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Attitudes, Adoption, and Awareness of Conservation Agriculture Techniques by Farmers in the Karatu Highlands

by

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Environmental Studies
With Honors

May 2018

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Date: 5/8/18

Abstract

Rising temperatures and varying rainfall, as results of anthropogenic climate change, are threatening the livelihoods and food security of small-scale agro-pastoralists throughout East Africa. However, the use of conservation agriculture (CA) techniques as climate change mitigation strategies remains largely unexplored in this region. This study interviewed 101 participants using questionnaires to examine the awareness, challenges, and uses of different CA techniques in the rural village of Kilimatembo in the Karatu highlands of Tanzania. While the use of CA techniques, such as terracing (69.13%), intercropping (82.18%), and cover cropping (46.35%) is prevalent in the area, awareness of climatic changes varies greatly, and knowledge of the use of CA techniques as climate change mitigation strategies is relatively nonexistent. No correlation was found between the use of CA techniques and the respondents' levels of climate change awareness, and, as such, it could be determined that knowledge of the use of CA techniques as climate change mitigation strategies is similarly lacking. Many respondents cited rainfall variation (67.33%) and higher temperatures (43.6%) as the most prevalent climate change impacts and 88.12% of respondents additionally noted decreasing crop yields as a major consequence of these climatic changes. CA techniques could provide necessary relief from the negative impacts of climate change; however, challenges such as cost (31.68%), labor (24.75%), and neighbor conflicts (17.82%) still prevent many farmers from implementing these strategies. Increased soil fertility (68.32%), increased crop yield (73.27%), and reduced soil erosion (80.20%) were the three benefits of CA implementation most often answered by interview respondents. A majority of farmers in Kilimatembo village stated themselves as very likely (91.09%) to continue implementing CA techniques or implement CA techniques in the future. However, the extension of educational opportunities and monetary support to local small-scale agro-pastoralists is needed before the use of CA can be fully realized in the region.

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Acknowledgements

We would like to extend our sincerest acknowledgements to the numerous people who contributed to this study. Namely, we would like to thank Hilda Gasto, for collecting much of the background information and connecting us with local farmers and acting as a translator as well as Gregory Peter and Pius Cornell for acting as translators and assisting with field data collection. We would additionally like to thank the School for Field Studies-Center for Wildlife Management Studies for hosting us and funding this research.

Introduction

Background

Agriculture is the leading sector of Tanzania's economy, accounting for 24.6% of the total GDP and 31% of merchandize exports (Lugandu, 2013). Within the Karatu highlands, located in northern Tanzania, crop and livestock production employ over 90% of the labor force (Mkomwa et al., 2011). However, agricultural expansion in many regions has resulted in soil erosion, depletion of natural resources, and food instability through the extension of intensive and unsustainable agricultural practices such as overgrazing and deforestation (Rohde and Hilhorst, 2001). As a result, many farmers have recently turned towards conservation agriculture (CA).

CA focuses on three objectives: permanent soil cover, minimal soil disturbance, and crop rotation. Techniques such as terracing, cover cropping, and intercropping have been implemented in isolated areas throughout Tanzania and East Africa (Shetto and Owenya, 2007). These techniques can be used to reduce soil erosion and increase crop yields (Mkwomwa et al., 2011).

Previous studies have concluded that knowledge of sustainable farming practices exists in the Karatu highlands (Rohde and Hillhorst, 2001). However, while many village councils developed bylaws to protect forests and other commonly used areas, it was found that enforcement was often difficult (Rohde and Hilhorst, 2001). In addition, many small-scale agro-pastoralists have yearned to incorporate CA techniques into their farming practices, but lack of capital has prevented many from adopting them (Shetto and Owenya, 2007). Even where capital is available, a lack of knowledge and support from extension services may prevent implementation of CA techniques. Success has been attained through the use of educational workshops, but many past practices have neglected to fully educate farmers in order to provide

for long-term adoption of CA (Lugandu, 2013). As such, weak bylaw establishment, restricted access to cover crop planting materials, limited knowledge in agronomic practices for different cover crops, competition for livestock feeds, and challenges of attaining permanent soil cover and weed control all contribute to minimal expansion of CA (Mkwoma et al, 2011).

Problem

Existing issues of soil erosion and seasonal water scarcity in East Africa are becoming increasingly noticeable due to climate change. In addition, increased temperature and variability of rainfall have resulted in flooding, drought, crop failures, livestock deaths, and intensification of climate sensitive diseases (Shemsange et al., 2010). Average annual temperatures across East Africa have increased by 0.7 degrees Celsius, threatening the livelihoods of many agro-pastoralists who depend on crops and livestock for food and income (Hulme et al., 2001). For example, a mere two-degree Celsius alteration in temperature could reduce Tanzania's maize yield by up to 33% (Mwaikinda, 2011).

Small-scale, rural farmers are often at greater risk as they lack the resources and knowledge to adapt to a more variable environment. CA techniques provide a valuable opportunity for small-scale farmers to participate in climate mitigation strategies and expand their crop yields. However, education and facilitation concerning such techniques have been limited so far. As such, further assessment of CA practices in rural Tanzania is needed. This study assessed the attitudes and awareness of the community towards CA in the Karatu highlands and determined the challenges limiting implementation of CA. Additionally, the study examined the viability of CA as a climate change mitigation strategy for local small-scale agro-pastoralists in Kilimatembo village in the Karatu highlands, Tanzania.

Objectives

The objectives of this study were:

i. To assess attitudes and perceptions of small-scale farmers towards CA techniques.

ii. To evaluate knowledge of the link between CA techniques and climate change.

iii. To identify challenges for local small-scale farmers to implement CA.

Justification

Agriculture accounts for more than 75% of rural household incomes in Tanzania (Shemsanga et al., 2010). As such, the effects of climate change through local phenomena, such as increased drought and

temperature, threaten the livelihood of many rural populations. These effects are exacerbated by present concerns of soil erosion along steep slopes and unpredictable rainfall.

CA techniques effectively utilize limited time and monetary resources and typically have a large satisfaction rate among participants (Lugandu, 2013). When effectively implemented, the benefits of CA techniques outweigh the costs and serve as a promising strategy for climate change mitigation in agriculture (Lugandu, 2013). By surveying farms and interviewing farmers in the Karatu highlands, this study identified challenges farmers face and assessed levels of awareness of climate change and CA techniques.

Methods

Study Area

This study was conducted in the village of Kilimatembo, located in the Karatu highlands in northern Tanzania (Figure 1). Four sub-villages were surveyed, Kilimatembo juu, Gilala, Huduma, and Barabarani. The Iraqw tribe constitutes a majority of the 178,434 people who reside in the Karatu highlands, and the population continues to grow at an annual rate of 3.2%. Population density averages approximately 100 persons per kilometer squared (Lugandu, 2013). Agriculture serves as the main livelihood for the area with an emphasis on maize, beans, and paddy (rice). Rainfall in the district of Karatu is bimodal, with long rains occurring March through June and short rains from October to December. Annual rainfall usually totals approximately 1000 millimeters in the highlands, and temperatures range from 15 degrees Celsius to 24 degrees Celsius at the level at Lake Eyasi, with increasingly cooler temperatures as elevation increases (Mkomwa et al., 2011).

Field Methods

Interviews using questionnaires were conducted throughout the study area of Kilimatembo (Appendix I). Interviews were conducted in Swahili or Iraqw, as these are the predominant languages in the study area. Interview participants were asked to answer questions relating to their i) background and demographics, ii) climate change awareness, and iii) awareness of, usage of, and benefits and challenges relating to CA. GPS location was recorded at each interviewee's house. Farms were categorized by one of three categories, based on the amount of time that they have implemented terracing. Farms were categorized as a control farm if the farmers did not implement terracing, as a test farm if they had been terracing for one year or less, and as a sub-control if they had been terracing for more than one year.

Data Analysis

Keywords were identified and coded for each interview question and responses were categorized based on use of these keywords. Climate change awareness was analyzed using the keywords, unreliable rainfall, less rainfall, more rainfall, drought, water scarcity, higher temperatures, colder temperatures, and variation in temperatures, as well as keywords targeting the effects of climate change on crop yield, such as, low crop yield/production, low income, variation in planting season, difficulties attaining seeds, emergence of disease, emergence of pests, and reduce soil fertility. The benefits of CA were analyzed using the keywords, increased soil fertility, increased crop yield, reduced soil erosion, less labor, fodder for animals, increased income, and firewood, while the challenges were analyzed using the keywords, cost, labor/maintenance, neighbor conflicts, wildlife conflicts, availability of resources, and difficulties ploughing. CA techniques were separated into one of three categories, terracing, cover cropping, and intercropping. Respondents' likeliness to implement/continue to implement CA in the future was assessed on a scale of 1 through 5, with 5 being very likely and 1 being very unlikely. All other questions were binary and constituted a yes/no answer which was coded as 1 and 2. Overall trends were examined using descriptive statistics, and a two-sided Pearson Chi-squared test was used to test for significance. IBM SPSS Statistics 24 software was used to run the Chi-squared tests for all variables of this study.

Results

This study interviewed 101 participants using a questionnaire. All participants were small-scale agro-pastoralists in Kilimatembo village in the Karatu highlands, Tanzania. 73.7% of interview participants were male and 26.73% were female, and 97.03% of interview participants were Iraqw, with the remaining 2.97% of the sample population deriving from the Mang'ati tribe. Participants resided in four sub-villages: Kilimatembo juu (5.75%), Gilala (22.99%), Huduma (43.68%), and Barabarani (27.59%). Most participants were middle-aged, with 9.9% being 18-35 years old, 57.43% being 36-55 years old, and 32.67% being over 55 years old. However, the average years participants had lived in the area was more variable with 28.71% of participants having lived in the area for 1-25 years, 33.66% for 26-45 years, and 37.62% for over 45 years. The years participants' main occupation was farming additionally differed considerably with 49.5% having only spent 1-25 years farming, 36.63% having spent 26-45 years farming, and 13.86% having spent over 45 years farming. Most participants' highest level of education was primary

school (79.2%); however, 11.88% had no education and 8.91% had an education level of secondary school or above. The wide majority of participants were currently married (90.1%) with an additional 3.96% being single and 5.94% being widowed.

Climate Change Awareness and Effects

Participants were most likely to notice unreliable rainfall as a recent climatic change, with 67.33% of respondents citing this alteration (Figure 2). Other commonly observed climatic changes included higher temperatures (43.6%), less rainfall (25.74%), and variation in temperature (10.89%). All other responses (more rainfall, drought, water scarcity, and lower temperatures) were given by less than 10% of interview respondents. Chi-squared tests revealed no significant association between the demographic variables (age, education, years lived in area, ethnicity, gender, marital status) and the level of climate change awareness except for age and less rainfall, which had a P-value of .028 (df=2).

Participating farmers also noted a decrease in crop yield as one of the effects of climatic changes, with 88.12% of farmers responding that their crop yield has decreased over the past ten years as a result of climatic changes (Figure 3). Other effects mentioned included altered planting season (6.93%), low income (2.97%), emergence of disease (1.98%), difficulty getting seeds (0.99%), emergence of pests (0.99%), and reduced soil fertility (0.99%). A Chi-squared test revealed significant association between years farming and difficulty getting seeds (P-value=0.043, df=2), years farming and variation in planting season (P-value=0.022, df=2), education and difficulty getting seeds (P-value=0.024, df=2), and education and emergence of pests (P-value=0.006, df=2). No other associations were found between the impacts of climatic changes and the demographic variables of age, education, years farming, marital status, ethnicity, and gender.

Conservation Agriculture Implementation

Nearly all interview participants already employed at least one CA technique (Figure 4). The most commonly used technique was intercropping, with 82.18% of farmers implementing this technique, followed by terracing (69.13%) and cover cropping (46.35%). Total CA usage by interview participants was 99.01%.

While no patterns of distribution were found among sub-villages for the use of cover cropping and intercropping, a Chi-squared test revealed a significant association between the use of terracing and sub-village (P-value=0.003, df=3) (Figure 5). There were no significant associations between the

implementation of CA as a whole, or between the various individual CA techniques, and the variables of age, gender, education, marital status, ethnicity, and years farming.

Challenges of Conservation Agriculture

Cost was the main challenge faced by farmers, with 31.68% of farmers identifying this as an issue (Figure 6). Labor/maintenance and conflict with neighbors were also significant challenges associated with CA techniques, with 24.75% of respondents identifying labor as an issue, and 17.82% identifying neighbor conflict as an issue. Other challenges accounted for less than 10% of responses.

Using the Chi-squared test, many challenges were found to be significantly associated by sub-village. Cost had a P-value of 0.047 (df=3), resource availability had a P-value of 0.028 (df=3), and wildlife conflict had a P-value of 0.006 (df=3). Neighbor conflict additionally had a P-value of 0.053 (df=3). No significant associations were found between challenges and other demographic variables of age, gender, education, years farming, marital status, and ethnicity.

Benefits of Conservation Agriculture

Increased soil fertility, increased crop yield, and reduced soil erosion were the three benefits most frequently mentioned by interview participants (Figure 7). Reduced soil erosion was the most frequent answer, with 80.20% of respondents identifying this as a benefit, while increased crop yield was identified by 73.27% of respondents and increased soil fertility by 68.32%. Other responses included increased income (3.96%), fodder for animals (4.95%), less labor (0.99%), and firewood (0.99%). Of especial note is the respondent whom claimed less labor as a benefit, as labor was also considered to be a challenge for many participants. This discrepancy can be explained by the usage of different CA techniques by these farmers. Those that responded with less labor as a benefit only participated in cover cropping as a CA technique, which is generally less labor intensive than the other CA techniques of terracing and intercropping. The Chi-squared test revealed no significant associations between the demographic variables of age, gender, marital status, ethnicity, and education and awareness of the benefits of CA.

Availability and Usage of Support Systems

The most commonly named support system was the extension agency with 37.62% of respondents claiming to use this support system (Figure 8). The Center for Wildlife Management Studies (CWMS) (14.85%) and the greater village of Kilimatembo (6.98%) were also cited by many participants. Other

support systems were identified by 8.91% of participants, and 53.47% of participants claimed to use at least one support system. A Chi-squared test revealed no significant associations between utilization of support systems and age, ethnicity, sub-village, education, years farming, marital status, and gender.

Discussion

The large majority of farmers interviewed in the Karatu highlands implemented at least one CA technique on their farm. While the use of cover cropping and intercropping did not appear to have any patterns of distribution in the Kilimatembo village, the use of terraces was heavily dependent upon sub-village, with the sub-villages of Kilimatembojuu and Huduma being most likely to implement this technique. As terracing is the most labor and cost-intensive of the CA techniques used in the study area, it is likely that farmers who did not implement terracing were limited by the specific challenges of their area, such as cost, wildlife conflict, and neighbor conflict, as well as the educational resources and supports made available to them. Other variables such as wealth or average slope of farms in the area may have also contributed to the decision to implement terraces. However, there is insufficient data to corroborate this association.

Participants in each sub-village faced different challenges. While wildlife conflict was a significant challenge for CA in the sub-village of Kilimatembo juu, due to the proximity of this sub-village to Ngorongoro Conservation Area, resource availability was more likely to be a response in the sub-village of Gilala, and cost was most closely associated with the sub-villages of Huduma and Barabarani. In addition, conflicts with neighbors in the form of cattle grazing in fields and a lack of successful erosion mitigation strategies affecting neighboring fields, were a common complaint in the sub-village of Huduma, though these results were not of statistical significance. The availability of resources and support was thus likely dependent on area. This finding is similar to that of previous studies conducted in the Karatu and Kongwa districts (Lugandu, 2013). In turn, the use of more intensive CA techniques, such as terracing, is dependent on the socioeconomic status of the area, as well as the educational support and resources made available to farmers who wish to participate in these forms of CA.

The benefits of CA many noted were substantial, even though there were considerable challenges that the interview respondents faced while attempting to implement CA techniques. The benefits most often cited were increased soil fertility, increased crop yield, and reduced soil erosion. These findings are aligned

with additional studies which have found increased crop yield, increased soil fertility, and reduced soil erosion to be primary benefits of extended CA use (Lofstrand, 2005; Shetto and Owenya, 2007; Mkomwa et al., 2011). Many farmers showed knowledge of the link between these three benefits and the techniques of terracing and cover cropping; however, the majority of respondents did not immediately recognize intercropping as a CA technique. Intercropping maize and pigeon peas is a widely used crop production system in the Karatu highlands (Mkomwa et al., 2011). However, it is not often recognized as a CA technique or as providing positive benefits in the way of increased soil fertility and reduced soil erosion. This may be due to the use of intercropping as a farming strategy in the area long before CA became a common term. Intercropping is also a direct strategy to increase crop yield and is therefore more easily justified in comparison to cover cropping and terracing, which provide indirect benefits through reduced soil erosion and increased soil fertility. As many farmers possess limited background knowledge of the benefits of intercropping, increased educational outreach concerning this technique would likely benefit farmers in the area. Other benefits mentioned by interview respondents included increased income, fodder for animals, less labor, and firewood. As many of these benefits provide tangible relief in the way of money or increased resources, the inclusion of these benefits in further educational outreach would likely improve the responses of local farmers immensely. Farmers tend to emphasize economic benefits, so, by highlighting these more immediately tangible benefits, it increases the probability that farmers will choose to participate in CA (Lugandu, 2013). Most participants saw these benefits as outweighing the costs associated with CA, as 91.09% of respondents considered themselves very likely to implement or continue to implement CA techniques in the future. Additionally, many farmers noted that they would like to expand upon the practices they currently utilize. As anthropogenic climate change continues to alter weather patterns and threaten food security in the area, it is likely that many farmers will adopt CA as a means to increase crop yield.

Previous studies have found that higher temperatures and unreliable rainfall are the major consequences of climate change in East Africa (Shemsange et al., 2010). These climatic changes have resulted in flooding, drought, crop failures, livestock deaths, and intensification of climate sensitive diseases (Shemsange et al., 2010). Awareness of these climatic changes varied among participants. Respondents were more likely to identify unreliable rainfall as a climate change impact than higher

temperatures. These results may be due to the fact that rainfall variation is easier to recognize accurately without extensive equipment. In addition, large variations in rainfall are more likely to have direct impacts. For example, floods, droughts, and unpredictable rainfall can cause stunted growth and/or crop rot (Shemsanga et al., 2010). Many respondents mirrored this result, as the most common answer for the effects of recent climatic changes was reduced crop yield. However, there were no significant links between farmers that were aware of climate changes and those who implement CA techniques, suggesting that the use of CA as a climate change mitigation strategy is not widely known. As such, educational resources concerning the employment of CA techniques as climate change mitigation strategies are likely absent.

The only significant association between awareness of climatic changes and the demographic variables analyzed was that of age and less rainfall. Older participants were more likely to notice a decrease in rainfall over a ten-year period. However, due to the fact that all other correct climatic changes (variation in rainfall, less rainfall, drought, and higher temperatures) did not display any significant association to age or any other demographic variable, further investigation is needed before conclusions can be drawn about indicators of climate change awareness in the Karatu highlands.

Effects of these climatic changes were more likely to be associated with certain demographic features. Years farming was associated with both a varied planting season and difficulty getting seeds, and education was associated with difficulty getting seeds and the emergence of pests. While a low response rate for each of these effects may have skewed the results, it is also possible that the more complex nature of these effects was correlated to experience farming and a more advanced educational background. As a varied planting season, difficulty getting seeds, and an emergence of pests are all further extensions to the main effect of lowered crop yield which require a relatively thorough understanding of the agricultural system in the area, it is probable that education and years farming would increase knowledge of these effects. However, as noted, further investigation is needed before association can be satisfactorily established.

Conclusions and Recommendations

Considering these results, it is recommended that further educational programs are implemented in the area with the aim of teaching farmers the value of CA techniques as climate change mitigation

strategies. Previous studies have established the value of such long-term programs, as a period of four to five years is needed to attain full benefits of CA usage (Shetto and Owenya, 2007). As such, a plan for long-term educational and resource support of farmers should be undertaken by village leaders and community stakeholders.

Extension service workers are available in the area for information, advice, and education concerning CA techniques, though relatively few respondents (37.62%) named extension services as a utilized support system. The extension agents have thus not been fully used by the community, likely due to a lack of knowledge of the availability of these services. This problem is additionally exacerbated by the limited participation of the extension agents with local farmers. When asked whether there were support systems available in their area, 46.53% of participants responded no. As such, it is suggested that further outreach programs be implemented in order to reach the entirety of the Kilimatembo village population. Other studies have found that the most successful approach to long-term education is one that incorporates a family-based learning system, such as that upheld by farmer field schools (Mkomwa et al., 2011). These farmer field schools focus on the sharing of group ideals as well as the transfer of knowledge concerning CA techniques to all members of the household, and thus provide a cost-effective approach to CA promotion (Shetto and Owenya, 2007). Similar models would likely benefit the village of Kilimatembo and provide for the continuation and further implementation of CA.

Additionally, the creation of new partnerships with various organizations to help farmers obtain the necessary resources to employ these techniques would aid in the mitigation of some of the challenges the respondents of this study faced, and provide the additional support and resources necessary for more farmers to adopt new CA techniques as well as expand upon those that they already employ (Lugandu, 2013). This has already been undertaken to some extent at the village level through a partnership with the CWMS; however, the services provided by CWMS must be expanded or further partnerships with other organizations must be pursued before the needs of all farmers in the area are met.

While many people are eager to adopt CA techniques, capital is often considerably lacking, limiting the ability of these farmers to effectively implement CA (Mkomwa et al., 2011; Friedrich, 2012). Many farmers noted that the village had provided them with trees, but other resources such as elephant grass, tools, seeds, and start-up money for creation of terraces are noticeably absent and these partnerships

would benefit farmers in the area greatly by increasing accessibility to these necessities. As extension workers and village chair-people often have greater access to resources and the ability to create educational programs, partnerships and educational opportunities should continue to be sought at the village and sub-village level, as these partnerships are likely to benefit a majority of farmers in the area.

Study Limitations and Potential Sources of Bias

Possible biases include translation biases and mistranslation, interviewee biases, and researcher error. This study faced several limitations including lack of time, a small study area, limited sample size, and absence of diversity in occupations, ethnicities, and sexes. If this study continues, it would be beneficial to expand the study area in order to include a more ethnically, occupationally, and sexually diverse sample size. The use of other research methods, such as surveys and focus groups, should additionally be explored as a means for extending this study.

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Appendix I

Attitudes, Awareness, and Adoption of CA Techniques by Farmers in the Karatu Highlands

This questionnaire is intended to collect baseline information on the farmers who will participate in the climate change adaptation project executed by SFS-CWMS at Kilimatembo village, Karatu District.

Interviewer Background		
Interviewer's Name:	Date:	Time:
Location:	Translator's Name:	

Farm Type: Control Test Sub-Control

Interviewee Background			
Name:	Age:	Marital Status (Circle One): Single Married Widowed	
Gender: M F	***Ethnicity:***	***Hectares Farmed:***	
Years Lived in Area:	Years Farming:	***Years Terracing:***	
Crops Farmed (Circle All that Apply): Pigeon Peas Maize Rice Wheat Other (Specify): _____		Highest Level of Education (Circle Only One): None Primary School Secondary School University Tertiary Specify College Degree: _____	
Land Preparation Techniques (Circle All that Apply): Hand Hoe Plough Cattle Plough Tractor Plough	Land Inputs (Circle All that Apply): Chemical Fertilizers Organic Fertilizers	Seed Type: Local Seeds Improved Seeds	***# of Trees Planted:*** ***# of Trees Survived:***
2017 Crop Yield (List for each Crop): Pigeon Peas: _____		2016 Crop Yield (List for each Crop): Pigeon Peas: _____	

Maize: _____ Rice: _____ Wheat: _____ Other (Specify): _____	Maize: _____ Rice: _____ Wheat: _____ Other (Specify): _____

Climate Change Questions
Have you observed any changes in weather within the past ten years in the district? If so, what changes?
Have these changes affected your crop yield? If so, how?

CA Background Questions
Do you implement any CA Techniques (Circle One)? Yes No If yes, for how long? If yes, which ones?
What are the potential benefits of using CA techniques (Circle All that are Mentioned)? Increased Soil Fertility Increased Crop Yield Reduced Soil Erosion Less Labor Other (Please Specify): _____
How likely are you to implement/continue to implement CA techniques in the future? (Circle Only One): Very Unlikely Unlikely Neutral/Undecided Likely Very Likely
What difficulties do you experience or foresee in adopting CA techniques?
Do you receive any support from agricultural extension agencies to implement or promote CA?

Figure I

Karatu Highlands, Tanzania

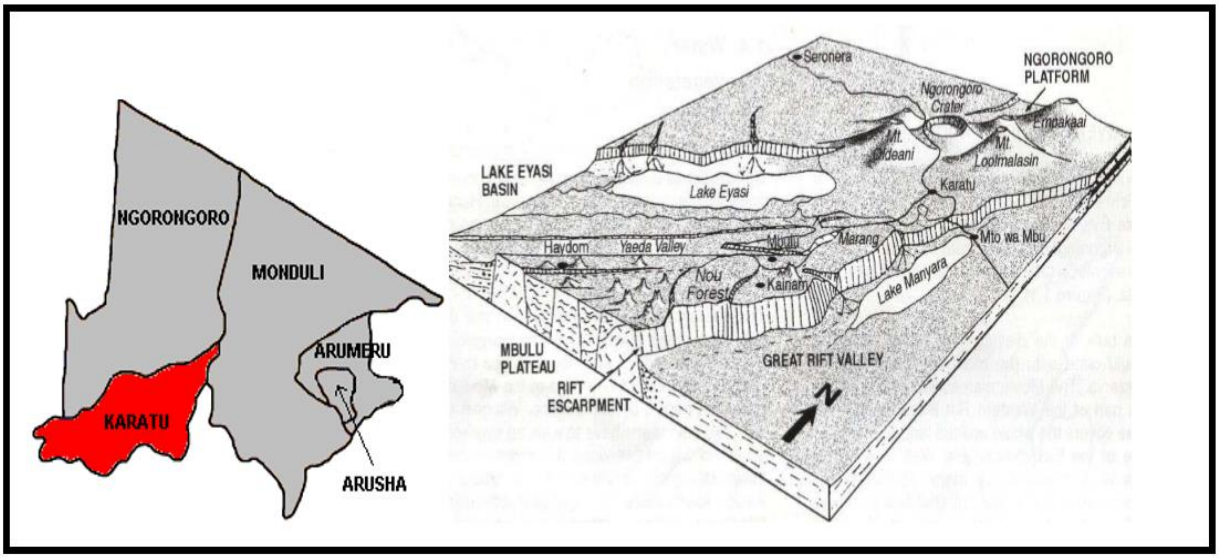

Figure 1: Map of Karatu District, including the study area of Kilimatembo (Richard and Marietha., 2007)

Figure II

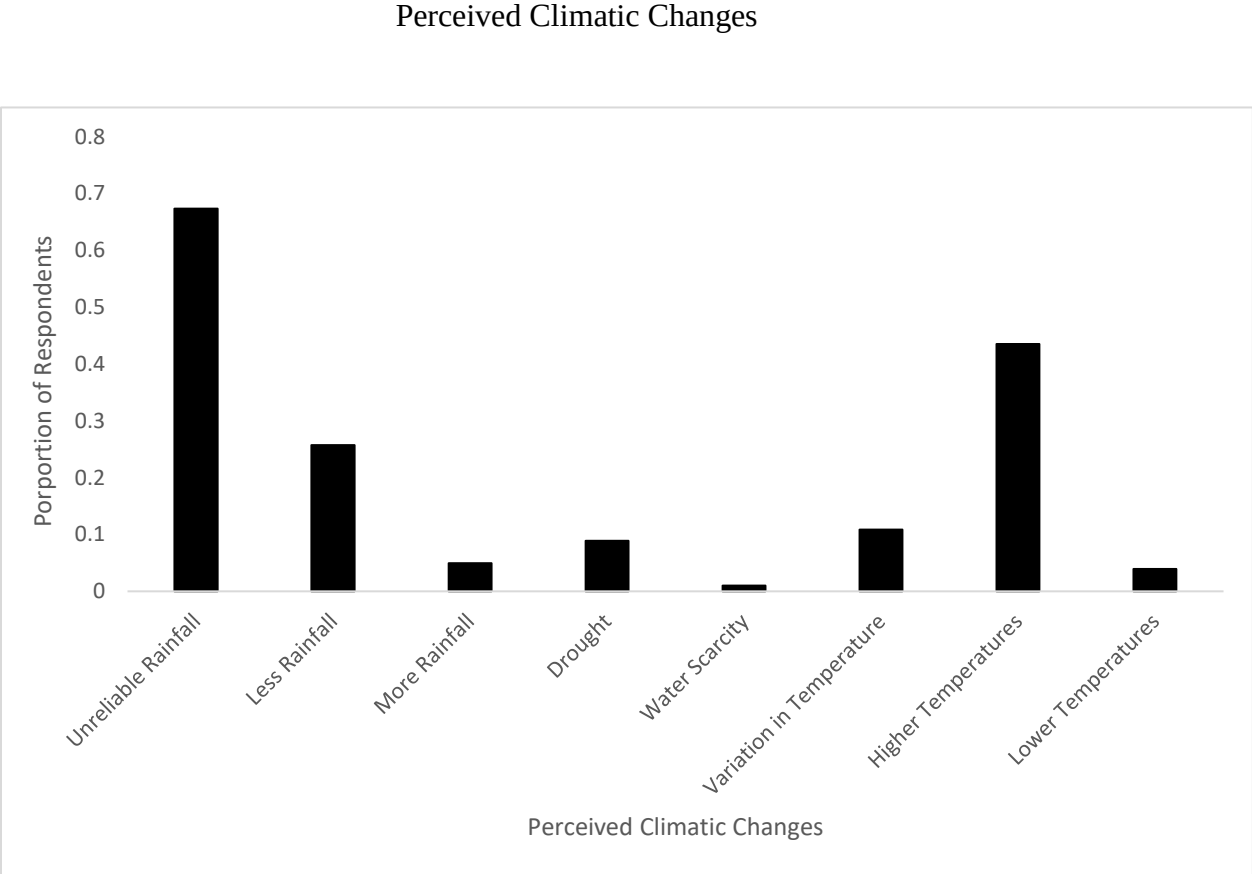

Figure 2: Percentage of respondents whom have observed various climatic changes within the past ten years in the Karatu district

Figure III

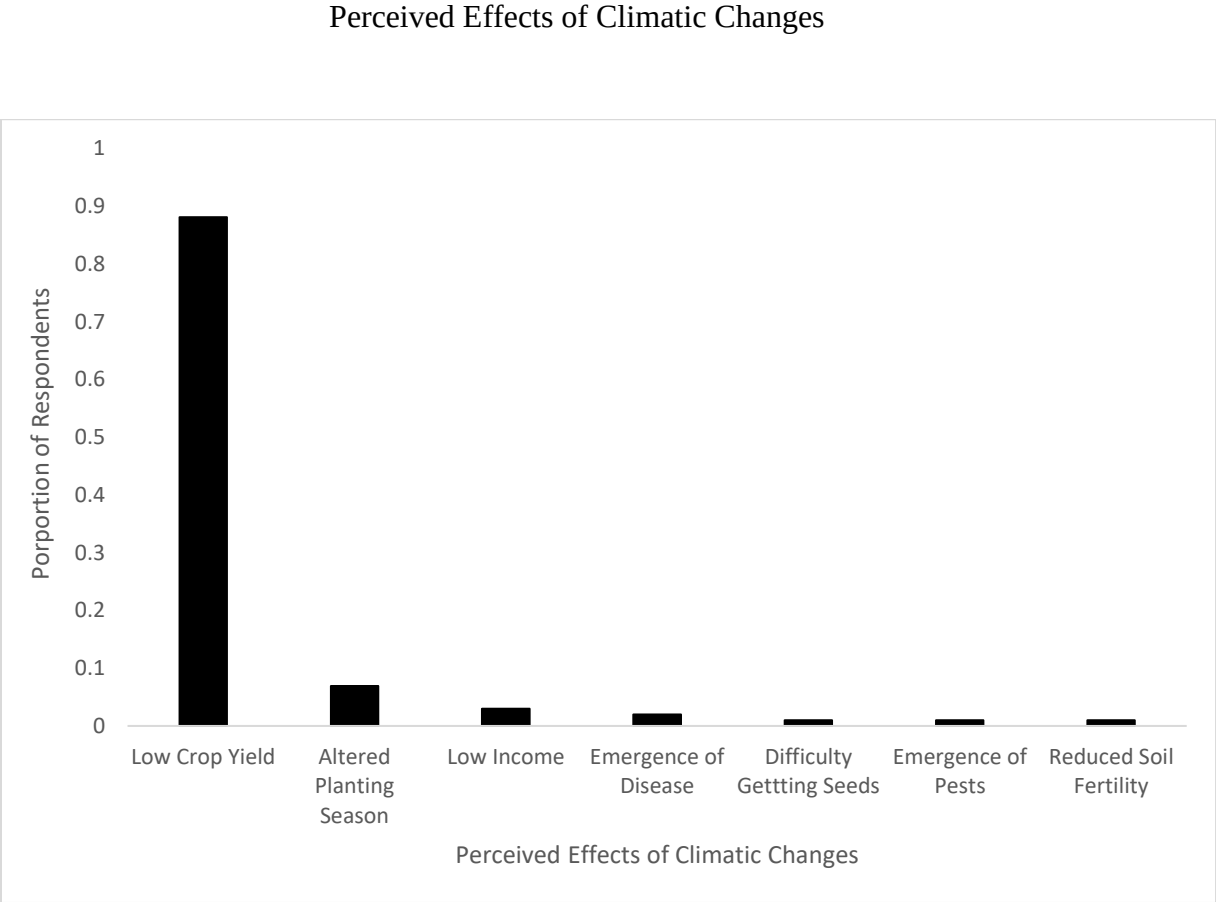

Figure 3: Percentage of respondents whom observed various effects on crop yield as a result of recent climatic changes

Figure IV

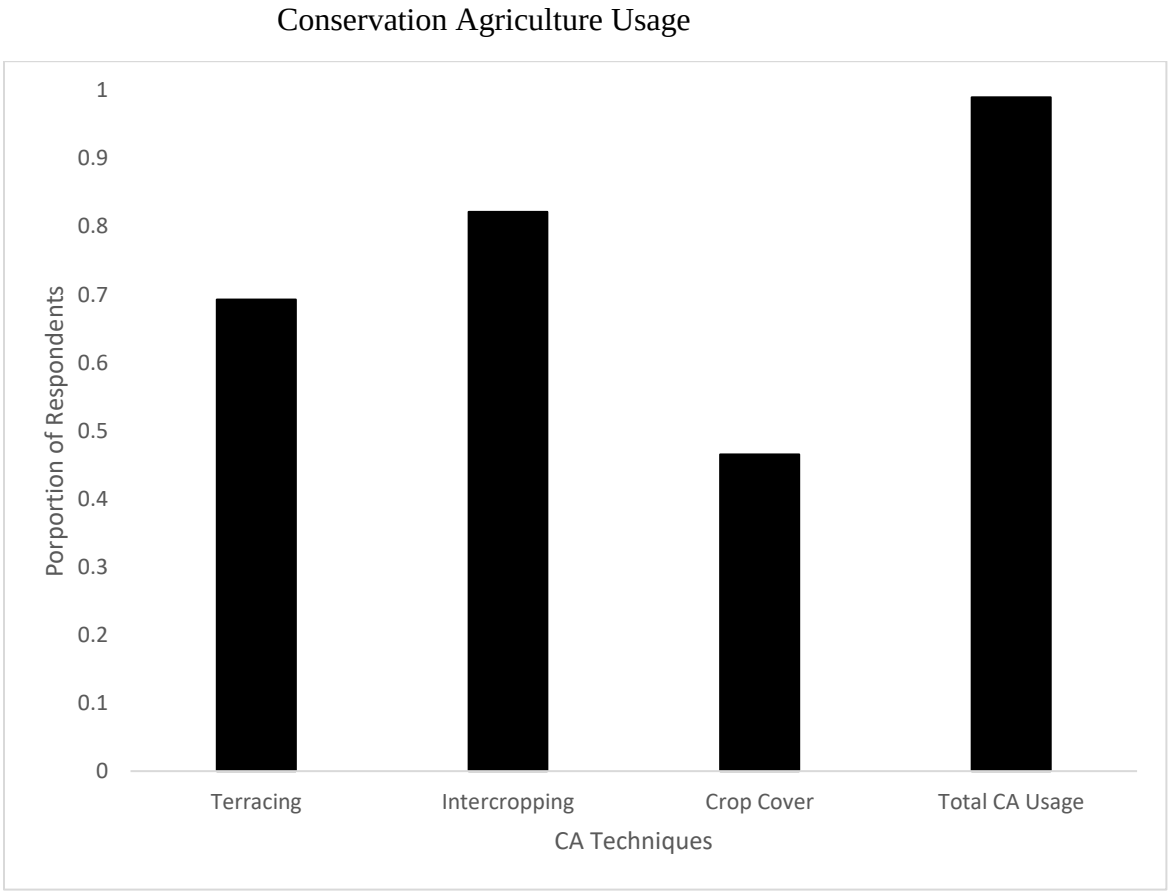

Figure 4: Percentage of respondents employing various conservation agriculture techniques

Figure V

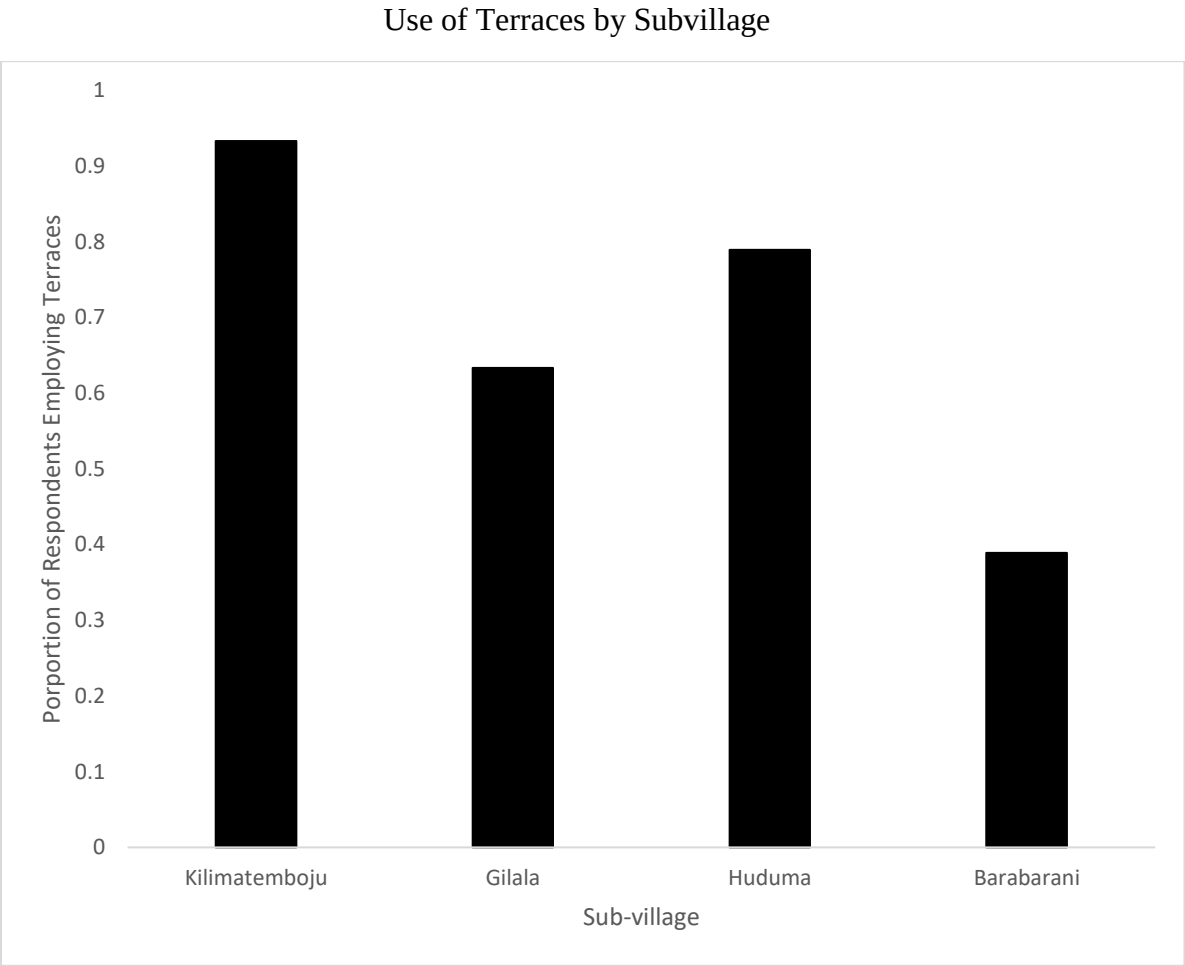

Figure 5: Percentage of respondents that employ terracing in each of the sub-villages sampled.

Figure VI

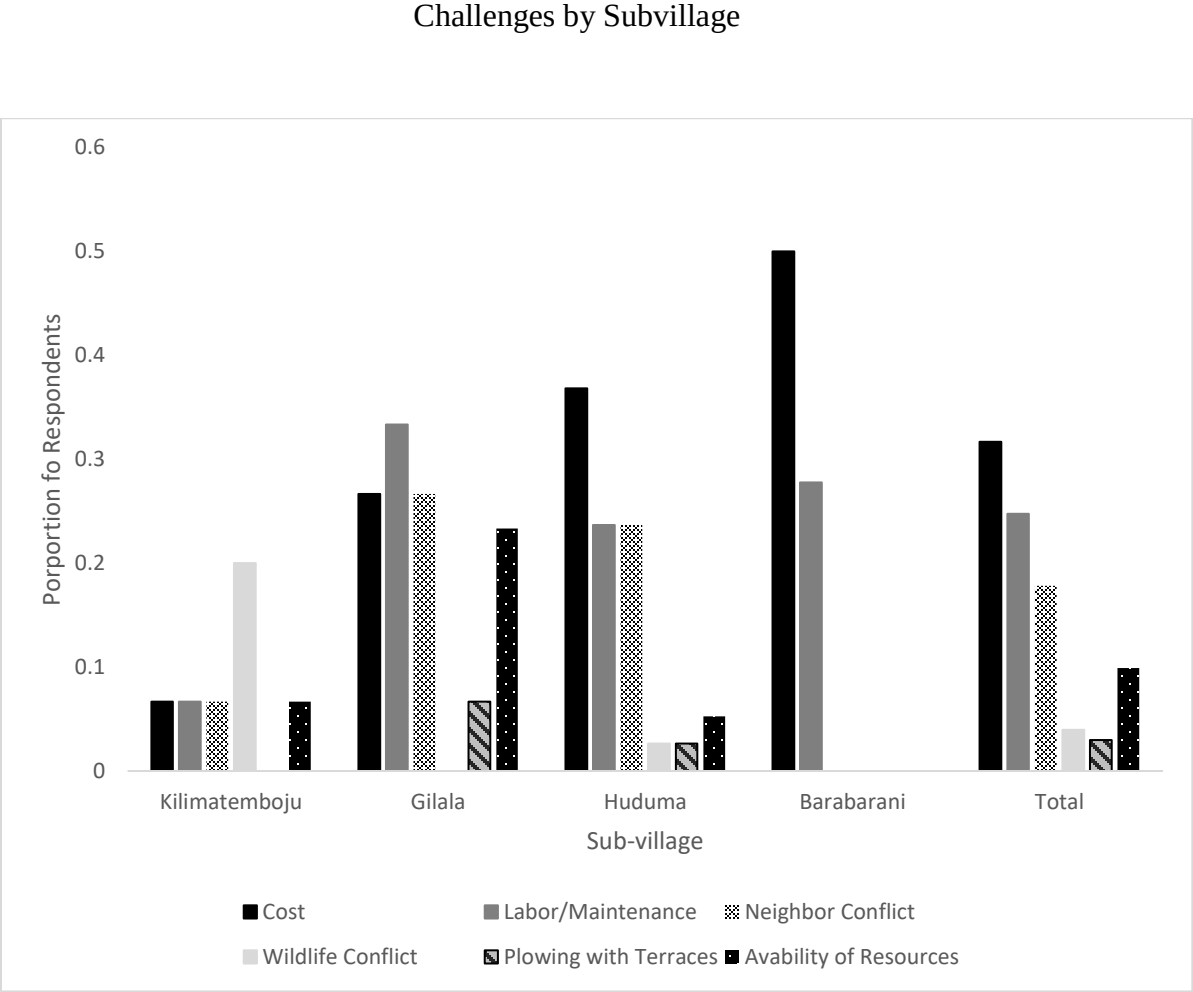

Figure 6: Percentage of respondents identifying challenges in the four sampled sub-villages

Figure VII

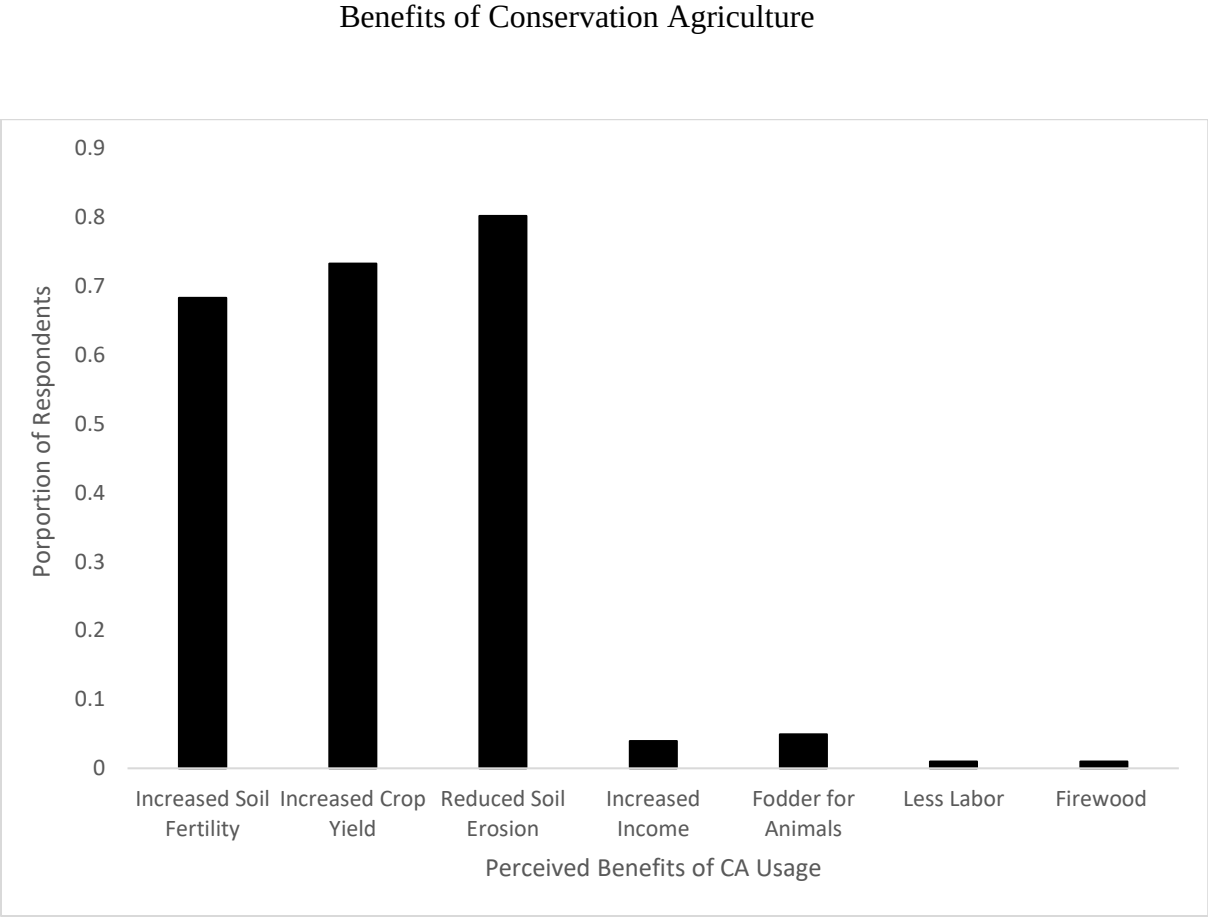

Figure 7: Percentage of respondents identifying various benefits of CA

Figure VIII

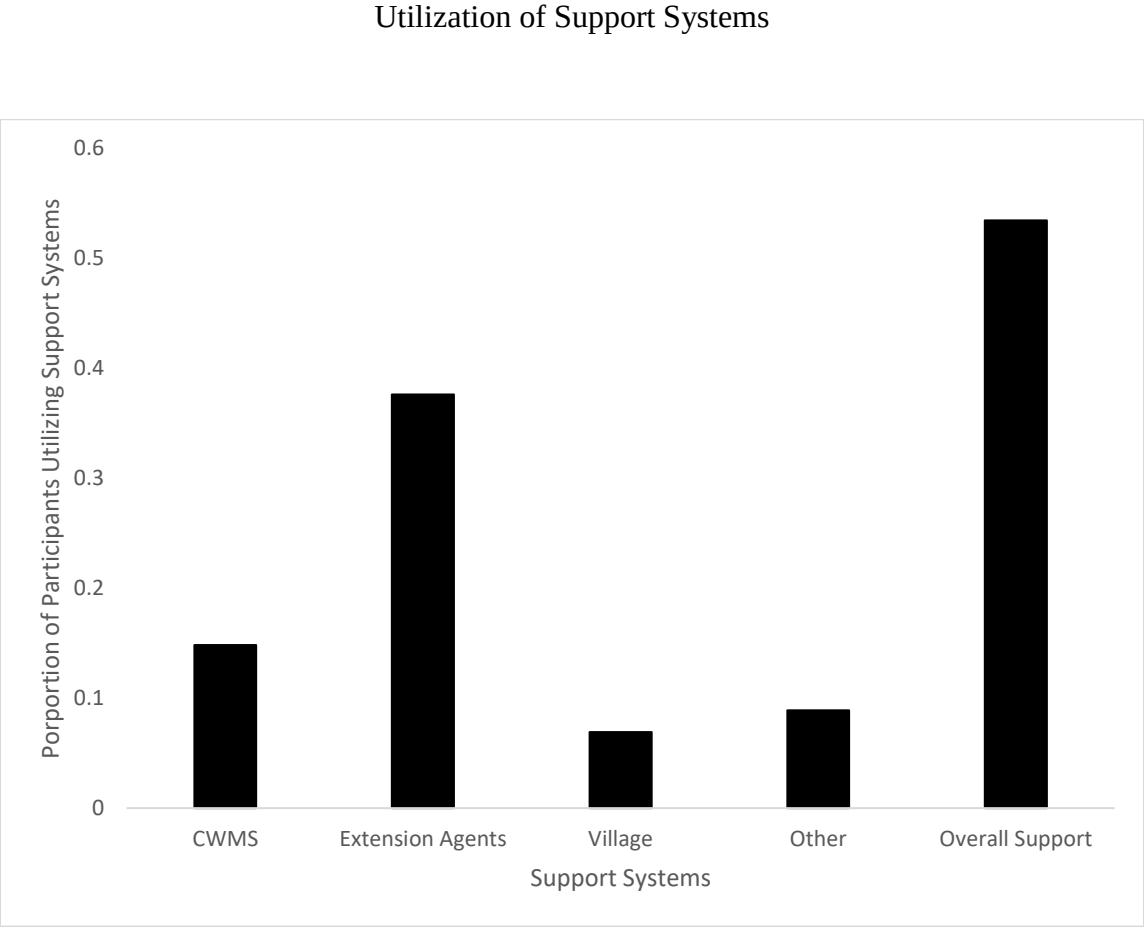

Figure 8: Percentage of respondents utilizing various support systems