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Smallholder farmers' resilience capacity to climate change shocks at Kikombo ward in Dodoma region

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Abstract

Despite the fact that, climate change is a threat worldwide, semi-arid areas are more vulnerable to its distress. This study was conducted at Kikombo Ward in Chamwino District to examine the local community's resilience capacity to climate change shocks using 73 families which were randomly selected. Cross tabulation, correlation, and Binary logistic regression were used to study the variables using IBM SPSS version 20. The results revealed that 97% of the respondents were aware of the impacts of climate change on agriculture, but only 43.7% were practicing Climate-Smart Agriculture (CSA). Even though 43.7% of smallholder farmers reported to practice CSA, their crop production was still low which raises questions about the effectiveness and challenges faced in the application of CSA. The findings further disclosed that most of the CSA practices were not done in the farmers' plots or were done partially. Challenges facing smallholder farmers in practicing CSA included; a lack of knowledge on the proper application of the CSA practices (p=0.023) as well as the cost of tools and inputs (p=0.034). The findings indicate that, most of the households had low resilience capacity to climate change shocks and the community's ability to absorb climate change shocks depended mainly on income accrued from small businesses. Services provided to promote the adoption of CSA were inadequate and therefore insignificant in enhancing the adoption of CSA. In this regard, the government and development partner's support are highly recommended for optimum CSA application in the community.

Keywords: Climate change, Climate-Smart Agriculture, Community resilience, Semi-arid area, household livelihood

1. Introduction

Agriculture is an essential sector for the production of food and it supports the livelihood of many people in the world, specifically in developing countries (Martey *et al.*, 2020, Ng'ang'a *et al.*, 2021). In Tanzania, agriculture plays a vital role in the economy as the sector employs about 80% of the total population, who are primarily smallholder farmers (Lema and Majule, 2009; FAO, 2017; Kurgat *et al.*, 2020). This sector is crucial for achieving Sustainable Development Goals (SDG, 2030) number 1 and 2, which are: no poverty (to less than 420 million people globally) and zero hunger by 2030, respectively. However, the number of hungry and poor people is increasing due to increased land degradation and climate change impacts (Habtewold, 2021). An increase in the world's population goes hand in hand with increased food demand which has further exacerbated the food crisis and poses a threat to the ability of agriculture to feed the growing population. In most African countries including Tanzania, agricultural activities rely primarily on rainfall, making agriculture productivity uncertain, especially in semi-arid environments which are more vulnerable to climate change shocks (Kangalawe and Lyimo, 2013; Ogada *et al*., 2020).

Climate change has been reckoned as a major threat to agriculture, food security and ultimately the livelihoods of millions of people across the globe (IPCC, 2014; Campbell *et al*., 2016; Lewis 2017; Makate, 2019). Various studies have indicated that agricultural production could be significantly wedged due to an escalation in temperature (Lobell *et al*., 2012), changes in rainfall patterns (Prasanna, 2014), and variations in the frequency and intensity of extreme climatic events such as floods and droughts (Brida and Owiyo, 2013). The estimated effects of both historical and future climate change on cereal crop yields in different regions indicate that the yield loss can be up to 35% for rice, 20% for wheat, 50% for sorghum, 13% for barley and 60% for maize depending on the location, future climate scenarios and projected year (Porter *et al*., 2014). A decrease in agricultural food production, increased oil prices and decreased agricultural land have resulted in amplified food prices and famine worldwide (Fan, 2011; Djido *et al*., 2021).

Climate change poses threats to local food production and family well-being resulting in malnutrition, hunger, and persistent poverty in the Kikombo ward in the Dodoma region of Tanzania where this study was conducted. Rural communities that depend entirely on subsistence agriculture are the most affected population by climate change impacts (Lema and Majule, 2009; Kangalawe and Lyimo, 2013; Djido *et al*., 2021). Women form the majority of rural dwellers and depend solely on subsistence rain fed-agriculture as their primary source of livelihood (Kalumanga *et al*., 2014; Shemdoe *et al*., 2015, Yadav and Lal, 2018). Where rainfall will be less, lower yields will be produced, thus negatively affecting household food security and the general well-being of the community. Women, children, and the disabled are the most hard-hit by the effects of climate change since their ability to adapt is relatively low compared to men and youths (Abegunde *et al*., 2020; Autio *et al*., 2021). In response to climate change challenges to food and nutrition security, the United Republic of Tanzania has undertaken various initiatives including the development of the National Climate Change Response Strategy 2021 – 2026 (URT, 2021); National Adaptation Programmes of Action (URT, 2007), the National Climate Change Strategy (2012), the Agriculture Climate Resilience Plan (2014–2019), and the National Climate-Smart Agriculture Programme (2015–2025), together with the Nationally Determined Contributions (2016) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) (FAO, 2017). The Climate-Smart Agriculture (CSA) guideline was framed according to these existing documents, reiterating the government's commitment to making the agricultural sector climate-smart by 2030 (FAO, 2017).

Climate-smart agriculture aims to sustainably increase productivity, reduce climate change vulnerability and reduce emissions of greenhouse gases that cause climate change while protecting the environment against degradation and enhancing food security (FAO, 2010; Lipper and Zilberman, 2018). The study by Imran *et al*. (2019) in Pakistan disclosed a significant difference between farmers who have adopted CSA and non-adopters with the likelihood of reducing the cost of production by 12% and 21%, respectively, without declining productivity. For customization and efficiency, the Climate-Smart Village approach (CSV) design was developed which focuses on developing a portfolio of practices and technologies (Weather-smart activities, Water-smart Seed/breed smart, Carbon/nutrient-smart practices, and Institutional/market smart activities) dealing with food security, adaptation and mitigation and on climate-information services (Aggarwal *et al*., 2018).

The adoption of CSA practices also requires appropriate institutional and governance mechanisms to facilitate the dissemination of information and ensure broad participation among smallholder farmers. The presence of an enabling policy and institutional environment helps to address barriers to the adoption of CSA (www.fao.org/3/ap401e/ap401e.pdf). Furthermore, Totin *et al*. (2018) argued that, promoting CSA technologies through integration of the technology packages with institutional enabling elements can provide potential opportunities for valuable scaling of CSA options.

Climate Smart Agriculture (CSA) is one of the approaches applied in Tanzania in different areas, including the Chololo Ecovillage, to cope with the challenges of climate change (Ecovillage, 2014). It is essential because of its triple potential benefits of improved productivity and high income, reduction or removal of greenhouse gases, and improved household food security (Ecovillage 2014; Ephraim and Fadhili; 2015, Wekesa, 2017; Amadu, *et al*., 2020a; Habtewold, 2021; Agbenyo, 2022). Non-adopters of CSA have been reported to use a considerable number of seeds, farm fertilizer, frequency of pesticide sprays, high amount of water, and labour hours compared to adopters of CSA and yet end up getting a low yield (Imran *et al*., 2019). Although the government of Tanzania and other stakeholders have been promoting several CSA practices in the country, the implementation of these initiatives has not been well accentuated in various areas across the country, as entailed by Kurgat *et al*. (2020). Kikombo ward and the Dodoma region as a whole, which is more susceptible to climate change impacts due to its semi-arid nature, have been among the targeted areas for CSA projects including the Ecovillage project. Thus. the present study was designed purposefully to unleash this knowledge gap through an exploratory study among small-scale farmers (adopters and non-adopters of CSA) in the area.

2. Material and Methods

2.1. Study area

The study was conducted at Kikombo ward on the outskirts of Dodoma city. Kikombo ward is located at latitude 6°

19' 14" South and longitude 35° 59'37" East at an elevation of 1,041m above sea level. The area is rural by nature and falls under a semi-arid climate in the central zone of Tanzania which receives a total annual rainfall ranging between 395 mm and 780 mm. Rainfall distribution is uni-modal and starts in late November, peaks in December/January, and ends in April. However, there have been variations in recent years, there has been a delay in the start of the rain until late December and a dry spell in February/March. The ward often experiences a long dry spell during the growing season, which sometimes lasts for 40 days. The dry season in this ward typically lasts for six months, from May to early November. The monthly maximum and minimum temperatures are about 29.6°C in February and 17.6°C in July, respectively (Msanya *et al.*, 2018). The nature of the study area and its vulnerability to climate change shocks sound similar to Gujarat in India according to the study by Angom *et al.* (2021).

The area has brown loamy and sandy soils, which are characterized by low content of both nutrients and organic matter due to the granitic parent materials and low vegetation cover. According to the physiognomic classification, the most predominant natural vegetation types at Kikombo include; woodland (0.5% of the area), bushland (about 50%), wooded bushland/grassland (15%), pure grassland (5%) and permanent swamp vegetation (15%) (Msanya *et al.*, 2018). The main reason for choosing Kikombo ward as the study area is that, the ward is within a semi-arid zone with limited water resources, which compels farmers to rely on rain-fed agriculture making them more vulnerable to climate change shocks.

2.2. Target study population and sampling frame

Based on the objective of the study, the targeted population was the families of smallholder farmers in the Kikombo ward. These smallholder farmers who solely rely on agricultural activities to sustain themselves are the ones who are highly affected by climate change's effects. The sampling frame was the list of smallholder farmers in the ward from which the sample for the study was randomly drawn.

2.3. Study design and Sampling

The design of this study was non-experimental, a cross-sectional survey design. The survey design allowed for a random selection of households in the Kikombo ward considering the main occupation is crop farming. The sample size of 73 farmers was randomly chosen to represent the families of smallholder farmers in the ward for the study. Key informants, (Agriculture Extension Officer (AEO) and Mtaa Executive Officer (MEO) were purposively selected to render key information about the study objective.

2.4. Data collection

Data were collected through face-to-face interviews and observation methods to get a real picture of the situation on the study topic. Primary data concerning the adoption of CSA, practices and significance of climate-smart agriculture interventions on communities' resilience to climate change effects were collected. Secondary data on the CSA program implemented at Kikombo village included qualitative data on trends in harvests and income and quantitative data on CSA practices and challenges were also collected.

2.5. Data analysis

Data analysis was achieved through descriptive and inferential statistics. Linear regression and correlation were used to measure the association between CSA practices and community resilience quantities by indicating the strength of their relationship. The study examined the correlation between incomes accrued by farmers and the number of years in practicing CSA. The correlation between these two variables was achieved through the use of the Pearson correlation model as given by Equation 1.

$$r = \frac{\sum(xi-x)\,(yi-\hat{y})}{\sqrt{\sum(xi-x)2\,(yi-\hat{y})2}} \quad \text{.......... (1)}$$

Where, r = correlation coefficient, xi= values of the x-variable in a sample, x=mean of the values of the x-variable, yi = values of the y variable in a sample, ŷ = mean of the values of the y variable.

On the other hand, the study used a Binary Logistic regression model (equation 2) to analyze the challenges facing smallholder farmers in practicing CSA. The choice of the model in this study was subjected to the normal distribution of variables as well as the number of choices in which respondents had to select one variable which affected the practice the most. The Binary Logistic Regression model was formulated using three dummy variables representing the challenges experienced by farmers in practicing CSA whereby Predictors (Constants), Affordability of CSA tools and inputs; extension services; and knowledge of CSA. The Binary Logistic regression model is characterized by a set of binary dependent variables X that is equal to 1 if the farmer experience that challenges and 0 otherwise, such that:

$$\text{Log}\,(P/(1-P)) = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \quad \text{.......... (2)}$$

Whereby P is a probability of an event, β are the parameters for estimation; X_1- Capital, X_2- Knowledge, X_3 – extension services, X_4 – Cost.

Similarly, the Binary logistic regression model (equation 3) was used to assess the contribution of income assets and services to the farmers in absorbing climate change shocks, whereby income assets (small business, livestock, land) owned by households were determined and analyzed. Extension services (education on climate change and advice from extension officers, improved seeds and weather information on adaptation before planting season) were also analyzed. Those who agreed to have benefited from assets and services in absorbing climate change shocks were coded (1), and those who did not benefit from the above-mentioned parameters were coded (0). In this case, the predictors (constants) included; community accessibility to extension services and income assets for absorbing climate change shocks as illustrated in equation 3.

$$\text{Log}\,(P/(1-P)) = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \quad \text{.......... (3)}$$

Whereby: P is a probability of an event (income asset to enhance coping with climate change), β are the parameters for estimation; X_1- Livestock selling, X_2- small business income, X_3-Livestock consumption, X_4-Land rent for income generation.

3. Results and Discussion

3.1. Household characteristics of respondents

The results for various household characteristics such as sex, age, marital status, education and main economic activities are shown in Table 1. The total number of responses attained from household respondents was 71 of which 2 did not return the questionnaires. Among the respondents, 60 were males and 11 were females and only 31 respondents practiced CSAof which males were twenty-four (24) and females were seven (7). The results in Table 1 indicate no statistically significant association between sex and practicing CSA as $p>0.05$. The age category of 31-40 years constituted the higher percentage (46.5%) of the respondents in the study area indicating the energetic labour category with a significant association with practicing CSA ($p<0.01$).

The study results further revealed that the majority of the respondents in the Kikombo ward were married couples (97.2%), with the majority (78.9%) having primary education. Although these statistics were not significantly associated with CSA practices still indicate that the majority of the studied population is literate signifying that they can easily adapt to the CSA practices introduced to them. For most of the rural households in developing countries, crop farming and animal keeping are the dominant economic activities which were also revealed in this study where 76% of respondents deal with crop farming only, while 24% deal with both crop farming and animal keeping. Interviews with the respondents revealed that most of the smallholder farmers adopt crop and livestock production to increase their source of income at the household level as one way of withstanding climate change shocks. A similar study by Abegunde *et al.* (2020) in South Africa considered integrating crop production and livestock keeping to be an effective technique for enabling smallholder farmers to adopt CSA practices though it requires more monitoring and management practices.

Table 1: Characteristics of household respondents (n=71)

		Do you practice CSA?		Total	χ2
		No	Yes		p- value
Sex	Male	36	24	60	
	Female	4	7	11	
Total		40	31	71	0.094
Age (years)	21-30	11	3	14	
	31-40	23	10	33	
	41-50	4	12	16	
	51-60	1	3	4	
	61 and above	1	3	4	
Total		40	31	71	0.000
Marital status	Single	1	0	1	
	Married	39	30	69	
	Widow	0	1	1	
Total		40	31	71	0.239
Education level	Primary education	32	24	56	
	College	0	1	1	
	No formal education	8	6	14	
Total		40	31	71	0.479
Main economic activities	Crop farming	33	21	54	
	Both crop farming and livestock keeping	7	10	17	
Total		40	31	71	0.08

3.2. Farmers' Knowledge of climate change and Response to the Adoption of CSA

Findings from this study revealed that about 97.2% of the farmers understand the concept of climate change while only 2.8% of them were not aware of it. These findings are in good agreement with the studies by Jianjun *et al*. (2015) in China and Djido (2021) in Ghana, who reported that farmers are aware of the effects of climate change on agriculture. They mentioned increasing temperature, changing rainfall patterns, and decreasing yields as some of the effects. Despite the understanding of the effects of climate change on agriculture, the initiatives among smallholder farmers towards resilience to climate change impacts are a major problem in the study area, unlike the study by Djido *et al*. (2021) in Ghana, which recounted farmers to be highly interested in the pilot project for CSA practices. Based on the study findings, the CSA practice rate in the study area is too low, where only 43.7% of the respondents were practicing it.

Amadu *et al*. (2020b) affirmed a high rate of adoption of CSA up to 74% through the Wellness and Agriculture for Life Advancement (WALA) project in Malawi. The determinants for adoption were social capital and fertilizer subsidies, which indicate high institutional support, something that is lacking in the Kikombo ward. In Kenya, Ojoko *et al*. (2017), Pagliacci *et al*. (2020) in Italy and Barnes *et al*. (2019) in the EU found that years of education and membership in a social group were significant variables influencing the level of adoption of CSA among smallholder farmers, which presents a new concept that organising smallholder farmers in social groups can propel them to practice CSA as it becomes much easier to organize them.

3.3. CSA practices in Kikombo

The practices of CSA in Kikombo have been inconsistent and inefficient as indicated in Table 2 that 30(97.8%) never practiced mulching, 29(94.5%) never practiced pruning, 23(74.2%) kept on conducting burning fields, 22(71.0%) never practiced contour farming. The CSA practices remained in theory and not in practice for most of the smallholder farmers in the study area, similar to other regions of the country, as highlighted by Kurgat et al. (2020). Fentie and Beyene (2019), in their study in Ethiopia, revealed that despite the release of different improved crop varieties, several farmers were still planting the improved varieties in a traditional way (broadcasting method). This elucidates the failure of farmers to adhere to the best practices of practicing CSA, which leads to low gains from CSA despite spending years believing that they are practicing CSA.

Table 2: CSA practices to farmers (%) (n=31)

CSA Practice	Never	Very Little	Moderate	High	Very high	Total
Ploughing	12(39.7)	0(0.0)	2(6.5)	12(38.7)	5(16.1)	31(100)
Planting by rows	3(10.7)	3(9.7)	20(64.5)	3(9.7)	2(5.5)	31(100)
Use animal manure	9(29.0)	0(0.0)	7(22.6)	10(32.3)	5(16.1)	31(100)
No field burning	23(74.2)	0(0.0)	0(0.0)	3(9.7)	5(16.1)	31(100)
Use improved seeds	7(23.6)	0(0.0)	11(35.5)	10(32.3)	3(9.7)	31(100)
Contour planting	22(71.0)	2(6.5)	4(12.9)	1(3.2)	2(6.5)	31(100)
Intercropping	15(48.4)	0(0.0)	0(0.0)	12(38.7)	4(12.9)	31(100)
Crop rotation	29(94.5)	0(0.0)	0(0.0)	1(3.2)	1(3.2)	31(100)
Terracing	25(81.6)	0(0.0)	1(3.2)	3(9.7)	2(6.5)	31(100)
Pruning	29(94.5)	0(0.0)	0(0.0)	1(3.2)	1(3.2)	31(100)
Mulching	30(97.8)	0(0.0)	0(0.0)	0(0.0)	1(3.2)	31(100)

3.4. CSA practices and income generation

Most of the households have remained to generate income between Tanzanian shillings (TZS) 100,000-200,000 per annum despite practicing CSA for more than five years, while one (1) farmer reported generating TZS 400,000-500,000 per annum despite practicing CSA for only three years (Figure 1). This implies that CSA practices were not fruitful to the majority of the farmers, contrary to the expectations which raised the question of "why". It is then anticipated that if this trend continues fewer and lesser farmers will adopt CSA. Findings by de Jalón *et al*. (2017) from nine Sub-Saharan Africa (SSA) countries, including Tanzania, found that almost 100% of the households presented a likelihood of adopting CSA at a rate lower than 50%. This indicates that it is very likely that a large number of rural households in SSA might not adopt any of the CSA practices in the near coming years if no efforts are made especially awareness creation and financial support. The study by Agbenyo *et al*. (2022) in Ghana showed that adopting irrigation practices lead to an increase in household income of 8.6% and 11.1%, respectively for cocoa farmers. Furthermore, the study by Nkumulwa and Pauline (2021) revealed that practicing CSA resulted in increased crop production and income, which in turn supported farmers in enhancing food security, purchasing production tools, livestock, payments for medical services, school fees, and the construction of modern houses. These findings provide a clear indication that if CSA practices are properly implemented, they can play a big role in enhancing smallholder farmers' resilience and capacity to withstand climate change shocks.

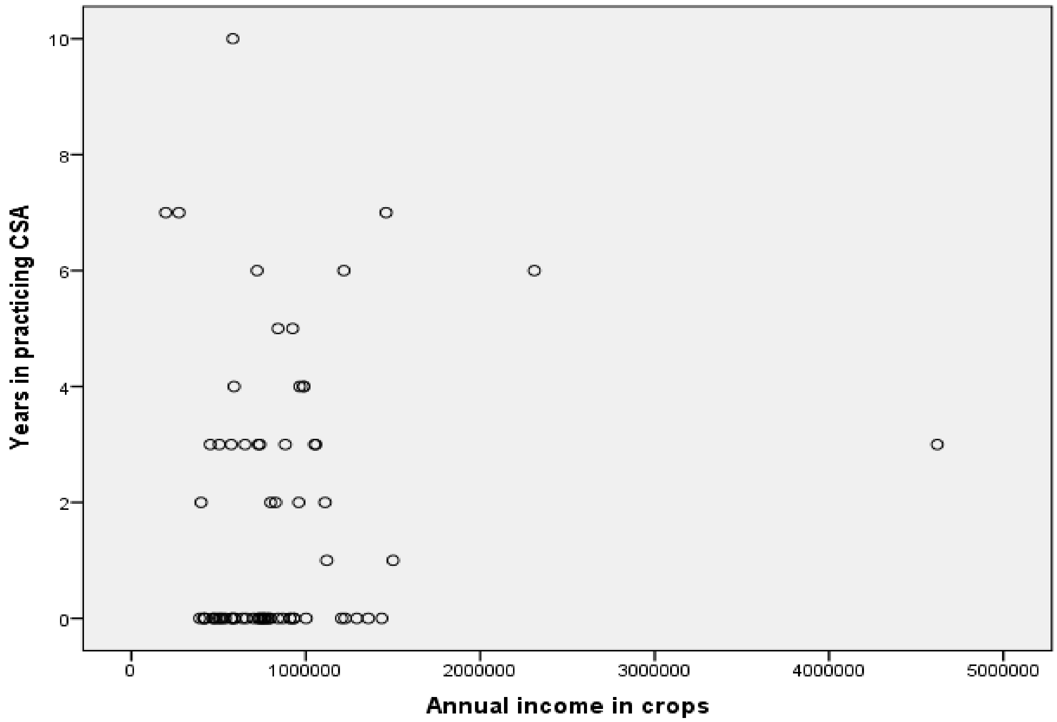

Figure 1: Association between years in practicing CSA and income (TZS) generated from crop cultivation

The results in Table 3 indicated no significant association between the years in practicing CSA and the income accrued from crop farming and small business with p=0.276 and p=0.4, respectively. This can be ascribed to the fact that despite practicing CSA for years, the yields have remained low due to partial applications of CSA as justified previously (Table 2). This has led to low-income gains, which might be discouraging others to practice CSA. This was also supported by Kangogo *et al.* (2021), who stated that "The benefits of CSA practices hinge on farmers adopting multiple practices. simultaneously to maximize the synergies among CSA practices."

Furthermore, Kangogo *et al.* (2021), recommended that, to accomplish the successful adoption of CSA, agricultural extension departments, development agencies, and policymakers need to integrate agronomic and entrepreneurship (social and business-oriented) knowledge into their training services for farmers. A similar approach is promoted through the CSV approach as expressed by Aggarwal *et al.* (2018). This is because farmers engage themselves in small businesses without prior knowledge and financial resources to support the planned businesses and are not aware of the financial risks of the businesses they engage in. Hence, instead of increasing income, they increase the burden of diversifying the economy with limited knowledge and resources.

Table 3: Correlation testing between years of practicing CSA and income

		Years in practicing CSA	Annual income from crops	Annual income in small business
Years in practicing CSA	Pearson Correlation	1	0.131	-0.101
	Sig. (2-tailed)		0.276	0.400
	N	71	71	71
Annual income from crops	Pearson Correlation	0.131	1	0.048
	Sig. (2-tailed)	0.276		0.693
	N	71	71	71
Annual income in small business	Pearson Correlation	-0.101	0.048	1
	Sig. (2-tailed)	0.400	0.693	
	N	71	71	71

3.3. Challenges in practicing CSA

Farmers at the Kikombo ward were interested in practicing CSA but encountered various challenges that limited their capacity to implement it fully as indicated in Table 4. The regression model (equation 2) was used to analyze the challenges, that impede smallholder farmers at Kikombo ward to harness fully the benefits of CSA. The analysis revealed that the knowledge of practicing CSA (p=0.023) and the cost of CSA inputs and tools (p=0.034) are significant challenges for smallholder farmers in the Kikombo ward to adopt CSA efficiently (Table 4). This was further illuminated by findings obtained through observations where it was noticed that most of the farmers who claimed to practice CSA were still using traditional seeds, failed to implement contour farming effectively and didn't practice proper pruning among other practices.

Table 4: Regression analysis of the challenges for the adoption of CSA

	Challenge	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	Capital	-.516	.952	.294	1	.588	.597
	Knowledge	-1.970	.867	5.169	1	.023**	.139
	Extension services	-.224	.564	.157	1	.692	.800
	Cost	-1.933	.912	4.494	1	.034**	.145
	Constant	2.341	1.217	3.702	1	.054	10.389

Dependent Variable: Do you practice CSA
** Significant at 5%

During focus group discussions, it was aired out that practicing CSA is still a problem in the Kikombo ward as the knowledge given is not satisfactory enough to put farmers in practice. Similar results were reported by Abebe *et al*. (2013) in Ethiopia who indicated that access to credible knowledge carries major weight in the adoption of the technology. Zakaria *et al*. (2020) in Ghana divulged that participation in climate change capacity building training was key in influencing farmers to practice CSA which cements the truth that, access to knowledge on CSA practices is an appealing factor for smallholder farmers to practice CSA. This was also supported by the study by Aryal *et al*. (2018) in India.

On the other hand, the affordability of CSA inputs especially improved seeds was a challenge as well. The analysis shows a significant association between the practice of CSA and the affordability of tools at p=0.034 (Table 4). It should be noted that, during the implementation of appropriate farming techniques which require knowledge, there are also costs to incur in buying seeds and sometimes animal manure for better yields. With the increasing demand for improved seeds and manure, the prices of these inputs have been increasing rapidly which makes it difficult for the smallholder farmers to afford them. These findings are in good agreement with the findings of the pilot study in Kenya by Mutoko *et al*. (2015), which established that lack of adequate knowledge, unavailability of seeds, and lack of funds to implement some of the improved practices are among the major constrictions to the adoption of CSA practices. Wassmann *et al*. (2019) reported that among the top five interventions that could enhance the adoption of CSA among rice farmers relying on rain-fed agriculture in Laos is the supply of improved rice seeds that are tolerant to both drought and weeds. The findings in this study are also supported by Khatri-Chhetri *et al*. (2019) who reported from India that CSA interventions did not get high priority due to various factors including limited access to knowledge and climate-resilient seeds/breeds. With a comparable view, the study by de Jalón *et al*. (2017) specified that financial and physical capital are the most powerful predictors of the adoption of the selected CSA practices. Therefore, with limited financial and physical capital, CSA is hardly achieved.

3.4. Assets related to absorbing climate change shocks

Assets are considered a backup during an income crisis as they can be transformed into money or used as collateral. The results in Figure 2 show the assets that were used by farmers at Kikombo ward to absorb the climate change shocks on their livelihood. These assets were livestock (65%), savings (4%), small businesses (7%), and charcoal marking (1%). On the other side, 23% of the respondents were not conversant with the assets related to absorbing climate change shocks in the study area. Most of the primary assets (such as livestock keeping) on which the community depends are also affected by climate change which makes the community's ability to cope with climate change much harder.

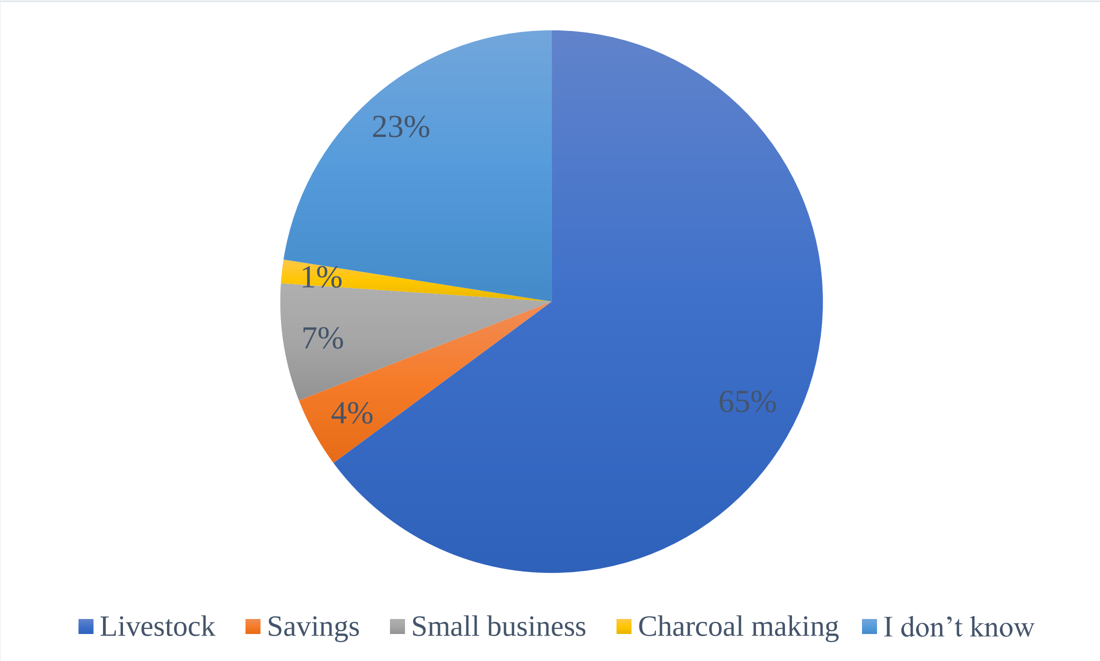

Figure 2: Assets related to absorbing climate change shocks

3.5. Ability of the community in absorbing climate change shocks

In the Kikombo ward, community esilience depends greatly on household efforts to generate income to sustain itself during climate change shocks. The application of assets reported by farmers in Table 5 included; selling livestock for buying food (66.2%), buying food using money obtained from small businesses (11.3%), slaughtering livestock for eating purposes (1.4%) and renting land to obtain money for household uses (1.4%). Nevertheless, the results showed that 19.7% of the respondents were not aware of the use of assets to offset climate change shocks.

Table 5: Application of assets during climate change shocks

Assets	Frequency	Percent (%)
Selling livestock and buying food	47	66.2
Buying food using money obtained from small business	8	11.3
Slaughtering livestock for food	1	1.4
Renting land and obtaining money	1	1.4
I don't know	14	19.7
Extension services		
Education and advice from extension officers	6	8.5
Provision of improved seeds	2	2.8
Information on weather adaptation before the planting season	12	16.9
I 'don't know	51	71.8

On the other hand, the results in Table 5 show that 51(71.8%) of the respondents were not familiar with the extension services available to be accessed by farmers to help them to cope with climate change shocks. Those who are aware have already accessed various services, including; information on planting season (16.9%), education and advice from extension officers (8.5%), and the use of improved seeds (2.8%) as means of absorbing climate change upsets. In the study by Jianjun *et al.* (2015) in China, the farmers' adoption strategies for CSA were based on farming activities, including adopting new drought-resistant crop varieties and increasing investments in irrigation infrastructure. In Kenya, Kangogo *et al.* (2021) revealed that irrigation and crop calendars were significant techniques used by smallholder farmers to cope with climate change shocks. On the contrary, in the Kikombo ward, most of the smallholder farmers shift completely from agricultural activities and focus on selling livestock or engaging themselves in small businesses to earn a living in times of climate change stress. The study by Kangogo *et al.* (2021) supports the idea of moving away from farm activities and depending on other assets as coping strategies because the probability of adopting practices that require skilled labor and financial resources requires farmers to invest in assets that may not be within their reach. For instance, searching for production knowledge or finance is often sought from financial institutions.

In the Kikombo ward, extension services for adopting CSA were not efficiently provided to the smallholder farmers (Table 5). However, practitioners' support such as extension services is key to promoting the adoption of CSA with ultimate tangible results (Martey *et al.*, 2020). In this study, most of the farming households were unaware of the services provided and the few who benefited were not satisfied with the level of support provided. This was justified by the key informant (MEO) who stated:

"*Households depend on limited resources; hence, if the household size is large; then the assets and extension services do not meet the overall needs of the households. The seeds and other incentives the government offers are hardly enough for a household with six members and other dependants*".

Despite using various assets and extension services provided to enhance community resilience to climate change distresses, still they were not sufficient to ensure community resilience as the binary regression analysis in Table 6 indicates a significant association only with small businesses among other measures of offsetting climate change shocks at p=0.005. The responses indicate that the use of assets and income from small businesses, do help them to cope with climate change shocks which can be attributed to the fact that small businesses are among the sectors that are not severely affected by climate change. Other measures such as selling livestock and slaughtering livestock for food have not been helpful to this community. This makes sense because with prolonged droughts caused by climate change, livestock a also highly affected. The malnourished livestock are hard to sell and even when slaughtered the meat quantity and quality are poor. Furthermore, consuming livestock and land renting were insignificant because they were not common practices.

Table 6: Binary Logistic regression on income assets application on absorbing climate shocks

Income assets		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	Livestock	.085	.614	.019	1	.889	1.089
	Smallbusn	1.891	.669	7.994	1	.005	6.629
	Livconsum	22.585	40192.970	.000	1	1.000	6433219568.285
	Land rent	22.585	40192.970	.000	1	1.000	6433219568.285
	Constant	-1.467	.541	7.363	1	.007	.231

a. Variable(s) entered on step 1: Livestock, smallbusn, Livconsum, Landrent.

4. Conclusion and Recommendations

4.1. Conclusion

The Kikombo ward community's climate change resilience is still a problem both in theory and in practice. In this ward few smallholder farmers are aware of CSA and few of them practice the methods partially with none effectively implementing CSA practice. With the great opportunity of programs promoting and enhancing CSA in vulnerable areas, the failure of smallholder farmers to adopt is a puzzle. While most of the smallholder farmers still fight to uproot themselves from poverty and diseases, climate change has become an extra burden for them, especially for those who solely rely on agriculture to earn their living. Most of the smallholder farmers are not aware of the services provided by the government to enhance community resilience to climate change shocks. This knowledge gap on the importance of CSA in adopting

CSA practices limits the capacity of smallholder farmers to produce and earn a living. On the other hand, the services provided by the government do not meet the requirements of households which impedes them from practicing full CSA. Therefore, they have not been in a good position to harness fully the benefits of practicing CSA. The capacity of most households to confront the shocks of climate change is still low making them more vulnerable to the climate change tragedy.

4.2. Recommendations

As the impacts of climate change are overwhelming, there is a need for the government, NGOs and development partners to build capacity among the smallholder farmers such as by creating awareness about the importance of CSA and training them on how to implement CSA practices. Also, they should be encouraged to form social groups that can facilitate their access to credits from various financial institutions for better implementation of CSA as well as undertaking other economic activities to enable them to withstand climate change shocks. Social pressure has been reported to induce the implementation of CSA among smallholder farmers; hence, the formulation of social groups that bring together smallholder farmers is highly recommended. Access to extension services is highly advocated since it has been reported to play a big role in enhancing the practice of CSA among smallholder farmers in various countries.

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