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Perceptions of Climate Change among Small-Scale Farmers in Kasambandola, Katete District, Zambia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Climate change poses a significant global development challenge, particularly for communities that rely on rain fed agriculture for their livelihoods, such as small-scale farmers. This study investigated small-scale farmers' perceptions of climate change manifestations in the Kasambandola community of Katete District, in Eastern Province of Zambia. It employed a convergent mixed methods research design (QUAL+quant) where quantitative data played a complementary and supportive role to the qualitative data. The data was collected using semi-structured questionnaires, key informant interviews and focus group discussions. The sample comprised of 91 small scale farmers and 6 key informants. Qualitative data were analyzed thematically, while quantitative data was analyzed using Excel.

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The findings highlighted farmers' perceptions of climate change as characterized by unpredictable rainfall patterns, shorter rainy seasons, and extreme weather events. These perceptions were corroborated by meteorological data, which showed significant variations in rainfall patterns over time. Respondents reported that these climatic changes severely impacted agricultural productivity, with maize yields—once ranging from 15–20 oxcarts per farmer—declining to just 2–8 oxcarts. In response, farmers implemented a mix of traditional practices, such as making heaped lines and expanding their farms through deforestation, alongside modern techniques like ripping, the *Gamphani system*, improved crop varieties, and crop diversification. While these adaptation strategies have shown promise, the study recommended the need for small-scale farmers to fully embrace sustainable agricultural practices to enhance resilience and mitigate the adverse effects of climate change.

Keywords: Climate change; small-scale farmers; droughts; floods.

1. INTRODUCTION

Climate change is one of the most pressing global challenges of the 21st century, with profound impacts on various sectors, including agriculture. Besides its impact on crop yields and production, climate change also affects the natural resources, primarily land and water that are fundamental to agricultural production. Water availability is expected to decline due to climate change, while agricultural water consumption is predicted to increase by 19% in 2050 (Siamabele, 2021, Aryal et al., 2020). Climate change poses a major and growing threat to global food security. The expected effects of climate change – higher temperatures, more frequent extreme weather events, water shortages, rising sea levels, ocean acidification, land degradation, the disruption of ecosystems and the loss of biodiversity–could seriously compromise agriculture's ability to feed the most vulnerable, impeding progress towards the eradication of hunger, malnutrition and poverty (Food and Agricultural Organization, 2026). This has been caused by a number of factors including but not limited to the industrial and agricultural revolutions which have led to the development of a variety of chemicals ranging from insecticides, pesticides, fungicides and bactericides (Department for Environment, Food and Rural Affairs, 2006). However, the demand for these chemicals led the manufacturers to manufacture the chemicals without considering the sustainability of using such chemicals and environmental impacts (Chilonda et al., 2013).

The agricultural sector is particularly vulnerable in developing countries like Zambia, where over 90% of small-scale agricultural production is rain-fed, making it highly susceptible to climate variability (Hamududu & Ngoma, 2020). The adverse effects of climate change on agriculture threaten food security, livelihoods, and overall socio-economic stability, particularly for rural communities.

Scientific evidence overwhelmingly confirms that climate change disrupts environmental and ecological systems, affecting key aspects of daily life, including agriculture, water supply, and biodiversity. However, much less attention has been given to how small-scale farmers perceive and respond to climate change manifestations (Otitoju and Enete, 2016) especially in the Zambian context. Farmers' perceptions are shaped largely by their direct interactions with the environment and personal observations, while scientists rely on meteorological data and advanced analyses (Morton, 2007). Integrating these two perspectives can offer a more comprehensive understanding of climate change and its impacts. For example, Marin (2010) highlights that combining local observations with scientific records often reveal critical insights that might otherwise be overlooked.

Rainfall variations, one of the most observable impacts of climate change, disproportionately affect rural farming households that depend heavily on rain-fed agriculture. Studies in Ghana (Adaawen, 2021) and South Africa (Modise, et al., 2022) reveal that small-scale farmers perceive climate change through phenomena such as unpredictable rainfall and rising temperatures. However, these perceptions differ significantly across regions due to varying climatic conditions and socio-economic contexts (Negash, 2016). These regional differences underscore the need for localized studies that explore farmers' unique perceptions and adaptation strategies.

In Zambia, small-scale farmers face significant challenges from climate change, including reduced crop yields, soil erosion, and the increased prevalence of pests and diseases (Bryan, et al., 2009). Despite these challenges, research on how small-scale farmers perceive and adapt to climate change in specific regions remains scarce (Siamabele and Manda, 2024). This study focuses on the Kasambandola community in Katete District, examining farmers' perceptions of climate change manifestations and their implications for agricultural productivity and adaptation strategies. By exploring these perceptions, this study aims to contribute to the formulation of localized and effective climate adaptation strategies, ensuring the resilience and sustainability of rural agricultural systems (IPCC, 2021, IPCC, 2013).

As noted by Tesfahunegn et al. (2016)**,** farmers' perceptions of climate change in Ethiopia were linked to shifts in temperature and rainfall patterns, with many perceiving changes that would affect crop yields and water availability (Simelton et al., 2023). Similarly, Banerjee (2015) observed that farmers in semi-arid regions of India reported shifts in seasonal weather patterns and extreme events, influencing their agricultural practices and adaptation strategies (Ndlovu et al., 2020).

2. RESEARCH CONTEXT

Climate change presents a global developmental challenge with disproportionate impacts on communities that rely heavily on natural resources for their livelihoods, such as small-scale farmers. These communities are among the most vulnerable to climatic variability, as they lack the resources and infrastructure needed to mitigate its adverse effects. While extensive research has focused on the scientific dimensions of climate change, fewer studies have examined local communities' perceptions and how these shape their adaptive responses (Nakashima, et al., 2018, Whitmarsh & Capstick, 2018).

Local perceptions of climate change are often informed by direct experiences, such as shifts in rainfall patterns, temperature fluctuations, and the frequency of extreme weather events. For instance, the IPCC (2022) notes that rural communities often observe changes in seasons and increasing incidences of droughts, floods, and other weather extremes. Studies have also shown that farmers' perceptions are deeply influenced by their socio-economic realities and environmental interactions. In Ghana, farmers identified high temperatures and unpredictable rainfall as key indicators of climate change (Adaawen, 2021), while in Ethiopia, perceptions varied across regions, with some farmers noting changes in rainfall patterns and others not perceiving any significant shifts (Negash, 2016). These findings suggest that localized perceptions are critical for designing effective adaptation strategies tailored to specific contexts.

In Zambia, the agricultural sector is characterized by low productivity, declining soil fertility, and poor farming systems, which are exacerbated by climate change (Siamabele, 2019. Small-scale farmers, who form the backbone of the country's agricultural economy, are particularly vulnerable to these challenges. Many rely on traditional farming practices that are ill-equipped to cope with changing climatic conditions. To address these challenges, farmers have adopted various adaptation strategies, such as crop diversification, conservation agriculture, and integrated crop-livestock systems (Siamabele, 2021; Bryan et al., 2009; Deressa et al., 2011). However, the success of these strategies often depends on farmers' awareness and understanding of climate change, of which, in rural Zambia, there is still a dearth of literature.

The Kasambandola community in Katete District represents a typical rural farming area in Zambia that is highly dependent on rain-fed agriculture (District Agricultural Coordinator, 2013). This community faces numerous challenges from climate variability, including reduced crop yields, food insecurity, and declining incomes. Understanding how farmers in this community perceive climate change is crucial for developing effective adaptation strategies that align with their lived experiences and socio-economic realities. Additionally, incorporating local knowledge into climate change studies can provide valuable insights into community-specific risks and opportunities, strengthening resilience and adaptive capacity (Kaganzi, et al., 2021, Cohn, 2017). Adaptation has become more than a requirement for sustainable development, considering that the majority of rural households depend on agriculture for their livelihoods (Siamabele & Manda 2024). Changes in the climate directly implicate the agricultural productivity of the small-scale farmers who have weak fall-back strategies. Largely, the majority of the people in developing countries find their livelihoods from agriculture (Siamabele, 2021). By integrating local observations with scientific insights, the study seeks to also contribute to the growing body of knowledge on climate adaptation in rural contexts and inform policies and programs aimed at enhancing agricultural resilience.

3. AIM OF THE STUDY

The primary aim of this study was to find out small-scale farmers' perceptions of climate change manifestations and adaptation strategies in the Kasambandola community of Katete District, in Eastern Province of Zambia.

4. STUDY AREA

This study was conducted in the Kasambandola community of Kapangulula ward, located in Katete district, Eastern Province, Zambia. The community primarily relies on rain-fed agriculture for sustenance and livelihoods, making it particularly vulnerable to the effects of climate change. According to the District Agricultural Coordinating Office (DACO, 2022), Kasambandola community is designated as Zone 1 and comprises 10 villages with a total of 910 registered farmers under the Farmer Input Support Program (FISP). Despite being one of the largest zones in the ward, it ranks among the lowest in terms of agricultural productivity (DACO, 2022). The map below illustrates the location of the study area.

5. METHODOLOGY

5.1 Research Design

This study used mixed methods research methodology. It is an approach which combines both qualitative and quantitative data. The aim was to provide a more comprehensive understanding of the research problem.

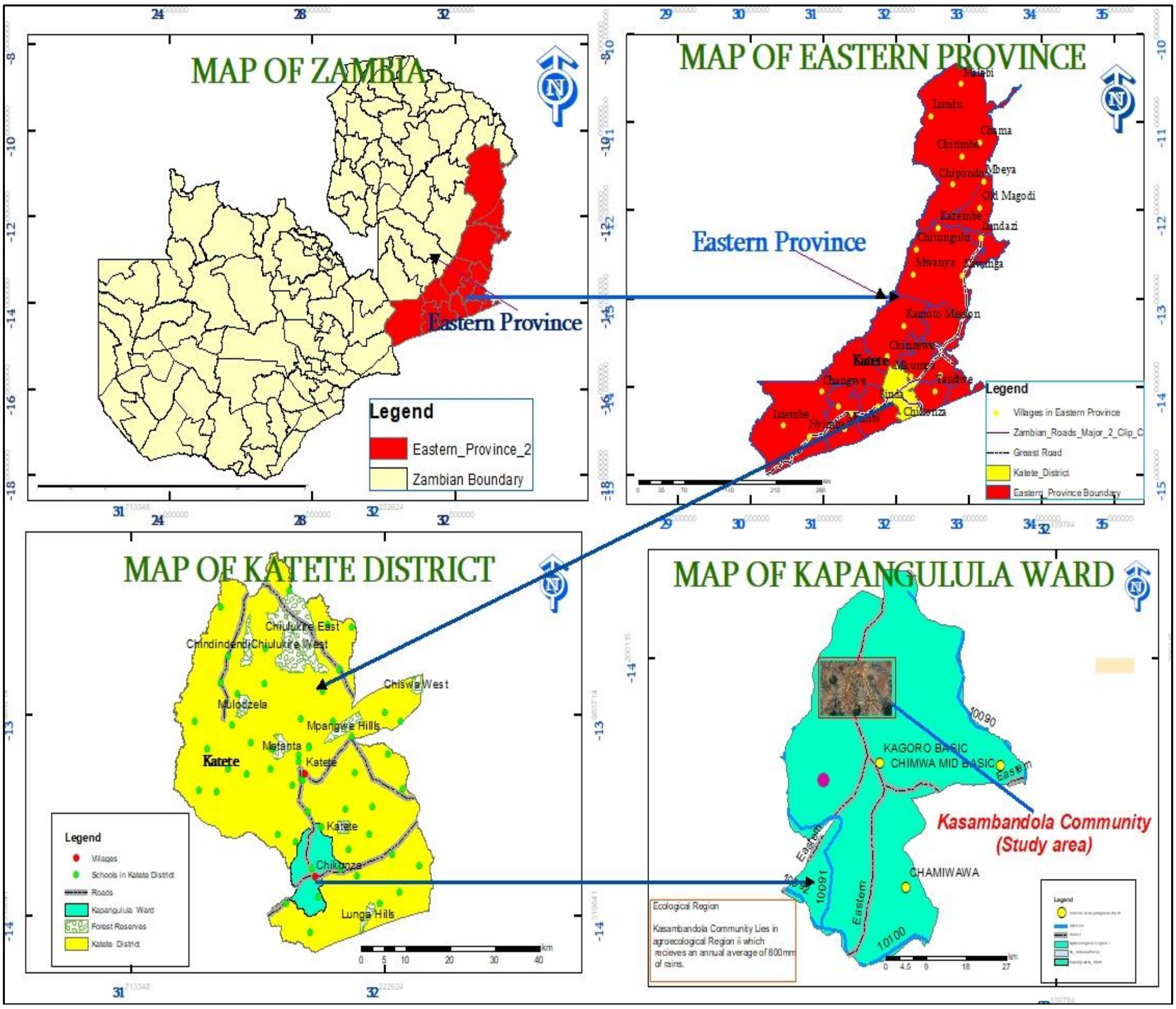


Fig. 1. Map of Zambia Showing the Location of the Study Area
Source: Zulu, 2023

Specifically, it used convergent parallel mixed methods design with purposes of drawing comparisons between various perspectives (Creswell, 2013) relating to climate change. The study was more qualitative (QUAL+quant) with the quantitative data playing a complementary and supportive role. This design was also chosen in order to cross-validate and corroborate findings from both data types. Also, the nature of the topic at hand required diverse perspectives showing both perceptions and statistical trends (Dooly et al., 2017).

A simple random sampling technique was used to select study participants for the quantitative component of the study. This was because a sampling frame was readily available which showed a list of all registered small scale farmers under the Farmer Input Support Program (FISP) in Kasambandola community. This list was obtained from the District Agricultural Coordinating Office (DACO). A representative sample size was determined using a statistical sampling technique (Krejcie & Morgan, 2022). The formula used for sample size calculation is as follows:

$$n = \frac{N}{1+N(e)^2}$$

Where:

- n= sample size
- N= total population (910 registered farmers)
- e= margin of error (10% at a 95% confidence level)

Calculation: $n = \frac{N}{1+N(e)^2}$

$$n = \frac{910}{1+910(0.1)^2}$$

n =90.20

The total sample size is ≈ 91

The total sample size for small scale farmers was 91 participants. The 91 small scale farmers were sampled using the lottery technique. Based on the list of 910 registered small-scale farmers, each name was written on a separate slip of paper. These were then placed into a box and shuffled thoroughly to ensure randomness. The required number of slips was then drawn from the box one at a time, without looking. Afterwards, the names on the slips were noted and constituted the sample (Research Pages, 2023).

From this same sample, 30 small scale farmers were further purposively selected to participate in three (3) focus group discussions, with each focus group comprising of 10 small scale farmers. The selection of these farmers was based on such criteria as length of stay in the community. Preferably, those who had stayed a minimum of 10 years were better suited for focus group discussions. The duration of stay in the area was deemed sufficient for the farmers to observe the changes regarding climate change and agricultural productivity. Furthermore, six (6) key informants were purposively selected to participate in key informant interviews. The selected key informants included: two community leaders, two Ministry of Agriculture officers, one meteorological officer and one Non-Governmental Organisation (NGO) officer involved in agricultural activities.

Three data collection methods were used in this study. For the quantitative component, a semi structure questionnaire was used to collect data from small scale farmers. The questionnaire captured demographic information, farming practices, perceived effects of climate change, and adaptation strategies. Questionnaires ensured uniformity in the questions asked and data collected. For the qualitative component, three Focus Group Discussions (FGDs) were conducted with a total of 30 small-scale farmers (10 participants per group). These discussions provided in-depth insights into farmers' experiences and perspectives on climate change and adaptation strategies. FGDs allowed researchers to explore perceptions of climate change in more detail, uncovering insights that were hard to capture through questionnaires by building on each other's ideas. For the key informants, key informant interviews (KIIs) were conducted with individuals who were deemed to possess specialized knowledge, expertise, or experience related to the study topic. The purpose of these interviews was to gather detailed insights and nuanced understanding from knowledgeable sources within Kasambandola community.

Qualitative data from FGDs and key informant interviews (KIIs) was analyzed thematically. Both KIIs and FGDs were recorded using audio recorders with participants' consent. The audios were then transcribed and analyzed manually. The different categories and codes grouped to generate sub-themes. Sub-themes were then further grouped to come up with main themes. For quantitative data, it was analyzed using

Microsoft Excel. Data trends and relationships between climate change and farming yields were examined and summarized using graphs, tables, and charts. Further, historical climate data and yield records were also incorporated to identify patterns over time. These were obtained from secondary sources such as the Msekera weather station (Msekera Research Institute, 2023).

6. RESULTS

Respondents' characteristics: Respondents' characteristics were analyzed based on gender, age, education level, and length of residence in the area.

Gender and age of respondents: The study had male and female participants which helped to understand on whether there were gender disparities in small scale farmers' perceptions of climate change and how this might affect the type of adaptation strategies they employed. Table 1 below, show the gender and age distribution of small scale farmers.

From the findings presented in Table 1, it was revealed that majority of participants were women. This aligned with the national trend where women in agriculture constituted about 78% (UNDP, 2024). With regard to age, most of the participants were aged between 40 - 49 years. Their ages which ranged from 30 to 80 years helped to collect data from people that had different experiences regarding climate change and agricultural productivity. This helped to understand climate change across different generations and farming trends over time.

Respondents' level of education: Small scale farmers' level of education is important in shaping their perceptions of climate change and their adoption of adaptation strategies. Education directly impacts their perception, and adaptive capacity in responding to climate change. The table shows small scale farmers' level of education.

The table shows that majority of the small scale farmers went up to primary school level, which also speaks to low literacy rates in rural

Table 1. Gender and age distribution

Gender	Female	Male	Total
	57	34	91
	63%	37%	100
Age range (Years)	30 – 39	31	34%
	40 – 49	32	35%
	50 – 59	16	18%
	60 – above	12	13%
	Total	**91**	**100**

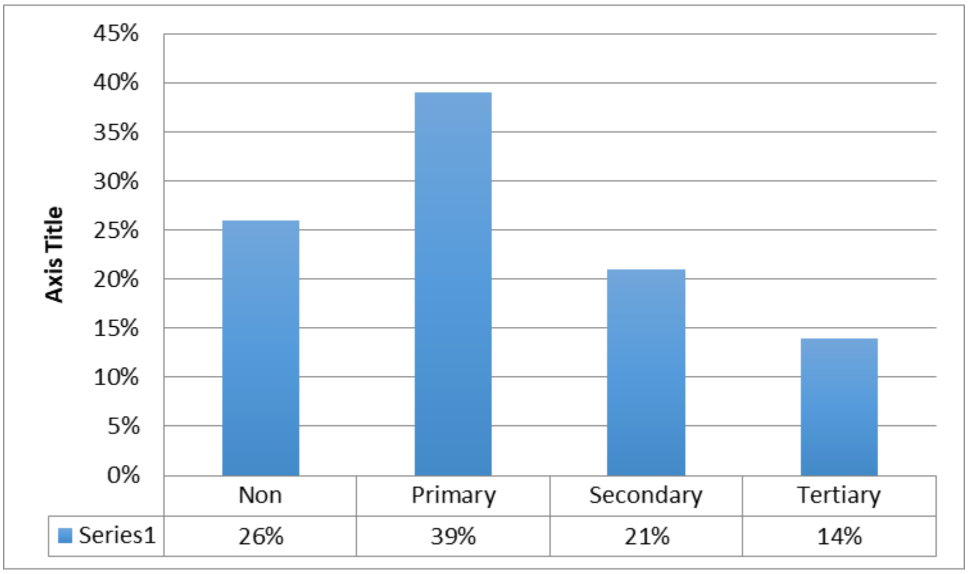


Fig. 2. Respondents' level of education

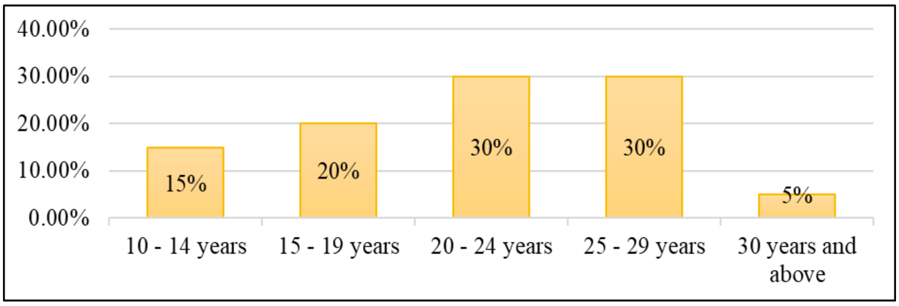


Fig. 3. Length of stay in the community

areas in Zambia. Interviews also revealed that most of the farmers that had no education or only gone up to primary level had difficulties adapting to climate change as they did not easily understand issues of climate change.

Period of stay in the community: Regarding length of stay in the community, it was established that all participants had stayed a minimum of 10 years while engaging in agriculture. Fig. 3 shows the results.

The majority of participants had lived in the community for 20–29 years. This prolonged residence provided them with a comprehensive understanding of the factors influencing crop yields and productivity, offering valuable insights for the study. The interview findings indicated that the farmers could articulate their experiences regarding agricultural productivity and climate change with ease and clarity, largely due to their long-term familiarity with the area.

Community perceptions of climate change manifestation: The study revealed that small-scale farmers perceived manifestations of climate change primarily through perceptions of changes in rainfall, including irregular rainfall, reduced amount of rainfall as well as reduced yields.

Reduced and unpredictable rainfall pattern: The small-scale farmers were asked if they have observed any changes in rainfall pattern comparing the period between 2012 and 2022. It was revealed that all the participants observed a change in the rainfall pattern over the years. They highlighted that the rainfall duration has reduced, some time back the rainfall period was about 5 to 6 months but now it's 2 to 3 months and in those months, they usually have dry spells. They further added that such rainfall Pattern has affected their productivity as maize, which is the staple food and the most grown crop requires a lot of water for it to produce good yields.

Results from focus group discussions indicated that farmers have observed changes in rainfall. During FGDs, one respondent said;

> *"Some time back, rain used to start in October, and end in April which was a duration of almost 6 months but nowadays rains start in December and end by February which brings the current duration to about 2 month. This makes it hard for us to grow crops especially maize, a staple food which requires a lot of water".* FGD 2 participant (45-year-old woman).

It was further revealed by elderly people who explained by comparing the current rainfall pattern to how it was 30 years ago. They indicated that sometime back rains were very predictable and similar for consecutive years unlike now where each year has its own pattern. This makes planning hard because a farmer cannot use one years' experience to predict how rainfall is going to be the following year, and this also affects their productivity as they cannot foresee situations and prepare ahead of time. One respondent said;

> *"In my younger days, rains were so predictable. Every year, rains would start on Zambia's Independence Day (24th October), and they would end in April. This helped us to plan on when to plant specific crops based on how much rain it needs. But these days, rain comes and goes when least expected where one would plant a crop that needs a lot of water, but instead rains go, and that crop is wasted as it will not mature. This is affecting productivity as it leads to a lot of wastage of resources such money, seeds, and energy"* FGD 3 participant (80-year-old woman).

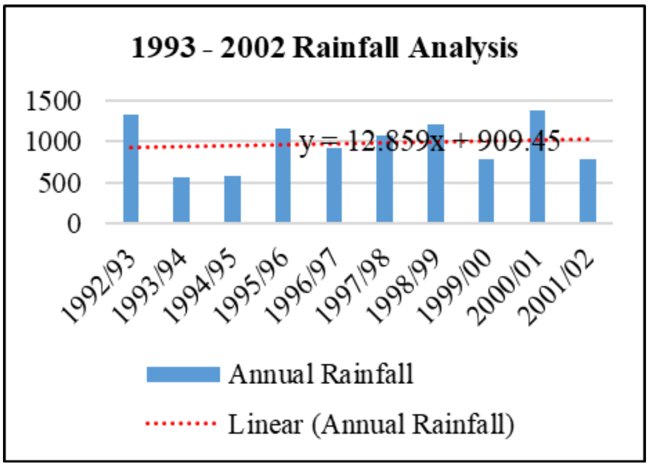


Fig. 4A. 1993 – 2002 Rainfall Analysis
Source: ZMD Msekera, 2023

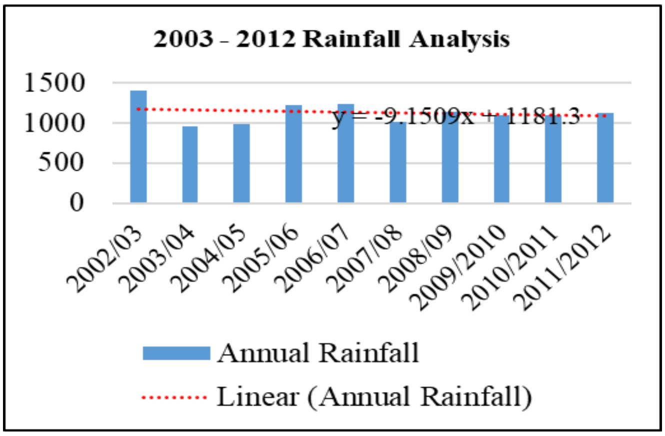


Fig. 4B. 2003 – 2012 Rainfall Analysis
Source: ZMD Msekera, 2023

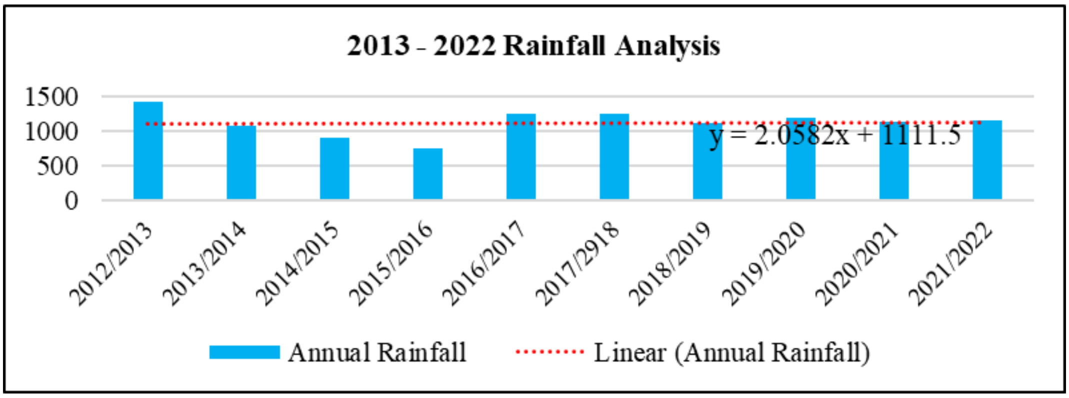


Fig. 4C. 2013 – 2022 Rainfall analysis from Msekera weather station
Source: ZMD Msekera, 2023

In addition, to further compliment small scale farmers' perception of reduced rainfall period and unpredictable rainfall pattern, the researchers analysed 30 years of rainfall data from the Zambia Meteorological Department (ZMD) derived from the Msekera Weather Station in Chipata. By comparing these perceptions with actual meteorological data, it was found that the

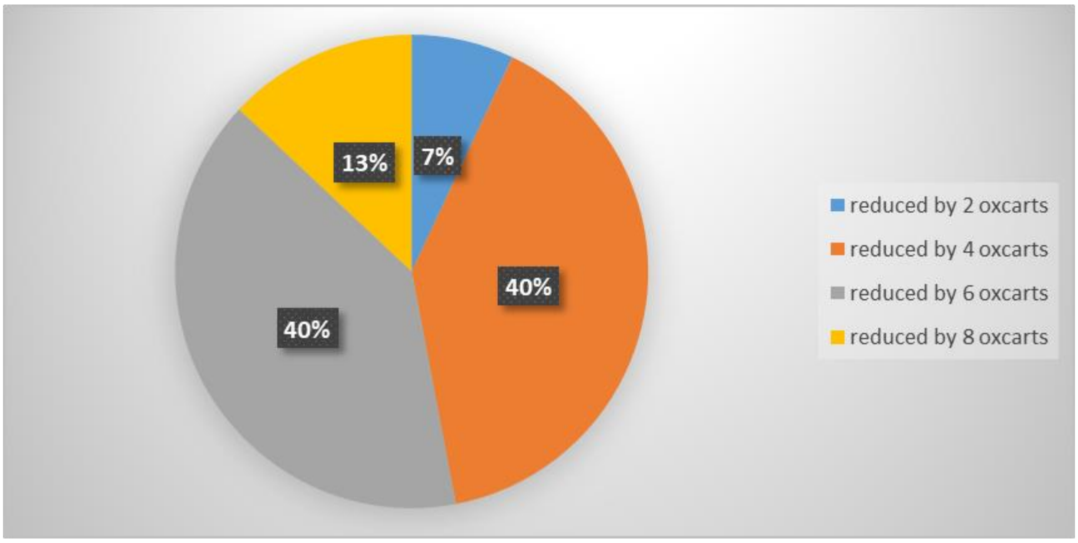


Fig. 5. Reduced crop productivity
**1 oxcart = 6 to 8 (50kg) bags of maize*

farmers' observations aligned with recorded patterns, validating their perceptions. The figures shows meteorological data from 1993 to 2022.

According to the trendline equation, the first decade shows that annual rainfall was increasing at the rate of 12.859mm, annual rainfall for the second decade was decreasing at the rate of -9.1509mm and the third decade show annual rainfall increasing at the rate 2.0582mm. All the graphs show irregularities in rainfall within and amongst the decades. This shows that the rainfall pattern has been inconsistent and unpredictable which can eventually affect agricultural productivity. This alignment between recorded meteorological data and small scale farmers' observations is essential for developing effective adaptation strategies to address the challenges faced by the community.

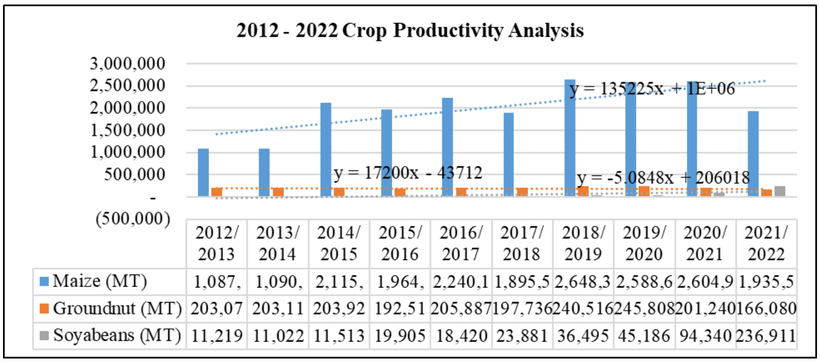
Reduced farming yields: To have a clear understanding of how change in rainfall pattern affects farming/crop yields, a crop productivity analysis was conducted using both primary and secondary data, with a focus on a 10-year period. It was revealed that most of the farmers are cultivating maize, groundnuts, and soya beans and there have been reduced crop yields especially on maize which was easily quantified by the farmers. The details are shown in the chart.

The farmers explained that some years back, many would harvest about 15 to 20 oxcarts of maize, but these days majority are harvesting about 2 to 8 oxcarts on the same piece of land. *The oxcart is the local measure of how much one has harvested (1oxcart = 6 to 8 (50kg) bags of maize).* The extent to which productivity has been affected was indicated by majority to have reduced by 4 to 6 oxcarts.

> *"10 years ago, I would harvest about 15 to 20 oxcarts these used to be enough to feed my family sell the surplus in order to take care of my financial needs such as taking children to school, buying farming inputs for the next farming season etc. But with the reduced harvest of nowadays where I harvest 4 to 6 oxcarts, I can barely feed my family throughout the year".* FGD 2 participant (41-year-old man).

The key informant interviews further indicated that 10 years ago, farmers would produce enough maize such that they would sell most of it and still keep enough for home consumption. The money realized from the sell would be used to pay school fees for their children, buy farm inputs for the next farming season, buy animals such as cattle, pigs and goats that would help them diversify their income once they start reproducing and selling them. But these days, not much is sold as most people are producing fewer harvests. Therefore, there is very little income realized from their farm produce.

To have a deeper understanding of the extent to which climate change has affected crop yields, secondary data was also analysed based on the crop yields. The findings are shown in the figure.



	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022
Maize (MT)	1,087,	1,090,	2,115,	1,964,	2,240,1	1,895,5	2,648,3	2,588,6	2,604,9	1,935,5
Groundnut (MT)	203,07	203,11	203,92	192,51	205,887	197,736	240,516	245,808	201,240	166,080
Soyabeans (MT)	11,219	11,022	11,513	19,905	18,420	23,881	36,495	45,186	94,340	236,911

Fig. 6. 2012 – 2022 Crop Productivity Analysis
Source: DACO's Office, 2023

The figure above indicates the trend analysis for three crops (maize, groundnuts, and soybeans) that are mostly grown in the area. The results show that maize productivity was fluctuating at the rate of 3662.2MT/year, groundnut at -10259MT/year and soybeans at the rate of 48391MT/year. These findings highlight the widespread recognition of climate change as a significant challenge for agricultural production in the community with the reduction in crop productivity being a clear indication of the detrimental effects of changing climatic conditions.

Small-Scale farmers' adaptation strategies to climate change: The farmers in Kasambandola demonstrated that their perceptions significantly shaped their adaptation strategies. The results revealed varying adaptation measures, with some farmers relying solely on traditional knowledge, believing their conventional farming practices were sufficient to handle changing climates. However, this resistance often resulted in poor adaptation and declining productivity due to increasingly unpredictable climate conditions.

In contrast, farmers who adjusted their strategies by integrating climate-smart agricultural practices based on a more accurate understanding of climate change experienced improved resilience and productivity. Many farmers adopted practices such as crop diversification, conservation agriculture (e.g., gamphani and ripping), and the use of improved crop varieties. Despite this, others still combined these with conventional methods due to limited resources or lack of access to proper machinery for a full transition.
Similarly, focus group discussions indicated that many farmers were adapting by combining conventional farming with climate-smart practices such as conservation agriculture (*gamphani* and ripping), utilising improved crop varieties and crop diversification. One respondent said,

> *"Nowadays, the farming methods of our forefathers don't work very well. Therefore, instead of just ploughing and making heaped lines, we have now added climate smart methods as these are effective."* FGD 1 participant (33-Year-old man).

The key informants also responded in the same way by highlighting climate smart agriculture to be one of the major strategies and further added that there are still some farmers who still use conventional methods wholly where they are still making heaped lines and expanding their farming activities to new lands. On responding to the question on how the rural small-scale farmers are adapting to changing climatic conditions during interviews, one headperson said.

> *"Despite farmers having heard about the new farming methods, some of them still practice old farming methods where they use a plough to make heaped lines. And there are some that are expanding their fields to new areas so that they can grow more crops on a larger farm". And they say this has helped them to produce more"* (headperson, 65 years man).

Generally, most farmers indicated that adaptation strategies, such as crop diversification and conservation agriculture, are important to maintain and improve their productivity amidst climate change. By integrating these practices, they were able to mitigate the adverse effects of unpredictable rainfall patterns, such as droughts and irregular rainfall. For instance, crop diversification allowed farmers to spread the risk of crop failure, ensuring that at least some crops thrived even under harsh weather conditions. Conservation agriculture, which includes practices like minimal tillage and crop residue retention, enhances soil health and moisture retention, making fields more resilient to extreme weather. Therefore, small-scale farmers believe that these adaptation strategies are not only helping to stabilize their yields but also making farming more sustainable in the long run, thereby safeguarding their livelihoods in the face of climate change.

7. DISCUSSION

Study findings showed that small-scale farmers in the Kasambandola community perceived changes in climate primarily in terms of rainfall patterns. These manifestations included unpredictability, reduced quantity, and shorter duration of rainfall. It was revealed that, in the past, rains were highly predictable, typically beginning around October 24 and ending in March or April. In contrast, recent years have seen rains starting late in December and often ending by February or March. This shift aligns with findings by Kurji et al. (2003), who observed that Zambia’s rainfall events traditionally ran from October to March, with occasional rains in April and May. Similarly, Tesfahunegn et al. (2016) noted that farmers’ perceptions of changing rainfall patterns are crucial for developing appropriate adaptation strategies. Banerjee (2015) also highlighted that farmers in semi-arid regions observed a shift in rainfall, leading to difficulties in planning agricultural activities (Ruz et al., 2020).

In addition to unpredictability, the quantity of rainfall has decreased. Less rainfall means that there is less water available for crops, which negatively impacts growth and productivity. This aligns with data from Zambia's Meteorological Department, which also shows variations in rainfall patterns over the years. The data reveals that each year presents a different rainfall pattern, further confirming the farmers' perceptions. Moreover, the duration of the rainy season has shortened, which means the period during which farmers can expect consistent rainfall is now shorter. Shorter rainy seasons reduce water availability during critical crop growth stages, potentially leading to lower yields. This finding is consistent with Ali et al. (2020), whose study showed reduced grain production due to reduced rainfall. Nevertheless, adverse impacts from climatic shocks can be decreased through adaptation efforts, which range from slight to significant changes in approach that can bring about transformation in the farming systems (Siamabele 2021).

The study also found that small-scale farmers in Kasambandola have been harvesting less maize compared to previous years. In the past, many farmers would harvest about 15 to 20 oxcarts of maize, but today most are harvesting only 2 to 8 oxcarts from the same land area. Crop data from the Ministry of Agriculture shows similar trends, with fluctuations in yields. This suggests that the inconsistencies in rainfall quantity and duration have negatively affected agricultural productivity. These findings are supported by Zhou et al. (2022) and Tayengwa et al. (2020), who found that rural households, especially small-scale farmers, face significant challenges due to drought and inconsistent rainfall. The IPCC (2007) further highlighted that yields from rain-fed agriculture in Africa could be reduced by up to 50% in some countries, leading to decreased agricultural production and exacerbating food insecurity (Climate Research Unit, 2009). Given that African agriculture is predominantly rain-fed, these changes in rainfall patterns are a serious concern for food security. Study findings aligned with Chilambwe’s (2021) projections that districts like Katete would experience moderate to large crop yield reductions.

Despite these challenges, farmers in Kasambandola have adopted various adaptation strategies. Although some continue to rely on traditional knowledge and farming methods, believing they are sufficient to handle the changing climate, others have embraced more climate-smart agricultural practices. Resistance to change among some farmers may have contributed to poor adaptation and declining productivity. However, those who have adjusted their strategies by incorporating climate-smart practices, such as crop diversification and conservation agriculture, have experienced improved resilience and productivity.

Crop diversification, for example, helped spread the risk of crop failure, as some crops thrived while others perished due to extreme weather conditions. Conservation agriculture, which included practices like minimal tillage and crop residue retention, improved soil quality by returning nutrients to the soil. These climate-smart practices not only helped to maintain farming yields but also contributed to long-term sustainability, safeguarding farmers' livelihoods in the face of climate change.

The study also revealed that while some farmers fully embraced sustainable practices, others combined them with conventional methods due to a lack of proper machinery to fully transition. Traditional farming methods, however, posed risks, as practices such as making heaped lines and clearing trees to expand farmland exacerbated the effects of climate change. In contrast, Deressa et al. (2011) found that some small-scale farmers successfully integrated livestock with crop production as an adaptation strategy. Understanding the perceptions of local farmers is crucial for developing effective adaptation strategies that are tailored to their specific context. As Mucahid et al. (2020) noted, efficient adaptation requires a thorough understanding of local knowledge and practices, ensuring that strategies are not only scientifically sound but also culturally appropriate and accessible.

8. CONCLUSION

This study aimed at investigating small-scale farmers' perceptions of climate change manifestations in the Kasambandola community of Katete District. Based on the findings, it is concluded that the farmers were well aware of climate change occurring in their area, which is primarily manifested through inconsistent rainfall patterns and reduced yields. These climate variations have had a profound impact on agricultural productivity, with farmers observing a reduction in crop yields, particularly maize, their staple food.

In response to these challenges, many farmers have begun adopting climate-smart agricultural practices, such as crop diversification and conservation agriculture, as strategies to mitigate the effects of climate change. However, despite these adaptive measures, some farmers continue to rely on traditional and unsustainable farming practices, such as clearing land and cutting down trees to expand farming areas. This dual approach of combining both sustainable and unsustainable practices highlights the need for targeted interventions to address the old, unsustainable farming methods, as they risk exacerbating the impacts of climate change.

It is therefore, crucial that these outdated farming practices are addressed to prevent further environmental degradation and to improve the livelihoods of small-scale farmers in the long term. Ensuring that farmers have access to resources, training, and appropriate technologies will be essential in fostering sustainable agricultural practices and enhancing resilience to climate change. By tackling these challenges and fostering the adoption of sustainable practices, the Kasambandola community, along with similar rural areas, can better adapt to the evolving climate conditions, securing food security and promoting long-term agricultural productivity.

9. RECOMMENDATIONS

Based on the findings of this study, the study recommends that:

Firstly, the government should acknowledge farmers' perceptions when designing climate change adaptation strategies. It is crucial for the government and relevant agencies to recognize the perceptions and experiences of small-scale farmers regarding climate change. Incorporating farmers' local knowledge into climate change adaptation strategies will enhance the effectiveness and relevance of these strategies, ensuring they are better suited to the needs of the farming communities.

Secondly, small scale-farmers should adopt sustainable farming practices that minimise environmental degradation. Small-scale farmers need to fully embrace and practice sustainable farming methods. While some farmers already adopted climate-smart agricultural practices such as crop diversification and conservation agriculture, others continue to rely on traditional, unsustainable methods. It is important for farmers to transition completely to sustainable practices to improve resilience to climate change and protect long-term productivity. This includes integrating modern techniques while phasing out harmful practices like deforestation and land over-exploitation. This would require more information and recruitment of agriculture extension officers to assist in changing farmers, attitudes.

Thirdly, there is need to strengthen access to resources and technology**.** The government, NGOs, and private sector should facilitate greater access to affordable climate-resilient seeds, fertilizers, and modern farming tools. This can be achieved through subsidies, microfinance schemes, or community-based support systems, which will help farmers improve productivity and cope with changing climatic conditions.

Lastly, there is need to invest in water management infrastructure**.** Building and improving irrigation systems, rainwater harvesting techniques, and other water management infrastructure will enable farmers to better adapt to fluctuating rainfall patterns. Such investments will ensure reliable water availability during dry spells and enhance food security. This would require policymakers to ensure that climate change adaptation is prioritized in national and local agricultural policies. This should include providing financial support, training, and incentives for farmers to adopt climate-smart practices. Policies should also promote sustainable land use and soil management practices to mitigate the impact of climate change.

ETHICAL APPROVAL AND CONSENT

Ethical standards were upheld throughout the study. Information sheets and written consent forms were provided to the participants before participating in the study. Potential ethical issues of the research were communicated to the participants and they were informed of their right to withdraw from the research at any point without repercussions. Further, confidentiality and anonymity were guaranteed as no real names were used and the data was used only for scholarly purposes. Personal information of participants was kept confidential and anonymized in all reports. All sources used in the study have been appropriately acknowledged, and ethical approval was obtained from the relevant authorities, that is, the University of Zambia Ethics Committee.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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