PERCEIVED EFFECT OF DROUGHT ON AGRICULTURAL YIELD IN LIBORÉ, TILLABERI, NIGER: A REVIEW

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ABSTRACT

Purpose: This study reviewed the perceived effects of drought on agricultural yield in Liboré, Tillabéri, Niger. It aimed to assess how farmers interpreted drought-related risks, how these perceptions influenced their adaptation strategies; and the broader implications for agricultural resilience.

Theoretical Framework: The study was grounded in the theory of environmental perception and adaptation, which posits that individuals' responses to environmental threats were shaped by socio-economic, cultural, and institutional contexts. It also drew from climate vulnerability and resilience frameworks to assess farmers' capacity to cope with drought.

Design/Methodology/Approach: The study adopted a literature review approach, synthesizing empirical research on climate change impacts, agricultural adaptation, and farmers' perceptions of drought. It examined both qualitative and quantitative studies, with a focus on West Africa and the Sahel region, particularly Niger.

Findings: The review revealed that farmers' perceptions of drought were influenced by multiple factors, including past experiences, socio-economic status, and access to resources. While many farmers relied on traditional soil and water conservation techniques, the effectiveness of these strategies varied based on local conditions. The study also found that discrepancies between perceived and actual drought conditions sometimes led to maladaptive decisions.

Research, Practical, and Social Implications: The findings underscored the importance of integrating scientific data with farmers' local knowledge to improve adaptation strategies. Policymakers and agricultural extension services are needed to enhance climate information dissemination and promote sustainable practices tailored to local realities. Socially, strengthening community networks and institutional support could enhance resilience to drought and mitigate its adverse effects on agricultural.

Keywords: Drought perception, Agricultural yield, Climate adaptation, Farmers' resilience, Niger, and Climate change.

INTRODUCTION

Climate change instigates significant and perilous disruptions in nature, impacting the lives of billions worldwide, with the most profound repercussions felt by people and ecosystems. The surge in temperatures, droughts, and floods already surpass the tolerance thresholds of plants and animals, leading to mass mortality. These extreme weather events have exposed millions to acute food and water insecurity, notably in Africa, Asia, Central and South America, small islands, and the Arctic (IPCC, 2022). Over the decades, numerous studies have aimed to provide projections on climate change. These projections underscore the vulnerabilities of territories to future climate change scenarios, which could bring about significant societal disruptions, profoundly affecting the livelihoods of affected populations (Desquith and Renault, 2021).

Sub-Saharan Africa emerges as a highly vulnerable region regardless of the envisaged climate change scenario, owing to its geographical exposure and sensitivity to climatic hazards (Morris, 2023). Climate change posed a significant challenge in the West African Sahel, a region identified as one of the most vulnerable to climate change globally. The West African Sahel region would be particularly affected by the risks posed by climate change in terms of food security. Several studies carried out across the region have highlighted the impact of current and future climate change on crops and food security (Abdoul Rachid et *al*., 2023).

Located in the Sahel West Africa, Niger is landlocked, covering an area of 1, 267,000 km², three-quarters of which is desert. Its climate is semi-arid tropical. The population of Niger was estimated at 22 million inhabitants in 2021 and the majority of this population is rural (CNEDD et *al*., 2022). The early end of the rains is the most important climate risk for rain-fed agriculture in Niger. It is followed respectively by strong winds at the beginning of the season and prolonged dry sequences. The diversity of risks is greater in the North than in the South. Also, the delay of the first useful rains, the strong wind at the beginning of the season, the irregularity of the rains, and the insufficiency of the rains are more worrying in the North than in the South. Conversely, prolonged dry sequences, strong winds at the end of the season, and flooding are of greater concern to producers in the south than in the north (Nassourou et *al*., 2018). The variability and unpredictability of these climatic conditions pose significant challenges for agricultural productivity, particularly in areas like Liboré.

Accurately assessing and disseminating information on these climate risks is crucial for informed decision-making and the development of effective adaptation strategies. A nuanced understanding of local perceptions of drought and its impact on agricultural yield is essential for designing interventions that address the specific vulnerabilities and needs of rural

communities in Niger. This literature review aims to examine the perceived effects of drought on agricultural yield in Liboré, and identify the factors that shape these perceptions. Understanding these perceptions is critical for informing policy and practice, enhancing resilience, and ensuring sustainable agricultural development in the face of increasing climate variability.

I. CONCEPTUAL FRAMEWORK

Drought is a multifaceted phenomenon that significantly impacts agricultural productivity through multiple pathways, including reduced water availability, increased evapotranspiration, soil degradation, and altered pest dynamics. In regions like Liboré, where agriculture is primarily rain-fed, the effects of drought are particularly severe, leading to crop yield losses. Perceptions of drought among farmers play a critical role in shaping their adaptive behaviors, as these perceptions are influenced by various socio-economic factors, such as age, education, access to resources, and past experiences with drought (Bharwani et *al*., 2005; Sissoko et *al*., 2011). Understanding these perceptions is essential because they drive decisions on crucial adaptation measures like selecting drought-resistant crop varieties, changing planting dates, or adopting soil and water conservation techniques (Mertz et *al*., 2009; Morton, 2007). Effective adaptation to drought depends on accurate perceptions that align with scientific data, thereby reducing vulnerability and improving resilience to climate variability (Adger et *al*., 2013).

In the context of Liboré, farmers' perceptions of drought are shaped by their local environment, socio-economic conditions, and traditional knowledge systems, which may differ significantly from scientific assessments of drought risk. Studies have shown that local perceptions often guide adaptation practices, but these practices effectiveness varies depending on how well they are aligned with actual climatic conditions (O'Brien et al., 2006; Tschakert, 2007). For instance, research indicates that adaptation strategies based on community knowledge, such as the use of "zai" pits and "demi-lunes", can enhance soil water retention and improve crop yields under drought conditions (Wildemeersch et *al*., 2015). However, there is a need to integrate local perceptions with empirical data to develop a more comprehensive understanding of drought impacts and support more effective adaptation strategies in Liboré (Mertz et *al*., 2009; Tambo and Abdoulaye, 2013).

II. REVIEW OF EMPIRICAL STUDIES

Understanding the perceived effects of drought on agricultural yield in Liboré, requires examining empirical studies that assess both the impact of drought on agricultural systems and the adaptation strategies employed by farmers in response to these conditions. Several studies

provide valuable insights into these dynamics across different contexts in Niger and the broader Sahel region.

The study by Lokonon (2019) focuses on the vulnerability of farm households in the Niger basin of Benin to various climate shocks, including droughts, strong winds, heat waves, and erratic rainfall. It highlights that 57.43% of households are vulnerable to climate shocks, with 31.74% classified as very vulnerable. While the study does not specifically target Niger, its findings on how social capital can enhance resilience to climate shocks are relevant to understanding the context of Liboré, where community networks play a crucial role in agricultural adaptation. The study underscores that droughts significantly increase vulnerability due to their direct impact on water availability and crop productivity, an aspect that is likely mirrored in the Liboré region due to similar climatic conditions.

Wildemeersch et *al*. (2015) conducted a detailed study on agricultural drought trends and mitigation strategies in Tillabéri, Niger, combining long-term rainfall data with root zone water distribution analysis under different management practices. The findings indicate that the increase in agricultural droughts is not solely due to decreasing annual rainfall but is also driven by changes in daily rainfall patterns, such as prolonged dry spells that critically affect crop growth stages. The study demonstrates that specific soil-water management practices, like the use of "zaï" and "demi-lunes" combined with manure, are effective in mitigating drought effects by enhancing soil-water retention and boosting millet yields. These findings are highly relevant for Liboré, where similar practices could be adapted to local conditions to improve crop resilience against droughts.

Akumaga et *al*. (2018) utilized the AquaCrop model to simulate the impact of climate change on maize, millet, and sorghum yields under rain-fed conditions in the Niger River Basin, which includes parts of Tillabéri. The study revealed that climate change would have varying effects on crop yields across different agro-ecological zones, with potential yield decreases of up to 20% in the Northern Guinea savanna. The findings emphasize the need for adaptation strategies such as improving soil fertility, which could significantly mitigate negative yield impacts. This study highlights the importance of soil management and adaptation strategies that could be relevant to farmers in Liboré who are dealing with similar challenges related to climate variability and drought.

Abdoulaye and Lowenberg-DeBoer (2000) explored the intensification of farming systems in Niger, demonstrating how farmers gradually move from traditional low-input methods to adopting modern agricultural inputs like fertilizers and improved seeds. This progression is

seen as a response to the limitations of traditional methods, especially under conditions of increasing drought and soil degradation. Their findings suggest that starting with traditional intensification methods (e.g., higher planting densities, use of manure) before adopting modern inputs can be more sustainable and cost-effective for resource-limited farmers. For Liboré, this study offers insights into how traditional practices could be optimized before promoting more advanced technologies to cope with drought.

The study by Zakari et *al*. (2023) assessed the impact of adopting improved crop varieties (ICVs) on household welfare in Niger. It found that the adoption of ICVs significantly enhances household welfare by increasing income, food expenditure, and dietary diversity. The study underscores that promoting drought-tolerant varieties is crucial for mitigating the adverse effects of drought on agricultural yields. This finding is particularly relevant for Liboré, where the adoption of ICVs could provide a viable strategy to enhance resilience against drought conditions, ensuring better yield stability and food security.

The research by Wezel and Haigis (2002) analysed traditional fallow cultivation systems and the use of various fertilization techniques to manage soil fertility in Niger. They observed that traditional fallow periods have significantly decreased, necessitating alternative soil fertility management practices, such as the use of manure and mulching. These practices are essential to maintaining soil health and protecting against erosion, which in turn affects crop productivity. The study's findings suggest that resource-constrained farmers in Liboré could benefit from similar strategies to sustain soil fertility and enhance yield under drought conditions.

Mahamadou et *al*. (2019) investigated the impact of diversifying millet-based farming systems in Niger's agricultural zones on forage availability. The study found that mixed cropping systems, particularly those incorporating legumes and fodder crops, significantly improved soil fertility and overall biomass production, contributing to better drought resilience. These results imply that diversifying crop systems could be a key strategy for farmers in Liboré to improve soil health and increase crop yield despite recurrent droughts.

This section provides a comprehensive overview of the relevant empirical studies, highlighting how they contribute to understanding the perceived effects of drought on agricultural yield in Liboré.

III. FACTORS INFLUENCING PERCEPTIONS OF DROUGHT

Farmers' perceptions of drought are shaped by a variety of socio-economic, environmental, and cultural factors. Understanding these factors is crucial for developing effective adaptation strategies that align with local contexts. The following key factors have been identified in the literature as significantly influencing how farmers perceive drought and its impact on agricultural yield.

Socioeconomic status, including income level, education, and access to resources, plays a critical role in shaping how farmers perceive drought. Studies show that farmers with higher education levels and access to agricultural extension services are more likely to perceive drought accurately and adopt appropriate adaptive measures. For instance, the study by Zakari et *al*. (2023) highlighted that knowledge about improved crop varieties (ICVs) significantly influenced farmers' adoption decisions. Farmers who were better informed about the benefits of ICVs perceived drought as a less severe threat, believing that these varieties could mitigate its impact on crop yield. Conversely, resource-limited farmers with lower educational levels or limited access to extension services may have less accurate perceptions, which can affect their response strategies.

Perceptions of drought are also closely linked to environmental and climatic conditions. Farmers who have experienced prolonged periods of dry spells or unpredictable rainfall patterns are more likely to perceive drought as a frequent and severe threat. According to Wildemeersch et *al*. (2015), farmers in Tillabéri, Niger, attributed increasing agricultural droughts not only to decreasing annual rainfall but also to changes in daily rainfall patterns, such as longer dry spells. These climatic changes affect farmers' perceptions by heightening their awareness of the vulnerabilities in their farming systems, particularly in regions heavily reliant on rain-fed agriculture like Liboré.

Cultural beliefs, social norms, and local institutional frameworks significantly shape how farmers perceive and respond to drought. In many rural communities, traditional knowledge systems and communal decision-making processes play a significant role in how environmental changes are interpreted and acted upon. For example, the study by Wezel and Haigis (2002) observed that in Niger, traditional fallow cultivation practices were adapted over time to address reduced soil fertility, a change largely driven by community experiences and shared cultural practices. These adaptations were guided by local norms and collective experiences of managing drought impacts. Additionally, access to local institutions, such as farmer cooperatives or community-based organizations, can provide critical support and information, influencing farmers' perceptions and their willingness to adopt new practices or technologies.

Farmers' personal and collective experiences with past droughts are fundamental in shaping their perceptions. The study by Lokonon (2019) revealed that vulnerability to climate shocks, including drought, was perceived differently depending on the community's historical experiences with these events. In regions where drought has led to significant crop failure and food insecurity, farmers are likely to perceive future droughts as severe and recurrent threats. These perceptions are shaped by the memory of past losses and the strategies employed to cope with those conditions, whether successful or not. This experience-based knowledge often guides farmers' decisions on whether to invest in adaptation measures, such as changing planting dates or adopting drought-resistant crops.

Social capital, which includes the strength of social networks and the level of trust among community members, can significantly influence perceptions of drought. According to Lokonon (2019), social capital enhances resilience by facilitating access to resources, information, and support networks, which in turn shapes how farmers perceive and respond to climate shocks like drought. In communities where social capital is strong, collective actions are more likely, leading to shared learning and coordinated adaptation strategies. Farmers may perceive drought as less threatening if they know they can rely on communal support and collective resource management practices.

Access to agricultural extension services and climate information also plays a pivotal role in influencing farmers' perceptions of drought. Farmers with regular access to extension services are more likely to be aware of drought risks and informed about adaptation options. The study by Akumaga et *al*. (2018) demonstrated that providing farmers with knowledge about soil fertility management and climate adaptation techniques significantly impacted their perceptions and subsequent actions. In regions like Liboré, where access to reliable information can be limited, the presence of effective extension services can bridge this gap and positively influence perceptions of drought.

IV. IMPLICATIONS OF PERCEPTIONS ON AGRICULTURAL PRACTICES AND YIELD

Farmers' perceptions of drought play a critical role in shaping their agricultural practices and, ultimately, their crop yield outcomes. Understanding how these perceptions translate into specific adaptation strategies provides insight into the effectiveness of different agricultural responses to drought conditions in regions like Liboré. The literature highlights several key implications of these perceptions on agricultural practices and yields.

Perceptions of drought severity and frequency significantly influence farmers' decisions on adopting adaptation strategies. For example, farmers who perceive drought as a frequent and

severe threat are more likely to adopt drought-resistant crops, alter planting dates, or implement water conservation techniques. The study by Zakari et *al*. (2023) found that farmers who were aware of the benefits of improved crop varieties (ICVs) and perceived drought as a major risk were more likely to adopt these varieties. The adoption of drought-tolerant ICVs resulted in higher income levels, better food security, and increased dietary diversity, demonstrating that accurate perceptions of drought can lead to effective adaptation measures that mitigate yield losses.

Farmers' perceptions of drought often lead to modifications in agricultural practices, such as changes in cropping patterns, soil management techniques, and irrigation practices. For instance, the study by Wildemeersch et *al*. (2015) showed that in Tillabéri, farmers who perceived increasing agricultural droughts adopted soil-water management practices, like "zaï" and "demi-lunes" combined with manure, to improve soil-water retention and reduce drought impact on crop yields. These practices have been shown to be effective in maintaining or enhancing millet yields under drought conditions, demonstrating that perception-driven changes in agricultural practices can positively influence yield outcomes.

Perceptions of drought directly impact crop yields through the adaptation measures that farmers choose to implement. When farmers accurately perceive drought risks and adopt appropriate adaptation strategies, they can reduce yield losses or even achieve yield gains under certain conditions. Akumaga et *al*. (2018) found that in the Niger River Basin, improving soil fertility and adjusting sowing dates in response to perceived climate risks could significantly mitigate negative yield impacts caused by drought. These findings suggest that accurate perceptions aligned with scientific understanding can lead to better adaptation outcomes, resulting in more stable and possibly improved yields.

There can be a divergence between perceived and actual drought conditions, which may lead to maladaptation. Farmers who underestimate the severity or frequency of droughts may delay adopting necessary adaptation strategies, such as investing in water-saving technologies or switching to drought-resistant crops, resulting in greater yield losses. On the other hand, overestimating drought risks could lead to excessive precautionary measures, which might limit productivity gains. The study by Lokonon (2019) highlighted that in communities with strong social networks, even when perceptions do not align perfectly with scientific data, collective actions and mutual support can mitigate the risks of maladaptation. This suggests that understanding and addressing the gap between perception and reality is crucial for optimizing agricultural practices and ensuring better yield outcomes.

Perceptions of drought often reinforce traditional agricultural practices, particularly in areas with limited access to modern technologies. The research by Wezel and Haigis (2002) demonstrated that farmers in Niger have adapted traditional fallow cultivation systems over time in response to perceived decreases in soil fertility and increased drought frequency. While these adaptations, such as using manure and mulching, are driven by perception, they have been shown to help maintain soil health and protect against erosion, ultimately influencing yield stability under drought conditions. This suggests that perception-driven adherence to traditional practices can be beneficial when these practices are well-aligned with local environmental conditions.

Perceptions of drought are not static; they evolve with changing climatic conditions, experiences, and access to information. Farmers who perceive drought as an increasingly severe and frequent phenomenon are likely to shift towards more sustainable and long-term adaptation strategies. Mahamadou et *al*. (2019) highlighted that diversifying millet-based farming systems by incorporating legumes and fodder crops improved soil fertility and increased overall biomass production, leading to better drought resilience. Farmers' perceptions of the benefits of such diversification practices can motivate broader adoption, promoting sustainable agricultural practices that enhance resilience and yield stability over time.

V. IDENTIFIED GAPS IN THE LITERATURE

While the existing literature provides valuable insights into the perceived effects of drought on agricultural yield, several gaps remain that limit a comprehensive understanding of these dynamics, particularly in the context of Liboré. Identifying these gaps is crucial for guiding future research and ensuring that adaptation strategies are well-targeted and effective.

Most of the studies reviewed focus on broader regions such as the Sahel, West Africa, or Niger as a whole, with limited specific attention to the micro-regional context of Liboré. For example, while Wildemeersch et *al*. (2015) and Akumaga et *al*. (2018) provide relevant data on agricultural practices and climate change adaptation strategies in Niger, there is a lack of empirical studies that specifically analyse farmers' perceptions and responses to drought in Liboré. This gap limits our understanding of localized factors that influence perceptions, such as specific socio-cultural dynamics, local agricultural practices, and micro-climatic conditions.

The current literature often lacks an integrated approach that combines qualitative insights (e.g., farmers' narratives and experiences) with quantitative data (e.g., climate models and yield statistics). Studies like those by Zakari et *al*. (2023) and Lokonon (2019) primarily focus on quantitative assessments, such as the impact of improved crop varieties or vulnerability indices,

without deeply exploring the qualitative dimensions of how farmers perceive drought and its effects on their livelihoods. An integrated approach would provide a more nuanced understanding of the complex interplay between perception, behavior, and actual outcomes.

While some studies touch upon the role of social and cultural factors, there is limited exploration of how local cultural beliefs, social norms, and institutional frameworks specifically shape perceptions of drought and influence adaptation decisions. For instance, Wezel and Haigis (2002) mention traditional practices, but there is a need for more in-depth studies that examine how cultural and institutional contexts in Liboré affect farmers' responses to perceived drought risks. Understanding these influences could provide valuable insights into the drivers of local adaptation strategies and their effectiveness.

There is a significant gap in the literature regarding the direct link between farmers' perceptions of drought and their actual agricultural practices and yield outcomes. While studies like those by Zakari et *al*. (2023) and Lokonon (2019) indicate that perceptions influence adaptation choices, they do not adequately explain how these perceptions are formed or the psychological and behavioral processes that drive decision-making. Further research is needed to explore the cognitive and social processes through which perceptions translate into specific actions or inaction, especially in the face of uncertain and changing climatic conditions.

Most studies provide a snapshot of farmers' perceptions at a single point in time, without accounting for how these perceptions may change over time in response to evolving climatic conditions, economic shifts, or policy changes. For example, the research by Mahamadou et *al*. (2019) highlights adaptation practices but does not track how farmers' perceptions of drought and adaptation strategies evolve over longer periods. Longitudinal studies would help capture the dynamic nature of perceptions and better inform strategies to support sustained adaptation.

There is a noticeable lack of focus on the perceptions and adaptive responses of women and other marginalized groups, who often play crucial roles in agriculture but may have different perceptions and constraints compared to their male counterparts. The study by Lokonon (2019) broadly discusses household vulnerability but does not disaggregate findings by gender or socio-economic status. Future research should explore how gender, age, and social status affect perceptions and adaptive capacities to ensure inclusive and equitable adaptation policies.

While several studies discuss various adaptation strategies, there is a lack of detailed analysis on the economic trade-offs involved in adopting these practices. For instance, Abdoulaye and Lowenberg-DeBoer (2000) suggest that farmers gradually move from traditional to modern inputs due to capital constraints, but there is limited exploration of the cost-benefit analysis that

farmers undertake when choosing specific adaptation measures. Understanding these economic trade-offs is crucial for designing interventions that are both practical and beneficial for farmers facing drought conditions.

VI. KEY VARIABLES FOR ANALYZING DROUGHT IMPACT ON YIELD

Based on the literature review, a strategic selection of variables is essential for accurately modeling the perceived effects of drought on agricultural yield in Liboré. The literature highlights the importance of focusing on factors directly linked to drought resilience and adaptive capacity, such as household characteristics, farm practices, and institutional support. Variables like "Age," "Gender," "Marital status," and "Household size" are relevant, as they align with studies indicating that these demographic factors influence access to resources and decision-making processes related to drought adaptation (Lokonon, 2019; Zakari et *al*., 2023). Additionally, institutional characteristics like "Access to credit," "Access to drought-resistant seeds," and "Access to training" are critical, given their established role in enhancing farmers' ability to cope with drought conditions (Mertz et *al*., 2009).

Conversely, variables related to activities with limited relevance to agricultural resilience, such as "Arts and crafts," "Taxi," "Joinery," "Fish farming," and "Bulgarization," can be excluded. The literature does not support a significant connection between these off-farm activities and effective adaptation to drought. Instead, retaining variables related to rain-fed cropping systems such as "Millet," "Sorghum," and "Okra" is crucial, as these crops have been shown to respond differently to drought conditions, influencing yield outcomes (Mahamadou et *al*., 2019; Wildemeersch et *al*., 2015).

CONCLUSION

This literature review has explored the perceived effects of drought on agricultural yield in Liboré, by examining empirical studies that shed light on the factors influencing these perceptions and their implications for agricultural practices and yield outcomes. The review highlights that farmers' perceptions of drought are shaped by a complex interplay of socioeconomic, environmental, cultural, and institutional factors, which collectively determine their adaptive responses and resilience to drought conditions. Accurate perceptions of drought risks, supported by access to relevant information and resources, are crucial for guiding effective adaptation strategies that mitigate yield losses and enhance food security.

However, several gaps in the literature have been identified, particularly the need for more localized studies focused on Liboré and similar contexts. There is also a lack of integrated approaches that combine qualitative and quantitative data to provide a more comprehensive understanding of how perceptions influence agricultural decisions and outcomes. Furthermore,

the role of cultural and institutional factors in shaping perceptions and the dynamic nature of these perceptions over time remains underexplored. Addressing these gaps through future research is essential to inform targeted and context-specific adaptation strategies that align with farmers' needs and capacities.

Overall, this review underscores the importance of understanding farmers' perceptions of drought to design effective adaptation policies and practices. By acknowledging the local realities and incorporating farmers' perspectives, policymakers and development practitioners can support sustainable agricultural development in drought-prone regions like Liboré, fostering resilience and improving livelihoods in the face of increasing climate variability.

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