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An Analysis of Risk Perception and Management Among Smallholder Maize Farmers in Mazabuka District, Southern Province [2015–2017]

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ABSTRACT: Agriculture is a critical sector in Zambia, with approximately 60% of households depending on it for their livelihoods. However, smallholder maize farmers face various risks, including climate variability, pest infestations, price fluctuations, and market access. The study investigated risk perceptions of smallholder maize farmers in Mazabuka District, Southern Province of Zambia, and how these perceptions influence risk management strategies and productivity. A cross-sectional survey design was employed, collecting data from 51 randomly selected smallholder farmers using structured questionnaires. Farmers' risk perceptions were assessed using a five-point Likert scale across three agricultural seasons (2014/15, 2015/16, and 2016/17). Findings revealed that environmental risks, particularly drought and irregular rainfall patterns, were the most significant, with 72% of respondents identifying climate change as a primary concern. Economic risks, including fluctuating maize prices and rising input costs, were reported by 65% of farmers, while 58% cited pest infestations, such as fall armyworm, as a major threat. Social risks, including labour shortages and inadequate extension services, also contributed to production challenges. In response, farmers employed various coping mechanisms, such as crop diversification (49%), reliance on government subsidies (42%), and participation in farmer cooperatives (38%). However, risk management practices remained limited due to financial constraints and lack of access to timely weather forecasts. The findings highlight the urgent need for targeted interventions to strengthen smallholder farmers' resilience by enhancing extension services, improving access to climate information, and promoting sustainable farming practices to mitigate risks and boost productivity.

KEYWORDS: Perception, Production, Risk, Smallholder Farmers.

INTRODUCTION

Smallholder agriculture is a fundamental driver of Zambia's economy, serving as the main source of livelihood and food security for most rural households [1]. Despite its importance, agriculture's contribution to Zambia's Gross Domestic Product (GDP) has remained relatively small compared to other sectors and has declined over time [2]. Maize, the country's staple crop, is primarily grown by smallholder farmers, who face significant challenges and risks due to climate uncertainties, fluctuating prices, and potential disease outbreaks [3].

Understanding how these farmers perceive risk is essential for addressing production challenges, as they often experience uncertainties related to output and input prices, as well as changes in production technology. The severity and sources of these risks vary depending on factors such as geographic location, weather conditions, and government policies [2]. Additionally, smallholder farmers frequently struggle to predict key variables such as labor availability, input costs, and weather patterns, further compounding the risks associated with their farming operations [4,5].

Production and market-related risks stand out among the most common risks faced by farmers. Production risks comprise of droughts, pests, and diseases, while examples of market-related risks include price volatility and limited market access. In addition, climatic events such as El Niño and La Niña worsen these challenges, with extreme weather conditions significantly reducing maize production in recent years [6].

To mitigate these risks, it is essential to understand the risk perceptions of smallholder farmers and how these perceptions influence their decisions. Farmers` attitudes towards risk, whether risk-averse, risk-neutral, or risk-taking, play a significant role in

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determining their responses to these challenges [7]. However, there is limited empirical research on how these perceptions shape the productivity and income of small-scale farmers in Zambia, particularly in the Southern Province, where climate-related risks are most pronounced.

The focus of this study was to investigate the risk perceptions of smallholder maize farmers in Mazabuka District, Southern Province, and to relate these perceptions to their socioeconomic characteristics. By analyzing these perceptions, the study aims to provide insights into farmers coping mechanisms adopted.

The research is particularly significant as it fills a gap in the literature regarding the relationship between risk perception and agricultural productivity among small-scale maize producers.

LITERATURE REVIEW

2.1 Agricultural Production in Zambia

Zambia is endowed with a substantial natural resource base for agriculture, covering 75 million hectares of land, 42 million of which have medium to high potential for agricultural production [1] . The country also holds 40% of the water resources in Central and Southern. Agro-ecologically, Zambia is divided into three zones based on rainfall patterns:

Zone I:

Receiving less than 800 mm of annual rainfall, constituting 12% of Zambia's land area. This zone, covering parts of the Southern, Eastern, and Western provinces, is suitable for extensive cattle production and drought-resistant crops like cotton, sorghum, and millet.

Zone II:

Receiving between 800-1000 mm of annual rainfall and covering 42% of Zambia's land area. It is further subdivided into Zone IIa, covering parts of Central, Lusaka, Southern, and Eastern provinces, and Zone IIb, covering parts of the Western province.

Zone III:

Receiving 1000-1500 mm of annual rainfall, covering 46% of Zambia's land area, including the Copperbelt, Luapula, Northern, North-Western, and parts of Muchinga provinces. This zone is characterized by highly leached soils.

Zambian agriculture consists of three broad farmer categories: smallholders, medium-scale, and large-scale farmers [8]. Smallholders, mainly located in rural and peri-urban areas, make up 76% of the farming population and are classified as:

Category A: Cultivating between 0 and 2 hectares, primarily growing staple crops such as maize with limited market surplus.

Category B: Cultivating between 2 and 5 hectares.

Category C: Cultivating between 5 and 20 hectares. Medium and large-scale farmers, though a small fraction, contribute significantly to local and export markets [8].

2.2 Maize Farming in Zambia

Maize production in Zambia is largely rain-fed, making it vulnerable to weather variability, price fluctuations, input availability, and bio-hazards such as armyworm invasions. Government policies have historically prioritized maize self-sufficiency. Between 1970 and 2019, maize production increased substantially, reaching 2,004 thousand tonnes in 2019 [9]. This increases enabled Zambia to export to regional markets, making it a leading supplier in the 2015/16 marketing year, nearly matching South Africa [10]. However, production growth has been driven by land expansion rather than yield improvements, which is unsustainable given increasing land fragmentation [6] .

The 2018/2019 agricultural season was adversely affected by extreme weather conditions and climate change, leading to a sharp decline in maize production growth from 9.8% in 2017/2018 to -21.2% in 2018/2019 [11]. The rain-fed nature of maize production has made the sector prone to crop failures, particularly in the Southern and Western provinces, which have experienced prolonged dry spells. Additionally, electricity rationing due to reduced hydropower generation at Lake Kariba further constrained production [11].

Zambia's maize sector exhibits a dualistic structure, with both small- and large-scale farmers engaged in production. During 2011/12 and 2014/15 farming seasons, small-scale farmers dominated in maize production by 86% and 88.7%, respectively. [12]. However, most smallholders are asset-poor and rely on basic cultivation technologies, lacking access to functional input and output markets.

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In addition, it is estimated that less than 50% of smallholders sell their produce annually [13]. In contrast, large-scale commercial farms employ modern technologies and have better access to both domestic and international markets [14].

2.3 Agricultural Risk

Farmers face multiple risks, including weather variability, diseases, natural disasters, market fluctuations, infrastructure challenges, policy changes, and political instability [12]. Smallholder farmers are particularly vulnerable due to their limited capacity to absorb shocks.

While studies have increasingly focused on weather variability and crop yields , [4] argue that analyzing only one risk provides an incomplete understanding of agricultural risks. The degree to which farmers' exposure to risks has increased remains context-dependent, with evidence showing mixed results, particularly concerning weather variability and commodity prices [15]

2.4 Risk Perception Among Farmers

Risk perception refers to farmers' judgments about the likelihood and severity of specific risks which in turn influence their response strategies [16]. Research has examined various factors affecting risk perception and the barriers to effective risk management [17]. Studies indicate that market risks, particularly price fluctuations, are perceived as the most critical by farmers, alongside risks from global supply and demand shifts, technological advancements, and workforce skill levels [18]. Other notable risks include government regulations, production challenges, and climate-related threats [19]. Additionally, asset endowments, livelihood strategies, locational factors, and risk attitudes further shape risk perception [20].

In Zambia, traditional maize farmers face multiple risks, including production, environmental, market, and policy-related risks [21]. Key risks identified include variability in input access, livestock diseases, financial constraints, limited weather information, and climate variability [22] . [12] identified government regulations, market risks, and climate change as significant concerns, while [23] highlighted human resource risks such as illnesses, deaths, and marital disputes as factors affecting smallholder resilience. A comprehensive understanding of risk perception and management is therefore crucial for developing targeted interventions that can enhance resilience and productivity in Zambia's agricultural sector.

RESEARCH METHODOLOGY

3.1 Study area – Zambia

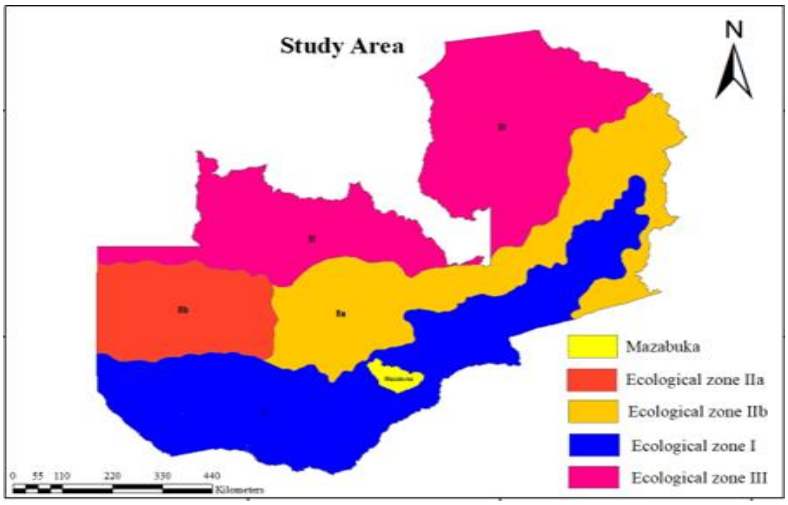

Figure 1: Map of the study area.
Source: [1]

Zambia is a land linked country in Southern Africa, covering an area of approximately 75 million hectares [1]. The country is divided into 116 districts, with Mazabuka District located in the Southern Province, a key agricultural hub. This study was conducted in Mazabuka District, located in Zambia's Southern Province. Positioned south of the Kafue Flats, a vast floodplain of the Kafue

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River. Mazabuka has an estimated population of 230,972, with approximately 75% residing in rural areas [24]. The district experiences a tropical climate characterized by three distinct seasons: the rainy season (November to April), the cool dry season (May to August), and the hot dry season (September to October). Annual rainfall ranges between 600 and 800 mm, making the region more vulnerable to drought compared to Zambia's northern regions [25]. These climatic conditions significantly influence agricultural productivity, particularly maize farming, which is the region's staple crop.

METHODS

A quantitative research approach was employed to assess smallholder farmers' perceptions of risk in maize farming. A cross-sectional survey design was used, allowing for data collection at a single point in time. The study adopted a simple random sampling technique, selecting 51 smallholder maize farmers from a total population of approximately 400 farmers. To ensure representative coverage, the systematic skip method was applied: the first household at the centre of a settlement was randomly selected, followed by every fourth household until the target sample size was achieved.

Data were collected using a structured questionnaire adapted from Holmes Sackett and Associates [26] The questionnaire covered two key areas: (i) risk perception in maize farming, where respondents assessed the likelihood of various risks over three consecutive agricultural seasons (2014/15, 2015/16, and 2016/17) using a five-point Likert scale (0 to 5), and (ii) demographic and socioeconomic characteristics, capturing data on age, household size, number of farm employees, farming experience, and maize production levels measured in 50kg bags.

Prior to full-scale data collection, the questionnaire was pre-tested with a small subset of farmers to enhance clarity and ensure validity. Respondents were briefed on the study objectives, and informed consent was obtained in accordance with ethical research guidelines. Quantitative data were analysed using Microsoft Excel, employing descriptive statistical techniques to summarize demographic characteristics and risk perception scores. Mean scores, standard deviations, and frequency distributions were computed to identify trends in risk perception across the study period, offering insights into the potential effects of climatic variability, input availability, and other external factors on maize production.

4. RESULTS AND DISCUSSION

This section presents the findings of the study.

4.1 Smallholder Maize Farmers' Perception of Risk Sources

Smallholder farmers in Mazabuka face various risks that impact their maize production. As shown in figure 2 below, these risks can be classified into four main categories: environmental (Climate variability), economic (fluctuating maize prices), biological (pests and diseases), and social risks (labour shortages and poor infrastructure).

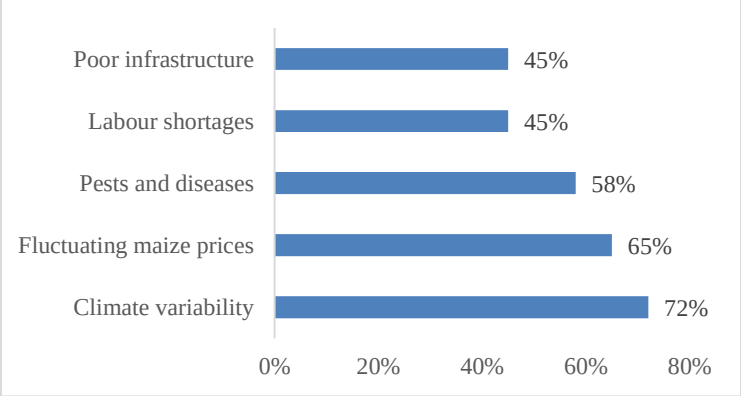

Figure 2: Perception of Risk Sources

Climate variability was the most significant risks identified by 72% of farmers. This aligns with findings from [32], who highlighted the vulnerability of smallholder farmers in Zambia to climate change, resulting in erratic rainfall patterns and prolonged dry spells. This climate variability leads to crop failure or significant reduction in yields.

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Economic risks, particularly the fluctuating prices of maize, were reported by 65% of respondents. As maize is a staple crop in Zambia, its price volatility significantly affects farmers' income stability. Farmers expressed concerns about market dynamics, which often result in unpredictable income, making it difficult to plan for the future. This finding is consistent with the findings of [27], who observed that price volatility and inadequate market access are major barriers to smallholder farmers' economic stability in Zambia. Additionally, 58% of farmers cited the high cost of inputs, such as seeds, fertilizers, and pesticides, as a significant economic risk. This corroborates the work of [28], who found that the high cost of agricultural inputs exacerbates the financial strain on smallholder farmers.

Biological risks were also prominent, with 58% of farmers identifying pests and diseases as major threats. The fall armyworm, maize weevil, and maize streak virus were the most commonly mentioned pests and diseases. This is in line with the findings of [29], who reported that pests and diseases are significant challenges to smallholder farming, especially when compounded by environmental stressors like drought.

Social risks, such as labour shortages and poor infrastructure, were cited by 45% of farmers. Labour constraints, particularly during critical periods like planting and harvesting, were a significant challenge. Furthermore, poor road networks and inadequate transportation options limited farmers' access to markets, affecting their ability to sell their produce at competitive prices. This is supported by the study done by [17] who revealed that inadequate infrastructure and labour shortages often exacerbate the vulnerability of smallholder farmers, reducing their capacity to respond to market and environmental changes.

These findings indicated that smallholder farmers in Mazabuka face multiple, interconnected risks, with climate-related and economic factors being the most prevalent. Addressing these risks will require complex risk management strategies.

4.2 Smallholder Maize Farmers' Risk Coping Strategies

In response to these risks, smallholder maize farmers have adopted various coping strategies to mitigate the effects and ensure the sustainability of their farming activities. Figure 3.0 below shows various risk coping strategies used by smallholder farmers in the area.

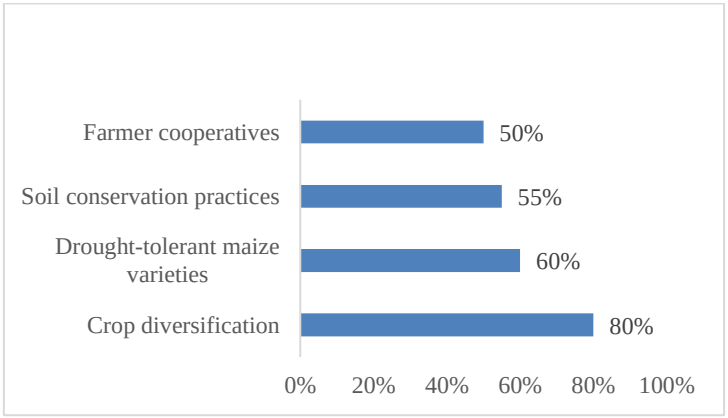

Figure 3: Risk Coping Strategies

Crop diversification was the most widely adopted coping strategy, used by 80% of farmers. By planting a variety of crops such as beans, groundnuts, and millet alongside maize, farmers reduce the risk of total crop failure. This strategy also helps to stabilize income and maintain food security, particularly in years when maize yields are affected by climatic conditions. This finding is supported by [17] who emphasized crop diversification as a key strategy to reduce vulnerability to climate variability in sub-Saharan Africa.

Drought-tolerant maize varieties were used by 60% of farmers. These varieties are better suited to periods of drought and low water availability, helping farmers maintain productivity even in the face of adverse climatic conditions. However, the cost of purchasing drought-tolerant seeds remains a barrier for some farmers, limiting their widespread adoption. This aligns with the findings of [30] who noted that while drought-tolerant varieties are an effective coping mechanism, high input costs hinder smallholder farmers' ability to fully benefit from such innovations.

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To address environmental risks such as soil erosion and reduced fertility, 55% of farmers adopted soil conservation techniques, including mulching, minimum tillage, and contour ploughing. These practices are designed to improve soil moisture retention, reduce erosion, and enhance fertility, thus improving productivity over time. This is in line with the work of [31], who argued that conservation practices are critical for sustaining soil health and enhancing productivity in smallholder farming systems.

Farmer cooperatives were another important coping mechanism, with 50% of farmers being members. Cooperatives allow farmers to pool resources, reduce input costs, share knowledge, and improve market access. Cooperatives also facilitate access to extension services, which provide training on best agricultural practices. This finding supports the conclusions of [29], who found that farmer cooperatives significantly enhance resilience by promoting collective action and resource sharing.

While these strategies were widely adopted, there were limitations. Many farmers faced financial constraints that limited their ability to access high-quality inputs and technologies. The lack of affordable credit facilities also restricted farmers' ability to invest in necessary tools and technologies. This barrier to financial access is consistent with the findings of [27], who noted that limited access to credit and financial services impedes the adoption of modern agricultural technologies

4.3 Key Agricultural Risk Management Factors Influencing Maize Productivity.

Figure 4.0 summarizes the Key Agricultural Risk Management Factors that Influence the production of Maize in the district.

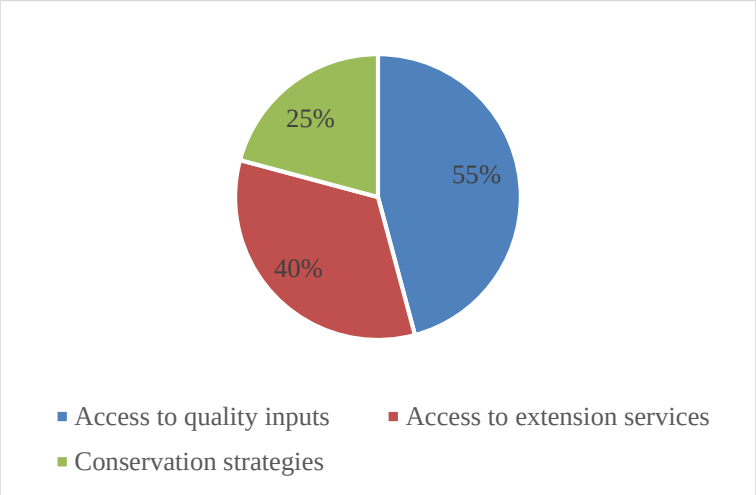

Figure 4: Key Agricultural Risk Management Factors Influencing Maize Productivity.

Farm characteristics, including land size, access to resources, and support networks, play a critical role in determining a farmer's ability to manage risks and improve maize productivity.

Land size was positively correlated with both better risk management practices and higher maize yields. Farmers with more than 3 hectares of land were able to invest in irrigation systems, purchase quality seeds, and adopt soil conservation practices. These farmers were also more likely to engage in crop diversification, reducing their exposure to risks. This finding aligns with, [32], who reported that smallholder farmers with larger landholdings have more resources to invest in risk management strategies, leading to higher productivity.

Access to agricultural inputs such as quality seeds, fertilizers, and pesticides was a significant determinant of productivity. Around 55% of farmers in Mazabuka reported regular access to these inputs, which enabled them to improve their maize yields. This finding is consistent with the work of [27], who found that access to quality agricultural inputs is a major determinant of smallholder productivity in Zambia.

Extension services were another key factor in improving both risk management and productivity. Approximately 40% of farmers had access to extension services, which provided guidance on pest management, soil fertility, and new agricultural technologies. Those with access to extension services reported higher productivity and better risk management outcomes. This supports the

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findings of , [33], who found that access to extension services significantly improves agricultural outcomes by providing farmers with the knowledge and skills needed to adopt sustainable practices.
Farmers with larger landholdings and better access to inputs and extension services experienced higher productivity. These results are in line with [43], who concluded that farmers with larger farms and better access to resources are more likely to achieve higher productivity due to their ability to invest in risk management practices.

5. CONCLUSION

This study highlighted the various risks faced by smallholder maize farmers in Mazabuka District, Southern Province of Zambia. The results revealed that climate-related risks, particularly drought and erratic rainfall patterns, were the most significant challenges affecting maize productivity, with 65% of farmers reporting drought as the primary risk. Economic risks, including fluctuating maize prices and high input costs, were reported by 54% of farmers as major concerns. Biological risks, such as pests and diseases, affected 48% of farmers, further exacerbating these challenges. The study found that smallholder farmers in Mazabuka had adopted a variety of coping strategies to manage these risks. These strategies included crop diversification [reported by 42% of farmers], the use of drought-tolerant maize varieties [32%], soil conservation techniques [25%], and participation in farmer cooperatives [18%]. The findings suggested that these strategies were effective in reducing the impacts of certain risks, especially drought and soil degradation. For instance, 70% of farmers who adopted drought-tolerant maize varieties reported a reduction in drought-related losses. However, access to financial resources, improved seeds, and credit facilities remained key barriers, with 55% of farmers identifying these as significant limitations to the full adoption of risk management strategies. The study also identified that farm characteristics such as land size, access to resources, and membership in farmer cooperatives significantly influenced the effectiveness of risk management strategies and maize productivity. Larger farms (45% of respondents) and those with access to better resources tended to employ more effective risk management practices, with 60% of these farmers reporting higher maize yields compared to those with smaller farms. Overall, the findings underscored the need for tailored risk management interventions that addresses the specific challenges faced by smallholder farmers in Mazabuka.

6. RECOMMENDATIONS

To enhance the resilience and productivity of smallholder maize farmers in Mazabuka, targeted interventions are essential. Promoting drought-tolerant maize varieties through subsidies and improving irrigation infrastructure can help mitigate climate risks. Strengthening weather forecasting and early warning systems will enable better planning. Economic stability can be improved by establishing price stabilization mechanisms, providing affordable credit facilities, and strengthening market linkages. To address pest and disease challenges, integrated pest management strategies and access to extension services should be expanded.
Strengthening farmer cooperatives, improving rural infrastructure, and enhancing access to extension services will further support risk management efforts. Tailored policies that address the specific needs of smallholder farmers, particularly those with limited resources, should be developed, alongside public-private partnerships to drive sustainable agricultural development.

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