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Article

Differentiated Adaptation Dynamics to Climate Change in the Cameroonian Sahel: Local Perceptions and Agricultural Resilience in a Context of Multidimensional Vulnerability

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Abstract: This study examines perceptions of climate change and the adaptation strategies adopted by small-scale producers in the sudano-sahelian region of Cameroon. The survey was conducted in five villages distributed along a North-South ecological gradient: Pintchoumba, Bamé, Bang (North Region), and Gadas and Douroum (Far North Region). A sample of 250 producers comprising 30 agro-pastoralists, 10 livestock farmers, and 10 crop farmers per village was interviewed using a structured questionnaire based on a three-level Likert scale. The data, processed using R and Excel, primarily represent individuals aged 36 to 45, with women accounting for 22% to 30% of respondents. Findings indicate that 60% of participants perceive climate change through rainfall variability, rising temperatures, vegetation loss, and increased incidence of crop diseases. Perceptions and vulnerability levels vary by geographic location, gender, and livelihood. The northernmost villages, particularly Douroum and Gadas, appear to be the most affected, especially among livestock farmers. Reported adaptation strategies include crop diversification, adoption of short-cycle seeds, transhumance, and food storage. The study recommends context-specific responses: promotion of organic farming in the South, irrigation and farmer innovation hubs in central zones, and microcredit schemes, pastoral corridors, and assisted natural regeneration in the arid North. Emphasis is placed on integrating local knowledge, empowering women, and fostering inclusive governance.

Keywords: perception; sahelian gradient; local knowledge; resilience; farming practices; agricultural challenges

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1. Introduction

Climate change is a global phenomenon whose effects are felt across nearly the entire surface of the Earth. It manifests through profound and lasting changes in climate systems, affecting the frequency, intensity, duration, and spatial extent of extreme events such as heatwaves, cyclones, prolonged droughts, sudden floods, as well as the emergence of agricultural diseases and pests (Bryan et al., 2013; Gaymard et al., 2015; Mbuli et al., 2021; Verma et al., 2025). These disturbances have significant ecological, social, and economic consequences, making adaptation essential, particularly in climate-sensitive sectors such as agriculture.

These climatic disturbances have directly impacted on agricultural productivity. Recent studies indicate that average cereal yields in northern Cameroon have declined by 15 to 30% over the past two decades, mainly due to decreased rainfall, shortened growing seasons, and the increased prevalence of diseases and agricultural pests (Fofiri Nzossie et al., 2016). Staple crops such as millet and sorghum critical for household food security are particularly affected. For example, sorghum yields dropped from 1.1 tonnes per hectare in 2000 to less than 0.8 tonnes per hectare in

some departments by 2022 (MINEPAT, 2022). This decline threatens the livelihoods of over 730,000 people, including many women and youth highly dependent on subsistence agriculture.

Globally, approximately 475 million smallholder farmers cultivate less than two hectares of land (Aguiar et al., 2020; Morton, 2007). These farmers, who contribute significantly to food security in developing countries, are especially vulnerable to climate change impacts. Their reliance on rain-fed agriculture, limited financial and technical resources, restricted access to climate information and technologies, as well as social and land tenure inequalities, increases their exposure to poverty and food insecurity (Njoya et al., 2022; Verma et al., 2025).

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In sub-Saharan Africa, this vulnerability is even more pronounced. The region is among the most exposed to climate change effects due to low adaptive capacities, heavy dependence on rain-fed agriculture, and multiple socio-economic challenges (Ofori et al., 2021; Sani & Chalchisa, 2016). Extreme weather events are becoming more frequent and severe, threatening the livelihoods of millions of farmers. For example, in East Africa, recurrent droughts have caused crop failures, large-scale population displacement, and increased food insecurity (Bryan et al., 2013; Verma et al., 2025). Adaptation challenges are compounded by limited access to infrastructure, agricultural extension services, and financing.

In Cameroon, climate change affects the entire country, but its impacts are particularly pronounced in the sudano-sahelian zone in the northern part of the country. This region experiences high climate variability: declining rainfall, rising temperatures, frequent droughts, floods, soil degradation, and biodiversity loss (Bienvenu et al., 2023; Raimond et al., 2020; Traore, 2022). According to the UN, 80% of agricultural land in this area is degraded. Lake Chad, which plays a crucial role in the region's water balance, has lost 95% of its surface area over the past sixty years (United Nations High Commissioner for Refugees [UNHCR], 2021). These harsh conditions threaten the food security of approximately 730,000 people, including many women and youth (Douswe, 2023).

In this context, smallholder farmers, often reliant on traditional practices, develop adaptation strategies based on their perceptions, local knowledge, and available resources (Gashure & Wana, 2023; Soumaoro, 2022; Takpa et al., 2022). However, these perceptions are influenced by various factors such as socioeconomic characteristics, gender, geographic location, and type of agricultural activity (Intergovernmental Panel on Climate Change, 2023; Kabore et al., 2019; Momangi et al., 2023; Ngoukwa et al., 2023). For instance, some farmers associate climate change with declining rainfall, while others link it to rising temperatures or violent winds (Ofori et al., 2021; Oumarou et al., 2017; Raimond et al., 2020). Other studies highlight that farm income per hectare is linked to adaptation strategies implemented, access to credit, education level, fertilizer use, and government support (Asravor, 2023).

However, few studies examine farmers' perceptions based on the intensity or combination of these criteria. Differentiated assessments by territory or social category remain limited. Despite numerous efforts to strengthen farmers' resilience to climate change, there is still a lack of a solid analytical and action-oriented framework that takes local specificities into account.

It is within this framework that the present study is situated. It combines a mixed qualitative and quantitative approach to thoroughly explore the differentiated perceptions of smallholder farmers according to gender, socio-professional category, and geographic location along the sudano-sahelian gradient of Cameroon. This approach not only identifies manifestations of climate change as locally perceived but also analyzes adaptation strategies implemented, while accounting for social and territorial disparities often overlooked in the literature.

The study thus aims to answer the following questions:

- What are the major environmental problems faced by villages in Northern Cameroon over the past five years?

- How do smallholder farmers perceive the degree of manifestation of these environmental problems?
- What measures have been taken by this population to address these issues?

Does the level of appreciation of environmental variations vary according to gender and category of farmers along the sahelian gradient?

1.1. Problem Statement

Climate change is one of the most significant challenges facing rural communities worldwide, particularly in ecologically vulnerable areas such as the sudano-sahelian region of Cameroon. This region is characterized by high climatic variability, including prolonged droughts, unpredictable floods, rising temperatures, accelerated soil degradation, and dwindling water resources most strikingly illustrated by the dramatic shrinkage of Lake Chad, which has lost nearly 95% of its surface area over the past sixty years (Gaymard et al., 2015; Raimond et al., 2020; UNHCR, 2021).

Observations gathered from several villages in the region, including Pintchoumba, Bamé, Bang, Gadas, and Douroum, reveal direct impacts on the livelihoods of smallholder farmers. They report a continued decline in agricultural yields, the gradual disappearance of traditional millet and sorghum varieties, and major disruptions in the agricultural calendar, which was once regulated by relatively predictable seasons. For instance, in Gadas, farmers now say that the rainy season begins nearly a month later than it did twenty years ago, severely affecting planting and harvesting cycles.

In response to these disruptions, local communities have developed empirical adaptation strategies rooted in indigenous knowledge, such as the observation of natural indicators (e.g., bird migrations or the flowering of certain plant species), community-based cooperation, and the diversification of crops and income sources. In Bamé, for example, some households are turning to agroforestry or off-season vegetable gardening to compensate for losses in staple crops.

However, local perceptions of climate change, which shape these adaptive practices, remain insufficiently documented and rarely integrated into public policies or climate resilience programs. Few studies have explored how farmers perceive the intensity and frequency of climatic events, especially in relation to variables such as gender, type of agricultural activity, geographic location, or access to resources (Kabore et al., 2019; Momangi et al., 2023; Ngoukwa et al., 2023). Yet these perceptions play a crucial role in shaping risk awareness, responses to environmental change, and the adoption of appropriate adaptation measures.

This lack of integration of local experiences and knowledge constitutes a major obstacle to the design of inclusive, effective, and sustainable adaptation strategies (Akinkuolie et al., 2025; Bryan et al., 2013). A deeper understanding of farmers' worldviews, their primary concerns, and the adaptive responses they develop is thus essential to inform public policy, support community-led initiatives, and foster climate resilience grounded in local realities.

This study offers a novel contribution by integrating local perceptions of climate change with territorial, social, and occupational dimensions, aiming to develop tailored and context-sensitive adaptation strategies in Cameroon's sudano-sahelian region.

1.2. Research Objectives

1.2.1. General Objective

The general objective of this study is to analyze smallholder farmers' perceptions of climate change in the sudano-sahelian region of Cameroon and to examine the adaptive responses they implement, taking into account the lived experiences in the affected villages.

The study is grounded in field observations conducted in several communities, including Pintchoumba, Bamé, Bang, Gadas, and Douroum, where farmers have expressed growing concerns about shifting rainfall patterns, declining soil fertility, and emerging socio-economic vulnerabilities. The adaptation strategies observed vary depending on gender, social status, primary occupation, available resources, and proximity to markets or agricultural services.

1.2.2. Specific Objectives

To identify how smallholder farmers describe climate change based on their local experiences, highlighting observed indicators (e.g., delayed rains, excessive heat, disappearance of local species) and the perceived impacts on their farming activities, crops, and immediate environment.

To document the main concerns expressed by farmers, particularly regarding food security, soil exhaustion, and the erosion of traditional knowledge linked to the agricultural calendar.

To inventory the adaptation strategies adopted across villages along the sahelian gradient, with a focus on indigenous knowledge and farmer-led innovations. These include the use of early-maturing crop varieties, crop rotation, community savings mechanisms, and ancestral water conservation techniques such as stone bunds and infiltration pits.

To analyze how perceptions of climate change vary by gender, socio-professional status, and types of agricultural activity (e.g., crop farming, livestock rearing, or agro-pastoralism), in order to better understand the diversity of vulnerabilities and adaptive capacities among respondents.

2. Methodology

2.1. Description of the Study Area

This study focuses on five villages located along the sahelian gradient of Cameroon (see Figure 1): Pintchoumba, Bamé, and Bang in the North Region, as well as Gadas and Douroum in the Far North Region. This selection follows a south-to-north ascending gradient, from southern sahelian zones to the most northern areas, allowing for a detailed understanding of climatic, environmental, and socio-economic dynamics. These villages are distributed across the departments of Faro, Bénoué, and Mayo Louti (North Region), and Mayo Kani and Diamaré (Far North Region).

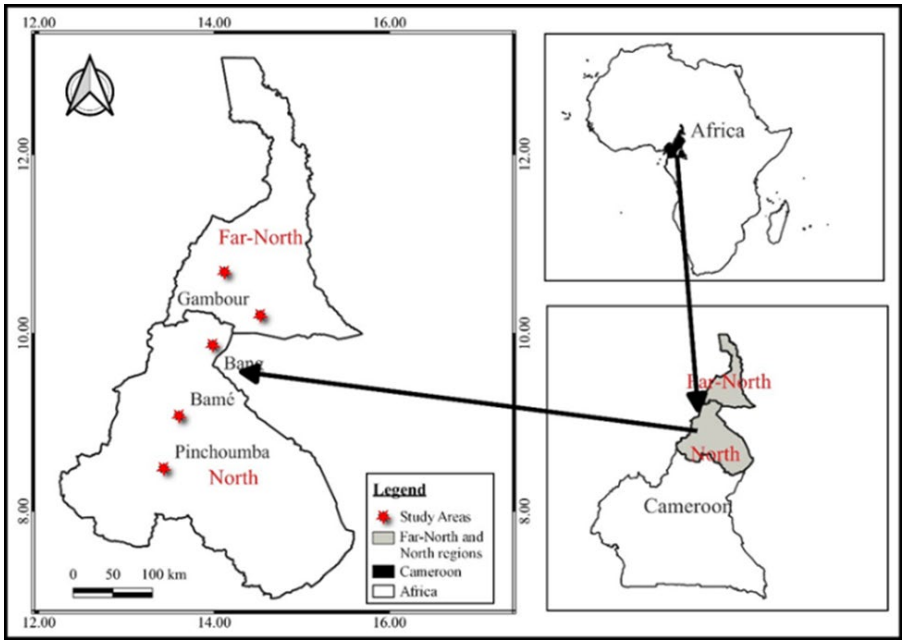

Figure 1. Location maps of the study areas.

The North Region extends between 9.2458° North latitude and 13.3145° East longitude, covering approximately 66,550 km², which represents 14.2% of the national territory (Beauvilain, 1989). Each village in this region faces specific climatic challenges:

At Pintchoumba, increasing rainfall irregularity and soil degradation have led to declining millet and sorghum yields, undermining food security and pushing farmers to diversify their crops. These climatic stresses also reduce fodder availability, weakening livestock health and productivity. Consequently, both crop farming and animal husbandry are increasingly vulnerable, resulting in greater reliance on external food sources.

At Bamé, prolonged droughts followed by sudden floods cause severe soil erosion, crop losses, and disruptions to the agricultural calendar. Farming households struggle to maintain stable production cycles, while livestock often suffers from disease outbreaks due to water contamination and insufficient pasture regeneration. These fluctuations lead to unstable incomes and food supplies for local populations.

In Bang, water scarcity for irrigation and livestock deeply affects agro-pastoral practices. Crop yields are steadily declining, particularly for rainfed cereals, while the lack of grazing areas and watering points threatens livestock survival. As a result, some households reduce herd sizes or sell animals prematurely. This dual pressure contributes to rising food insecurity and drives a shift toward non-agricultural income activities.

The Far North Region, situated around 10.5847° North latitude and 14.2623° East longitude, is the most densely populated region of Cameroon, sharing borders with Chad and Nigeria. Its sudano-sahelian climate features a seven-month dry season and a five-month rainy season. Rainfall ranges from 900 mm in the south to less than 350 mm in the extreme north. Vegetation is sparse, dominated by species such as *Piliostigma reticulatum*, *Dichrostachys cinerea*, and *Tetrapogon*

cenchriformis. Traditional agriculture relies mainly on rainfed crops such as Muskuwaari sorghum, millet, and cowpea.

In Gadas, severe water shortages and accelerated soil degradation have resulted in reduced crop diversity and poorer pasture quality. Farmers report decreased yields of staple crops, while herders face declines in animal weight and reproductive performance. Water scarcity frequently triggers conflicts over access to wells and grazing corridors, destabilizing agro-pastoral systems.

In Douroum, located in the region's most arid zone, conditions are extreme, with recurrent droughts, soil salinization, and a generalized decline in agricultural productivity. Farming is increasingly unsustainable, and livestock losses due to thirst, disease, and malnutrition are common. The limited natural resource base intensifies competition between communities, increasing the risk of conflict and forced migration.

The impacts of these environmental pressures are significant for local communities. Declining crop yields, livestock mortality, and loss of arable land exacerbate food insecurity and rural poverty (Bryan et al., 2013; Njoya et al., 2022). Women, who play a central role in food production, are particularly vulnerable due to their limited access to productive resources and agricultural service . These dynamics contribute to social tensions, especially between farmers and herders, amid shrinking water and grazing resources (Sani & Chalchisa, 2016). Such tensions threaten social cohesion and complicate local conflict and resource management.

In sahelian countries with similar soil and climatic conditions to Cameroon's sudano-sahelian zone, farmers face comparable challenges. Households adopt diverse resilience strategies, including crop diversification, seasonal migration, small-scale trading, collection of non-timber forest products, and community-based mutual aid (Bauer et al., 2022; Fabien & Enock, 2022; Mossie & Chanie, 2024; Toure & Zerbo, 2022). However, these strategies remain constrained by inadequate infrastructure, poor extension services, and limited access to credit and climate information (Verma et al., 2025).

Therefore, a better understanding of local specificities and farmers' perceptions of climate change is essential to guide relevant, equitable, and sustainable adaptation policies.

2.2. Development of the Data Collection Tool

The data collection process was carried out in three distinct phases. First, a literature review was conducted to define climate change in the study area and to identify the main environmental factors contributing to this phenomenon. The results of this literature review were synthesized into a guide that served as the basis for the second phase, the monographic study. This study was conducted using a focus group approach and field observation. The focus groups allowed us to analyze in depth the general situation concerning climate change and environmental factors, while field observation was useful to verify the relevance of the information collected. The monographic study was carried out at the village level to obtain general impressions from different categories of producers and as a group. The results of these two phases formed the basis for developing the individual questionnaire. At the end of this stage, it was found that the majority of the population had a memory of past environmental events over a period of about five years. For this reason, information was collected over a 5-year period.

The third and final phase involved designing the questionnaire. The primary objective of this phase was to assess the perception of climate change by the population individually. Another objective was to establish a list of harmful environmental factors faced by the population and to identify the measures they implement to address these issues locally. Next, the degrees of these findings and the actions taken by the producers were collected, and we obtained very variable responses. Regarding the producers' perception, the recorded events were evaluated using a 3-level Likert scale to describe their intensity. This attitude or multiple scales allowed us to measure different concepts. By operationalizing the qualitative information, it enabled us to transform it into quantified data. It is presented as a three-level measurement scale. Scores from 1 to 3 were used to describe the degree of perception, represented by: 1- "very intense," 2- "moderate," and 3- "not at all."

2.3. Selection of Households: Category of Producers

This study employed a snowball sampling technique to select households, necessitated by the absence of comprehensive records on agro-pastoral farmers in the targeted villages. Snowball sampling, a non-probabilistic method based on peer referrals, was particularly suitable for identifying key local actors while respecting social and community dynamics.

2.3.1. Implementation Procedure

The sampling process was conducted in several stages:

Initially, key informants were identified through collaboration with traditional authorities, community leaders, and local farmers' organizations. These initial respondents, recognized as prominent farmers within their communities, served as seeds for the sampling chain.

Subsequently, these farmers recommended other individuals meeting the following criteria:

(i) active involvement in agriculture, livestock rearing, or both;
(ii) minimum residency of ten years in the village to ensure familiarity with local socio-environmental dynamics;
(iii) voluntary consent to participate in the study.

This approach generated a convenience sample targeting those most representative of local agro-pastoral practices, while considering accessibility and willingness to participate.

2.3.2. Sample Composition

Based on prior research indicating that over 70% of the local population engages in agro-pastoralism (Lasseur et al., 2019; Morgan & Solarz, 1994), the study surveyed 50 households per village, totaling 250 households across five villages. The sample breakdown per village was:

- 30 agro-pastoral households (combined agricultural and livestock activities);
- 10 purely agricultural households;
- 10 purely livestock-rearing households.

Gender representation was intentionally ensured, with women constituting 30% of the sample. This reflects the study's focus on the gendered dimensions of climate change adaptation and acknowledges women's crucial, yet often under-recognized, role in food production and natural resource management.

2.4. Data Collection

The questionnaire designed for this study incorporated multiple environmental factors affecting agro-pastoral systems, including rainfall variability, temperature fluctuations, and specific phenomena such as the disappearance of certain crops and trees, floods, extreme heat waves, severe cold, strong winds, heavy rains, early or late onset and cessation of rains, irregular or insufficient rainfall during the growing season, drying up of rivers and lowered water levels in ponds within Mayo, river siltation, animal epidemics, pasture drought, reduction in tree size, decrease in grass size and density, soil degradation and infertility, field siltation, sand encroachment, as well as increased incidence of plant diseases and crop at-tacks by animals (birds, livestock).

The primary objective was to understand farmers' perceptions of these phenomena and the adaptation strategies they employ to address these challenges. To this end, enumerators, assisted by local guides, conducted face-to-face, individual interviews with each farmer in every village. This method enabled the collection of detailed information on:

- The perceived impacts of various environmental factors on their agricultural and livestock activities;
- Adaptation strategies implemented by farmers, including crop diversification to mitigate risks, adjustment of agricultural calendars in response to changing climatic conditions, adoption of drought- and disease-resistant crop varieties and livestock breeds, improved water resource management (reuse and storage), sea-sonal migration to access better grazing conditions, and engagement in alternative income-generating activities such as small trade and collection of non-timber forest products;
- Community-based mutual aid and resource-sharing practices as forms of collective resilience;
- Constraints faced in implementing these strategies, notably limited access to reliable climate information, infrastructure, credit, and agricultural extension services.

This mixed qualitative and quantitative data collection approach provides a nuanced understanding of local adaptation dynamics in response to environmental pressures, offering critical insights to inform climate adaptation policies at the regional level.

2.5. Data Analysis

To achieve the objectives of this study, two primary analytical approaches were employed: descriptive data analysis and comparative analysis of means. The descriptive analysis involved calculating key statistical measures such as means and standard deviations for each environmental phenomenon reported by the farmers. This process enabled us to quantify farmers' perceptions and assess the variability and distribution of responses within the dataset. Descriptive statistics provided a foundational understanding of how different groups experienced and perceived climate change-related impacts.

To explore differences in perception across various socio-professional categories, specifically farmers, herders, and agro-pastoralists, within each village, means and variability measures were

computed separately for each group. This approach allowed for a nuanced comparison of perceptions at both the group and village levels. Following the descriptive stage, a comparative analysis of means was conducted to identify statistically significant differences in the perception of climate change impacts among groups and between villages. This analysis helped to highlight social and spatial variations in climate change awareness and experience. All analysis was conducted using R and Excel software. R was primarily used for statistical calculations and comparative testing, while Excel supported data organization and initial visualization.

This combined methodological framework enabled a robust quantification of farmers' perceptions and a systematic comparison across demographic and geographic variables, thereby providing clear insights into the differentiated impacts of climate change as perceived by local agro-pastoral communities.

3. Results

3.1. Indicators Reflecting Climate Change

Farmers' perceptions of climate change are grounded in key agro-climatic parameters that directly affect the success or failure of agricultural activities. In this study, these indicators were defined based on farmers' observations of the following environmental variations:

- Changes in rainfall patterns: irregularity, intensity, onset and cessation dates of the rainy season, droughts, and floods.
- Temperature fluctuations: extreme heat waves and periods of intense cold.
- Transformations in local vegetation: disappearance or decline of certain crop and tree species, pasture degradation, and reduction in plant density and size.
- Other related environmental phenomena: river siltation, drying up of water points, soil erosion, and increased incidence of plant diseases and crop damage caused by animals.

These indicators reflect both measurable climatic conditions and the direct impacts experienced by farmers, providing an integrated view of perceived climate change in the study area.

3.2. Factors Influencing Perception of Climate Change: Socio-Economic Variables

The socio-economic variables selected to explain differences in perception of climate change are gender and age of farmers. These choices are theoretically justified as follows:

3.2.1. Gender and Activity Distribution

Incorporating gender and age dimensions into the analysis of climate change perceptions and adaptation strategies is crucial to understanding differentiated vulnerabilities and adaptive capacities within rural communities. Gender influences access to land, financial resources, agricultural inputs, and decision-making power factors that directly affect how individuals perceive and respond to climatic variations (Arora-Jonsson, 2011; Djoudi & Brockhaus, 2011; Nhemachena et al., 2014). For example, women often play a central role in food production and natural resource management, while simultaneously facing structural constraints limiting their adaptive capacity (Babugura et al., 2010; UNDP & UN Women, 2023). Examining gender differences highlights inequalities in exposure and access to adaptive resources, which are essential for designing more inclusive policies (Chidakwa et al., 2020).

Table 1 shows the proportions of women and men in our sample. Moving from south to north along the sahelian gradient, we notice that women are more prevalent in the south and less so in the north. For instance, 30% of those surveyed are women in Pintchoumba village, 32% in Bamé village, 26% in Bang and Gadas villages, and only 22% in Douroum village. This can be explained by the fact that as we move towards the more extreme zones, women are less heard and even less likely to own property.

Table 1. Proportions of Men and Women Based on Their Activities.

Villages	*Pintchoumba*		*Bamé*		*Bang*		*Gadas*		*Douroum*	
Gender	F(%)	H(%)	F(%)	H(%)	F(%)	H(%)	F(%)	H(%)	F(%)	H(%)
Farmers	6	14	8	12	6	14	8	12	6	14
Herders	6	14	4	16	4	16	4	16	2	18
Agro-pastoralists	18	42	20	40	16	44	14	46	14	46
TOTAL	30	70	32	68	26	74	26	74	22	78

Note: F for females, H for males.

3.2.2. Population Distribution by Age Category/Village

Age is a crucial factor as it reflects accumulated experience and the capacity for adaptive flexibility. Older farmers often possess long-term climatic memory and draw upon traditional knowledge to interpret environmental changes (Grothmann & Patt, 2005), whereas younger farmers are generally more open to innovation and changes in agricultural practices. Analyzing differences related to age thus helps to better understand intergenerational dynamics in the perception of climate risks and adaptive decision-making.

Respondents' ages were categorized as follows: young (20–35 years), middle-aged (36–45 years), elderly (46–59 years), and very elderly (60 years and above).

Figure 2 provides an overview of the characteristics of the surveyed producers regarding their age range. It shows that there are four categories of respondents: young, middle-aged, elderly, and senior.

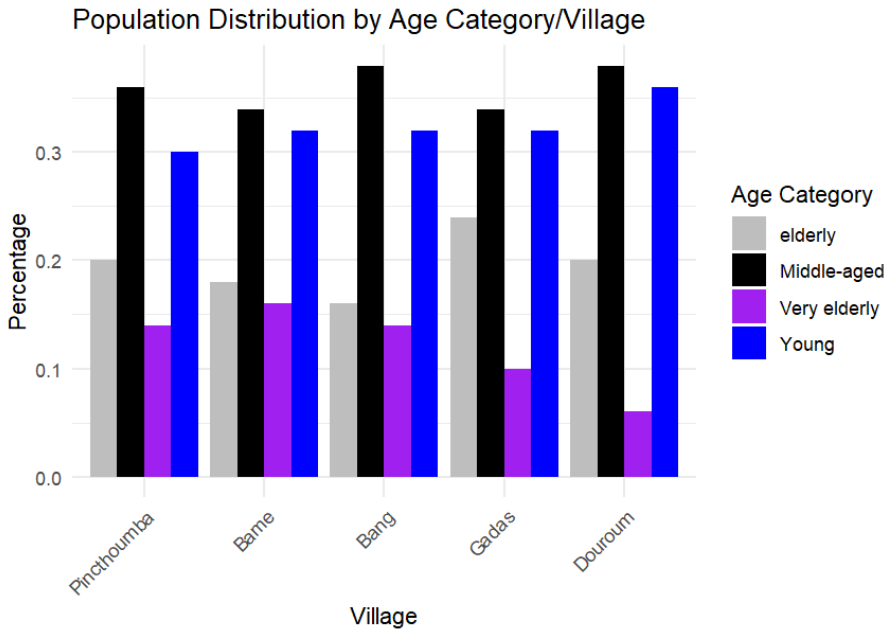

Figure 2. Population distribution by age category/village.

Based on this figure, we observe that the population in our various villages is predominantly composed of middle-aged individuals, with respective percentages of 36% in Pinctchoumba, 34% in Bamé, 38% in Bang, 34% in Gadas, and 38% in Douroum. To explain the observed changes in the different villages, producers use concepts that can be classified into three main categories: disruptions in rainfall patterns, variations in temperature, and changes observed in vegetation.

3.3. Climate Change Indicators According to Producers

Indicators of climate change in the sudano-sahelian zone of Cameroon are assessed along a south-to-north gradient, as each locality exhibits specific socio-environmental characteristics.

3.3.1. Sudano-Sahelian Gradient

The evaluation of recorded phenomena varies according to the intensity and type of activities practiced by the farmers interviewed.

Figure 3 illustrates the perception of climate phenomena by village (Pintchoumba and Bamé) and by activity (agro-pastoralists, farmers, and herders). The y-axis represents the mean perceptions, while the x-axis indicates the activities. The error bars show the variability within each group. The differences between the villages are notable, with Bamé having a higher perception of most phenomena, which could indicate greater awareness or a more significant impact of climate change in this village. Farmers, herders, and agro-pastoralists have different perceptions of climate phenomena, likely due to how each activity is affected by climate change. The variability in perceptions is significant, possibly due to personal experience, access to information, and available resources.

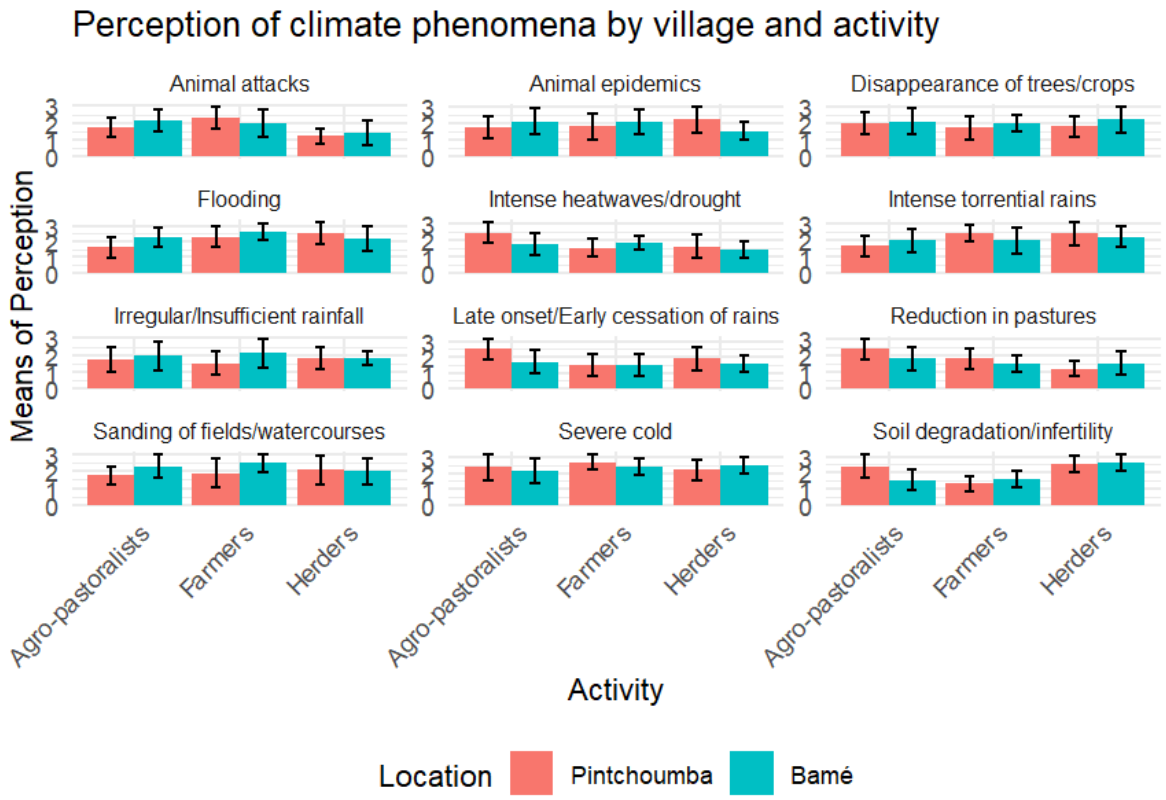

Figure 3. Phenomena recorded by producers in Pinctchoumba and Bamé.

Regarding specific phenomena, animal attacks and animal epidemics are perceived as relatively low, but Bamé has a slightly higher perception. The disappearance of trees/crops is perceived as a high phenomenon in Bamé, likely due to deforestation and land degradation. Inundations are better perceived by farmers and herders in Bamé, due to its geographical situation. Intense heatwaves/droughts are more strongly perceived by agro-pastoralists in Pintchoumba, which could be linked to the impact on pastures and livestock. Torrential rains are perceived relatively uniformly between villages and activities. Irregular/insufficient precipitation is better perceived by farmers in Bamé, which could be due to the impact on crops. The late onset/early cessation of rains is perceived as less important. The reduction of pastures is more strongly perceived by agro-pastoralists in Pintchoumba, which could be linked to drought and land degradation. The siltation of fields/watercourses is better perceived by herders in Bamé, probably due to the impact on water points and pastures. Intense cold is perceived relatively uniformly between villages and activities. Finally, soil degradation/infertility is better perceived by herders in Bamé, which could be due to overgrazing and erosion.

The differences in perception between Pintchoumba and Bamé highlight the importance of geographical location in the perception of climate change. The variable perceptions between activities show that different livelihoods are affected uniquely. Effective climate action requires strategies tailored to specific activities and locations, addressing relevant local issues and engaging the most affected communities.

This graph illustrates the perception of climate phenomena by village (Pintchoumba and Bamé) and by activity (agro-pastoralists, farmers, and herders). The y-axis represents the average perception scores, while the x-axis identifies the different activities. Error bars indicate the variability of perceptions within each group.

Notable differences emerge between the villages, with Bamé showing higher perception levels for most climate phenomena. This suggests either greater awareness or a more significant impact of climate change in this area. The perceptions also vary considerably among agro-pastoralists, farmers, and herders, reflecting the distinct ways in which each livelihood is affected by climatic variations. The variability within groups likely stems from individual experiences, access to climate information, and availability of resources.

Regarding specific phenomena, animal attacks and epidemics are generally perceived as less intense, although Bamé reports slightly higher concern. The disappearance of trees and crops is perceived as a major issue in Bamé, likely linked to deforestation and land degradation. Flooding

is more acutely perceived by farmers and herders in Bamé, which corresponds to the village's geographical vulnerability. Intense heatwaves and droughts are most strongly perceived by agro-pastoralists in Pintchoumba, probably due to their direct impact on pastures and livestock health. Torrential rains are perceived fairly evenly across both villages and all activities.

Irregular or insufficient rainfall is more sharply perceived by farmers in Bamé, likely reflecting its consequences on crop yields. The late onset or early cessation of rains is considered less problematic overall. Reduction in pasture availability is most strongly felt by agro-pastoralists in Pintchoumba, reflecting drought effects and land degradation. Field and watercourse siltation are more frequently reported by herders in Bamé, likely due to the effects on water sources and grazing areas. Perceptions of intense cold are relatively uniform across villages and activities. Finally, soil degradation and infertility are more strongly perceived by herders in Bamé, which may be attributed to overgrazing and soil erosion.

These differences in perception between Pintchoumba and Bamé underscore the importance of geographic context in shaping local experiences of climate change. Similarly, the variation in perceptions across livelihood activities highlights the need for differentiated approaches to climate adaptation. Effective responses should be tailored to specific activities and local conditions, ensuring that the concerns of the most affected communities are addressed.

3.3.2. Median Sahelian Gradient: Bang

Figure 4 illustrates how the inhabitants of Bang, a village in northern Cameroon located in the median sahelian gradient, perceive different climatic phenomena. Perceptions are divided into three groups: agro-pastoralists, farmers, and herders. The height of the bars indicates the average perception, while the error bars show the diversity of responses.

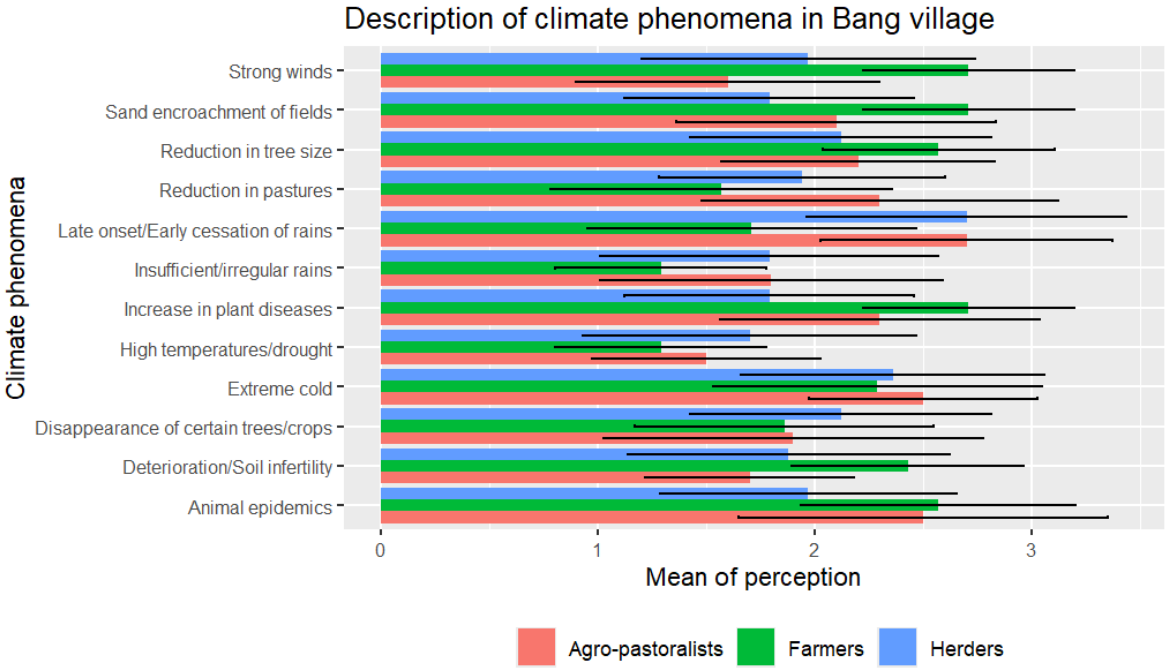

Figure 4. Description of climate phenomena in Bang village.

The most concerning phenomenon: Agro-pastoralists and herders are particularly concerned about the late onset or early cessation of rains (around 2.70), a sign of great climatic uncertainty. Farmers, on the other hand, are more sensitive to strong winds (2.71) and soil degradation (2.57), as they depend directly on the quality of the land. Herders are also concerned about the disappearance of trees and grazing areas (2.12 and 1.94), which are essential for feeding their livestock.

Less concerning phenomena: High temperatures and drought are less concerning (between 1.29 and 1.70), as is the lack or irregularity of rainfall (between 1.29 and 1.80).

Variations between groups: The standard deviations reveal that some perceptions vary greatly, such as for animal epidemics or the reduction in tree size. This suggests that these problems are experienced differently depending on the activity.

Also, by comparing with Pintchoumba and Bamé, villages in the southern Sahel, we see that the climatic issues are different. In Bang, drought and soil degradation are major problems, while

in Pintchoumba and Bamé, where the climate is wetter, other concerns emerge. It is therefore essential to put in place solutions adapted to each region to help populations adapt to climate change.

Finally, the graph highlights the direct impact of climate on activities in Bang. The main concerns relate to the lack of rain and the degradation of natural resources, making the region very vulnerable. In the southern Sahel, although conditions are slightly better, adaptation to climate change remains a priority.

The graph illustrates the perceptions of climatic phenomena among inhabitants of Bang, a village situated in the middle sahelian gradient of northern Cameroon. Perceptions are categorized into three groups: agro-pastoralists, farmers, and herders. The height of the bars in the graph represents the average perception score, while the error bars indicate the variability of responses within each group.

The most concerning phenomena vary depending on the type of activity. Agro-pastoralists and herders express significant concern about the late onset or early cessation of rains (with an average score of around 2.70), reflecting considerable climate uncertainty. Farmers, on the other hand, are particularly sensitive to strong winds (2.71) and soil degradation (2.57), due to their direct dependence on land quality. Herders also report notable concern about the disappearance of trees (2.12) and grazing areas (1.94), which are essential for livestock feeding.

Conversely, some phenomena appear less worrying. High temperatures and drought elicit relatively low concern, with perception scores ranging from 1.29 to 1.70. Similarly, irregular or insufficient rainfall is perceived as less alarming, with scores between 1.29 and 1.80.

Variations between groups are also notable. Standard deviations reveal significant differences in the perception of certain issues, such as animal epidemics or the reduction in tree size, indicating that the perceived impact of these phenomena varies depending on the activity practiced.

When comparing the results from Bang to those from other villages, such as Pintchoumba and Bamé, located in the southern Sahel, clear differences in climate-related challenges emerge. In Bang, the primary concerns are drought and soil degradation, whereas in the more humid south, other climate-related issues are more prominent. This highlights the importance of adapting resilience strategies to regional specificities to effectively address the needs of local populations.

In summary, the graph highlights the direct impact of climate on livelihoods in Bang. The main challenges are related to rainfall irregularity and natural resource degradation, making the region particularly vulnerable. Although conditions are somewhat more favorable in the southern Sahel, adapting to climate change remains a crucial priority across all areas.

3.3.3. Northern Sahelian Gradient

Considering Figure 5 and the location of Gadas and Douroum in the most sahelian zone of Cameroon's sahelian gradient, a thorough analysis reveals complex and nuanced realities. The inhabitants of these villages perceive a series of climatic phenomena as major challenges, although the intensity of these perceptions varies considerably depending on the activity and the village in question. Thus, agro-pastoralists seem particularly concerned about animal attacks and animal epidemics, reflecting their dependence on both agriculture and livestock and, consequently, a greater vulnerability to these hazards. Farmers, for their part, highlight soil degradation and infertility as paramount problems, emphasizing their direct dependence on soil health to ensure viable agricultural production. As for herders, the reduction of pastures is perceived as a dominant concern, highlighting the challenges related to the availability of land needed to feed livestock.

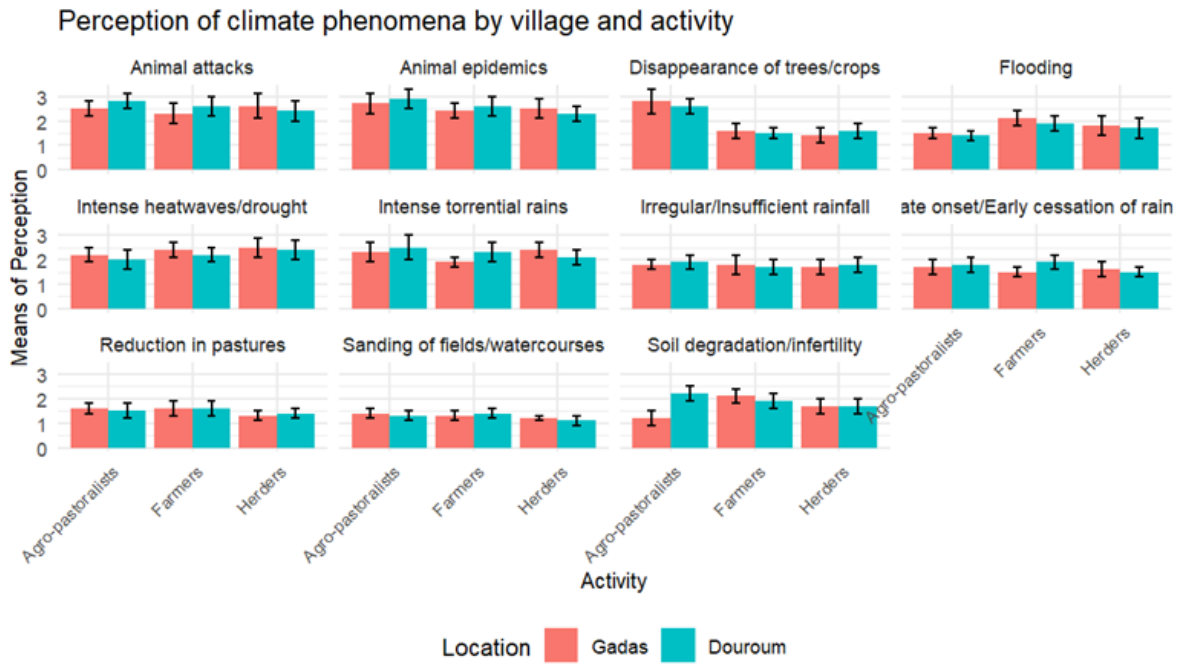

Figure 5. Description of climatic phenomena by producers in Gadas and Douroum.

While perceptions between Gadas and Douroum do not present notable differences for many phenomena, suggesting shared environmental and climatic challenges, some variations can be attributed to local microclimates, distinct agricultural practices, or socio-economic factors specific to each village. Faced with increased drought, intense heat waves, and irregular rainfall patterns, the sahelian communities, which include Gadas and Douroum, face constant challenges that threaten agricultural yields and pasture availability. In addition, soil degradation and infertility emerge as cross-cutting problems, placing additional pressure on livelihoods and agricultural production capacity. These realities underscore the imperative for targeted and context-specific interventions, whether it is to improve soil health for farmers or promote sustainable pasture management strategies for herders. In summary, the graph highlights the complexity of the climate challenges faced by the inhabitants of Gadas and Douroum, emphasizing the need to adopt integrated and adapted adaptation strategies to strengthen the resilience of these sahelian communities.

Considering the location of Gadas and Douroum in the most sahelian zone of Cameroon's sahelian gradient, the graph reveals a complex and nuanced perception of climatic phenomena by the inhabitants of these villages. The intensity of perceived challenges varies significantly according to both the type of activity and the village.

Agro-pastoralists appear particularly concerned by animal attacks and animal epidemics, reflecting their dual dependence on agriculture and livestock, which heightens their vulnerability to such hazards. Farmers, meanwhile, emphasize soil degradation and infertility as critical issues, underscoring the importance of soil health for sustaining agricultural productivity. For herders, the reduction of pastures stands out as the most pressing concern, highlighting the challenges linked to the availability of grazing land for livestock.

While many perceptions between Gadas and Douroum are similar, suggesting shared environmental and climatic stresses, some differences can be attributed to local microclimates, variations in agricultural practices, or socio-economic factors unique to each village. Faced with increasing drought, severe heat waves, and irregular rainfall, these sahelian communities continuously confront challenges that threaten both crop yields and pasture quality. Soil degradation and infertility emerge as cross-cutting issues, further straining livelihoods and production capacities.

These findings underscore the urgent need for targeted, context-specific interventions such as soil restoration programs for farmers and sustainable pasture management for herders to effectively support these communities. In summary, the graph illustrates the multifaceted nature of climate-related challenges in Gadas and Douroum and highlights the importance of integrated, locally adapted strategies to enhance the resilience of sahelian populations.

3.3.4. Measures Taken by Producers

Climate change presents numerous challenges for small-scale farmers, threatening their food security, livelihoods, and resilience to environmental shocks. In response, these rural communities have developed a range of mitigation and adaptation strategies tailored to their local realities and

expectations. These measures are aimed at sustaining agricultural productivity and managing climate-related risks in both farming and livestock systems.

Among the strategies reported by farmers are: crop substitution, acquisition of improved varieties, reforestation, construction of dikes, contour (furrow) cultivation, building animal shelters, spacing houses to reduce wind impact, planting windbreaks, brick stabilization, pruning, clearing irrigation channels, using field supports, hilling crops, early sowing, applying organic fertilizers, exploiting lowlands, building stone cordons, deep plowing, abandoning unproductive fields, veterinary and traditional livestock treatments, transhumance, cultivating forage crops, practicing fallow rotation, using phytosanitary products or biopesticides, and protecting fields from external threats.

For analytical clarity, these measures have been grouped into broader categories, which are visually represented in the graphs that follow. The main categories of adaptation strategies include:

Agricultural Practices: Encompassing actions such as the use of improved crop varieties, contour farming, deep plowing, early sowing, organic fertilization, and the exploitation of lowlands.

Crop Substitution: Referring to the replacement of traditional crops with more climate-resilient species or varieties.

Ecological Measures: Including reforestation, dike construction, windbreak planting, brick stabilization, pruning of trees, and the clearing of water and irrigation channels.

Food Storage: Addressing post-harvest management and crop conservation methods to prepare for periods of scarcity.

Forage Crop Cultivation: Focusing on the production of livestock feed, especially important during the dry season.

Preventive Livestock Treatment: Encompassing both veterinary care and traditional medicinal practices to prevent animal diseases.

Reforestation and Pruning: Aimed at increasing tree cover and managing natural vegetation sustainably.

Housing Restructuring: Involving physical modifications of housing infrastructure to reduce vulnerability to flooding, winds, or storms.

Transhumance: Referring to the seasonal movement of herds in search of better grazing conditions, a key strategy in pastoral systems.

Field Abandonment: Representing an extreme but sometimes necessary measure when land degradation or climate stress render farming no longer viable.

Table 2 enables a differentiated understanding of the adaptation strategies adopted by farmers in response to climate change. By categorizing the measures according to agricultural systems (crop or livestock), ecological approaches, or social resilience mechanisms, the table highlights the diversity and complementarity of local responses.

Table 2. Comparative summary of climate change adaptation measures implemented by farmers

Category	Measures	Objectives	Applicability Conditions	Constraints
Agronomic (Crops)	- Crop substitution - Use of improved seeds - Early sowing - Deep plowing - Exploiting lowlands - Fallowing	Maintain or reduce yield losses caused by climatic hazards	Access to technical knowledge Availability of adapted seeds Land tenure security	High seed costs Lack of technical training Limited water availability
Pastoral (Livestock)	- Transhumance - Forage crop cultivation - Veterinary treatment - Abandonment of grazing areas	Ensure livestock health and feeding during critical periods	Availability of grazing areas Access to veterinary care or traditional remedies Safe mobility routes	Land-use conflicts Livestock diseases Climatic unpredictability
Ecological/Environmental	- Reforestation - Windbreak planting - Dike construction - Stone bunds - Cleaning water channels	Restore and protect natural resources and farming infrastructure	Community engagement Access to natural resources Institutional support	High labor demand Scarcity or cost of materials
Social/Organizational	- Food storage - House spacing - Field abandonment	Reduce the structural and organizational vulnerability of households	Access to storage infrastructure Village-level coordination and planning	High cost of restructuring Lack of community organization

Source: Field survey, 2024.

It also reveals that the implementation of these strategies is conditioned not only by environmental and agronomic variables but also by institutional, financial, and socio-cultural factors. For instance, while agronomic and pastoral adaptations often depend on technical inputs and land access, ecological and infrastructural measures require collective mobilization and material support.

The table thus serves as a valuable tool for identifying entry points for public policy and development programs. It supports the targeting of the most effective and contextually appropriate strategies while drawing attention to the practical constraints, particularly in terms of cost, training, and the availability of resources, that limit the adaptive capacity of smallholder farmers.

Figure 6, illustrating the climate change adaptation strategies implemented by farmers in the villages of Pintchoumba, Bamé, Bang, Gadas, and Douroum, positioned along a sahelian gradient from south to north, reveals distinct dynamics shaped by geography, environmental vulnerability, and access to resources.

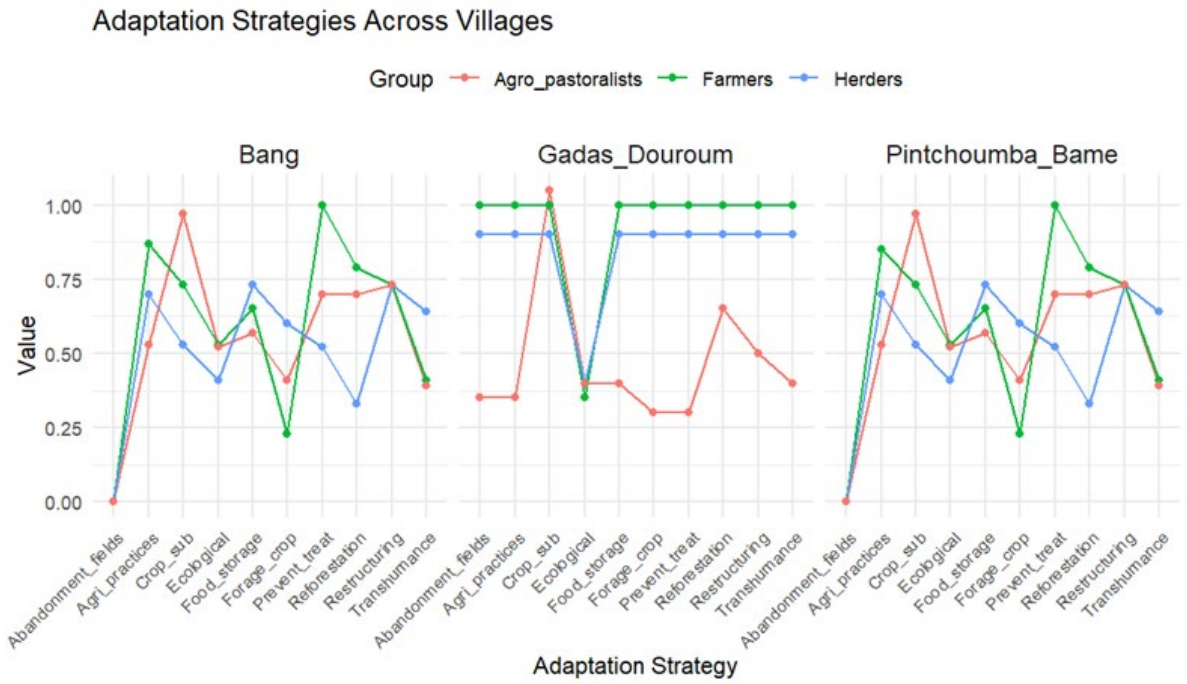

Figure 6. Strategies across villages.

In the less arid southern villages of Pintchoumba and Bamé, farmers primarily adopt agricultural practices (adoption levels around 0.8) and ecological measures (approximately 0.75), reflecting significant efforts to enhance resilience to climate variability. Herders in these areas also implement complementary strategies such as forage crop cultivation and preventive veterinary care (around 0.6). Transhumance is less common (0.4), suggesting greater stability in local pastoral resources. The widespread use of food storage and housing restructuring (values above 0.7) further highlights a strong emphasis on food security and flood risk management.

In Bang, located in the central part of the gradient and subject to higher climatic variability, the adoption of agricultural practices remains strong (0.8), but strategies are more diversified. Agro-pastoralists exhibit high adaptability, with crop substitution reaching maximum levels (value of 1). Transhumance is more widespread than in the southern villages, reflecting growing pressure on grazing resources. Here, strategies are more evenly distributed to address a broader range of climate risks.

In the more arid northern villages of Gadas and Douroum, field abandonment emerges as the dominant strategy among farmers (value of 1), indicating heightened environmental stress. While certain agricultural practices persist, they are constrained by increasingly adverse conditions. Herders rely heavily on extensive transhumance and cross-border grazing, reflecting a deep reliance on mobile livestock systems. High adoption levels (close to 1) of strategies such as food storage, use of improved seeds, reforestation, and forage cultivation are observed, although these often depend on access to external resources and institutional support.

In Bang, the most widely adopted strategies include forage crop cultivation, improved seed use, and transhumance, particularly among agro-pastoralists and herders. Farmers tend to prioritize food storage and crop substitution. More costly or socially disruptive strategies, such as field abandonment or housing restructuring, are less commonly employed.

In Gadas and Douroum, all socio-professional groups widely implement collective and innovative measures, including food storage, improved seed use, and reforestation. Field abandonment remains an option only in extreme cases.

The adaptation profiles of Pintchoumba and Bamé are relatively similar to Bang, with strong engagement in pastoral strategies by herders and agro-pastoralists, and a focus on agronomic innovation among farmers.

The adoption of climate adaptation strategies is closely linked to local contexts. Villages with better access to water, improved seeds, and infrastructure, such as Gadas and Douroum, demonstrate higher uptake of collective and innovative approaches. Conversely, in areas marked by land-use conflicts, high climatic stress, or limited resources, communities tend to adopt more accessible measures such as transhumance or crop substitution.

Strategic choices also vary by livelihood type. Herders and agro-pastoralists prioritize livestock-related measures transhumance and forage cultivation, while farmers focus on conventional

agronomic solutions, such as improved seed use, food storage, and crop diversification to secure production.

Some strategies, despite their effectiveness, remain underutilized due to high costs or technical complexity. For instance, field abandonment and housing restructuring are generally last-resort solutions. In contrast, more affordable and accessible practices such as improved seeds, food storage, and reforestation are widely adopted, particularly when supported by technical assistance or institutional programs.

This comparative analysis of adaptation strategies along the sahelian gradient underscores the need for differentiated, context-sensitive policies. In southern areas, the emphasis is on sustainable intensification and ecosystem management. In the central zone, communities diversify their strategies to respond to growing variability. In the northernmost villages, farmers and herders adopt more survival-oriented approaches. These findings highlight the necessity of tailoring adaptation interventions to local realities, resource availability, and the unique socio-economic fabric of each region.

4. Discussion

The analysis of producers' profiles reveals a predominance of male respondents, typically heads of households, and mostly married. The average age of these heads of household, 35 years, indicates a relatively mature population, likely possessing experiential knowledge and long-term awareness of climatic changes. Gender distribution shows a clear spatial disparity: women are more present in southern villages (30–32%) than in northern ones (22–26%), reflecting unequal access to land ownership and public representation. This disparity is more pronounced in agroecologically extreme zones, where patriarchal norms are more deeply entrenched. A gendered approach to perception analysis thus provides a deeper understanding of local adaptation dynamics and the differentiated needs of each group (Nhemachena et al., 2020; UNDP & UN Women, 2023).

Smallholder farmers along the sahelian gradient of Cameroon perceive climate change through direct, tangible impacts on their daily activities rather than through systematic observation of meteorological trends. These perceptions are grounded in their lived experience of recurrent climatic events such as reduced rainfall, delayed onset and early cessation of rains, droughts, floods, violent winds, vegetation loss, and soil degradation. These findings are consistent with studies emphasizing farmers' experiential understanding of climate (Abou-Shleel & El-Shirbeny, 2014; Abdoul Habou et al., 2016; Adaawen, 2021; Yashele & Mosombo, 2017; Zhai et al., 2018).

Differences in perceived intensity are observed between villages. For instance, respondents in the extreme north report more severe irregularities in rainfall and higher exposure to desertification and violent climatic phenomena, compared to those in southern areas. These patterns align with studies conducted in other sahelian regions such as Burkina Faso reflect broader dynamics described by Momangi et al. (2023). Additionally, increased incidence of plant diseases, a recurrent concern across all sites, is perceived as one of the indirect effects of climatic disruptions.

The effects of climate change are strongly mediated by the respondents' primary livelihood activities. Farmers report soil degradation and declining crop yields, especially for maize, a major staple. In the livestock sector, herders are particularly vulnerable to the reduced availability of water and forage due to irregular rainfall. Northern Cameroon, especially, faces recurrent forage deficits, making it a hotspot for resource-based tensions and conflicts among pastoral communities. These conditions exacerbate livestock morbidity and reduce productivity, consistent with findings in other parts of West Africa (Kabore et al., 2019; Mekila et al., 2023).

To cope, farmers have adopted a range of strategies: the use of short-cycle crop varieties, reforestation, early sowing, intercropping, field protection against animals, and crop diversification. These practices are widely documented in the literature (Diallo et al., 2023; Soumaoro et al., 2022; Takpa et al., 2022). However, their implementation is constrained by limited financial means and access to technical support. Even widely accepted practices such as reforestation face barriers, as their success depends on factors often beyond the control of smallholders, such as cost, required surface area, and ecological conditions (Mosquera-Losada et al., 2012; Sani & Chalchisa, 2016).

To address these constraints and strengthen farmers' resilience, various intervention measures have been proposed. One of the most important is capacity building, which involves enhancing local skills through targeted training (e.g., on agroecology, reforestation, water management, seed selection). In Burkina Faso, for instance, the Yelemani project demonstrated the effectiveness of such training in improving farmer resilience (Ouédraogo & Ouédraogo, 2023).

Another essential strategy is access to agricultural inputs. The provision of microcredit or subsidies for the acquisition of improved seeds, irrigation systems, or post-harvest tools facilitates farmers' adaptation to climate change. The *One Acre Fund* program in Kenya is a clear example of this approach, having strengthened the resilience of over 500,000 smallholder farmers (Kropff et al., 2023).

Infrastructure development, especially in the water sector, also plays a crucial role. These infrastructures, intended for agriculture and pastoralism, help reduce vulnerability to drought and inter-community conflicts. In Niger, community-managed water points have fostered social cohesion (Seibou et al., 2023).

Economic diversification offers another path to sustainable adaptation. Promoting off-season farming, agroforestry, or small-scale processing helps reduce dependence on climate-sensitive activities. In Ethiopia, agroforestry diversification under the *Sustainable Land Management* project has contributed to improved food security (Gashure & Wana, 2023).

Gender inclusion and the valorization of traditional knowledge are also key levers. Recognizing the role of women and indigenous practices promotes more equitable and locally appropriate solutions. In Mali, the *Femmes et Terroirs* program significantly increased women's participation in forest governance (Salam et al., 2006).

Finally, participatory climate monitoring strengthens community preparedness for environmental changes. The collection of local data and the shared analysis of this information help tailor responses to specific needs. In Tanzania, this approach has improved the sustainability of water projects (Mgoba & Kabote, 2020).

Building on such participatory approaches, targeted measures have been developed to address the specific needs of different agroecological zones. In southern zones, where conditions are more favorable, efforts focus on empowering women through cooperatives and seed banks, and promoting organic farming and composting via farmer field schools. In central zones, marked by greater climatic variability, interventions include the deployment of rainwater harvesting systems, mobile agricultural and veterinary services, and the establishment of farmer innovation centers. In the more arid northern zones, strategies involve the installation of solar-powered micro-irrigation systems, the promotion of climate micro-insurance, the reinforcement of cross-border livestock mobility, and the expansion of assisted natural regeneration (ANR). In Niger, ANR has successfully restored over five million hectares of degraded land (Perring et al., 2018).

Altogether, these experiences highlight the urgent need for contextualized adaptation policies that reflect agroecological realities, socio-economic vulnerabilities, and cultural specificities. The success of local adaptation strategies depends on their technical feasibility, economic viability, and social acceptability. Effective implementation requires strong engagement from local institutions and sustained support from development partners.

5. Conclusions

This study has explored local perceptions of climate change and the adaptation strategies implemented by agro-pastoral communities in the sudano-sahelian zone of Cameroon. Drawing on data collected in five villages distributed along a sahelian gradient from the more humid south to the arid north, it examined the impact of seven major climatic phenomena, including extreme heatwaves, floods, heavy rainfall, and disruptions in the agricultural calendar (late or early rains, shortened seasons). These changes are perceived as serious threats by local farmers due to the profound disruptions they cause to both agricultural and pastoral livelihoods.

The findings underscore the significant socio-economic repercussions of climate variability, affecting crop yields, livestock productivity, and the integrity of natural ecosystems. The study reveals a wide range of endogenous adaptation strategies shaped by household socio-economic characteristics, environmental exposure, and available resources. These practices illustrate a remarkable adaptive capacity but also highlight the limitations of local knowledge when operating in isolation. Greater integration of traditional practices with scientific approaches is necessary to develop tailored, effective, and sustainable climate adaptation strategies.

Importantly, the study emphasizes the heterogeneity of climate impacts and responses across the villages studied. It confirms the need for context-specific policies that take into account local agroecological conditions, socio-economic vulnerabilities, and the differentiated roles of farmers, herders, and agro-pastoralists. Particularly concerning are the high levels of concern reported for flooding, deforestation, and pasture degradation issues that call for urgent policy action to promote sustainable land management and climate-resilient agriculture.

The study has certain limitations. The use of snowball sampling, though appropriate in the field context, reduces the statistical representativeness of the sample. Climate perceptions, based on memory, may be biased, especially in the absence of long-term meteorological data. Additionally, focusing on only five villages limits the generalizability of the findings to the broader Sahelian region or neighboring countries with different contexts.

To deepen and expand these results, longitudinal studies combining perceived data with objective climate measurements are recommended. Large-scale probabilistic surveys would improve representativeness. It is also necessary to assess adaptation strategies using economic, social, and environmental indicators. Finally, more research should include women and youth, whose voices remain insufficiently heard.

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Abbreviations

The following abbreviations are used in this manuscript:

UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
UNDP	United Nations Development Programme
MINEPAT	Ministry of Economy, Planning and Regional Development (Cameroon)
UN	United Nations
UNHCR	United Nations High Commissioner for Refugees
ANR	Assisted Natural Regeneration

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