy Research Institute, Washington, D.C.

Lal, R., Singh, B. R., Mwaseba, D. L., Kraybill, D., Hansen, D. O., & Eik, L. O. (2015). *Sustainable intensification to advance food security and enhance climate resilience in Africa*. Heildelberg: Springer International Publishing.

Lasage, R., Aerts, J., Mutiso, G.-C. M., & de Vries, A. (2007). Potential for community-based adaptation to droughts: Sand dams in Kitui, Kenya. *Physics and Chemistry of the Earth 33*, 67–73.

Leopold, A., & Mead, L. (2009). Third international workshop on community-based adaptation to climate change. *Community Based Adaptation to Climate Change Bulletin 135*, 2.

Lin, B. B., Philpott, S. M., & Jha, S. (2015). The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps. *Basic and Applied Ecology 16*, 189–201.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P., & Naylor, R. L. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Science 319*, 607–610.

Low, J., Walker, T., & Hijmans, R. (2001). *The potential of orange-fleshed sweet potatoes on vitamin A intake in Sub-Saharan Africa*. Paper presented at regional workshop on food-based approaches to human nutritional deficiencies. Centro Internacional De La Papa, Nairobi, Kenya.

Lowicki-Zucca, M., Walugembe, P., Ogaba, T., & Langol, S. (2014). Savings groups as a socioeconomic strategy to improve protection of moderately and critically vulnerable children in Uganda. *Children and Youth Services Review 47*: 176–181.

Maalim, A. D. (2006). Participatory rural appraisal techniques in disenfranchised communities: A Kenyan case study. *International Nursing Review 53*: 178–188.

MacGregor, S. (2010). A stranger silence still: The need for feminist social research on climate change. *Sociological Review 57*, 124–140.

Maddison, D. (2007). *The perception of and adaptation to climate change in Africa*. World Bank Policy Research Working Papers. Center for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.

Magnan, A. K., Schipper, E.L.F., Burkett, M., Bharwani, S., Burton, I., Eriksen, S., Gemenne, F., Schaar, J., & Zievogel, G. (2016). Addressing the risk of maladaptation to climate change. *Climate Change 7*(5), 646–665.

Mansuri, G., & Rao, V. (2004). Community-based and –driven development: A critical review. *The World Bank Observer 19*(1), 1–39.

McCarthy, J., Canziani, O. F., Leary, N. A., Dokken, D. J., & White, C. (2001). Impacts, adaptation, and vulnerability. *Climate Change*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

Messerschmidt, D. (1991). Some advantages of having an outsider on the team. RRA Notes. 12, 47–53. London: IIED.

Miller-Gavin, J., & Naeve, S. L. (2016). *United States soybean quality annual report 2016*. Chesterfield, MO: United States Soybean Export Council.

Mitchell, T., Tanner, T., & Lussier, K. (2007). '*We know what we need!' South Asian women speak out on climate change adaptation*. Action Aid International.

Mok, H., Williamson, V. G., Grove, J. R., Burry, K., Barker, S. F., & Hamilton, A. J. (2014). Strawberry fields forever? Urban agriculture in developed countries: A review. *Sustainable Development 34*, 21–43.

Molnar, A. (1989). *Community forestry: Rapid Rural Appraisal*. Food and Agriculture Organization. Rome.

Moore, F. C., & Lobell, D. B. (2014). The adaptation potential of European agriculture in response to climate change. *Nature Climate Change 4*, 610–614.

Morton, J.F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences of the United States of America*.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Science 107*(51): 22026–22031.

Moyo, D. (2009). *Dead aid: Why aid is not working and how there is a better way for Africa*. New York: Penguin Books.

Moyo, D. (2009). Foreword. In *Dead aid: Why aid is not working and how there is a better way for Africa* (p. ix). New York: Penguin Books.

Nyantakyi-Frimpong, H., & Benzer-Kerr, R. (2015). The relative importance of climate change in the context of multiple stressors in semi-arid Ghana. *Global Environmental Change 32*: 40–56.

Nyong, A., Adesina, F., & Osman Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change 12,* 787–797.

O'Brien, K. (2009). Do values subjectively define the limits to climate change adaptation? In *Adapting to climate change: Thresholds, values, governance* (pp. 164–180). Cambridge, MA: Cambridge University Press.

O'Brien, K. L., & Leichenko, R. M. (2003). Winners and losers in the context of global change. *Annals of the Association of American Geographers 93*:1, 89–103.

O'Brien, K. L., & Wolfe, J. (2010). A values-based approach to vulnerability and adaptation to climate change. *Climate Change 1*(2), 232–242.

Okonya, J. S., Syndikus, K., & Kroschel, J. (2013). Farmers' perception of and coping to climate change: Evidence from six agro-ecological zones of Uganda. *Journal of Agricultural Science* 5(8), 252–263.

Olazabal, M., Galarraga, I., Ford, J., Lesnikowski, A., & de Murieta, E.S. (2017). Towards successful adaptation: A checklist for the development of climate change adaptation plans. *BC3 Working Paper Series 2017-01*. Basque Centre for Climate Change (BC3). Leioa, Spain.

Orlove, B., Roncoli, C., & Kabugo, M. (2010). Indigenous climate knowledge in southern Uganda: The multiple components of a dynamic regional system. *Climate Change 100:* 243–265.

Osbahr, H., Dorward, P., Stern, R., & Cooper, S. (2011). Supporting agricultural innovation in Uganda to respond to climate risk: Linking climate change and variability with farmer perceptions. *Agricultural Innovation and Climate Risk 47*: 293–316.

OXFAM (Oxford Committee for Famine Relief). (2008). *Turning up the heat: Climate change and poverty in Uganda*. UK: Oxfam House.

OIES (Oxford Institute for Energy Studies). (2015). *Oil in Uganda: Hard bargaining and complex politics in East Africa*. UK: University of Oxford.

Patz, J. A., Campbell-Lendrum, D., Holloway, T., & Foley, J. A. (2005). Impact of regional climate change on human health. *Nature 438*, 310–317.

Paustian, C., Sauerbeck, D., & Sampson, N. (1998). CO_2 mitigation by agriculture: An overview. *Climate Change 40*, 135–162.

Powlson, D. S., Stirling, C. M., Jat, M. L., Gerard, B. G., Palm, C. A., Sanchez, P. A., & Cassman, K. G. (2014). Limited potential of no-till agriculture for climate change mitigation. *Nature Climate Change 4*, 678–683.

Pretty, J. N., & Scoones, I. (1989). *Rapid rural appraisal for economics: Exploring incentives for tree management in Sudan*. IIED, London.

Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability 9*(1): 5–24.

Rama, I., & Lawrence, P. (2008). *Food miles–A critical evaluation*. *Connections Paper,* (29).

Rawlani, A. K., & Sovacool, B.K. (2011). Building responsiveness to climate change through community-based adaptation in Bangladesh. *Global Change 16*, 845–863.

Reid, H., & Huq, S. (2007). *Community-based adaptation: A vital approach to the threat climate change poses to the poor*. London, UK: International Institute for Environment and Development.

Rist, G. (2014). *The history of development: From western origins to global faith*. New York NY: Zed Books.

Rosenzweig, C., & Parry, M. L. (1994). Potential impact of climate change on world food supply. *Nature 367,* 133–138.

Rosenzweig, C., & Tubiello, N. T. (2007). Adaptation and mitigation strategies in agriculture: An analysis of potential synergies. *NASA Publications 25*.

Salick, J. (2009). Traditional peoples and climate change. *Global Environmental Change 19*, 137–139.

Saxena, N. C. (1998). What is meant by people's participation? *Journal of Rural Development 17*(1), 111–113.

Scoones, I., & McCracken, J. (1989). *Participatory Rapid Rural Appraisal in Wollo: Peasant association planning for natural resource management*. IIE, London.

Sherman, M., Berrang-Ford, L., Lwasa, S., Ford, J., Namanya, A. Llanos-Cuentas, Maillet, M., & Harper, S. (2016). Drawing the line between adaptation and development: A systematic literature review of planned adaptation in developing countries. *Climate Change 7*, 707–726.

Shiferaw, B., & Holden, S. (1998). Resource degradation and adoption of land conservation techniques in the Ethiopian highlands: A case study in Andit Tid, North Shewa. *Agricultural Economics 18*, 233–247.

Short, S. (2006). Focus group interviews. In E. Perecman & S. Curran (Eds.), A handbook for social science field research (pp. 103–115). Thousand Oaks, CA: Sage Publications.

Smit, B., & Pilifosova, O. (2001). Adaptation to climate change in the context of sustainable development and equity. In J. J. McCarthy, O. Canziani, N. A. Leary, D. J. Dokken, & K. S. White (Eds.), *Climate change 2001: Impacts, adaptation and vulnerability* (pp. 877–912). IPCC Working Group II. Cambridge: Cambridge University Press.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change 16*: 282–292.

Smith, P. (2004). Carbon sequestration in croplands: The potential in Europe and the global context. *European Journal of Agronomy 20*(3), 229–236.

Smith, P., & Olesen, J. E. (2010). Synergies between the mitigation of, and adaptation to, climate change in agriculture. *The Journal of Agricultural Science 148*(5), 543–552.

Smithers, J., & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change 7*: 129–146.

Sommer, R., & Bossio, D. 2014. Dynamics and climate change mitigation potential of soil organic carbon sequestration. *Journal of Environmental Management 144*, 83–87.

Spires, M., Shackleton, S., & Cundill, G. (2014). Barriers to implementing planned community-based adaptation in developing countries: A systematic literature review. *Climate and Development 6*:3, 277–287.

Suarez, P., de Suarez, J. M., Koelle, B., & Boykoff, M. (2012). Serious fun: Scaling up community-based adaptation through experiential learning. In *Community-based adaptation to climate change: Scaling it up* (pp. 136-151). New York: Routledge.

Tandon, Y. (2008). *Ending Aid Dependence*. Oxford: Fahamu.

Tompkins, E. L., Adger, W. N., Boyd, E., Nicholson-Cole, S., Weatherhead, K., & Arnell, N. (2010). Observed adaptation to climate change: UK evidence of transition to a well-adapting society. *Global Environmental Change 20*, 267–235.

Tornaghi, C. (2014). Critical geography of urban agriculture. *Progress in Human Geography 38*(4), 551–567.

UBS (Uganda Bureau of Statistics). (2014). *National population and housing census*. Republic of Uganda, Kampala.

UNFCCC (United Nations Framework Convention on Climate Change). (1992). United Nations Framework Convention on Climate Change. Geneva: World Meteorological Organization and United Nations Environment Program.

UNFCCC (United Nations Framework Convention on Climate Change). 2009. *Least developed countries*. Germany: UNFCCC.

USAID. *Fistula repair outreach at Hoima Regional Hospital*. Retrieved from: https://fistulacare.org/country-stories/hoima-outreach/

Vadjunec, J. M., Radel, C., & Turner II, B. L. (2016). Introduction: The continued importance of smallholders today. *Land 5*(34) 1–12.

Van Aalst, M. K. (2006). The impacts of climate change on the risk of natural disasters. *Disasters 30*(1), 5–18.

Walthall, C. L., Anderson, C. J., Baumgard, L. H., Takle, E., & Wright-Morton, L. (2013). Climate change and agriculture in the United States: Effects and adaptation. *Geological and Atmospheric Sciences 1*.

Wandiga, S. O., Opondo, M., Olago, D., Githeko, A., Githui, F., Marshall, M., Downs, T., Opere, A., Oludhe, C., Ouma, G. O., Yanda, P. Z., Kangalawe, R., Kabumbuli, R., Kathuri, J., Apindi, E., Olaka, L., Ogalla, L., Mugambi, P., Sigalla, R., Nanyunja, R., Baguma, T., & Achola, P. (2010). Vulnerability to epidemic malaria in the highlands of Lake Victoria basin: The role of climate change/variability, hydrology and socio-economic factors. *Climatic Change 99*: 473–487.

Warner, K., Ehrhart, C., Sherbinin, A., Adamo, S., & Chai-Onn, T. (2009). *In search of shelter: Mapping the effects of climate change on human migration and displacement*. London, UK: Climate Change CARE International.

Whyte, W. (1989). Advancing scientific knowledge through participatory action research. *Sociological Forum 4*(3): 367–385.

Zimmerer, K. S., & Vanek, S.J. (2016). Toward the integrated framework analysis of linkages among agrobiodiversity, livelihood diversification, ecological systems, and sustainability amid global change. *Land 5*(10).

APPENDICES

APPENDIX A

BACKGROUND OF PEACE CORPS SERVICE IN UGANDA

In June of 2015 I began my two years of service in Uganda as a Peace Corps Volunteer (PCV) after completing two semesters of course work in Utah State University's Master's International (PCMI) program. I was assigned to the Community Agribusiness Project, which aimed to build community capacity to address food security vulnerabilities while creating sustainable livelihoods and growing vibrant economies as part of the United States Agency for International Development (USAID) Feed the Future initiative. Consequently, my first three months in Uganda were spent receiving technical training in tropical agriculture and small-scale business development. Additionally, I was trained in speaking Runyoro, the language of the Bunyoro Kingdom and tribe of western Uganda where I was assigned to work.

More specifically, I was stationed in the district of Hoima near Lake Albert and the border of the Democratic Republic of Congo. I was partnered with the local non-profit NGO Environmental Conservation and Agricultural Enhancement Uganda (Eco-Agric). As a PCV, my aim was to integrate into my community as well as possible while gaining knowledge and expertise in local customs. This allowed me to best work with Eco-Agric and other local partners to support rural communities in a wide-ranging variety of training in agriculture, entrepreneurship, health, environmental conservation, and youth empowerment.

For example, I worked with farmers to sustainably intensify their crop yields by developing permagardens that incorporated agroforestry methods and promoted the

growth of nutritious vegetables. I assisted in establishing village saving and loan associations (VSLAs), which created a previously nonexistent outlet to save and invest finances. I worked with youth groups and discussed the prevention of HIV/AIDS, malaria, and other infectious diseases. I worked in schools and taught students and teachers how to make reusable menstrual pads (RUMPs) as an affordable alternative to store-bought sanitary pads to promote school attendance and self-empowerment of girls.

These are just a few examples of projects I conducted that allowed me to witness and better understand the many challenges present in the communities I worked. Without these experiences, I could not hope to conduct my own research in a fair and comprehensive way. Furthermore, and more importantly, these projects allowed me to build relationships and trust among the local stakeholders with whom I worked, lived, and interacted with on a daily basis.

Simple activities like spending time digging in fields with my neighbors, sharing meals, attending community meetings, playing in local football matches, and speaking as much of the local language as I could greatly increased my credibility among the local people. Despite many setbacks and barriers, my experience, credibility, and my overall knowledge gained as a researcher in a foreign country was undoubtedly improved by the fact I was also a PCV.

APPENDIX B

DESCRIPTION OF PEACE CORPS VOLUNTEER SERVICE FOR TOM DERR,

COMMUNITY AGRIBUSINESS PROJECT – PEACE CORPS UGANDA

After a competitive application process stressing applicant skills, adaptability, and cross-cultural understanding, Tom Derr was invited into Peace Corps Service. As part of the language and cross-cultural component of the training program, Mr. Derr lived with a Ugandan family in Kyenjojo for approximately 4 weeks and was made to feel welcome and at home. This home stay assisted Mr. Derr in adapting to the Ugandan culture and acquiring local language abilities, thus facilitating the transition into his two-year site assignment.

Tom began Peace Corps training on June 3, 2015 at the training site in Mukono District, Uganda, where he completed an intensive ten-week training program encompassing the following subject areas:

CULTURE: The cultural training component focused on politics, geography, history, cultural values, social norms, and community economic development including agribusiness (42 hours).

TECHNICAL: Technical training focused on the Ugandan economy, agricultural best practices, food security, financial services, enterprise development services, value chain analysis, Village Savings and Loan Associations (VSLAs), value addition, post-harvest handling, and permagardening. (105 hours).

LANGUAGE: The language component of training was comprised of an intensive study of the Runyoro language, centering on practical application through various community simulations. The ACTFL exam for Runyoro was passed with a score of Intermediate Low (129 hours).

HEALTH & SAFETY: The health and safety training consisted of first aid, tropical medicine, preventative medicine, stress management, personal safety issues, and road safety (35 hours).

Mr. Derr entered into Peace Corps service on August 13, 2015 and was assigned to the nonprofit organization Environmental Conservation Agricultural Enhancement Uganda (Eco-Agric Uganda) based in Hoima Town in western Uganda as an Agriculture and Environment advisor. The initial three months of his service in Hoima were spent as an integration and community assessment period, whereby Mr. Derr worked to identify potential development partners in the community. During this time, he focused on meeting with local organizations in the community, working at the Eco-Agric office,

observing operations in the different departments, participating in all prior-scheduled activities and field work, and becoming familiar with community members. Mr. Derr also forged relationships with local farmer groups, women's groups, and several primary schools. Mr. Derr's specific activities completed during his service included the following:

Project Development and Organization Support:

- Advised the Lead Program Manager of Eco-Agric on grant writing, project development, design, and implementation.
- Operated as a Field Change Agent alongside Eco-Agric staff to advise and train rural farmers in agriculture, livelihood development, entrepreneurship skills, health, and other topics. Advised over 200 individuals in this setting.
- Established demonstration sites promoting different permagardening methods and the use of improved agricultural technologies.
- Trained 20 Eco-Agric staff on Participatory Analysis for Community Action (PACA) methods.
- Supported the construction of volunteer accommodation using sustainable natural building methods.

Agribusiness and Environmental Projects and Trainings:

- Obtained a Peace Corps Partnership Program grant ($2,000) through the World Wildlife Fund Climate Crowd program in response to a community site analysis identifying poor water resources as the primary challenge within a rural village. In response to this, funds were used to repair and construct four fully protected water sources, providing clean water to over 200 households.
- Trained three farmer groups totaling 60 people in improved agriculture methods and financial management.
- Trained three youth groups totaling 50 people in improved agriculture methods and life skills.
- Worked with two primary schools to initiate gardening and health clubs.

Specialized Workshops:

- Obtained a Water Hygiene and Sanitation grant ($1,435) to develop and implement Camp BLUE (Building Leaders Understanding of the Environment) that trained 35 youth, 50 of their parents, and 8 teachers in improved agriculture, health, and leadership skills.
- Trained 150 university students in climate change communication at the Makerere University Center for Climate Change Research and Innovation (MUCCRI) Climate Change Boot Camps in 2016 and 2017.
- Trained 30 students from St. Lawrence University in climate smart agriculture and paermagardening during a 3-day field training.
- Participated in a 5-day Youth Technical Training organized by Peace Corps Uganda.

- Organized a DEAR Day (Drop Everything and Read) event at two primary schools that promoted the importance of literacy among 250 youth.

Leadership in Peace Corps:

- Served as the Chair of the Conservation Think Tank:
  - Worked as a lead organizer and facilitator during a 5-day Conservation Camp 2016, which trained 50 youth and 10 teachers in good environmental practices.
  - Organized and implemented a country-wide Environmental Awareness Month.
  - Mobilized members and initiated a Ugandan Chapter for the Society of Conservation Biology.
  - Lead to promotion of the World Wildlife Fund Climate Crowd partnership.
  - Organized an office greening program at the Peace Corps Uganda Head Office in Kampala.

Mr. Derr successfully completed his service on August 13, 2017.

This is to certify in accordance with Executive Order 11103 of April 10, 1963, that Thomas Derr served successfully as a Peace Corps Volunteer. He is therefore eligible to be appointed as a career-conditional employee in the competitive civil service on a non-competitive basis. This benefit under the Executive Order extends for a period of one year after termination of Volunteer service, except that the employing agency may extend the period for up to three years for a former Volunteer who enters military service, pursues studies at a recognized institution of higher learning, or engages in other activities that, in the view of the appointing agency, warrant extension of the period.

Pursuant to section 5(f) of the Peace Corps Act, 22 USC 2504(f), as amended, any former Volunteer employed by the United States Government following his Peace Corps Volunteer service is entitled to have any period of satisfactory Peace Corps Volunteer service credited for purposes of retirement, seniority, reduction in force, leave, and other privileges based on length of Government service. Peace Corps service shall not be credited toward completion of the probationary or trial period or completion of any service requirement for career appointment.

APPENDIX C

CLIMATE CHANGE AND THE ROLE OF AGRICULTURE IN ADAPTATION AND MITIGATION

The theory that there will be winners and losers in the many aspects of climate change (i.e., economics, biology, globalization, energy, etc.) is not new (O'Brien & Leichenko, 2003). Undoubtedly, some systems and people will flourish while others struggle under new climate regimes. This remains true with regards to agricultural production. Models show that developed countries in the Global North will likely be able to produce more food as temperatures rise (IPCC, 2007). Alternatively, the Global South, where food is needed the most to keep pace with large and growing populations, will struggle (IPCC, 2007). How different regions respond to changes in their respective agricultural systems will be critical to the overall success or failure of people to sustain themselves.

Article 4.1b of the United Nations Framework Convention on Climate Change (UNFCCC) states that parties are "committed to formulate national and, where appropriate, regional programs containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change" (UNFCCC, 1992). This holds true for responses to climate change in the agricultural sector where people will be faced with the dual task of reducing greenhouse gas emissions while having to cope with an already changing climate (Rosenzweig & Tubiello, 2007). The following text therefore explores the role of agriculture mitigation and adaptation in response to climate

change. These themes will be analyzed in the context of both developed and developing regions to highlight key similarities and differences.

Agricultural Mitigation

Agricultural mitigation of climate change is an extremely complex topic that is highly debated in the scientific community. This section draws heavily from the IPCC's (2007) AR4 chapter on agriculture and its AR5 chapter on agriculture, forestry, and other land use (AFOLU) activities as a generally accepted basis for the topic. Supplemental literature is used to provide supporting or alternative viewpoints when necessary.

The IPCC (2007) defines mitigation of climate change as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)." Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the three main greenhouse gases emitted from agricultural activities. Carbon dioxideemissions are released during the burning of organic matter and the destruction of carbon sinks, though these impacts are negligible because of natural carbon reabsorption in soil and forests. Furthermore, carbon dioxide emissions from farming machinery like tractors and irrigation systems are usually categorized in the energy sector and therefore not considered to be emissions from agriculture. Methane is released when organic matter is decomposed in oxygen deprived conditions, most commonly from fermentative digestion by ruminant livestock and during the production of rice under flooded conditions. Nitrous oxide is released when available nitrogen exceeds plant requirements, which is common during the use of fertilizers (IPCC, 2007).

Agriculture alone directly accounts for 47% of total CH_4 emissions and 58% of total N_2O emissions making up 10–12% of all anthropogenic greenhouse gas emissions. Comparatively, CO_2 emissions directly from agricultural activities are considered to be neutral because of annual cycles of carbon fixation and oxidation through photosynthesis. Carbon sinks in soil and forests are therefore most useful when absorbing CO_2 emissions from other sectors (IPCC, 2007).

Agriculture, forestry, and other land-use (AFOLU) activities are considered as a separate stand-alone category by the IPCC to convey the total combined emissions of these sub categories. The AFOLU sector is unique in that it considers the direct mitigation potential of agriculture (i.e., manure application, enteric fermentative, rice cultivation, etc.) in combination with the mitigation potential of the land itself via ecosystem services like carbon sinks. The AFOLU activities are reported to account for nearly a quarter (24%) of all anthropogenic GHG emissions. Emissions from forestry and other land use (FOLU) activities mostly focus on net gains and losses from changes in land use patterns like deforestation and regrowth or the abandonment of croplands.

Older literature has claimed that GHG mitigation in agriculture should be focused around strategies to maintain and increase carbon stocks in soil [e.g., soil organic carbon (SOC) sequestration] through practices like zero-till farming, restoration of degraded lands, and the establishment of permanent “set-asides” of surplus farmland (Paustian, Sauerbeck, & Sampson, 1998). More recent literature, however, elaborates upon the shortcomings of SOC sequestration as a mitigation tactic (Powlson et al., 2014). Points include that SOC sinks are limited by the amount of carbon they can accumulate over time, leveling out as they reach a certain equilibrium, making them time-limited (Sommer

& Bossio, 2014). Additionally, changes in soil carbon can be difficult to measure, meaning that verifiability of success or failure is challenging (Smith, 2004). Even if SOC sequestration could be implemented and measured effectively, its net gains in the agriculture sector would be insignificant since carbon emissions from land-use change in the tropics is absorbed by regrowth in the middle and high latitudes through the global carbon cycle. At best, SOC sequestration practices can be most appropriately used as an adaptation strategy to improve soil quality.

Regional differences in total emission output and type vary significantly in terms of sources based on economics, resources, and culture. For example, 82% of CH_4 emissions specifically from rice production occur mostly in South and East Asia where it is a major food source (IPCC, 2007). Emissions from biomass burning occur mostly in Sub-Saharan Africa, Latin America, and the Caribbean where deforestation commonly occurs during the creation of new farmland (IPCC, 2007). Conversion of lands into cropland and pasture is happening rapidly in the developing world to meet the livelihood needs of small-scale farmers. Overall, developing countries were responsible for 74% of total agricultural emissions in 2005 (IPCC, 2007). More so, this number is expected to rise as global demand for food increases and diets shift. Nitrous oxide emissions from increased nitrogen fertilizer and manure production are projected to increase 35-60% by 2030 to meet this demand (IPCC, 2007). Additionally, global CH_4 emissions may increase by 60% by 2030 as global demand for livestock increases (IPCC, 2007).

Developed countries, in comparison, are reducing or leveling off their overall emissions from agriculture due to a number of mostly socioeconomic reasons. In Western Europe specifically, emissions are declining primarily because of the climate and

environmental policies of the European Union (IPCC, 2007). In the U.S., farming is not as economically feasible at small scales as it once was and, as a result, fewer farmers are working less land. Additionally, conservation policies throughout the developed world have preserved lands that may have otherwise been cleared. In Australia, for example, land clearing has declined by 60% since 1990 (IPCC, 2007). In the U.S., 500,000 ha of farmland are converted away from agriculture annually, though much of this is for housing and industrial development, which could contribute more to climate change (Francis et al., 2012).

Mitigating emissions in agriculture can be broadly broken down into three categories (IPCC, 2007). The most obvious and most effective tactic is to reduce emissions through better management practices. There are many of these practices to consider, and they focus primarily on using inputs more efficiently to reduce N_2O and CH_4 emissions. Secondly, enhancing carbon reserves can increase photosynthetic input of carbon (primarily from other sectors) and slow the return of stored carbon to CO_2 through respiration. As previously discussed, the net benefits of this tactic are ambiguous and debated, but there is still not significant evidence to discredit it. Lastly, crops and residue from agricultural lands can be converted into fuel sources like ethanol that still emit CO_2 when burned, but of recent atmospheric origin that can be reabsorbed more rapidly.

To be sure, most mitigation practices can be applied to farming systems everywhere, but some may be more efficient or suitable than others, depending on the region. For the purposes of this review, mitigation tactics will be analyzed for the developed world and the developing world.

Mitigation in the developed world

The potential for mitigating emissions from agriculture in the developed world is limited compared to the developing world. This is most notably due to a decline in overall agriculture production for various sociopolitical reasons. Nonetheless, there are still certain farming practices that can be altered to significantly reduce emissions. Furthermore, while potential may be relatively low, the capacity the developed world has for mitigating emissions from agriculture through technological innovations and resources is very high (IPCC, 2007).

The greatest driving force behind agricultural mitigation in the developed world may be the strong obligation to meet climate change commitments as part of national and international policies. In Europe, specifically, there has been a major shift to sustainable agriculture practices as part of the European Union's Common Agricultural Policies (CAP), which accounts for half of the EU's total budget. The CAP has promoted a rapid modernization of European agriculture through more sustainable practices that have reduced emissions while also intensifying production (European Environment Agency, 2015). This sustainable intensification of European agriculture has occurred mostly in its northern and western regions, where climate change will actually benefit agricultural production, while in Mediterranean and southeastern Europe there has been an abandonment of farming lands (Bindi & Olesen, 2011). This regional division of agricultural production in Europe caused by climate change is possible because the CAP promotes even food distribution throughout all EU nations.

Overall, within the agricultural sector of the developed world, emissions of N_2O from the soil are estimated to be the highest (Franzluebbers & Follett, 2005). In the U.S.

alone, corn and soybean production systems were estimated to emit the greatest amount of N_2O compared to all other major cropping systems (Franzluebbers & Follett, 2005). It is therefore estimated that conservation-tillage practices implemented on the approximately 94 million acres of land dedicated to corn production and 83 million acres of land dedicated to soybean production in the U.S. in 2016 would significantly reduce N_2O emissions with the use of improved nitrogen fertilizer management (Miller-Gavin & Naeve, 2016).

Methane emissions from the production of ruminant livestock in the developed world are also significant, meaning that the technical reduction potential for enteric CH_4 emissions is high (IPCC, 2007). Improved feeding practices, like replacing roughage with high-energy concentrates and adding extra dietary oil, will result in the highest possible reduction of emissions from enteric fermentation. Additionally, improved breeding practices and long-term management of ruminants will reduce CH_4 emissions.

Overall, reductions in N_2O and CH_4through improved management practices hold the greatest potential for mitigating climate change within the agriculture sector of the developed world (IPCC, 2007). Combined with the use of technological innovations and a shift to more sustainable practices in all aspects of production, agriculture in the developed world can have an impactful role in mitigating climate change.

Mitigation in the developing world

Emissions from agriculture in the developing world are far greater than in the developed world, and they are expected to rise as populations increase and diets shift. As far back as 2005, developing regions were responsible for 74% of all agricultural

emissions (IPCC, 2007). This is logical given that the majority of people in developing regions depend on agriculture as their primary livelihood. If improved management practices could be implemented, the immediate and future mitigation potential would be tremendous.

Unfortunately, the main challenge for the developing world is a lack of capacity to implement mitigation practices, especially when eliminating food insecurity and poverty take precedence over reducing GHG emissions. Consequently, mitigation tactics in the developing world must have the added benefit of improving livelihoods, and barriers to adoption must be low (Hickman, Scholes, Rosenstock, Garcia-Pando, & Nyamangara, 2014). It should be noted that many of the mitigation practices discussed in this context could also be considered adaptation practices.

Arguably, the most feasible way for developing regions to mitigate climate change is through a wide variety of improved management practices that fall under the umbrella term of sustainable intensification, defined as "producing more output from the same area of land while reducing the negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services" (Pretty, Toulmin, & Williams, 2011). While sustainable intensification practices are recognized mostly for their practicality in adaptation, they can also serve an important role in mitigation. They are useful in mitigation for reducing the amount of land needed for agriculture, therefore increasing the amount of land that can be set aside for SOC sequestration. This is critical in a developing world context where from 1961 to 2002 there was a 19% increase in lands converted for agricultural purposes (IPCC, 2007).

Additionally, certain sustainable intensification practices have the potential to significantly reduce emissions in the developing world. Some of the more notable practices are listed here (IPCC, 2007; Lal et al., 2015):

- Agroforestry: The production of crops or livestock on land that also grows trees, therefore enhancing carbon sequestration and improving soil quality through reduced erosion, improved water-holding capacity, and added carbon from leaf litter.
- Tillage management: Reduced or no-till agriculture can increase carbon holding and absorption capacity in soil. It also has the potential to reduce N_2O emissions.
- Crop variety and system improvements: These include using improved crop varieties, extending crop rotations, and avoiding the use of fallow lands, all to increase soil carbon storage and generate higher yields.
- Nutrient management: Nitrogen in fertilizers and manure is not always used efficiently when applied to crops and can lead to emissions of N_2O. Adjusting nitrogen application rates through improved timing and placement allows crops to use it more efficiently and prevent unnecessary emissions.

A wide variety of sustainable intensification practices need to be considered for every unique farming system since there is no single path to success. Rather, multiple options exist for every system, and the proper choices must be made for site-specific biophysical, economic, and social conditions (Lal et al., 2015).

Another promising mitigation tactic for developing regions is to focus efforts on reducing demand through the prevention of food production losses. Unlike developed regions, where approximately 40% of food loss occurs at the retail and consumer level

(Gustavsson, Cederberg, Sonesson, van Otterdijk, & Maybeck 2011), developing regions lose a large amount of their crop production at the harvesting and post-harvest handling stages. This is mostly due to avoidable poor harvesting practices that ultimately result in an unnecessary need for more crop production (Bajzelj et al., 2014). Estimates from one study in Sub-Saharan Africa show that a 25% reduction in post-production losses could lead to a 10% decrease in emissions (Hickman et al., 2014). Investigators have also claimed that a reversion to traditional or indigenous farming systems, which often have many similarities to sustainably intensified systems, can lead to reduced emissions because of less reliance on high energy inputs like pesticides and fertilizers (Altieri & Nicholls, 2017).

Agricultural adaptation

Agriculture and food production are among the most frequently cited human systems to be impacted by climate change and will hold a significant position in dictating human response to climate change. There is no doubt that other human systems will also be substantially impacted, such as health (Haines & Patz, 2004; Patz, Campbell-Lendrum, Holloway, & Foley, 2005), natural disaster prevalence (Van Aalst, 2006), and human migration (Warner et al., 2009) to name a few. But of all the different interconnected components influenced by climate change, it cannot be ignored that the success or failure of agricultural systems to produce food will carry considerable weight when determining the future prosperity of humans in certain global regions (Lobell et al., 2008; Rosenzweig & Parry, 1994). Considering under even the most optimistic

mitigation estimates that there will be irreversible changes in the climate, adaptation is essential.

The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects," which "seeks to moderate or avoid harm or exploit beneficial opportunities" in human systems (IPCC, 2014). Adaptation therefore involves reducing vulnerability, otherwise known as a system's "propensity or predisposition to be adversely affected" while simultaneously seeking to build the capacity of nations, regions, cities, communities, or individuals to cope with climate impacts.

As can be expected, the list of adaptation options is virtually endless (IPCC, 2007). There are three generalized categories that adaptation options fit into. Structural/physical adaptations are perhaps the most common, specifically in the agricultural sector due to their focus on clear and direct outcomes from locally or individually implemented efforts. Social adaptation options focus on the use of education and information to influence behavior. It is of particular relevance to this research, which heavily relies on community-based adaptation, a major social adaptation option. Lastly are institutional adaptation options, implemented from the top-down through laws, regulations, policies, and programs.

Adaptations can be distinguished further as either reactive or proactive. Those that are reactive are in a direct response to a certain climate stimulus while those that are proactive are planned responses to an expected climate stimulus. Proactive adaptations are usually more successful and sustainable than reactive adaptations, which focus more on short-term benefits that may ultimately prove to be maladaptive by causing unintended negative consequences. Generally, vulnerable communities tend more towards reactive

adaptations, which have a greater potential to become maladaptive and further exacerbate vulnerability (Magnan et al., 2016).

Agriculture adaptation efforts will ultimately be dependent on many different factors, including the specific climate-change impacts felt, which vary significantly by region. Perhaps most apparent will be the stark contrast in impacts experienced in high latitude temperate regions where changes in the climate may have a net positive effect on agriculture, compared to the tropics where agricultural systems are already struggling to cope with changes. Furthermore, socioeconomic factors will play an integral part in determining agricultural adaptation efforts from the national down to the individual level. These topics will be explored further in a developed and developing world context.

Adaptation in the developed world

Agriculture in the developed world has demonstrated extraordinary adaptive capacity with production systems expanding and thriving across many different environmental conditions. This is being challenged by the onset of more pronounced climate change impacts, increasing the uncertainty of what future management and production will look like. Furthermore, despite the common presence of high adaptive capacity, successful adaptation to climate change in the developed world is not guaranteed (Walthall, Anderson, Baumgard, Takle, & Wright-Morton, 2013). In Europe, for example, estimates show that total yields could increase by 1.5% with successfully implemented adaptation measures but could decline 2.3% without adaptation (Moore & Lobell, 2014).

This suggests that the greatest barriers to agricultural adaptation in developed regions may be human-imposed constraints such as social values and culture, opposed to physical, biological, or economic constraints commonly seen in the developing world. Supporting this theory is a large body of literature demonstrating that social values can significantly limit adaptation (Adger et al., 2009; Moser & Ekstrom, 2010; O'Brien, 2009; O'Brien & Wolf, 2010). For example, Walthall et al. (2013) find that the modern agricultural economy forces farmers to make decisions that are logical for the development of their business instead of the betterment of the natural resources they depend on such as soil and water. Additionally, croplands are often leased on short-term contracts, so farmers lack incentives for implementing conservation agriculture management practices (Walthall et al., 2013).

Encouraging farmers to change their management practices through increased technical assistance, awareness raising, and education may prove to be the best way to overcome social barriers to agricultural adaptation in the developed world (Walthall et al., 2013). Certain programs like, for example, the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP) funded by the United States Department of Agriculture (USDA) promote and incentivize agricultural adaptation to climate change (Duffy, 2015; USDA, 2016).

These programs apply to the large-scale farming systems that dominate rural areas of developed regions. Farming systems in the developed world, though, can no longer be defined solely by these systems. There has been a recent boom promoting the development of small-scale farming in cities across the Global North. This has become known as urban agriculture, broadly defined as "food cultivation and animal husbandry

on urban and peri-urban land" (Tornaghi, 2014). As large-scale rural farming in the developed world become less feasible and attractive from an economic and livelihood perspective, urban agriculture has responded to fill this gap and help meet the demand for locally grown food.

Characterized by small, intensively managed plots, urban agriculture is much more sustainable than large-scale rural farm systems and consequently represents a major agricultural adaptation in the developed world. For example, urban agriculture promotes greater biodiversity and enhanced ecosystem services in cities and peri-urban areas while improving food security (Lin, Philpott, & Jha, 2015). There are significant costs and constraints associated with implementing urban agriculture, but if overcome it may ultimately have a legitimate role in resolving global food production challenges (Mok et al., 2014).

Adaptation in the developing world

Agriculture in the developing world is dominated by small-scale farmers who depend on the productivity of the land for their livelihoods. Furthermore, the majority of these farmers are disadvantaged or vulnerable in some way, greatly adding to the complexity of adopting adaptation measures. For example, farmers are often restricted by a lack of resources, insufficient information, or degraded agro-production systems that make taking on adaptation strategies infeasible. In other words, altering a system to adapt is a risk that will only be taken proactively if it is feasible and has a promising end result, or reactively as a forced last resort, usually in an ad hoc manner. Reactive adaptations are

therefore more common in the developing world than proactive adaptations, which are almost always a better option for creating sustainable livelihoods.

Community-based adaptation (CBA) has emerged in the developmental sector as a key tool to use with vulnerable groups in order to promote sustainable livelihoods through proactive adaptation. The IPCC refers to CBA as "the generation and implementation of locally driven adaptation strategies, operating on a learning-by-doing, bottom-up, empowerment paradigm that cuts across sectors and technological, social, and institutional processes" (IPCC, 2014). Numerous case studies have yielded positive results when using CBA in developing agricultural communities (Adhikari & Taylor, 2012; Dumaru, 2010; Kansiime, 2012; Lasage, Aerts, Mutiso, & de Vries, 2007; Rawlani & Sovacool, 2011). Despite these promising results, CBA is a relatively new field and there have been significant barriers to its implementation that must be taken into consideration. For example, a literature review by Spires, Shackleton, and Cundill (2014) indicate that poor coordination between implementing organizations and stakeholders, as well as a lack of information on climate change, hinder CBA the most.

Other literature has suggested that adaptation strategies that focus heavily on traditional or indigenous knowledge can be very useful among developing agricultural communities (Chowdhury and Moore, 2017; Nyong et al., 2007; Orlove et al., 2010. This is logical given that people have been naturally adapting to changes throughout history, though without as much urgency as is necessary today. Despite this, indigenous knowledge is often ignored or overlooked when designing modern adaptation strategies. Salick and Ross (2009) therefore strongly suggest that indigenous people should be included as primary actors in terms of responding and developing solutions to global

change. Additionally, the reversion to traditional management systems, in combination with modern agroecologically based management strategies, has been suggested to be one of the most viable pathways for adaptation for vulnerable farmers (Altieri & Nicholls, 2013).

It must be noted that agricultural adaptation efforts in the developing world are not limited to the local level only. There have been compelling efforts made by the governments of developing nations to promote top-down adaptation. The most apparent form of these efforts are the National Adaptation Programs of Action (NAPA) for the Least Developed Countries (LDCs), first mandated at the UNFCCC Marrakech Accords of 2001. The NAPAs were a logical response to the limited capacity of LDCs to adapt to climate change and, despite their top-down approach, they generally focus heavily on local level bottom-up solutions. Unfortunately, the main challenge for NAPAs has been an inability to implement the programs they propose due to a lack of funding (Abeysinghe et al., 2017).

Ultimately, whether implemented locally or nationally, agricultural adaptation efforts in the developing world focus heavily on physical changes in farming systems to sustainably intensify production. Sustainable intensification (previously discussed in the section on agricultural mitigation in the developing world) is perhaps best known for its application as an adaptation tactic for small-scale farming systems. It draws heavily from a wide range of horticulture and permaculture practices like crop improvements, agroforestry, conservation agriculture, integrated pest management, aquaculture, soil conservation, and many others. An analysis by Pretty et al. (2011) of forty case studies across Africa where sustainable intensification practices were implemented revealed an

average 2.13-fold increase in crop yields as well as an overall improvement in agricultural diversification. As a result, these systems and the farmers who created them are less vulnerable to shocks and stresses caused by climate change or socioeconomic shortcomings (Pretty et al., 2011).

As stated previously in the section on mitigation in the developing world, there is no single cure-all solution or panacea among the many sustainable intensification practices. This holds true for adaptation, as sustainable intensification practitioners must pursue multiple pathways to develop the most appropriate site-specific solutions for their cause (Lal et al., 2015).

Synergies between agricultural mitigation and adaptation

There is a high potential for synergy between mitigation of and adaptation to climate change within agriculture (Smith & Olesen, 2010). For example, most agricultural adaptation methods help to reduce CH_4 or N_2O emissions or improve the capacity of soil carbon sinks (Rosenzweig & Tubiello, 2007; Smith & Olesen, 2010). Nearly all sustainable intensification practices, used most commonly as farming adaptations in developing regions, have tangible benefits for mitigation (Lal et al., 2015). These include measures that reduce soil erosion and leaching, promote crop diversification, reduce the total land needed for agriculture, promote agroforestry, and many other practices. Urban agriculture, in addition to relying heavily on sustainable practices, may contribute to mitigation efforts by reducing high food miles that are normally associated with crop transportation, though the net benefits of this are still contested (Blanke & Burdick, 2005; Rama & Lawrence, 2008).

Production systems that integrate adaptation and mitigation together will allow agriculture to reach its full potential within the context of climate change. The most optimal systems will therefore be those that maintain or increase the resiliency of production systems while also reducing GHG emissions and sequestering carbon (Rosenzwieg & Tubiello, 2007). Synergies may not be possible everywhere though, due to restricting socioeconomic factors present in certain regions (Rosenzwieg & Tubiello, 2007). Adaptation, for example, will likely take precedent over mitigation strategies in developing regions. Nonetheless, programs are needed to encourage synergies to allow agriculture to thrive in a rapidly changing system.

APPENDIX D

COPY OF LOI

Letter of Information

Climate Change Perceptions and Adaptation Among Small-Scale Farmers in Hoima District, Uganda: A Community-Based Participatory Approach

Agricultural and Climate Research in Hoima District

Environmental Conservation and Agricultural Enhancement Uganda (Eco-Agric) in partnership with the United State Peace Corps and Utah State University are studying problems that small-scale farmers face in response to climate change. We are requesting your participation in this project.

Project Summary and Procedures

This project aims to collect qualitative data at the local level to empower communities to develop their own adaptive solutions to climate change. To do this, community members from rural and peri-urban villages will be asked to participate in activities that identify their true problems and needs related to climate change and agriculture. Using this information, participants will decide which problems they want to try to overcome and then create and implement a community action plan (CAP) based around solutions to those problems.

We will assist participating communities through this process by guiding them in activities such as focus groups and interviews, helping them to draft community action plans, and by helping to implement those plans. If necessary, resources and funds to implement community action plans will be solicited for.

Project Duration and Time Requested from Participants

The facilitation team anticipates that five days will be needed to sufficiently analyze and identify community resources, needs, and problems. Community members are not expected to participate all five days. Rather, a large community meeting that all participants will be expected to attend will be held on the first day and on the fifth day for no more than two hours. On the days in between these meetings, the facilitation team will work with individual households and groups in the community.

After the initial five days, participating communities will be responsible for implementing their CAPs. How long it takes to fully implement a CAP will be dependent on many different factors. A CAP may take one month or several months to fully implement.

Potential Project Risks

We do not anticipate any major risks to your participation in this project. The most significant risks may involve disagreements that arise among community members during focus group meetings and other group activities. Such disagreements may cause some personal discomfort. In any of

these cases or others that are not stated, know that you may refuse to answer a question or not join a discussion without penalty or judgment from the facilitators.

Potential Project Benefits
The benefits to your participation in this project may result from the interventions that arise from the CAP. Be aware, however, that implementing the CAP may not be easy and positive effects are not certain to happen. Additionally though, through your participation in this project you will likely have a better understanding of the problems that face your community and how to overcome them. Ultimately, this project aims to benefit participants by empowering them to be their own self-advocates.

Privacy and Confidentiality
The methods of this project are a very public process and some activities may involve most of the community. When you speak in a focus group or meeting you are not anonymous, your words are not confidential, and you have decided to give up your privacy. What you say during the activities of this project may be judged by others, so it is your responsibility to be wise in what you say and how you say it. The facilitation team wants everyone to be comfortable in expressing his or her opinions. More voices are better than fewer voices.

Most importantly you never have an obligation to speak if a question causes you discomfort. Whether you speak in a community meeting, a focus group, or an interview, know that the facilitation team will never write down your name or associate your name with a comment. We are only interested in mixing all the information we obtain into one picture for the community. Furthermore, you can decline to answer any question in any of the activities if it makes you uncomfortable.

Lastly, any written records or notes resulting from the project activities will be kept until the end of this project on August 31, 2018. The written records will be used to publish information from the project, and summaries will also be provided to the participating communities. Records will be kept under lock and key only by Eco-Agric Uganda and the participating researchers from Utah State University. If any new findings develop through the progression of the research project, Eco-Agric staff will share this information with the participating communities.

Compensation
Participants will not be given any direct compensation but should know that their active engagement in this project can result in the potential project benefits previously stated. Likewise, the project will not cover any transportation associated with your travel to or from the sites where project activities will be undertaken. The project is not liable for any injury that might occur during travel or project participation.

Your Participation is Voluntary and You Can Withdraw without Consequence
Your participation in this research is entirely voluntary. You may refuse to participate or withdraw at any time during the project without consequence. Alternatively, in some cases scheduled meetings or activities for this project may be canceled by the facilitators as a result of unforeseen events. Facilitators will contact you quickly so you can change your plans accordingly.

Questions:

If you have any questions related to the study, or your rights as a research participant, you can contact a member of the facilitation team (contact details are listed at the bottom of this document) or contact the Chairperson, Gulu University Research Ethics Committee, Professor Emilio Ovuga, Tel: No., 0712-220-125; email: mailto:Emilio.ovuga@gmail.com; or the Uganda National Council for Science and Technology, on plot 6 Kimera road, Ntinda, Kampala on Tel 0414705500.

Project Investigators:

The following is a list of the core research team:

- Principle Investigator: Dr. D. Layne Coppock- Professor at Utah State University
- Student Researcher: Tom Derr- Peace Corps Volunteer and Graduate Student at Utah State University
- Ugandan Co-Investigator: Atugonza Nicholus- Field Agent for Eco-Agric Uganda

Facilitation Team Contact Details

Tom Derr
0790290517 / 0772139798
mailto:thomasderr54@gmail.com

Atugonza Nicholus
0789515774 / 0700778665
mailto:atugonzanicholus@gmail.com

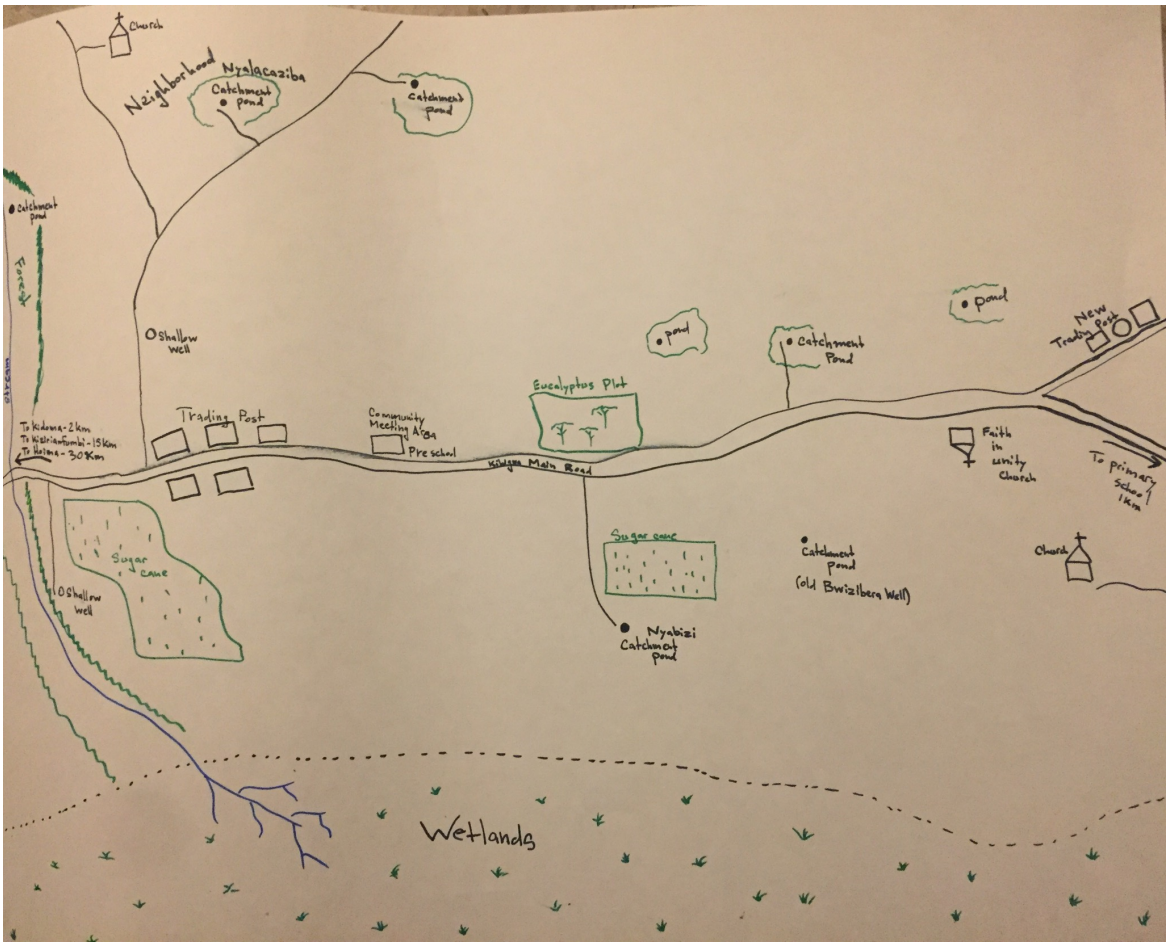
APPENDIX E

KIHIGWA INITIAL CHALLENGES LISTING

Challenge	**Challenge Description**
Agriculture/ Climate Change	Need for inputs (tractor, pesticides, herbicides). Shortage of land. High prevalence of pests/diseases in crops and animals. Poor soils. Low crop yields. Seasonal change makes planning difficult. More intense dry seasons. Heavier rains.
Water Resources	No easy access to clean drinking water. Protected sources (shallow wells) are broken. Unprotected sources are highly contaminated. Contaminated water is likely causing a lot of sickness.
Finance and Income	No money for agricultural inputs. No access to jobs besides farming. Forced to sell crops through middlemen at lower prices.
Health	A high prevalence of various health issues restricts community members from working. Water borne illnesses are likely to be high.
Social	Gender based violence. High alcohol consumption. Too much burden placed on the woman in the community.
Infrastructure	Poor roads restrict access to trading centers. No easy access to a nearby market.
Institutions	Local government has not been as active as it should be in supporting the community. No NGO presence.

APPENDIX F

KIHIGWA COMMUNITY SKETCH MAP



APPENDIX G

KIHIGWA SEASONAL CALENDARS

Calendar 1

Seasonal calendar of activities before major shifts in the climate

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall			X	X	X			X	X	X		
Land Preparation	X	X				X	X					
Planting		X	X				X	X				
Harvesting	X					X	X				X	X
Weeding Maintenance				X	X				X	X		
Animal Diseases	X	X		X	X				X	X		
Dry Season	X	X				X	X				X	X

Calendar 2

Seasonal calendar of activities after major shifts in the climate

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall				X	X				X	X		
Land Preparation	X	X	X			X	X	X				X
Planting			X	X				X	X			
Harvesting	X						X	X				X
Weeding Maintenance				X	X	X			X	X	X	
Animal Diseases	X	X		X	X				X	X		
Dry Season	X	X	X			X	X			X	X	X

APPENDIX H

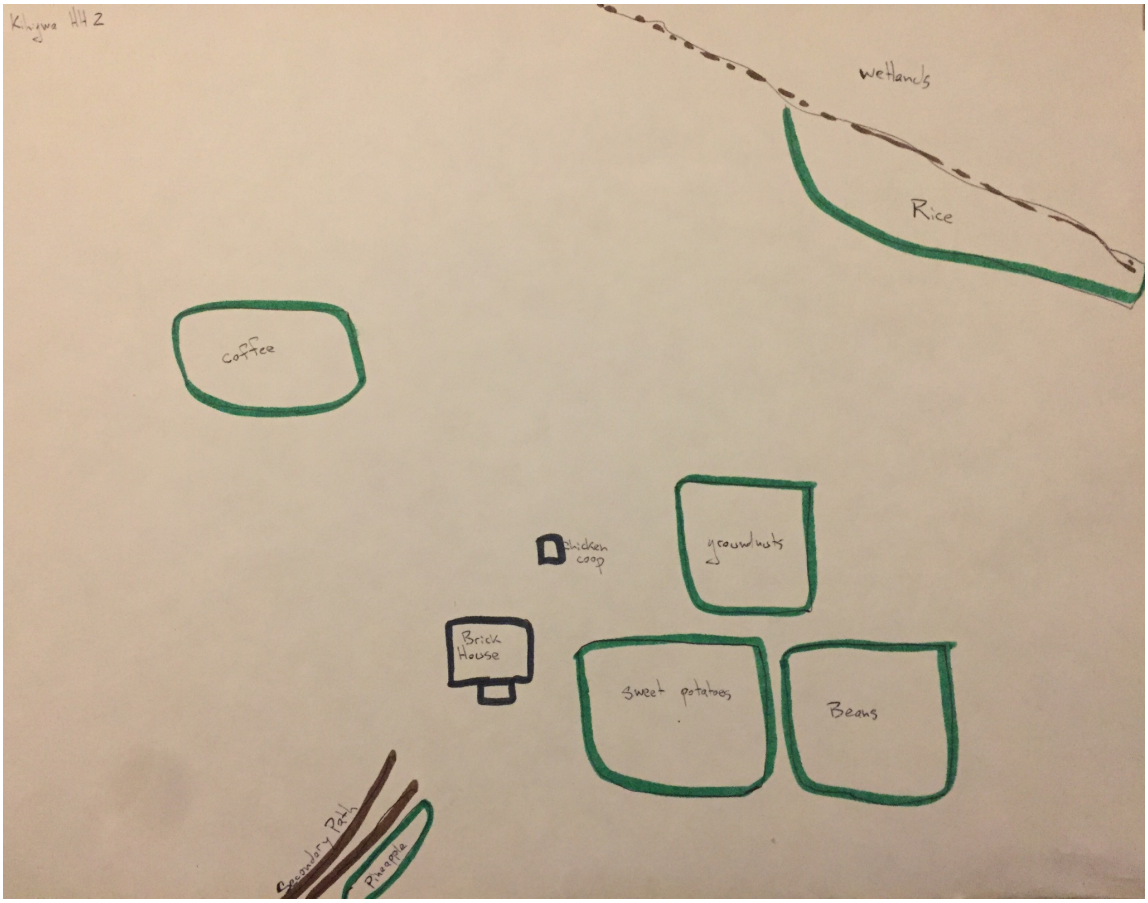
KIHIGWA HISTORICAL TIMELINE

Date	Event
1956	Invasion of mosquitoes
1958	Cassava mosaic virus
1962	Flooding in Kihigwa (as well as all over Uganda)
1980	Drought that forced people to eat inedible crops and caused a lot of hunger.
1987	Prevalence of HIV (correlates with the spread of the disease from west to east Africa with larger outbreaks beginning in the 1980s).
1988	Drought that caused hunger.
1992	Drought
1992	Outbreak of meningitis
1996	Drying of streams and wells (indicates drought)
2000	Major population boom from migration.
2003	Deforestation happens more rapidly.
2004	Gradual disappearance on wildlife from the area.
2005	World Vision first becomes active in the community. Distributes planting materials like improved seeds and other agricultural inputs.
2007	Land fragmentation starts to become a problem.
2008	World Vision establishes two shallow wells.
2015	A new trading post is established.
2016	Sugarcane plantation begins hiring farmers to plant sugarcane.

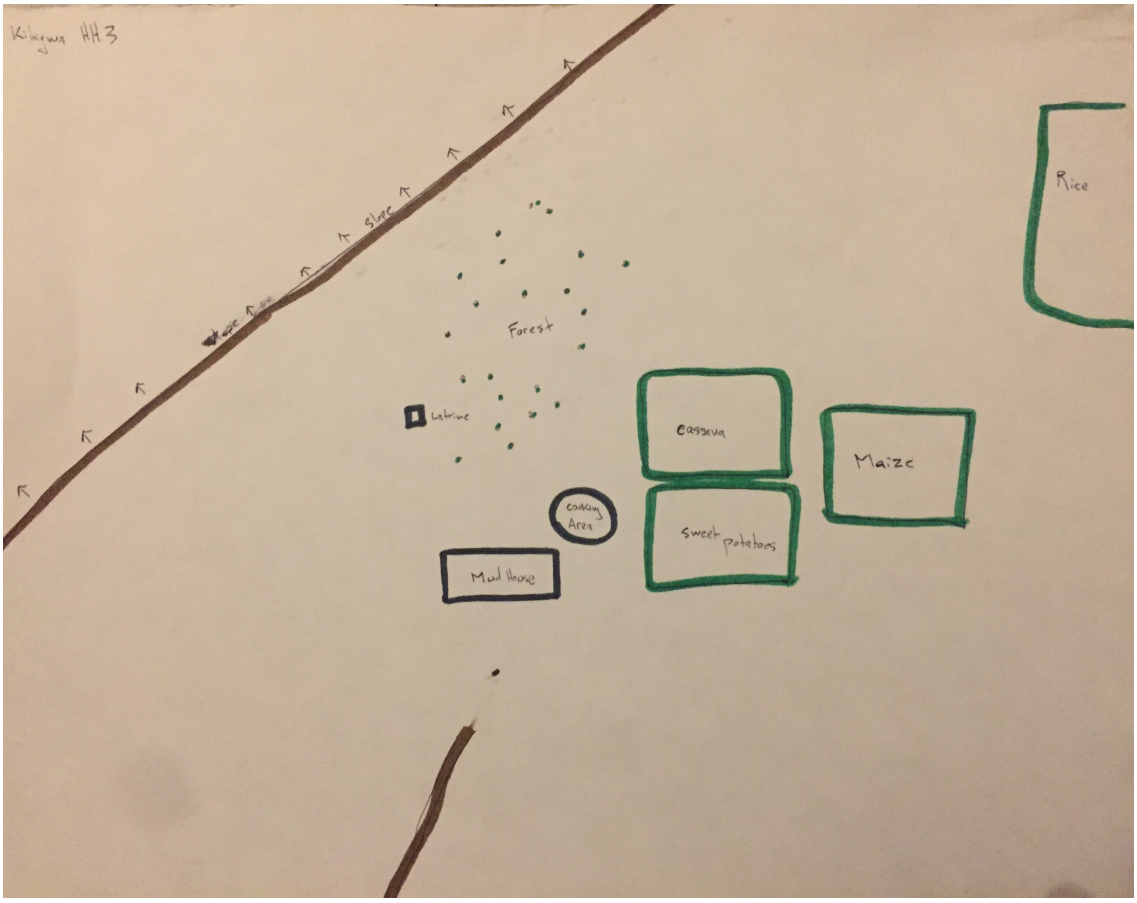
APPENDIX I

SKETCHES OF REPRESENTATIVE FARMS IN KIHIGWA

Kihigwa Household 1



Kihigwa Household 2



Kihigwa Household 3

APPENDIX J

KIHIGWA FINAL MATRIX RANKING

PROBLEMS	**AG**	**WR**	**IN**	**FI**	**HE**	**SO**	**INS**	**TOTAL**	**RANK**
Agriculture (AG)		WR	AG	FI	HE	AG	AG	3	4
Water Resources (WR)			WR	WR	WR	WR	WR	6	1
Infrastructure (IN)				FI	HE	IN	INS	1	6
Financial (FI)					HE	FI	FI	4	3
Health (HE)						HE	HE	5	2
Social/Gender (SO)							INS	0	7
Institutional (INS)								2	5

APPENDIX K

FINAL ACTION PLAN FOR KIHIGWA

Action/Step	**Who**	**Where**	**When**
Step 1: Surveying	Hired engineers, local leaders, and researchers.	All current water sources to gauge feasibility and cost of implementing full and partial protection measures	Immediately
Step 2: Resource allocation	25% from community members (natural resources and labor) and 75% from researcher (monetary funding).	Natural resources such as sand, gravel, and clay needed for the sources will be collected by community members from around the village and transferred to the designated sites. Researchers will apply for a grant via the WWF Climate Crowd and Peace Corps Partnership Program.	Immediately
Step 3: Identifying target sources based on total resources allocated	Engineers, community members, and researchers.	The sources that can have the greatest community impact by serving the largest number of people will be targeted first. The source must also be financially viable to improve or repair.	Once resources and funds are collected
Step 4: Carry out the improvements and repairs	Hired engineers will be responsible for the technical construction/repair of the sources. Community members will provide labor where necessary. Community members	The identified target sources will be taken on first as the bulk of resources and funding will go into constructing/ repairing these. Partial protection of the remaining sources will be implemented on a	Once resources and funds are collected and a trusted engineering team is hired

	and WRCs will be responsible for any partial protection measures for the remaining sources.	case-by-case basis.	
Step 5: Set up prevention measures on newly created/repaired sources	Community members will be directed by engineers to build strategic fences and restore the area surrounding the sources by planting trees and shrubs.	All newly created/ repaired sources	Immediately after the sources are established/repaired
Step 6: Hold trainings on the importance of water resource maintenance and the re-establishment of WRCs	The parish chief, LC1, and other local government bodies will provide the trainings for community members.	Village trading post	Immediately after the sources are established/repaired
Step 7: Reorganize the WRCs	Water users will be responsible for holding meetings and elections to establish WRCs for each of their respective sources. Local government and researchers will assist where necessary.	Village trading post	Immediately after trainings exercises
Step 8: Monitoring and follow-up	Community leaders/change agents and Eco-Agric staff will regularly check on the status of the sources to ensure maintenance is taking place and that the WRCs are operating smoothly.	All respective water sources	After project completion and onward

APPENDIX L

ITARA INITIAL CHALLENGES LISTING

Challenge	**Challenge Description**
Agriculture/ Climate Change	Need for inputs (irrigation, tractors, labor, pesticides, herbicides). Greater prevalence of livestock diseases. Climate challenges (too much sun, longer dry seasons, not enough rain).
Health	Available health services are of poor quality. Drugs are too expensive and should be more affordable. Problems are in both government and private health centers.
Finance	Agriculture is a poor income source to depend upon. There is a need for more jobs (livelihood diversification). Paying for school fees can be difficult.
Water Resources	Some households do not have easy access to clean drinking water. They instead rely on collecting contaminated water from streams.
Youth	There are no jobs for youth once they finish school besides farming, which does not appeal to youth. There are a lot of complacent youth in the community. Some youth are prone to abusing drugs and alcohol.
Gender	Too much of the domestic labor and farming burden is placed on woman. Women feel they should have a larger role in decision making. Men do not take on enough responsibility. Gender based violence and alcohol abuse is present.
Infrastructure	Roads are in poor condition. There is no easy access to markets.

APPENDIX M

ITARA COMMUNITY SKETCH MAP

APPENDIX N

ITARA SEASONAL CALENDARS

Calendar 1

Seasonal calendar of activities before major shifts in the climate

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall		X	X	X				X	X	X		
Land Prep	X	X				X	X					
Planting			X	X				X	X			
Harvesting	X					X	X	X	X	X	X	X
Weeding				X	X				X	X	X	
Human Disease				X	X					X	X	X
Animal Disease	X			X						X		X
Dry Season	X	X				X	X					X
Plant Disease				X	X				X	X		
NurseryBed Operations	X		X			X	X		X			X

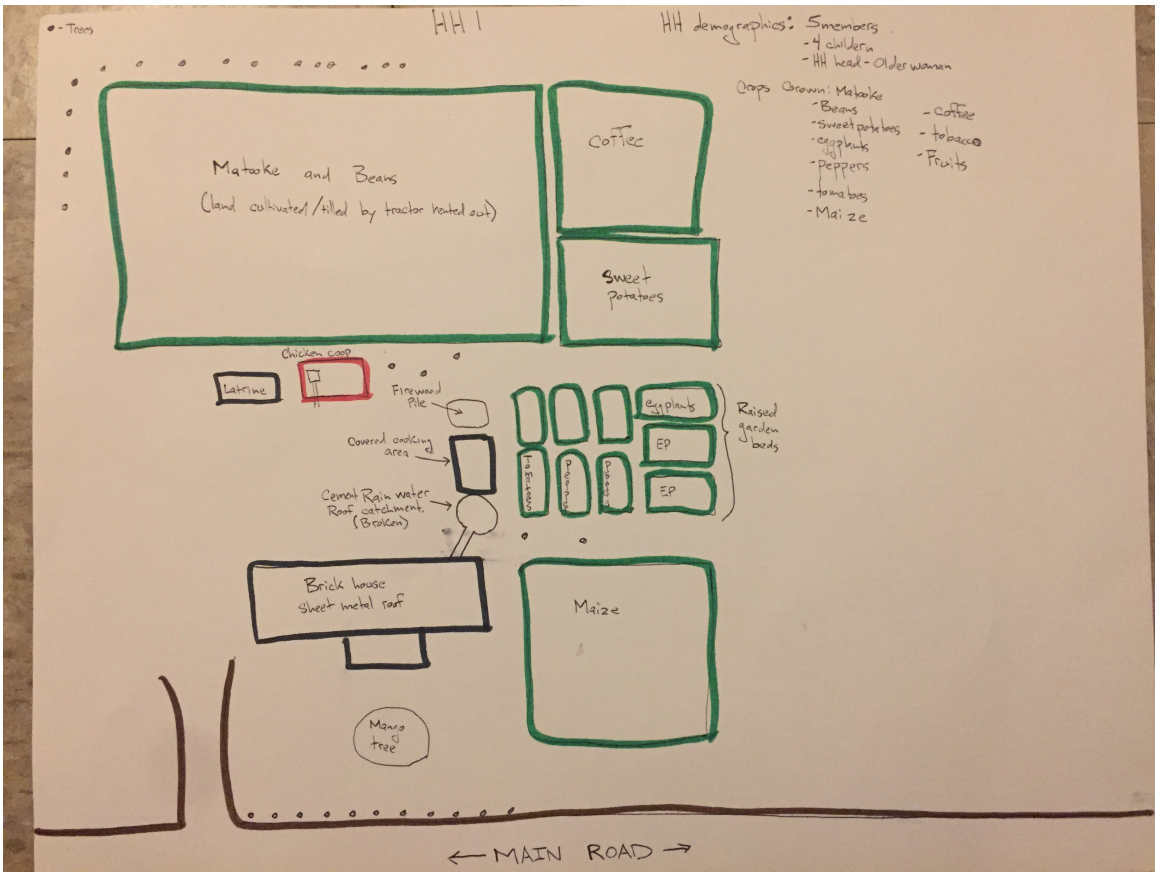
Calendar 2

Seasonal calendar of activities after major shifts in the climate

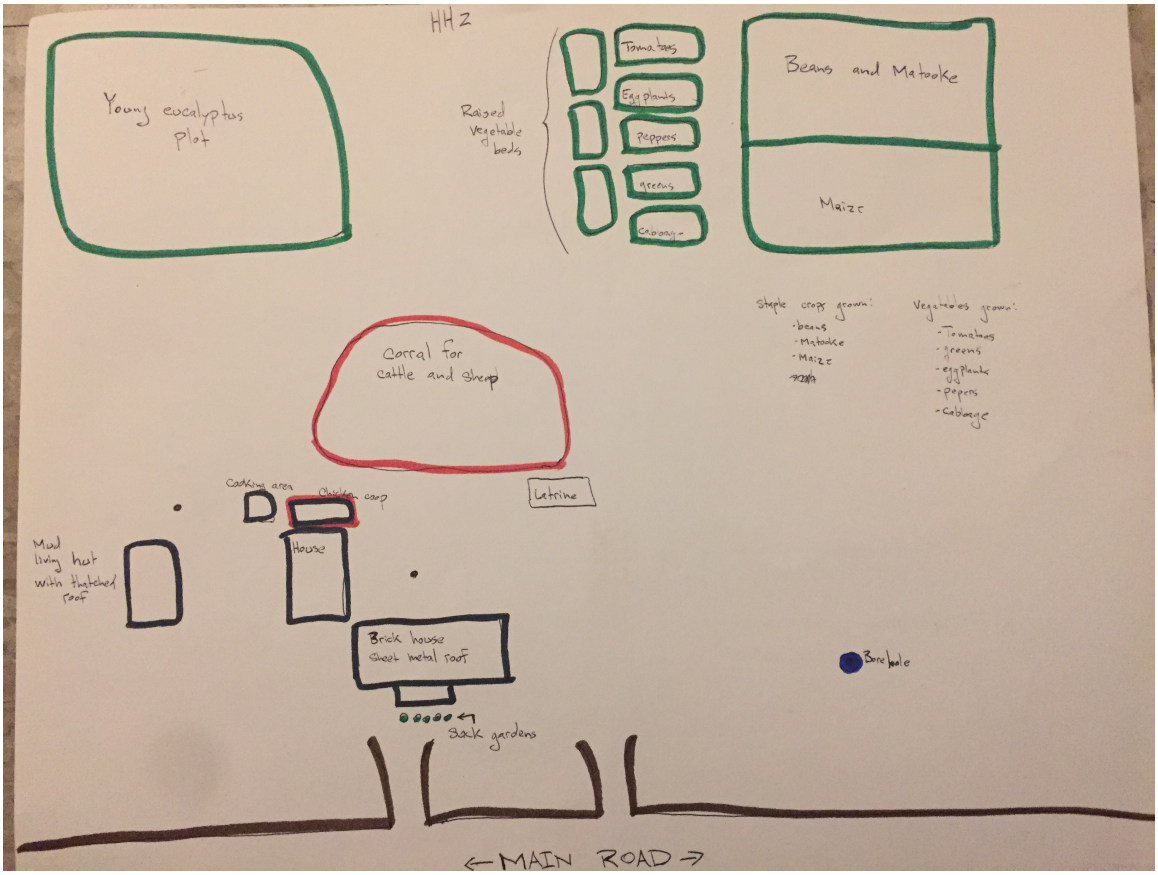
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall				X	X				X	X		
Land Prep	X	X	X	X	X	X	X	X	X	X	X	X
Planting				X	X				X	X		
Harvesting						X	X	X	X	X	X	X
Weeding				X	X	X			X	X	X	
Human Disease				X	X					X	X	X
Animal Disease	X			X						X		X
Dry Season	X	X	X			X	X	X			X	X
Plant Disease				X	X				X	X		
Nursery Bed Operations	X		X			X	X		X			X

APPENDIX O

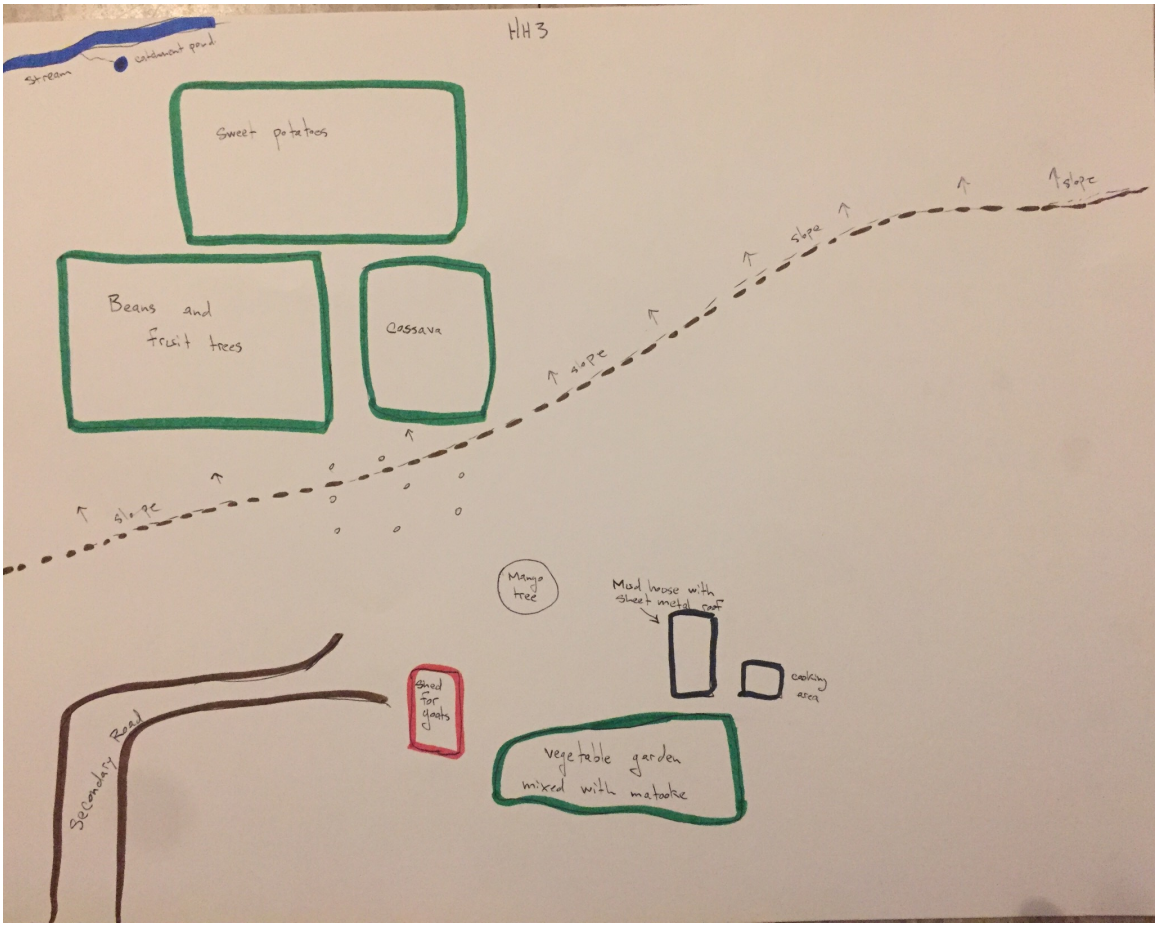
SKETCHES OF REPRESENTATIVE FARMS IN ITARA



Itara Household 1



Itara Household 2



Itara Household 3

APPENDIX P

ITARA FINAL MATRIX RANKING

CHALLENGE	AG	GE	WR	FI	YO	HE	INF	Total	Rank
Agriculture/ Climate Change		AG	AG	AG	AG	AG	AG	6	1
Gender			GE	GE	GE	HE	GE	4	2
Water Resources				FI	YO	HE	WR	1	7
Finance					FI	HE	FI	3	4
Youth						YO	IN	2	5
Health							IN/HE	3.5	3
Infrastructure								1.5	6

APPENDIX Q

FINAL ACTION PLAN FOR ITARA

Opportunity	Program	Materials Needed	Responsible Body
Agriculture	Scale up vegetable nurseries	Seeds	Women's group
	Establish an indigenous tree nursery	Tree seeds, timber for shades	Women's group
	Increase agriculture extension programs	Land	Eco-Agric
	Establish a piggery	Timber, pigs, feed	Women's group
Gender	Hold trainings on gender and gender-based violence in the community for men, women, and youth	Training materials (flipchart, marker, etc.)	Local government, Eco-Agric, health centers
	Hold a training on women's empowerment for women's group		
Health	Improve village level access to health information through trainings	Training materials (flipchart, marker, etc.)	Local health centers, Eco-Agric
	Provide household-level services for those that need them	Health professionals	Local health centers
Finance	Start a catering business	Dishes, cutlery, chairs, etc.	Women's group
	Scale up VSLA activities	Balance books	Women's group
Youth	Establish community youth groups	Training materials	Community leaders, Eco-Agric

Infrastructure	Advocate that the government takes on more infrastructure programs to improve roads and access to power	NA	Community leaders, local government officials
Water Resources	Advocate that the government establishes new protected water sources where needed Establish water catchment systems where needed	NA Water tanks, gutters	Community leaders, local government officials Concerned community members