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Ethno-Scientific Strategies to Cope with Climate Change Adopted by Dakamela Small Holder Communal Farmers in Nkayi District, Zimbabwe

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Abstract:
Zimbabwe is currently grappling with a climate change dilemma characterized by erratic rainfall patterns and extreme temperature fluctuations. These climatic challenges have detrimental repercussions on the rural populace, primarily dependent on rain-fed agriculture for their sustenance. To mitigate the socioeconomic ramifications of climate change in rural areas like Nkayi District, Zimbabwe, the focus must shift towards implementing climate change adaptation measures aimed at bolstering agricultural productivity amidst fluctuating weather conditions. Therefore, this study aims to investigate the utilization of ethno-scientific knowledge, commonly referred to as indigenous knowledge systems (IKS), by smallholder communal farmers in the Dakamela area of Nkayi District as a means to adapt to climate change. The key strategies currently adopted by farmers include dry planting, crop diversification, early planting, livelihood diversification and cultivation of drought-tolerant crops. The study adopted a qualitative study design and was conducted during the 2022/2023 rainy season from November 2022 to April 2023. The study period was intentionally selected based on Zimbabwe's rainy season to investigate and identify essential ethno-scientific strategies employed by district farmers to address climate change. The paper advocates for policymakers and climate change experts to incorporate the indigenous knowledge held by local communities into the formulation and execution of climate change adaptation and mitigation initiatives in rural areas like Dakamela.

Keywords*: Climate change, diversification, indigenous knowledge system, drought tolerant*

1. Introduction

Environmentalists, scientists and policymakers concur that the whole world is faced with a stern and long-standing threat from climate change (Hansen *et al*., 2007; Matarira *et al.,* 1995). In the same vein, scholars maintain that climate change remains the main challenge facing humankind worldwide (Abdallah *et al*., 2019; Pedersen *et al*., 2021). Similarly, Slater *et al*. (2007) propose that, by the end of the 21st century, climate change will have a considerable impact on agriculture globally. Climate change has a significant, potentially devastating impact on developing nations, where a majority of the population depends on climate-sensitive livelihoods and has limited adaptive capacity (Asfaw et al., 2021).

The Fifth Assessment Report from the Intergovernmental Panel on Climate Change, Working Group II (2014), illustrated that climate change impacts are expected to exacerbate existing poverty levels in many developing nations (Edenhofer, 2015). As noted by Von Braun (2020), Sub-Saharan Africa has experienced adverse effects on agriculture and food security due to climate change. The region's heavy reliance on rain-fed agriculture renders its agricultural system highly susceptible to climate change, as emphasized by Antwi-Agyei and Stringer (2021). Furthermore, Morton (2007) contends that the Sub-Saharan African region's vulnerability to climate change is exacerbated by limited technological advancement and a significant dependency on agricultural economies.

Scholars concur on the susceptibility of Zimbabwe's agricultural sector to climate change impacts (Matarira et al., 1995; Mendelsohn et al., 2000). The Food and Agriculture Organisation (FAO) (2018) underscores that Zimbabwe relies heavily on rain-fed crops, with maize, sorghum, and pearl millet accounting for 80 percent of agricultural production. Maize, in particular, dominates Zimbabwe's agricultural landscape, being cultivated extensively throughout the country. As noted by Matarira et al. (1995), who employed global climatic models and dynamic crop growth models, rising temperatures associated with dry land conditions result in a dramatic decline in maize yields, primarily due to the shortened crop growth period. As such, climate change diminishes soil moisture, reduces yields on rain-fed crops and leads to an increase in pests such as fall armyworm, thereby increasing the chances of total crop failure and causing food insecurity in Zimbabwe (Mafongoya *et* al., 2019).

Nkayi smallholder farmers predominately cultivate maize and keep cattle for survival (Homann-Kee Tui et al., 2013). The district has low agricultural productivity due to climate change. Moreover, a projected temperature rise by 3°C and a diminution in rainfall by 25% might result in 70% of households in the district being exposed to more vulnerability. As climate change increasingly impoverishes the population of Nkayi, smallholder farmers have turned to ethno-scientific strategies to address its impacts. Research by Audefroy and Sánchez (2017) revealed that these ethno-scientific approaches, often referred to as indigenous knowledge systems (IKS), employed by smallholder communal farmers to tackle climate change closely resemble scientific knowledge. Hence, the extensive practical wisdom held by indigenous communities plays a crucial role in formulating effective climate change adaptation strategies.

This study aimed to investigate the ethno-scientific strategies employed by smallholder farmers in Dakamela to mitigate the effects of climate change. Examining the practices of these communal farmers is vital, as it could offer innovative avenues for crafting more effective climate change adaptation policies (Karume et al., 2022). Furthermore, the study's findings may contribute to the development of contextually suitable, farmer-informed approaches that are less labor-intensive and better aligned with local conditions (Chuma et al., 2022).

2. Research Methodology

The study adopted a qualitative study design and was conducted during the 2022/2023 rainy season from November 2022 to April 2023. The study period was deliberately aligned with Zimbabwe's rainy season to investigate significant ethno-scientific strategies employed by district farmers for climate change adaptation. This facilitated a comprehensive examination and analysis of the strategies employed by smallholder farmers in coping with climate change.

The study period was deliberately aligned with Zimbabwe's rainy season to investigate significant ethno-scientific strategies employed by district farmers for climate change adaptation. This facilitated a comprehensive examination and analysis of the strategies employed by smallholder farmers in coping with climate change. The adopted key informant interviews and focal group discussions using an interview guide gathered information from local farmers, government and non-governmental experts who are working with communities in Dakamela area to enhance agricultural productivity in the wake of climate change. A convenience sampling technique was used to identify and select respondents, adapted from Zikhali (2022), due to limited financial resources and time constraints to cover the whole district. In convenience sampling, researchers selected respondents that were readily and easily accessible (Lewis-Beck *et* al., 2004). The study adopted this sampling approach as the researchers are familiar with the area under study; hence, they could identify the areas with diverse interventions from communities**.**

The study adopted thematic analysis to analyse the data that were collected. This approach was used due to its flexibility, which enabled the researchers to focus on the data in several diverse ways (Braun & Clarke, 2012). The thematic analysis provides for reasonably focusing on analysing connotation across the whole dataset or examining one specific aspect of a phenomenon in depth (Braun & Clarke, 2006). Data analysis included drafting notes of verbatim transcriptions from interview responses to identify themes.

3. Study Site

Nkayi district is situated in Zimbabwe's Matabeleland North province, which occupies part of the Zambezi scarp, characterised by erratic rainfall and poor agricultural outputs (Zikhali, 2022). Moreover, the district is located in an agro-ecological region that receives average-to-poor rainfall and has poor soils for agricultural production of major crops (Khumalo, 2021). Likewise, Chirima et al. (2018) contend that the region's annual rainfall of less than 650 mm and recurring droughts every 2 to 5 years expose farmers to the adverse effects of climate change, severely compromising agricultural production. Additionally, the 2013 Zimbabwe Vulnerability and Adaptation Assessment (ZimVAC) reported that the district has the highest poverty rate in the country, with over 76% of the rural population living below the poverty line (earning less than $1.5 USD per day), and more than 22% of the population living in extreme poverty (earning less than $1 USD per day) (ZimVac, 2013). Food self-sufficiency varies from 3 to 10 months depending on annual rainfall, further increasing the vulnerability of rural residents to climate change impacts. Scholars like Homann-Kee Tui et al. (2015) highlight that maize and cattle production dominate agricultural systems in Nkayi. Unfortunately, current crop yields in the district are exceptionally low, comparable to the national average.

4. Findings

In the Dakamela area of Nkayi district, smallholder communal farmers have proactively implemented a range of climate change adaptation and mitigation measures to bolster agricultural productivity amidst the challenges posed by climate change. According to Matanga and Jere (2011), climate change adaptation and mitigation strategies are commonly categorized into two broad groups: ethno-science and techno-science adaptation approaches. Ethno-science strategies are rooted in local people's knowledge of their physical environment, while techno-science strategies involve the application of contemporary modern technologies.

Interestingly, smallholder communal farmers in Dakamela appear to favor ethno-scientific strategies due to their cost-effectiveness and reliance on indigenous knowledge systems. Therefore, this paper delves into an exploration of the ethno-scientific methods embraced by Dakamela's smallholder communal farmers for climate change adaptation and mitigation purposes.

4.1. Crop Diversification

Crop diversification is a strategy involving the cultivation of various crops to serve as safety nets in case certain crops fail due to adverse weather conditions. Many Dakamela farmers reported practicing crop diversification by cultivating a mix of crops, including maize (Zea Mays), pearl millet (Pennisetum glaucum), rapoko (Eleusine coracana), groundnuts (Arachis hypogaea), and round nuts. Legume crops like groundnuts are particularly beneficial as they can fix nitrogen, which enhances soil fertility. This, in turn, supports the survival of other crops like maize that have high nitrogen requirements. Elaborating on this approach, one respondent said:

> *"We initiated crop diversification in 2012 after receiving training on this climate change adaptation strategy from a field officer representing the non-governmental organization Help from Germany. The officer clearly explained how crop diversification might help us in times of drought; hence, we did not hesitate to adopt this strategy. Our primary crops include millet, sorghum, groundnuts, and maize. Mixing maize with leguminous crops like groundnuts has significantly boosted yields due to nitrogen fixation, improving soil fertility. This strategy has been instrumental in averting food shortages, enabling us to support our children's education through revenue from selling our farm produce at Nkayi growth point."*

4.2. Cultivating Drought-Tolerant Small Grains

Due to the district's inadequate and irregular rainfall patterns, coupled with elevated temperatures, farmers have shifted their focus to cultivating drought-tolerant small grains such as pearl millet, rapoko, and sorghum. Although maize remains the staple cereal, respondents emphasized that prevailing weather conditions make its cultivation unviable. Therefore, the adoption of small grain crops, well-suited for arid conditions, ensures food security during drought periods, addressing the challenges posed by the adverse climate.

4.3. Dry Planting

Respondents stated that they adopted this strategy to counter uncertainty about when the season starts. Furthermore, they proposed engaging in land preparation and seed planting in September and October, preceding the arrival of rainfall, a practice referred to as *Ukuphalela* in the local Ndebele dialect. Farmers employ this method to ensure the germination of pre-sown seeds when the initial rains arrive, mitigating the uncertainty and unpredictability of rainfall patterns. Sorghum is the primary crop subjected to dry planting, particularly in Mfanovelayo village.

Additional to this strategy, one of the respondents stated:

> *"As a widow primarily reliant on crop farming, I have adapted to the prevailing rainfall patterns and high temperatures by focusing on sorghum cultivation. Sorghum's drought tolerance allows it to thrive in the region's extreme heat. To optimize my harvest prospects, I employ dry planting and take advantage of early rains. Typically, I initiate my planting in October, well in advance of the rainy season."*

When she was probed about where she learnt about this strategy and whether other nearby farmers have also adopted this strategy, this is what she had to say:

> *I learnt about dry planting in several training sessions organised by local Agricultural Extension Officers and officers from Non-governmental organisations, notably: MELANA. This strategy is common in this ward and more than half of the farmers are using the dry planting method; hence, this area is the bread basket for Nkayi district regarding sorghum amid climate change impacts.*

4.4. Early Planting

Some participants emphasized the practice of early planting to maximize the utilization of the initial rains and the full growing season. They explained that their extensive understanding of their agro-ecological conditions, coupled with observations of favorable rainfall indicators in the surrounding natural vegetation, guides them in planting crops at the onset of the first rains.

4.5. Livelihood Diversification

In response to climate change impacts, communal farmers in Nkayi district have shifted from exclusive dependence on agriculture to diversifying their livelihoods. These diversification strategies include the sale of local fruits, Mopani worms (Imbrasia belina), and engagement in brick molding. Moreover, the respondents highlighted that the failure of crops due to climate change has forced young people to migrate to major towns and cities, predominantly Bulawayo and Harare, in search of greener pastures. Other interviewees mentioned that other young individuals, mostly males, have emigrated to nearby countries such as South Africa to work as casual labourers.

One of the respondents said:

> *Poor rainfall and extreme temperatures, coupled with rocky soils here at Kimbi village, have forced us to resort to brick moulding and Mopani worms harvesting and selling as our main livelihood activities. We mould bricks using locally available kaolin-rich soils and sell them to local people at affordable prices. We mainly practise brick moulding at the end of the rainy season when water will be plenty at the local streams and rivers.*

5. Discussion

This section compares the study findings with what other scholars have postulated with regard to small holder communal farmers' adaptation to climate change. This study found that Dakamela smallholder communal farmers mainly

use crop diversification, early planting, livelihood diversification, cultivation of drought-tolerant crops and dry planting as climate change coping strategies. Similar findings were reported by Mushore et *al*. (2021) in a study that was conducted at Nyanga district in Zimbabwe. The study revealed that smallholder farmers in Nyanga district cultivate drought-tolerant crops and practice early planting and crop diversification. In another study conducted in Kenya, Asayehegn *et al*. (2017) found that crop diversification was implemented by smallholder farmers to cope with climate change. Similarly, a study conducted by Mutekwa (2009) in Zvishavane District, Zimbabwe, yielded analogous findings, highlighting livelihood diversification as a pivotal climate change adaptation strategy. The research revealed that young individuals turned to activities such as mining in Shabani mine, sought employment in Zvishavane town, or migrated to work in Botswana and South Africa. This aligns with the assertions of Kangalawe and Lyimo (2013), who argue that livelihood diversification is a vital climate change adaptation approach among smallholder farmers in Tanzania.

Furthermore, corroborating the outcomes of this study, Mashizha (2019) observed that farmers in Zimbabwe's Zvimba district cultivated drought-resistant crops like pearl millet, sorghum, and rapoko to mitigate the impacts of climate change. In support of early and dry planting as climate change adaptation strategies among smallholder farmers, Mushore et al. (2021) posited that farmers in Nyanga district, Zimbabwe, practiced early and dry planting of crops like pearl millet and sorghum to mitigate the uncertainties associated with rainfall patterns. These findings collectively underscore the importance of livelihood diversification and adaptive agricultural practices in the face of climate change.

6. Conclusion

Nkayi district, characterized by low and irregular rainfall, experiences frequent dry spells and droughts that significantly impede agricultural productivity. Consequently, smallholder farmers in Dakamela area (Ward 16) have turned to ethno-scientific strategies to mitigate the adverse effects of climate change, primarily due to their cost-effectiveness and lower technical requirements. These climate adaptation measures include dry planting, early planting, crop diversification, livelihood diversification, and the cultivation of drought-tolerant crops.

Therefore, it is recommended that climate change experts facilitating adaptation initiatives in Nkayi district should actively incorporate the local population's knowledge into their strategies. By leveraging and building upon local knowledge, there is a greater likelihood of fostering community engagement and ownership of climate change mitigation and adaptation programs. Initiatives grounded in the existing knowledge base of the local populace tend to garner broader support and enhance the effectiveness of climate change interventions.

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