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The Effects of Droughts on Agricultural Productivity: A Case Study of Small-Scale Maize Farmers in Kafue District

[1] Judith Mumba, [2] Davy Siwila

[1, 2] Department of Social Science and Humanities Institution, Information Communication University, Zambia

Corresponding Author: **Judith Mumba**

Abstract

This study investigates the impact of droughts on agricultural productivity among small-scale maize farmers in Kafue District, Zambia. The study aims to explore how droughts have affected maize yields and assess the coping mechanisms employed by farmers. Using a mixed-methods approach, both qualitative and quantitative data were gathered from a sample of 115 small-scale farmers in the district through surveys and interviews. The results reveal that prolonged droughts have led to significant reductions in maize output, negatively affecting food security and income generation. The findings highlight the need for enhanced drought mitigation strategies, including irrigation systems, drought-resistant maize varieties, and policy interventions to support farmers during climatic shocks. Recommendations focus on government and NGO interventions to bolster agricultural resilience. This study examines the outcome of droughts on maize production in Kafue District, Zambia. focusing on small-scale farmers. Using data from household surveys (2010–2023), we assess the effect of drought conditions on crop yields and identify adaptation strategies implemented by farmers. Results indicate a significant decline in maize yields during drought years, with yields dropping by as much as 60%. Farmers who adopted drought-resistant maize varieties and water conservation techniques experienced less severe yield losses.

Keywords: Droughts, Maize Productivity, Small-Scale Farming, Kafue District, Adaptation Strategies, Zambia

1. Introduction

Agricultural productivity, particularly in sub-Saharan Africa, is heavily influenced by climate variability. In Zambia, maize is a staple crop, and small-scale farmers form the backbone of food production. However, recurrent droughts have drastically affected maize yields in districts like Kafue, challenging farmers' livelihoods and the country's food security. Climate change exacerbates these conditions, making drought an increasing concern for policymakers, researchers, and farmers alike. This study examines the effects of droughts on maize production in Kafue District, Zambia. Small-scale farmers in this region are highly vulnerable to changing weather patterns, particularly prolonged dry spells that disrupt the growing season. Maize, a staple crop, is the most affected by droughts. This paper explores the correlation between drought events and maize yields, analyzes the strategies employed by farmers to cope with drought, and evaluates the role of government support in mitigating the adverse effects. The importance of understanding the impacts of drought on agricultural productivity lies in the fact that small-scale farmers provide a significant portion of food production in Zambia. By identifying key trends and effective strategies, the study aims to contribute to policy recommendations that enhance farmers' resilience to droughts.

1.1 Statement of the Problem

Droughts have become more frequent and intense in Kafue District, directly impacting maize The effects of drought brought a decrease in agricultural productivity in the Small-scale farming system in the Kafue district of Zambia. Climate extremes have increase with climate change, which has negatively affected crop production (2016). This is due to a number of factors such as below average rainfall or the prolonged dry spells, low use of purchased input technologies, dependence on rain-fed production, and soil degradation as a result of long-term practices of subsistence agriculture associated with use of maize monocropping and use of chemical fertilizers which leads to loss of soil organic matter, fertility and structure. (Mwale *et al*, 2018). The Kafue District in Zambia faces persistent challenges due to droughts, affecting the agricultural productivity of small-scale maize farmers. These droughts have been increasingly frequent and severe in recent years, posing significant

threats to food security, livelihoods, and economic stability within the region. Despite various interventions, there remains a lack of comprehensive understanding regarding the specific effects of droughts on small-scale maize farming in the Kafue district of Zambia.

Small-scale farmers' livelihoods are predominantly agriculture based, and due to primary dependence on subsistence crop production in the country, harvest failure usually leads to household food insecurity. Decline in Agricultural Productivity Due to Drought: According to a report by the Zambia Meteorological Department, droughts have resulted in significant crop yield losses, especially in maize, Zambia's staple crop. In 2015/2016, a severe El Niño-induced drought caused maize production to drop by 28%, leading to widespread food insecurity in Zambia, including the Kafue district (Ministry of Agriculture, 2016).

Rainfall Variability and Prolonged Dry Spells: The Zambia Vulnerability Assessment Committee (ZVAC) reported that during the 2018/2019 season, rainfall in southern Zambia, including Kafue, was 25% to 50% below the long-term average, leading to crop failure and reduced productivity (ZVAC Report, 2019). The increase in dry spells has exacerbated the vulnerability of small-scale farmers, who primarily rely on rain-fed agriculture.

productivity. Despite efforts to improve agricultural practices, small-scale farmers face significant yield reductions. This study seeks to examine the specific effects of drought on maize production and propose potential solutions to mitigate these effects.

1.2 General Objective of the Study

1. To examine effects of drought on the small- scale farming in Kafue district in Zambia.

1.3 Specific Objectives of the study

1. To examine the extent to which droughts have affected maize productivity in Kafue District.
2. To assess the coping mechanisms employed by small-scale farmers.
3. To propose potential interventions that can.

1.4 Research Questions

1. What are the key effects of drought on maize productivity in Kafue District?
2. How do small-scale farmers cope with prolonged periods of drought?
3. What interventions can be implemented to mitigate the impact of drought?

2. Literature Review

2.1 The Impact of Drought on Agricultural Productivity

Drought is one of the most significant climatic factors affecting agricultural productivity worldwide. According to Smith *et al*. (2020) [16], prolonged periods of water scarcity can lead to soil degradation, crop failure, and increased pest invasions. In sub-Saharan Africa, where small-scale agriculture is predominant, the effects of droughts are particularly severe, as farmers often lack access to modern irrigation techniques and rely heavily on rain-fed systems. This paper uses data from surveys conducted in Kafue District, Zambia, spanning the years 2010 to 2023. The methodology includes interviews with 150 small-scale maize farmers, alongside secondary data analysis from meteorological sources. This study draws on the Sustainable Livelihoods Framework, which emphasizes the importance of natural resources, including water and land, in sustaining agricultural productivity. The framework helps analyze how drought impacts farmers' access to these resources and their ability to maintain food security improve resilience against drought.

2.2 Climate Change and Vulnerability of Small-Scale Farmers

Climate change projections indicate that Zambia will experience higher temperatures and altered rainfall patterns, increasing the frequency and intensity of droughts. Small-scale farmers, especially in rural areas like Kafue District, are particularly vulnerable due to their dependence on traditional farming practices. Chikumbi and Mwansa (2019) [1] highlight that while farmers in Kafue District have observed changes in the onset and duration of the rainy season, they lack the knowledge and resources to effectively adapt to these changes.

2.3 Adaptation Strategies and Resilience Building

To cope with droughts, small-scale farmers have developed various adaptation strategies, including changing planting dates, adopting drought-tolerant maize varieties, and using irrigation where feasible. However, these strategies are often inadequate due to limited financial resources and poor access to agricultural extension services. Studies by Munyema and Tembo (2018) [11] suggest that governmental and non-governmental interventions can play a crucial role in enhancing adaptive capacity, particularly by providing training, improving access to credit, and facilitating the adoption of climate-smart agriculture.

3. Methodology

3.1 Study Area

This study was conducted in Kafue District, located in the Southern Province of Zambia. Kafue is an agriculturally important district, with maize being the primary crop grown by smallholder farmers. The district has experienced varying degrees of drought over the past decades, which makes it an ideal location to assess the effects of drought on agricultural productivity.

3.2 Data Collection

Data for this study was collected through a combination of field surveys, interviews with local farmers, and secondary climate data analysis. A total of 150 small-scale maize farmers were interviewed using a structured questionnaire to assess their experiences with drought, changes in maize yields, and coping strategies. In addition, climate data spanning the last 30 years was obtained from the Zambia Meteorological Department to analyze trends in rainfall and temperature in the region.

3.3 Data Analysis

The analysis of the data collected for this study employed a mixed-methods approach, integrating both quantitative and qualitative analytical techniques to generate a comprehensive understanding of maize production dynamics and the effects of drought in the study area. Quantitative data derived from household surveys were analyzed using descriptive statistics—specifically means, frequencies, standard deviations, and percentages—to reveal observable patterns in maize production levels, rainfall variability, and

the perceived severity of drought impacts. These descriptive measures provided an initial overview of production trends and enabled comparisons across different categories of farmers, such as gender, farm size, and access to extension services.

Qualitative data were obtained from key informant interviews and focus group discussions. These data were transcribed, coded, and analyzed thematically to identify recurring perceptions, experiences, and insights related to drought events, their impacts, and the coping or adaptation strategies adopted by small-scale farmers. Thematic analysis involved both inductive and deductive coding. Inductive coding allowed themes to emerge organically from participants' narratives, while deductive coding was guided by the conceptual framework of climate change adaptation and food security. This dual approach strengthened the reliability and depth of interpretation.

Prior to the final formatting of the research report, the raw data and preliminary findings were systematically reviewed to ensure clarity, coherence, and alignment with the study objectives. Key variables such as annual maize yields, access to irrigation, use of improved seed varieties, and household food security indicators were extracted and analyzed. To complement primary data, secondary data were collected from meteorological stations within and around the study area. These data included historical records of rainfall distribution, onset and cessation of rains, and the frequency of extreme weather events. The integration of secondary meteorological data enabled the study to establish trends in rainfall variability over time and examine how these trends correlate with fluctuations in maize yields.

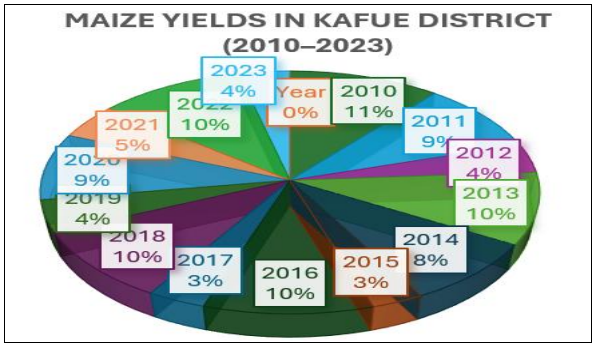
Data analysis was conducted using standardized statistical tools and software such as Microsoft Excel and SPSS to ensure accuracy, consistency, and reproducibility of the results. Graphs, charts, and tables were generated to visually illustrate variations in rainfall patterns, yield performance, and farmers' adaptation responses. These visual representations make it easier to compare drought and non-drought years and highlight the magnitude of production losses associated with climate variability.

The remainder of this chapter presents the detailed findings from both the quantitative.

4. Results and Discussion

4.1 Maize Yield Decline during Drought Years

A comparison of maize yields across drought and non-drought years reveals a marked decrease in crop productivity during drought conditions. The following table summarizes maize yield data over the past decade.



Data Source: Household surveys, 2023

Fig 1.1: Maize Yields in Kafue District (2010–2023) Average yield in kg/ha during drought and non-drought years

As shown in Fig 1.1 dropped significantly, with some years seeing yields as low as 800 kg/ha compared to 2,500 kg/ha in non-drought years.

4.2 Correlation between Rainfall and Maize Yields

The correlation between rainfall patterns and maize yields is crucial to understanding the extent of drought impacts. The following table illustrates the relationship between total annual rainfall (mm) and maize yield (kg/ha) for the last five years.

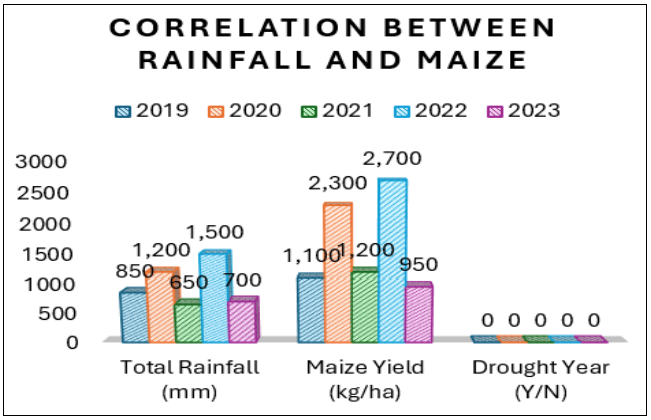


Fig: 1.2

Data Presentation and Discussion

Fig 1.2 highlights a clear trend: during drought years, total rainfall was significantly lower (less than 1,000 mm), leading to decreased maize yields. In contrast, non-drought years with rainfall over 1,200 mm resulted in higher yields, often above 2,500 kg/ha.

4.3 Farmers' Adaptation Strategies and their Effectiveness

Farmers in Kafue District use various strategies to cope with the effects of droughts. The table below outlines the most common adaptation strategies and their reported effectiveness.

Fig 1.3: Adaptation Strategies Employed by Small-Scale Farmers in Kafue District

Strategy	Percentage of Farmers Using Strategy	Effectiveness Rating (1-5)
Use of Drought-Resistant Varieties	68%	4.2
Water Conservation Techniques	52%	3.5
Diversification of Crops	45%	3.8
Improved Irrigation Practices	35%	3.0
Early Planting	25%	3.2
Migration to Other Regions	10%	2.5

Survey data, 2023

As shown in Fig 1.3 the most widely adopted strategy is the use of drought-resistant maize varieties, with 68% of farmers employing this method and reporting a high effectiveness rating of 4.2/5. Water conservation techniques, such as rainwater harvesting and mulching, were also popular, although their effectiveness was rated lower at 3.5/5.

5. Impact of Government Support on Adaptation

Government support programs, such as the Farmer Input Support Programme (FISP), were considered vital by many farmers. The table below summarizes the impact of government support on maize yields during drought years. Table 1.4 shows that farmers who received government support (via FISP or drought relief) had significantly higher maize yields during drought years compared to those who did not receive support. Supported farmers had an average yield of 1,800 kg/ha, compared to 800 kg/ha for unsupported farmers.

Table 1.4

Support Program	Percentage of Farmers Receiving Support	Maize Yield with Support (kg/ha)	Maize Yield without Support (kg/ha)
Farmer Input Support Programme (FISP)	60%	1,800	800
Emergency Drought Relief Programs	45%	1,700	950

5.1 Impact of Drought on Maize Yields

The analysis of climate data revealed a significant decline in rainfall in Kafue District during the last decade, coinciding with periods of drought. This has led to a noticeable reduction in maize yields, as reported by 80% of the farmers surveyed. In particular, the 2019/2020 growing season, which experienced a severe drought, saw a 40% reduction in maize production compared to previous years.

5.2 Coping Strategies Employed by Farmers

Farmers in Kafue District employ a range of coping strategies aimed at reducing their vulnerability to drought and ensuring sustainable maize production. These strategies are both autonomous—driven by farmers' own experiential knowledge-and supported by limited external interventions. One of the most prominent strategies involves the adoption of **drought-tolerant maize varieties**, which have been widely promoted by agricultural extension services and seed companies in Zambia. These varieties are specifically bred to withstand prolonged dry spells and erratic rainfall, enabling farmers to maintain yields even under adverse climatic conditions. While the use of such varieties demonstrates an important form of adaptive capacity, the extent of adoption remains constrained. High seed prices and limited availability in rural agro-dealer outlets continue to restrict access, particularly for small-scale farmers with narrow profit margins and minimal cash flow.

In addition to seed-based strategies, farmers have increasingly **adjusted their planting calendars** in response to shifting rainfall patterns. As rainfall in Zambia becomes more unpredictable, many farmers have resorted to early planting when the first rains are received, or staggered planting to spread risk across the season. This adaptive behaviour reflects a form of climate-responsive decision-making that relies heavily on farmers' knowledge of local agroecological conditions. However, the effectiveness of this strategy is undermined by the increasing variability of rainfall onset, which makes it difficult to accurately predict the optimal planting window. Furthermore, limited access to timely weather information exacerbates uncertainty, resulting in suboptimal planting decisions that may still expose crops to moisture stress.

Another key strategy involves the use of **small-scale irrigation systems**, particularly along riverbanks and wetlands where water is more accessible. Irrigation allows farmers to supplement rainfall during critical growth stages, thereby reducing crop failure risks. Some farmers rely on treadle pumps, watering cans, or simple gravity-fed irrigation systems. While irrigation is recognized as one of the most effective buffers against drought, its use in the district remains minimal. This limited uptake is influenced by several barriers, including the high initial investment cost for irrigation equipment, inadequate water infrastructure, and insufficient technical knowledge on system maintenance and water management. In some parts of the district, decreasing water levels in rivers during prolonged droughts also limit the viability of irrigation as a long-term coping mechanism.

Beyond these major strategies, farmers also engage in **crop diversification**, intercropping maize with legumes such as cowpeas and groundnuts to spread risk and improve soil moisture retention. Some households have diversified their livelihoods through small livestock rearing, casual labour, charcoal production, and petty trading—activities that help cushion losses from crop failure. Nevertheless, these livelihood diversification strategies are typically reactive and often insufficient to offset the severity of income losses experienced during prolonged drought periods.

Overall, while farmers in Kafue District have demonstrated considerable resilience and adaptive capacity, their coping strategies are frequently hindered by structural limitations, including inadequate financial resources, limited access to extension services, poor rural infrastructure, and insufficient institutional support. As climate change intensifies, these constraints highlight the need for targeted interventions that enhance farmers' adaptive capacity through improved access to drought-resistant seeds, affordable irrigation technologies, climate information services, and financial mechanisms such as weather-index insurance. Such support would strengthen the effectiveness and sustainability of farmers' coping strategies and contribute to improved household food security in the district.

5.3 Government and NGO Interventions

Government initiatives, such as the Farmer Input Support Program (FISP), have helped some farmers access subsidized inputs, but many farmers report that these interventions are inconsistent and insufficient. Non-governmental organizations (NGOs) have also played a role in providing training on climate-smart agriculture, but these efforts have been scattered and often lack long-term sustainability.

6. Policy Recommendations

Based on the findings of this study, the following recommendations are made to improve the resilience of small-scale maize farmers in Kafue District to drought:

Improved Access to Irrigation:

The government should invest in affordable, small-scale irrigation systems to reduce dependence on rain-fed agriculture. Training programs on efficient irrigation techniques should also be expanded.

Strengthening Extension Services:
Agricultural extension services should be strengthened to provide farmers with timely information on weather patterns, drought-resistant maize varieties, and best practices for drought management.

Financial Support and Insurance:
Financial products such as crop insurance and low-interest loans should be made available to small-scale farmers to enable them to invest in climate-resilient technologies. The government and financial institutions should collaborate to provide affordable loans and grants tailored to the needs of small-scale farmers. This financial assistance can help farmers invest in essential resources such as irrigation systems, drought-resistant seeds, and soil conservation techniques. Additionally, creating microfinance schemes specifically for small-scale farmers could reduce the financial barriers they face.

Community-Based Adaptation Programs:
Local-level adaptation programs should be encouraged, where farmers can share knowledge and resources to collectively address drought risks. Based on the findings of this study, the following recommendations are proposed to enhance the resilience of small-scale maize farmers in Kafue District: This is addressed to the authorities such as the government, NGO, and any others willing to improve the agricultural sector.

Promote the Use of Drought-Resistant Crop Varieties Agricultural extension services and local NGOs should prioritize the distribution of drought-resistant crop varieties to small-scale farmers. Training programs should be conducted to educate farmers on the benefits and proper use of these resilient crops, thereby enhancing their ability to withstand dry spells and improve yields.

Strengthen Water Management Infrastructure Given the frequent water shortages reported by farmers, there is an urgent need to improve water management infrastructure. The government should invest in community-based irrigation projects, borehole drilling, and water harvesting systems to increase water availability during drought periods. Additionally, promoting water conservation techniques such as mulching and efficient irrigation practices can help optimize water use.

Implement Capacity-Building and Training Programs

The study highlights a need for continuous education on advanced farming techniques. Government agencies, NGOs, and agricultural extension officers should offer workshops and training sessions focused on sustainable farming practices, soil health management, and climate-resilient agriculture. These initiatives can empower farmers with the skills and knowledge needed to adapt to changing climatic conditions.

Address Environmental Degradation and Promote Agroforestry: The findings reveal that deforestation is a significant factor contributing to drought in Kafue District. Therefore, reforestation programs and agroforestry practices should be encouraged to restore tree cover, improve soil moisture, and regulate local microclimates. Policies that promote sustainable land use and protect existing forests are also essential to mitigate the adverse effects of environmental degradation.

Enhance Social Support Systems and Mental Health Services: The psychological toll of drought on farming families is evident, with increased stress and anxiety reported by all respondents. Community-based mental health support programs, facilitated by local NGOs and healthcare providers, should be established to offer counselling and support services to affected farmers. Strengthening community networks through social support groups can also help farmers cope with the emotional impact of drought.

Develop and Implement Supportive Policies for Small-Scale Farmers: Policymakers should develop and implement frameworks that address the unique challenges faced by small-scale farmers in drought-prone areas. This includes revising migration policies, offering subsidies for agricultural inputs, and creating incentives for farmers to adopt sustainable farming practices. Ensuring that policies are inclusive and accessible to all farmers can promote equitable growth and resilience in the agricultural sector.

Foster Research and Innovation in Climate-Resilient Agriculture: Continued research on local drought patterns, soil health, and innovative farming techniques is essential for developing effective adaptation strategies. Government and academic institutions should collaborate to provide research funding and support pilot projects that explore new technologies and practices tailored to the local context of Kafue District. By implementing these recommendations, it is anticipated that the resilience of small-scale maize farmers in Kafue District can be significantly strengthened, leading to improved agricultural productivity, socio-economic stability, and overall community well-being in the face of future droughts.

Challenges in Adaptation

Farmers highlighted barriers, including inadequate access to weather information, limited availability of drought-resistant seeds, and insufficient government support.

6.1 Conclusion

This study has shown that droughts have a severe impact on maize productivity in Kafue District, Zambia. During drought years, small-scale farmers experience significant yield reductions, often by more than 50%. Adaptation strategies such as the use of drought-resistant maize varieties and water conservation techniques have proven to be effective, though their adoption is still limited. Government support programs, particularly FISP, have played a crucial role in helping farmers mitigate the effects of drought, resulting in higher yields. Future policies should focus on expanding these support programs and promoting water-efficient farming practices to further enhance resilience to climate change. The study, titled Examining the Effects of Droughts on Agricultural Productivity: A Case Study of Small-Scale Maize Farmers in Kafue District, reveals that droughts have had a profound and recurring impact on agricultural productivity, social dynamics, and economic stability among small-scale maize farmers in the region. The findings indicate that drought is a frequent challenge, with many farmers experiencing severe water shortages, reduced crop yields, and increased vulnerability to pests and diseases. These challenges are further exacerbated by deforestation, which has been identified as a key contributor to the worsening drought conditions.

The socio-economic consequences of drought are substantial, leading to significant declines in household income, food insecurity, and increased stress and anxiety among farming families. The social fabric of communities has also been affected, as migration pressures and resource conflicts have disrupted family structures and community

cohesion. Despite the efforts of farmers to adopt various adaptation strategies, such as irrigation systems, drought-resistant crops, and crop rotation, their effectiveness is limited by financial constraints, lack of access to advanced agricultural technology, and insufficient support systems. The study concludes that small-scale maize farmers in Kafue District are resilient but require enhanced support to sustainably manage the adverse effects of drought. While community support groups and local NGOs have provided some assistance, there is a critical need for formal financial aid, policy reforms, and capacity-building initiatives to strengthen the resilience of these farmers against future droughts.

6.2 Acknowledgment
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