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Agricultural Responses to Climate Change: A Study of Adaptive Farming Methods in Kizanda Village

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SIT Study Abroad

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Abstract

Agriculture is vital to the economic and social systems in Tanzania, composing 30% of the country's GDP as well as 80% of employment (FAO, 2014). Despite agriculture's important role, it remains one of the most vulnerable sectors to climate change. Current trends project global average temperature to increase by 0.8-2.6 degrees Celsius, leaving farmers to face changes in rainfall, soil quality, and new pests and diseases (IPCC, 2007). Farmers will be forced to adapt to the changing climate if they are to sustain their livelihoods and the Tanzanian economy. For these reasons, it is important to understand the types of adaptation strategies farmers use, and why. The following study examines the ways in which farmers in Kizanda Village adapt to environmental stress caused by climate change. Through in-depth interviews with farmers (n=45), this study looks at both agricultural and social adaptations to gauge how food, farming, and education are impacted by climate change. This study shows that the majority of farmers have already observed negative impacts of climate change and implement a variety of strategies to cope with these changes. Farmers reported changes in crop quality, temperature, rainfall, and soil since they started farming. These farmers display adaptive capabilities despite their limited access to agricultural education and other resources.

Introduction

Due to the diversity of agricultural systems in the world, small-scale studies are especially important to the growing literature on climate change, adaptation, and agriculture (Howden, 2007). The international community has expressed concern with African farmers' abilities to adapt to climate change. The Food and Agriculture Organization of the United Nations (FAO) has reported negative effects of climate change in Tanzania, and it is important to understand how farmers respond to these changes. Many farmers in Africa are smallholder farmers who may not benefit from long-term climate projections and modeling. This study will focus on short-term response strategies in order to add to the literature of small-scale adaptation.. Improving the resiliency of farmers will also maximize societal welfare under climatic stress (Howden, 2007). The Intergovernmental Panel on Climate Change Fourth Report (2007) also shows that agriculture in Africa is at a higher risk of negative factors associated with climate change. These changes will put food security, livelihoods, and environmental factors at risk for the 85 million people living in Tanzania. Tanzanians are particularly vulnerable, for 90% of the population has no protection against livelihood shocks or severe deprivation (FAO, 2014). Growing season, yield, arable land, and rainfall will be affected (IPCC, 2007) and agricultural practices will be forced to change.

These changes may need to take place very soon, as rain-fed crop output is projected to decrease by 50% as soon as 2020 (IPCC, 2007). Despite multiple case studies showing African farmers' abilities to implement new strategies, the IPCC believes that most African countries have low adaptive capacity and current adaptive measures are insufficient. This is due to inappropriate agricultural policy, education, and access for rural farmers. The FAO found that the majority of people in the agricultural sector have limited access to infrastructure and opportunities that would allow them to adapt (FAO, 2014). There are substantial benefits to agricultural adaptation, but further changes in science, policy, and practice are needed to fully address climate change.

Background and Site Description

Tanzania is highly dependent on agriculture both economically and socially. Agriculture composes around 30% of the country's GDP and employs 80% of the population (FAO, 2014). Around 40% of these farmers live below the poverty line with limited access to education and market resources (FAO, 2014). These farmers depend on their physical environment, which has, and will continue to change in the coming years. As the planet continues to warm, farmers will need to adapt their methods to changes in temperature, rainfall, and soil quality. Adaptive capacity depends on access to agricultural resources as well as cultural ones.

The agricultural impacts of climate change have already been observed in the East Usambara Mountains in the Lushoto District of Tanzania. Humans have inhabited the West Usambara Mountains for thousands of years, and land disturbance dates back to around 2,000 years ago (Newmark, 1998).. Thousands of farmers in this area will be forced to adapt their agricultural practices to respond to climate change, causing possible cultural shifts as well. Intensive farming and irrigation practices have been observed in these villages as early as the 1850s, a time when subsistence farms outnumbered cash crop farms. During this period, farmers grew beans, peas, pumpkins, tomatoes, cocoyams, sweet potatoes, sugar cane, and trees together while planting maize and cassava separately. These farmers used sustainable methods and practiced intercropping, green manure, and terracing before the colonists arrived (Johansson, 2001). Due to the high crop diversity, German colonists assumed the soil was fertile and suitable for growing coffee, so they established many coffee plantations as well as tea, cardamom, potato, and pear farms. The Germans implemented commercial farms, and higher yields were expected from farmers. More farmers planted monocultures and used burn and slash to increase their cash crop outputs (Johansson, 2001), changing the traditional methods that had been used for many years. These unsustainable methods persisted under German colonial rule and continued after World War I when Great Britain took power. When Tanzania gained independence, farmers using sustainable methods were discouraged from continuing to use sustainable methods that were often considered ancient methods. Under the first president, farmers were advised to remove trees and shrubs from

their fields and to till the land more often. Eventually, the land started to feel the affects of this intense cultivation, and soil erosion became an issue for farmers. Overcultivation and soil erosion persist in Kizanda today.

Study Site

Kizanda is a small agriculture village located in the Lushoto District, Tanga Region of Tanzania. Kizanda and the surrounding villages have historically been the home of the WaSambaa group. The village is located on the eastern slope of the West Usambara Mountains, which are part of the Eastern Arc Mountains that range from southern Kenya to Northern Tanzania. The area has a cool climate, bimodal precipitation, and highly acidic soil that is relatively fertile. The weather changes significantly each season. The long rainy season, masika, occurs from March to May and a shorter rainy season between November and January (Johonssen, 2001). The region is well suited for agriculture with adequate water resources and mild temperatures. Farmers in Kizanda reported that water was always available. The area is composed of protected natural forests and artificial forests, and people are highly dependent on these areas for firewood.

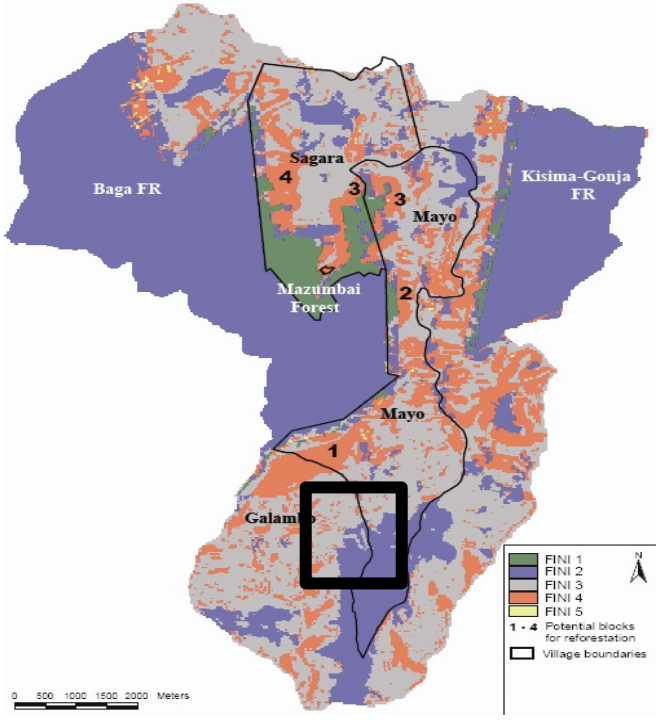

Figure 1: Approximate location of Kizanda Village

(Tanzania Wildlife Research Institute, 2017)

Objectives

The goal of this study is to assess the ways in which farmers in Kizanda Village have adapted their methods to the changing climate. Through this study, I hope to gain insight into the culture and responsiveness of farmers in Kizanda as well as add to the literature of small-scale agricultural adaptation.

Specific objectives for this study include:

- Examine perceptions of change and continuity in agricultural and environmental conditions.
- Outline adaptation methods of cash crop and subsistence farmers.
- Identify the pathways that lead farmers to make strategic changes.
- Assess the types of resources available to farmers.

Methods

Data was collected using ethnographic approaches, in-depth interviews, and one key informant interview in Kizanda Village. Interviews were semi-structured and contained open and close ended questions (Appendix 2). Participant selection was based on availability, location, and the discretion of my translator. Each day we went to a different area of Kizanda and interviewed the first farmers we saw. Due to my unfamiliarity with the community, I depended on my translator to find participants. In total, 45 interviews ranging from 40 minutes to one hour were conducted over the study period, with the help of a translator who speaks Kisambaa, Kiswahili, and English. 6 hours were also spent picking tea with 4 additional farmers. Each participant gave verbal consent (Appendix 1) before answering questions, and all responses were kept anonymous. These respondents were given 2,000 TSH for compensation. One supplementary interview with the agricultural officer of the ward was also conducted. This was an unstructured interview to provide context for the current farming conditions in Kizanda.

The main interview questions were separated into 4 sections (Appendix 2) and follow-up questions were introduced during many interviews. Section 1 began with basic farming information such as crops grown and number of years spent farming. In Section 2, questions focused on the ways in which farmers perceive environmental change, and how they may respond to it. Informal follow-up questions were common in Section 2.

This section also included questions about changes in food price and food preference. The goal of these questions was to understand how farmers perceive change. In Section 3, farmers were asked which methods they use from a list of 14 agricultural techniques that are common in the region. If a farmer answered yes to using a specific technique, they were asked why, and for how long have been using it. In the next section, farmers were asked where they learned these methods and decision-making. These farmers were also asked what they do if they need assistance. Lastly, simple demographic information was collected. These methods were used for 45 interviews. Key informant interview and participant observation did not use a formal set of questions.

The data was analyzed using coding techniques and descriptive statistics. Responses were separated by perception of change, adaptation, and farming methods and coded accordingly (if a farmer said they use the methods when rain is low, they are displaying adaptive measures, if they noticed a change in crop yield or quality they are affected by climate change). I compared answers by age, gender, and number of years farming to evaluate the relationships between these factors and perceptions of change.

Results

The following results reflect the responses of 45 individuals as well as qualitative data collected from participant observation.

Demographics

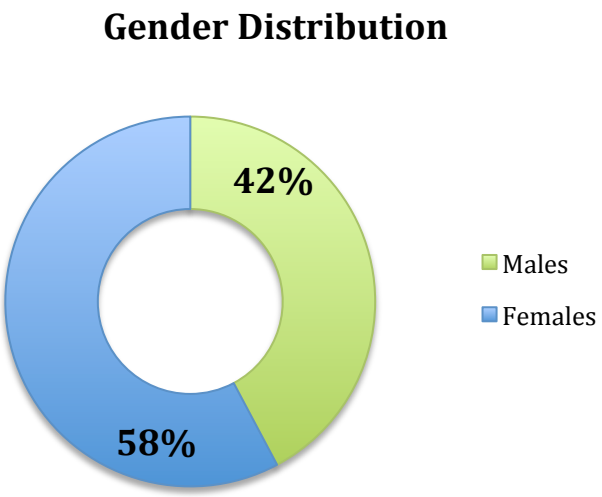

Figure 2: Gender distribution for the sample population. 19 males and 26 females were interviewed.

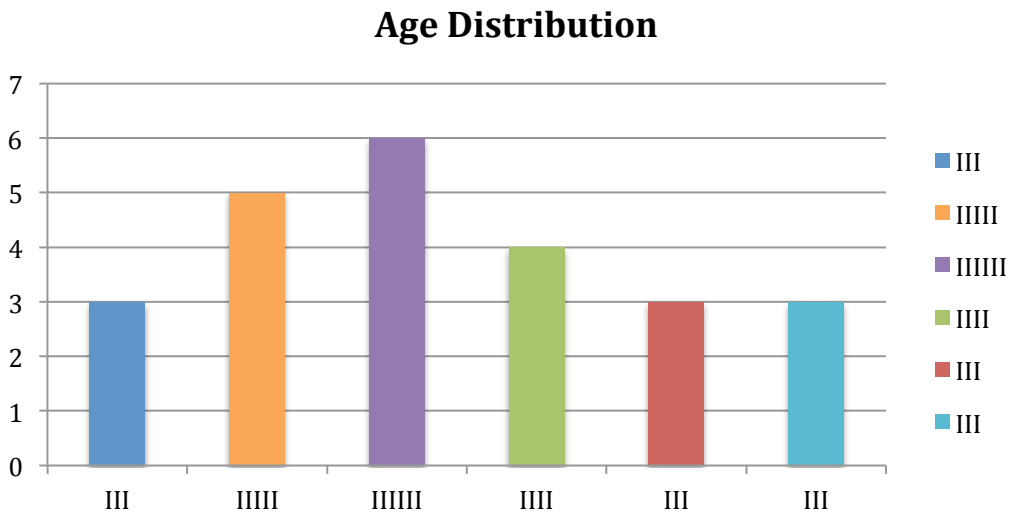

Figure 3: Age distribution of sample population.

The average age of farmers in my sample is 46.76. The majority of these farmers are second or third-generation farmers and had been farming 30.79 years on average.

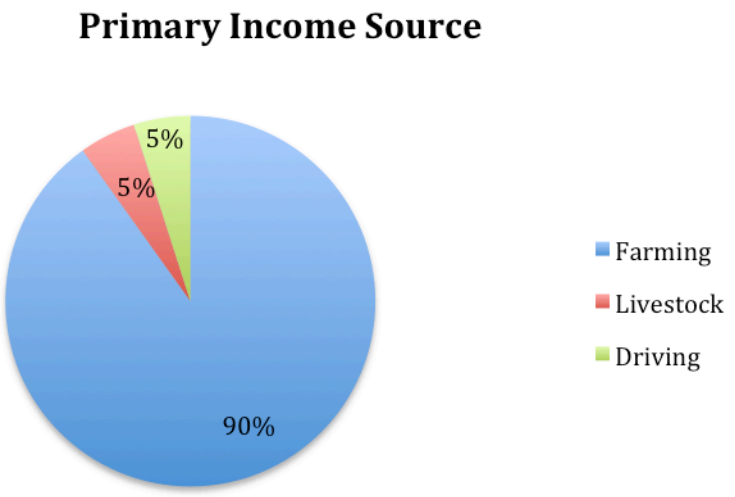

Figure 4: Primary source of income.

All participants depend on farming for a significant portion of their income; however, it is not the primary source of income for all farmers in this sample. I spoke with two farmers that earn the majority of their income from driving services and two farmers that said they get more money from raising livestock than selling crops. All but three of these farmers reported that they depend on their land for the majority of their food as well. 93% of farmers also grow more food than they buy.

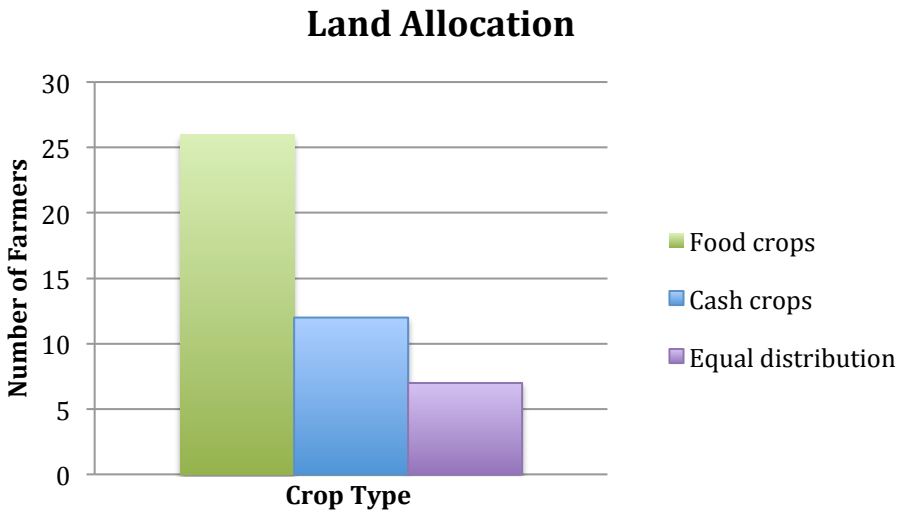

Figure 5: Division of land by crop type.

On average, farmers have 5.15 farms and 5.31 hectares of land both in the valley and on the hilly slopes of Kizanda. Most farmers divide their land between cash crops and subsistence crops, with more food crops on farms close to the home. If food crops used the most land farmers said: chakula (food), maize, maize and beans, maize and cassava, or maize and bananas. If cash crops used more land farmers said: biashara (business), tea, tea and cardamom, or tea and coffee. Only seven farmers said they split their land evenly between food crops and cash crops. It was unclear whether the farms in question used monoculture or polyculture.

Crop Type Grown	**Number of Farmers**
Maize	45
Beans	41
Cassava	41
Tea	37
Banana	36

Table 1 (Appendix 4): Crops grown in Kizanda. These are the most common crops grown in Kizanda.

Farmers in Kizanda grow a wide variety of crops for sale and for personal consumption. On average, farmers grow 12.44 different crops, and few use monoculture. Crops in Table 1 are organized by frequency and some crops were omitted due to translation errors or miscommunication, so this list may present a limited collection of the crops grown in Kizanda Village.

Perceptions

The majority of farmers in Kizanda report changes in the environment since they started farming (Figure 6) and have adapted strategic methods to deal with these changes. However, not all farmers reported the same trends.

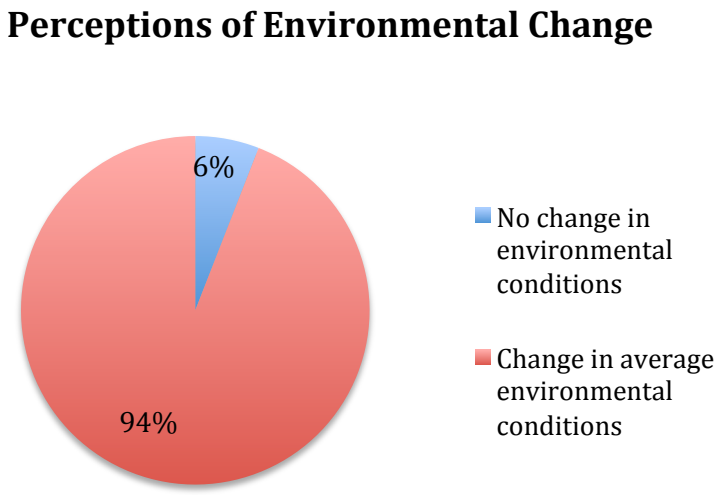

Figure 6: Farmers' perceptions of environmental change.

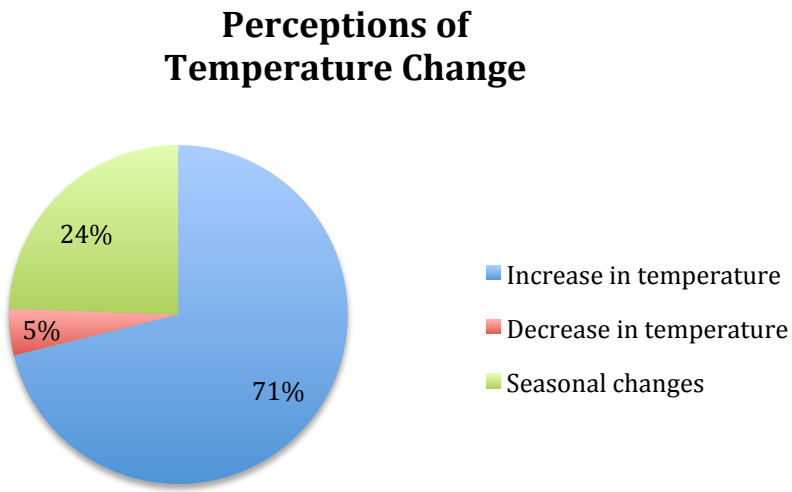

Figure 7: Trends in temperature change. Farmers were asked to explain how the temperature has changed since they started farming, or since they were young.

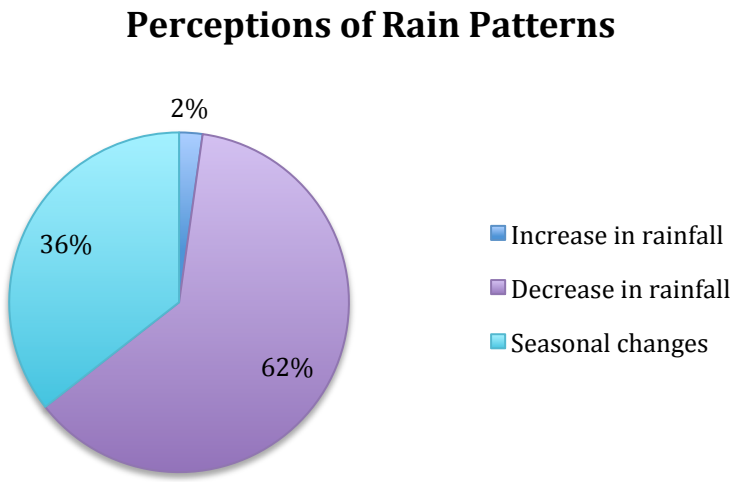

Figure 8: Trends in rainfall. Farmers were asked to explain how rainfall patterns have changed since they started farming, or since they were young.

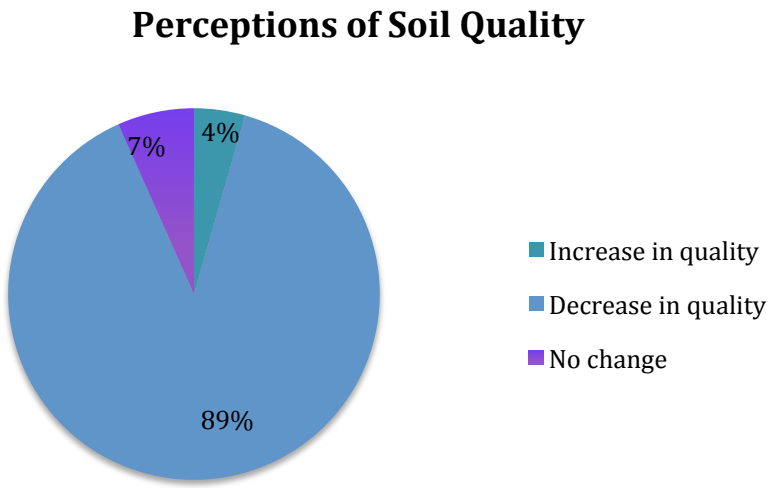

Figure 9: Trends in soil quality. The majority of farmers reported a decrease in soil quality due to overcultivation or overgrazing.

Responses to Climate Change

Farmers in Kizanda have implemented a number of strategies to respond to these environmental changes (Figure 11). Farmers were asked what methods they use and why. Farmers adjust these methods by season, particularly irrigation. Farmers were also asked

what they believed caused these climatic shifts, which warranted a number of interesting responses.

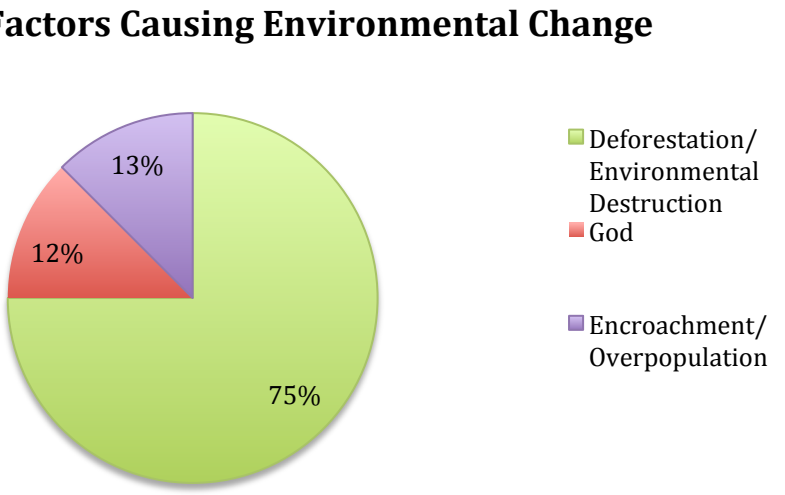

Figure 10: Factors involved in climate change. These are the factors that farmers mentioned when asked what causes climate change.

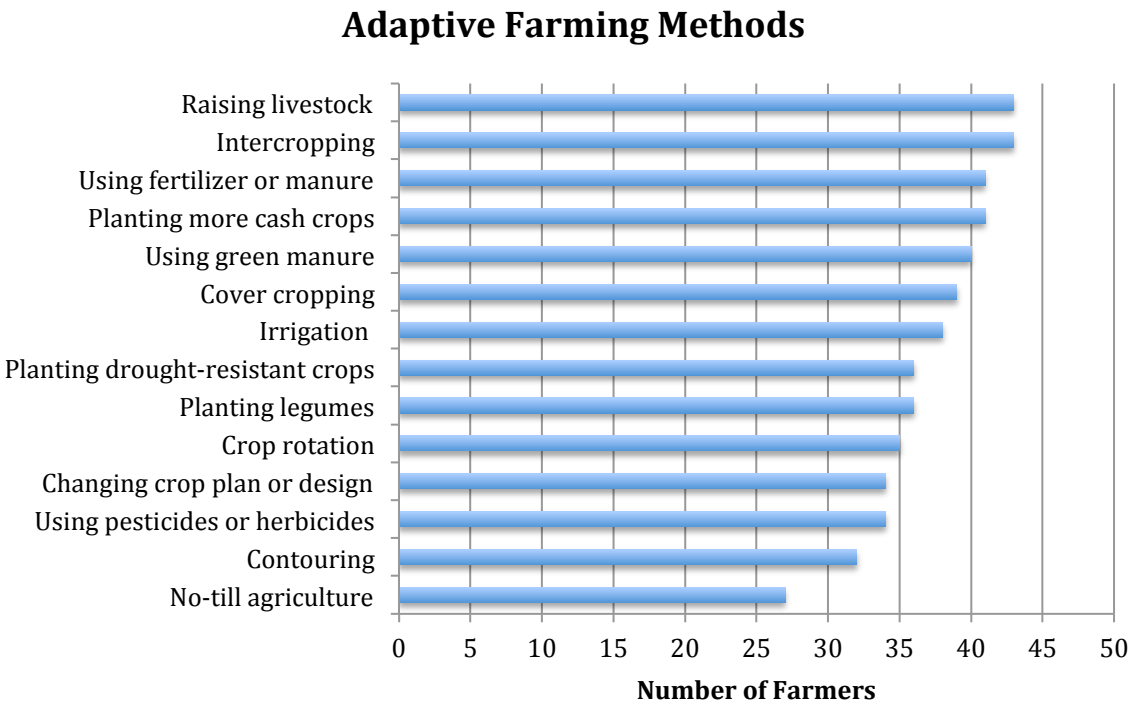

Figure 11: Adaptive farming methods. Methods were considered adaptive if they were used in response to changes in the physical environment.

Education

The majority of farmers in this sample received an agricultural education at a young age.

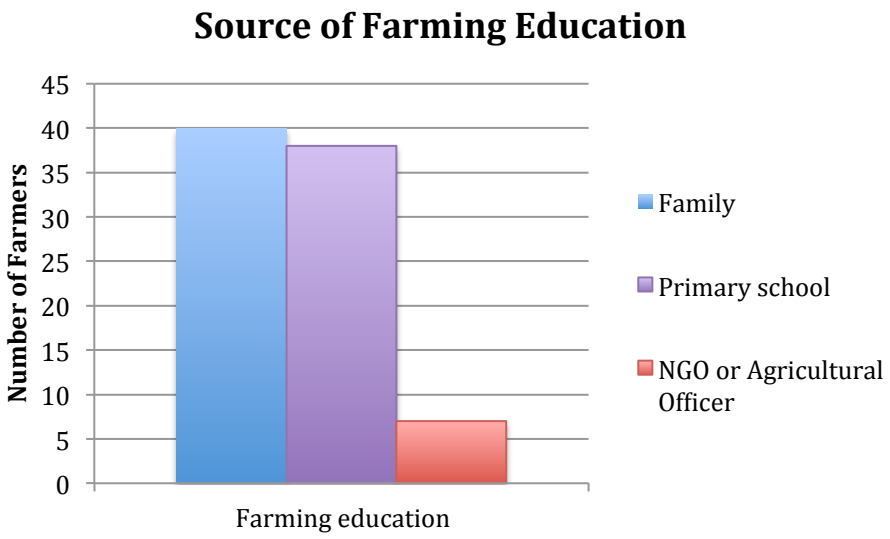

Figure 12: Source of agricultural education. Many farmers said they received their education from a combination of these three sources.

Despite the number of individuals that received an education from an NGO or agricultural officer, many farmers said they had worked with an NGO at some time in their lives.

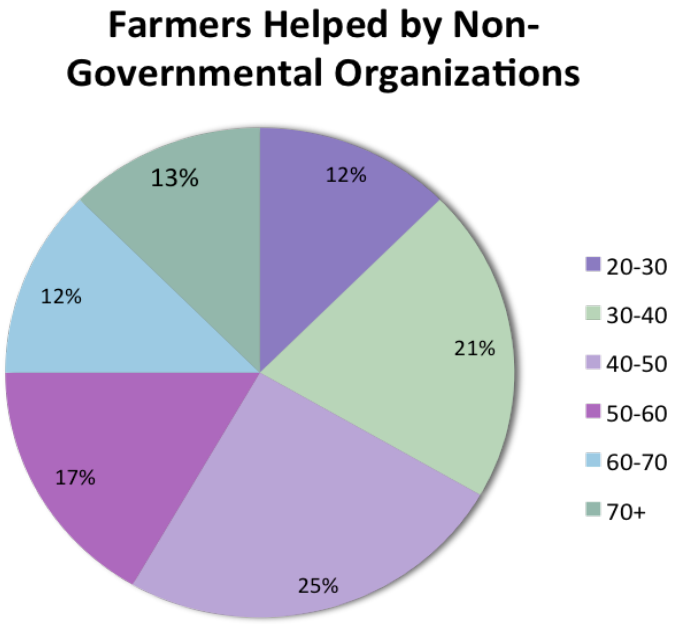

Figure 13: NGOs and age group.

Discussion

These findings reiterate the importance of farming and its vulnerability to climate change. 90% of the farmers interviewed depend on farming for both their income and food source (Figure 4), and rising temperatures, lower rainfall, and new pests pose a threat. The most common trend reported by farmers was a decrease in soil quality (Figure 9). Many farmers also reported an increase in the average temperature since they started farming (Figure 7). These farmers seemed certain that average temperature has increased in recent years, especially over the past two years. When asked what may have caused this change, I received one of two answers. Some farmers seemed confused by the question and said it changed due to weather conditions. But other farmers attributed the change to deforestation and environmental destruction. 22 farmers of the 45 interviewed said that temperature has increased due to cutting of trees, poor environmental conservation, or encroachment on forests. During these conversations, it seemed like more men than women attributed the change to environmental destruction. However, the numbers show only a slight discrepancy by gender, with 14 males and 8 females noting this cause. Interestingly, there was only a weak correlation between low crop yields and higher temperatures. Despite the high percentage of farmers reporting changes, only 60% of farmers reported a decrease in crop yield. This may be due to the adaptive measures taken by farmers: they have adapted to maintain high yields even with climatic changes. These findings are important because there is a lack of quantitative data documenting climatic changes in this area. However, further studies on the physical changes of the environment are needed.

This study found that farmers use a variety of methods to maintain high yields and productive farms. On average, farmers use a combination of 11.53 methods on their farms, adjusting them for seasonal variations. Some methods, such as raising livestock and growing more cash crops, are included as adaptive methods because they are supplementary to farmers' income and they're used when crop yield is low.

Surprisingly, farmers did not mention significant changes in their food consumption or food prices. Food consumption patterns seem to have remained

constant even with changes in the environment. While 46% of farmers reported higher prices for food, the majority of farmers (54%) said the price fluctuates by season, but the trends do not persist over time. This may suggest that adaptive measures are working: farmers are able to grow the same crops and sell or buy food at the same price despite environmental stresses. I had expected farmers to grow more drought-resistant crops, such as bananas, peas, and beans and less maize and mchicha/spinach but this was not the case (Table 1 and Figure 12). Farmers did not seem concerned with the amount of water their crops used and although they reported planting more drought resistant crops during the dry season, it was clear that they grew maize each season. This led me to reject my hypothesis that farmers would report a change in food consumption. Even though farmers have noticed a change in environmental conditions, they have not changed the type of crops they grow. Therefore, their food consumption has not changed. However, three respondents mentioned significant changes in their food consumption patterns. One man said that they could no longer cook food without a large amount of oil. Additionally, two participants mentioned that they could now eat a larger variety of food because they have higher yields.

Tea has been an abundant cash crop in the West Usambara Mountains for years, and it may become even more important to farmers in the coming years. Despite the importance of tea in the area, maize was the most common crop grown amongst farmers in this sample (Table 1). Although the data shows that all farmers grow maize, it seemed as if all farmers are somehow involved in tea farming. Even if a farmer does not own their own tea field, they may pick tea from other farms as an additional source of income. Picking tea may be the fastest and easiest way for farmers in this area to make money. Additionally, it can be a source of independence for many women and young people. Tea trucks come up the mountain two or more times a week, so anyone can sell and make quick money. As my translator described, when he wanted money to buy things like school books and pens, he picked tea for a few afternoons to buy them himself. Tea is the only crop that farmers can consistently sell to businesses and many farmers said it does well during the dry

season. Tea grows better in dry climates than many food crops and it provides a quick source of cash to farmers.

Responses to questions about education and non-governmental organizations were inconsistent. Tanzania Forest Conservation Group (TFCG) has been involved with farmers in Kizanda since the 1980s, but it is not clear whether the group is still a presence in the community. Many farmers said this organization did not help them, or that they are no longer in the area, while others said they are still involved. Furthermore, few farmers said they learned new farming techniques from TFCG (Figure 12), and the distribution of these answers was interesting. It seemed that farmers residing in a certain area of Kizanda, close to the village offices, were the most familiar with TFCG and these farmers were between the ages of 40 and 60 (Figure 13). Although, the difference between these age groups was insignificant, there may have been a location bias, which I discuss in the next section. The data also shows that most farmers learn about agriculture at a young age (Figure 12), suggesting that farmers do not receive education on new agricultural findings and techniques. If farmers are to adapt to climate change, they will need access to new agricultural knowledge.

Based on my interviews, farmers in Kizanda display high adaptive ability in farming. The majority of these farmers said they adjust their methods depending on the weather conditions, so it seems that they have the ability to adapt. However, farmers may be limited by their socioeconomic position: many of these farmers mentioned a need for more farming tools, such as irrigation pumps. These farmers expressed a need for more support from the government for these things.

Biases and Limitations

Sample Bias

It was difficult to conduct a study with random sampling in the villages surrounding Mazumbai Forest Reserve, and this created a substantial bias in my study. On some days, participants were randomly chosen as farmers walked by on their way to the fields, but on other days farmers were interviewed because of a previous arrangement with my translator. This allowed time for some farmers to prepare for interviews, which could have altered their answers. Furthermore, the small sample size limits the representativeness of the study. I had hoped to have a larger sample size, between 60 to 70 interviews, but translations took much longer than expected, so I was only able to interview 45 farmers. Interviews were only conducted between 8am and 12pm. This left out farmers that went to their fields early in the morning and those that were inside during these hours.

The physical location of interviews also affected the results of this study. We went to four different areas in Kizanda, but most interviews were collected in two of these areas. One group of farmers lived closer to the edge of the protected forest while the other group was in the center of Kizanda Village. The first group included multiple family members of one of the Mazumbai forest guides, a friend of my translator. A substantial number of participants were members of the same extended family, so the sample is not representative of Kizanda Village. The latter consisted of farmers related to the environmental officer or agricultural extension officer of Kizanda These farmers seemed to be more familiar with the agricultural officer, TFCG, and modern farming techniques. For these reasons, my sample is not entirely representative.

Question Bias

The language barrier caused a substantial bias in this study as well. All interviews were subject to the interpretation of my translator, and since I do not speak fluent Kiswahili or Kisaamba, I could not verify exactly what farmers said. During some interviews my translator asked farmers if they had noticed a change in temperature/rain/soil and in others he asked if they had noticed a change in temperature/rain/soil since they started farming or since they were young. This

inconsistency weighs heavily upon my data. There were times when my translator emphasized that I was asking about long-term weather changes, rather than seasonal variations in weather, but not at other times. This was also a problem when I asked farmers about their food consumption patterns. I wanted to assess how climate change may affect the types of food people grow and eat, so I phrased the question as, "have you noticed a change in the food you eat since you started farming" and, "did you eat different food when you were a child?" People usually answered that they eat different food everyday, and that they eat more variety because they didn't like to eat some food as a child. It was difficult to reframe the question in a way that produced an answer that I desired. Additionally, there were times when interviewees spoke for one to two minutes, but the translation only consisted of a few words. This also led to inconsistent questioning on climatic changes

There was also a bias in my follow-up questioning. I was inconsistent in these questions, and I did not pursue each question equally. At times I pushed for a more detailed answer, and at other times I did not. There were also times that I asked my translator to clarify questions for farmers and times I did not.

Time

This study is also limited by the three-week data collection period. The data would have been more representative had I spent more time in the village collecting interviews. Interviews also took longer than expected, and participants often seemed impatient toward the end of our conversations. I may have been able to collect more thoughtful qualitative data with shorter interviews.

Conclusion

This study shows that farmers in Kizanda Village have displayed the ability to adapt to environmental changes caused by climate change. The findings suggest that farmers are aware of changes in their environment, and that they can, and will adjust their methods, despite socioeconomic limitations. However, these farmers do not have sufficient access to extension services like agricultural education. The majority of farmers received their agricultural education as children and would benefit from continuous education on soil conservation, water management, and crop planning if they are to sustain high yields.

It is difficult to form conclusions based on such a small study, but this case can provide an optimistic view of African farmers' adaptability. These farmers, considered vulnerable by the rest of the world, have managed to feed their communities in a sustainable way, without causing detrimental harm to the environment. They have practiced mitigation techniques as well as adapting to the changing environment. And while farmers in Africa are forced to adapt to climate change, the agricultural industries in developed countries such as the United States continue to pollute. Mitigation and adaptation need to happen simultaneously to avoid the negative effects of climate change. There is significant literature on vulnerable populations and their adaptive techniques, but further studies of large-scale agricultural industries and mitigation techniques are needed. Still, additional case studies are necessary to fully assess the impacts of climate change and resiliency of small-scale farmers in order to develop sustainable policies that will protect farmers and the environment.

Recommendations

Social science studies require significant background research. This study could have been improved by a more thorough review of the history and culture of the West Usambara villages. It's difficult to learn about the cultural tendencies of an area before traveling there, but I could have done more research to prepare. It would have been beneficial to focus on the political history of the region as well as current policies.

I think it would have been valuable to isolate gender or age and compare different groups. Throughout the course of this study, I noticed differences in the ways women and men answered questions about change and continuity. It seemed that women spoke about short-term weather changes while men spoke about changes over multiple years. There could be implications for adaptation practices based on these differences. I also noticed that farmers of different ages answered questions differently. Although my data did not show any trends, I think this could be investigated further, looking at education and access to information as variables. This study would have been much better with a narrower focus on age or gender.

This topic could also benefit from a long-term natural science study. Almost all farmers reported a negative trend in soil quality, so they have become more reliant on fertilizer. It would be interesting to compare soil samples from fields with inorganic fertilizer, such as eulare, and organic fertilizer like samadi or manure.

Agriculture is so important to the economy and political structure of Tanzania, and I think it would have been interesting to learn more about the social aspects of agriculture. Although it is difficult to speak with people about political leaders, I think it would be possible to collect data about former political parties. It'd be interesting to compare the former agricultural policies under socialism with the current capitalist policies. From surface level research it seems that farming was more sustainable under socialism, but social services declined. However, this type of study would be difficult to conduct over a three-week period.

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Appendix 1 – Consent

"Hello! I'm a university student from America asking questions about farming methods and perceptions of climate change for an independent study project. Please answer as many questions as you can, but you don't need to answer a question if you feel uncomfortable. Your answers will not be published and you will remain anonymous. If you do not wish to participate in the study, you may leave at any time. Thank you for your help!"

Appendix 2 – Main interview questions

I. Section 1 – Basic Farm Information
    a. Did your parents or grandparents have a farm?
    b. How many years have you been farming?
    c. Which of these crops do you grow on your farm?
        i. Maize, beans, banana, coffee, tea, cassava, potato, sweet potato, onion, garlic, cabbage, carrot, spinach, chinezi, mboga mboga, tomato, bitter tomato, broccoli, squash, papaya, avocado?
        ii. Anything else?
        iii. Which crops do you sell and which do you consume?
        iv. Which crops take up more land (cash crop or subsistence)?
    d. Do you use monoculture or polyculture?
    e. Do you buy seeds or reuse them?
    f. Do you use irrigation for any crops?

II. Section 2 – Perceptions and Responses to Climate Change
    a. Have you noticed a change in crop yield or crop quality since you started farming?
        i. What do you think caused this change?
        ii. What do you do when there's not enough food?
    b. Do you think rainfall has changed since you started farming?
        i. Do you think the dry seasons are longer or the rainy seasons?
        ii. What do you do when there is not enough rain?

iii. Do you use irrigation?

c. Do you think average temperature has changed since you started farming?
    i. What do you think caused this change?
d. Have you noticed any change in soil quality since you started farming?
    i. What do you think caused this change?
    ii. Do you use fertilizer?
e. Have you noticed a change in the food you eat since you started farming?
    i. What do you eat everyday?
        1. Which of these foods come from your farm?
        2. Do you grow most of your food? Do you buy most of your food?
    ii. Do you eat the same food as you ate when you were a child?
    iii. What food do you eat in your household?
    iv. Has the cost of food changed since you started farming?
f. Which of these methods do you use? Why do you use this method?
    - Irrigation – what type?
    - Planting legumes
    - Intercropping
    - Planting drought-resistant crops
    - Planting more cash crops
    - Using pesticides or herbicides
    - Changing crop plan or design
    - Raising livestock
    - Finding another job
    - Contouring
    - Using green manure
    - Cover cropping
    - Crop rotation
    - No-till agriculture
b. Do you always use these methods? Does it change by season?

III. Section 3 – Education and Resources

a. How did you learn to grow crops?
    i. How do you decide which crops to grow?
    ii. Did you learn about agriculture in school?
b. Have you ever learned from an NGO, such as TFCG?
c. Where do you go if you have a problem or have questions about agriculture?

IV. Section 4 –Demographics
a. How old are you?
b. How much land do you own? How many hectares?
c. What village do you live in?
d. Is farming your primary source of food and income?

Appendix 3 – Interview notes for bwana shamba

1. How long have you worked in Kizanda?
    a. *2 years.*
2. How long have you been a farmer?
    a. *He doesn't farm on his own.*
3. What problems do farmers in Kizanda ask about? Are there problems with drought, crop disease, or prices?
    a. *He said the problems are with spacing and people not using his suggestions.*
    b. *He studied agriculture in school and he encourages farmer to use better methods, specifically better spacing and better fertilizer techniques.*
    c. *Problems with reusing seeds and with price of fertilizer.*
4. Do you meet with farmers individually? How do you distribute knowledge to farmers?
    a. *Sometimes holds group meetings. Farmers know where to find him.*
    b. *He can't travel far because of a lack of transportation, lack of funding.*
    c. *He taught people to grow seedlings and better spacing techniques during group meetings.*
5. What do farmers ask you for help with?
    a. *Farmers need help with buying seeds and fertilizer. Price is a problem.*

    b. *Experts need to do research on which seeds to reuse and how to reuse them efficiently.*
6. Do you teach farmers about environmental problems and sustainably?
    a. *Tries to teach about environment, sometimes talks about the dangers of pesticides but farmers don't care.*
    b. *There are no issues with irrigation or using too much water.*
7. Do you help farmers with sales or price negotiation?
    a. *No. Farmers can form groups of growers (like a union) to negotiate for better prices from tea companies or other buys. Farmers don't do this but they should.*
    b. *There are only a few tea companies that buy on the mountain so it isn't easy to argue for better prices.*
8. Do you get funding from the government? Do you reach out to your government representative when you have problems?
    a. *Not enough funding, he is supposed to work for 4 villages but can't travel to them.*
    b. *Government doesn't respond when he reaches out.*
    c. *They give promises but do not follow, no action.*
9. Does the government help with agricultural tool prices?
    a. *Some farmers need help with costs. Farmers have skills but need lower prices for fertilizer, the government has lowered it.*
10. Have you seen success from your teaching?
    a. *Seeing development with the modern farming methods*
    b. *Soil is exhausted and people need more fertilizer, it's very important.*
    c. *People ask a lot of questions, his help is free to farmers.*
11. How many farmers do you work with?
    a. *He does not know how many. He is the agricultural officer for 4 villages.*
12. Do you teach farmers about climate change?
    a. *Farmers ask about weather changes each season. Many of them depend on him to tell them what type of weather is coming in the next season.*

Most people hear about it from the radio or television, but some people don't have access to those.

13. Do you work with any organizations or government representatives?
    a. *TFCG used to be here before he started, but they aren't around anymore?*
14. Do you teach people about forest conservation or agroforestry?
    a. *People here practice agroforestry. There is an officer of the environment who educates people about that. He does not talk about trees at all.*
15. Do people raise livestock?
    a. *People only have a few cows, not enough to graze or cause overgrazing.*
    b. *Soil erosion exists on the hills but not because of livestock. He advises people to use terracing but adaptation doesn't happen. He provides farmers with the information but he never sees them implement it, people think it is too time consuming.*
16. Are there issues with pests or diseases?
    a. *There are pets like aphids. People need to use pesticides for tomatoes.*
    b. *Only a few people use natural pesticides like certain trees or mixing flour and soap and putting it on plant roots.*
17. What do you think is the biggest problem facing farmers here?
    a. *Fertilizer and seed resources. Farmers do not have access.*
18. Any discouragement from farmers?
    a. *No, but many farmers want to see things in action before they implement them. Farmers don't want to do things unless they've seen them in a test garden. People are not interested when things seem expensive.*

Appendix 4

Crop Type Grown	Number of Farmers
Maize	45
Beans	41
Cassava	41
Tea	37
Banana	36
Cabbage	29
Tomato	26
Sweet Potato	25
Cardamom	23
Mchicha	23
Carrots	22
Green Pepper	22
Coffee	21
Avocado	21
Mnavu	19
Potato	18
Yams	18
Onion	17
Spinach	12
Pumpkin	9
Cucumber	8
Bitter Tomato	7
Mango	7
Sugar Cane	5
Papaya	5
Peas	3
Pear	3
Grapes	3
Jackfruit	3
Oranges	3

Garlic	2
Pineapple	2
Passion Fruit	2
Lemon	2
Watermelon	2

Table 1