International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

DETERMINANTS OF FARMERS' PERCEPTION OF CLIMATE VARIABILITY IN THE RURAL COMMUNE OF SOURGOU (BOULKIEMDÉ PROVINCE), BURKINA FASO

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DOI: https://doi.org/10.51193/IJAER.2025.11406

Received: 21 Jun. 2025 / Accepted: 30 Jun. 2025 / Published: 16 Jul. 2025

ABSTRACT

Rainfed agriculture holds a central place in both the economy and food security of the population in Burkina Faso. This type of farming, which contributes significantly to the national economy, is currently facing the adverse effects of climate variability, compelling local populations to seek solutions to mitigate these impacts. To lessen the effects of climate variability on agriculture, farmers' perception is increasingly recognised as a relevant component of resilience. This study was conducted in the rural commune of Sourgou, where the population is predominantly made up of farmers. Data were collected through individual surveys conducted with 422 agricultural producers. An analysis of climate data was also carried out. The findings revealed that the majority of farmers reported irregular rainfall (87.6%) and rising temperatures (87.6%), which were corroborated by meteorological data analysis. Using logistic regression, the study showed that factors such as age, need for dietary supplements, farming experience, education level, length of the rainy season, number of fields, and having previously experienced flooding significantly influence farmers' perceptions of climate variability. Taking these factors into account in national policy-making could enhance the effectiveness of adaptation strategies. However, meaningful involvement of stakeholders in the agricultural sector is essential to ensure appropriate support and implementation.

Keywords: Farmers' perception, logistic regression, climate variability, rural commune of Sourgou, Burkina Faso.

1. INTRODUCTION

Climate variability has become a major global concern, with significant environmental, societal, and economic implications (IPCC, 2007, p.12). The increasing frequency of climatic fluctuations and extreme weather events, directly linked to climate change, profoundly affects all aspects of food and nutritional security (FAO, 2021, p.13). Understanding this phenomenon has never been more urgent than in the 21st century, particularly in regions highly exposed to climate variability, such as the Sahel, where rainfall remains a major source of uncertainty (Gnanglè et al., 2011, p.28). These variations in precipitation inevitably lead to changes in other climatic parameters, such as temperature and wind (Mamadou et al., 2020, p.70).

Burkina Faso, located at the heart of the Sahel, has faced numerous natural disasters since the 1970s, many of which are largely attributed to climate change (Bikienga, 2020, p.19). In this context, agriculture plays a central role in ensuring the country's food and nutritional security, serving as a cornerstone of both its economy and social stability (Semdé et al., 2021, p.1). The sector accounts for 40% of the GDP and employs approximately 86% of the active population (MAHRH, 2011, p.1).

Burkinabè farmers directly perceive the effects of climate variability. This perception, reflecting their relationship with the climate and the changes observed, is shaped both by their daily experiences and by the cognitive tools they use to interpret such phenomena (Ouédraogo et al., 2010, p.86). The way agricultural producers perceive climatic risks plays a key role in their adaptive capacity (Hansen et al., 2004, p.6).

To improve public policies and better support farmers in facing the challenges posed by climate variability, it is essential to gain a deeper understanding of their perceptions of climate change and the factors influencing those perceptions (Mustapha et al., 2012, p.1). This article therefore aims to analyse the perceptions of Burkinabè agricultural producers and to identify the main determinants that shape local communities' understanding of climate variability.

This study focuses on the determinants of farmers' perception of climate variability in the rural commune of Sourgou, located in the Boulkiemdé Province of Burkina Faso. It seeks to examine how farmers in this region perceive climate change and to identify the key factors influencing their perception. Through a combined approach of field surveys and statistical analysis, the study highlights the socio-economic, environmental, and institutional variables that shape farmers' understanding and adaptation strategies in response to climatic changes. These findings aim to

International Journal of Agriculture and Environmental Research
ISSN: 2455-6939
Volume: 11, Issue: 04 "July-August 2025"

inform more effective local adaptation strategies and support public policies concerning climate risk management and agricultural resilience.

2. MATERIALS AND METHODS

2.1. STUDY AREA

The commune of Sourgou is a rural municipality covering 266.03 km², with an estimated population of approximately 17,532 inhabitants (RGPH, 2019), the majority of whom rely on agriculture as their main livelihood activity. The commune is composed of six villages: Guirgo, Kougsin, Ouoro, La, Rogho, and Sourgou. It is one of the 14 rural communes in the Boulkiemdé Province. Geographically, it is located at latitude 12.1333 and longitude -2.2833 (12°7’60”N; 2°16’60”W) (see Figure 1).

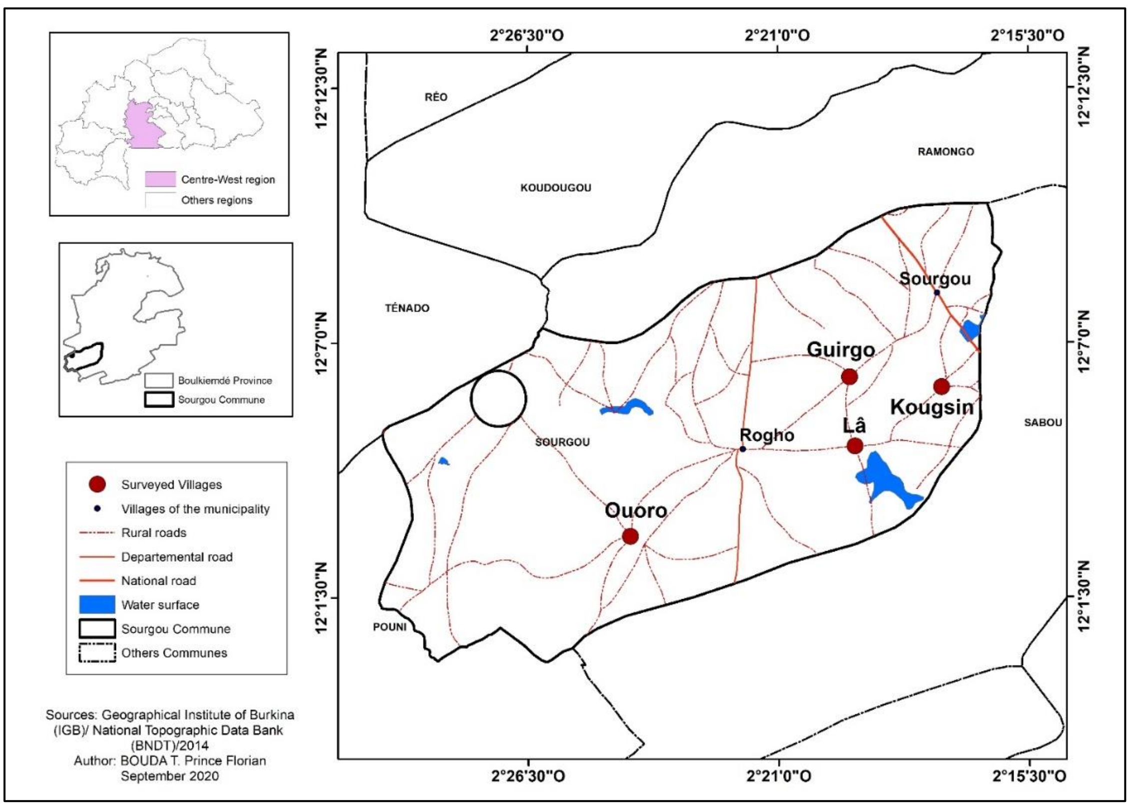

Figure 1: Location of the study villages.

The climate is classified as hot semi-arid (BSh) according to the Köppen classification. The average annual rainfall in the commune is approximately 817 mm (Bouda, 2020). The landscape is relatively flat, and the area features several soil types, with lithosols on lateritic crust and ferruginous soils being the most dominant. Vegetation is characterised by open wooded savannah

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interspersed with shrubs. The main species include *Vitellaria paradoxa*, *Bombax costatum*, and *Tamarindus indica*, along with an herbaceous layer and exotic tree species such as *Azadirachta indica* and *Mangifera indica*. The hydrographic network is poorly developed, which limits certain agricultural activities, such as off-season crop cultivation.

2.2. DATA COLLECTION AND ANALYSIS

Individual questionnaires and interview guides were used as tools for data collection. The survey targeted adult male and female farmers, with age being a key selection criterion, given its role in experience and, consequently, in climate and agricultural perception. In total, 422 farmers were surveyed. Data collected included variables such as age, level of education, farming experience, and the length of the rainy season. Respondents ranged in age from 16 to 92 years, with an average age of approximately 47.

In addition to the farmers, interviews were conducted with officials from various decentralised state technical services, including the departments of environment, agriculture, livestock, and the local council and its affiliated structures. Elderly individuals and key informants, such as village chiefs some of whom had experienced the droughts of the 1970s and other episodes of climatic stress in Burkina Faso were also interviewed. Data were collected between June and July 2020. Microsoft Excel 2019 was used to process and analyse 30 years of climatic data (1989–2018), obtained from the National Meteorological Agency (ANAM), in accordance with the guidelines of the World Meteorological Organization (WMO). The R software was used to model the farmers' perception of climate variability in Sourgou. ArcGIS software was employed for map creation. A total of 13 variables were selected from the survey data. The variables used in the multinomial logit model are summarised in Table 1.

Table 1: Types of Variables Used for Data Analysis

Explanatory Variables	Type / Categories
Age	Quantitative
Food self-sufficiency from production	2 categories
Need for food supplements	2 categories
Farming experience	Quantitative
Education level	2 categories
Length of the dry season	3 categories
Labour force	Quantitative
Mutual support group membership	2 categories
Number of fields	Quantitative
Place of origin	2 categories

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Flood experience	2 categories
Gender	2 categories
Marital status	3 categories

Source: Field surveys, 2020

2.3. STATISTICAL APPLICATIONS

The various categorical variables in the study concern food self-sufficiency from production, the need for food supplements, education level, length of the dry season, mutual support group membership, place of origin, exposure to flood events, gender, and marital status. These variables are either binary (yes, no) or ternary (yes, no, don't know). The remaining variables are quantitative, such as farming experience, measured in years.

To determine the factors influencing the perception of farmers in Sourgou, the R software was used for data coding and analysis, employing the binary logistic regression model to characterise their perceptions. Various studies have shown that perception—as a personal or collective interpretation of a phenomenon—can be influenced by several factors, including socio-economic characteristics, occupation, gender, and political or ethnic group membership. According to Tazeze et al. (2012, p. 3), analytical approaches commonly used in adoption studies involving multiple choices include the Multinomial Logit (MNL) and Multinomial Probit (MNP) models. The MNL model is widely used in studies on adoption and perception involving multiple options, due to its computational simplicity compared to the MNP model.

In this study, a binary logistic regression model was used instead of a multinomial model with multiple latent variables, as the dependent variable here is dichotomous. This model is appropriate for our study and enables us to identify the key explanatory variables influencing farmers' perception in Sourgou. The simplified formula derived from the empirical model proposed by Tazeze et al. (2012) was applied. In the model, let Y be the random dependent variable, and X the explanatory variable. It is assumed that, on average, A(Y) is a linear function of X, expressed as:

$$\mathbf{A(X) = f(X) = \beta_0 + \beta_1 X} \qquad \mathbf{(1)}$$

$$\mathbf{or \quad Y = \beta_0 + \beta_1 X + \varepsilon} \qquad \mathbf{(2)}$$

The parameters β_0 and β_1 are estimated by maximising the likelihood function. In this model, ε is the error term, which depends on the distribution of X, and Y is the dichotomous dependent variable (Y = 1 if "the farmer perceives climate change" and Y = 0 if "the farmer does not perceive it"). This binary dependent variable differs from the multicategorical dependent variable used by Tazeze et al. (2012), where the response variable could take three values. In our case, the X variables range from X_1 to X_{13}, representing the explanatory variables likely to influence farmers'

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perceptions. These are derived from data collected on adaptation strategies employed by farmers in the four villages studied.

The binary logistic regression model was also used by authors such as Loko et al. (2013, p. 4) to identify the determinants of yam farmers' perception of climate change. Their model is expressed as:

$$Y_i = x_i\beta + \varepsilon_i \quad (3)$$

Where Yi is a latent variable indicating whether or not the farmer perceives climate change, xi represents the set of explanatory variables, and εi is the standard error term.

Once the equation is determined, the model is interpreted to identify the key determinants of farmers' perceptions, based on the field data collected.

3. RESULTS AND ANALYSIS

Overall, the field survey was conducted with 219 men (52%) and 203 women (48%), all considered household heads or landowners. Most of the farmers surveyed were illiterate, with 76.8% stating they had never attended school. This high rate of illiteracy is a barrier to learning new techniques and adopting innovative adaptation strategies.

Regarding farmers' perception of climate variability, the majority demonstrated a clear awareness of climatic parameters. Among those surveyed:

- 88.5% reported that the seasons are becoming shorter.
- 87.6% observed that temperatures have increased.
- 88.1% perceived changes in monsoon wind patterns, particularly increased wind intensity. This was further supported by 83.4%, who specifically noted stronger wind activity. Additionally, 11.8% noticed a slight shift in the onset of the monsoon winds, mainly pointing to an increase in their strength, while 3.8% perceived no change in the monsoon wind regime.
- As for Harmattan winds, 46.7% stated that they have changed, and approximately 41.2% believed that this change relates to wind strength.

An analysis was also conducted on climatic parameter data. This showed a clear interannual variability in rainfall (Figure 1). The wettest years were successively 2014, 2016, 1999, 2010, and 1991, each recording a minimum total of 900 mm of rainfall.

The trend in average temperature revealed a rising curve with several oscillating phases (Figure 1).

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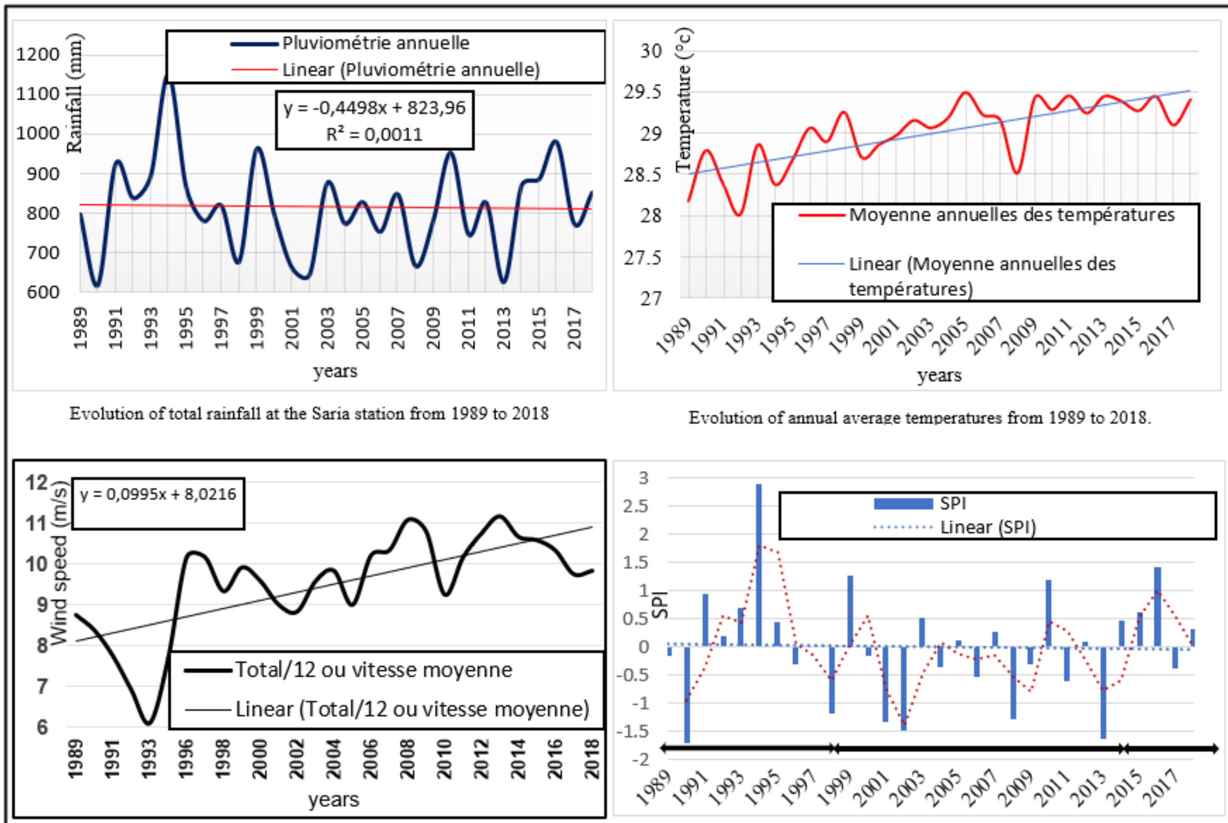
The wind curve also presented a two-phase pattern, with notable changes between March and July, indicating greater variability during this period.



Evolution of total rainfall at the Saria station from 1989 to 2018

Evolution of annual average temperatures from 1989 to 2018.

Monthly average wind speed from 1989 to 2018

Evolution of deviations from the average rainfall from 1989 to 2018.

Source: National Meteorological Directorate (Burkina Faso), 2020

Plate 1: Meteorological Graphs of Climatic Events

Based on these climatological data, the producers' perceptions of changes in their territorial dynamics can be confirmed, albeit to a lesser extent. These changes seem memorable to the producers because these three parameters "rainfall, temperature, and winds" have an impact on their production (Bouda, 2021, p. 56; A. Ouédraogo et al., 2017, p. 148; Bambara et al., 2013, p. 12). Consequently, these parameters are more noticeable to them than other climatic factors such as humidity.

The results of the analysis of determinants derived from the 13 explanatory variables are presented in the table below:

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Table 2: Determinants of Producers' Perception of Climate Variability

	Estimation	Standard errors	T value	Pr(>|T|)	
(Intercept) or Intercept	1.4307487	0.1148361	12.459	2e-16	
Age	-0.0385470	0.0020160	-19.121	< 2e-16	***
Food sufficiency of production	-0.0355396	0.0295348	-1.203	0.22956	
Need for food supplement	-0.0622335	0.0374726	-1.661	0.09753	.
Experience	0.0016580	0.0005233	3.168	0.00165	**
Education	0.0622348	0.0246564	2.524	0.01198	*
Length of dry season	0.1441371	0.0683736	2.108	0.03564	*
Labor	0.0022300	0.0024338	0.916	0.36007	
Mutual fund	-0.0046816	0.0213672	-0.219	0.82668	
Number of fields	0.0126447	0.0071575	1.767	0.07804	.
Origin	0.0448603	0.0412172	1.088	0.27707	
Flood situation	-0.0442074	0.0211717	-2.088	0.03742	*
Gender	0.0278699	0.0226413	1.231	0.21906	
Marital status	-0.0378517	0.0339062	-1.116	0.26493	

Significance codes: 0 ‘’ *0.001 ‘’ 0.01* ‘’ 0.05 ‘.’ 0.1 ‘’ 1
Residual standard error: 0.1995
Multiple R-squared: 0.5212
Adjusted R-squared: 0.5058
F-statistic: 33.99 on 13 and 406 degrees of freedom (DF), **p-value:** < 2.2e-16

The results from the binary logistic regression presented in the table reveal that age, need for food supplements, experience, education, length of the season, number of fields, and those who have previously experienced flooding are the seven explanatory variables out of the thirteen considered that influence or explain our model. The pre-established model in Table 2 is explained by these factors, which have an influence on farmers' perception.

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The analysis highlights that agricultural experience plays a key role in perceiving climate variability. The older the farmers, the more experience they accumulate, enabling them to identify observed climatic changes over the years (Experience: 0.0016, p = 0.00165). Education is also a determining factor: farmers with at least a secondary education perceive climate variability better and are more able to explain it (Education: 0.062, p = 0.01198). Education allows them access to scientific and technical information about climate, enhancing their understanding of meteorological phenomena.

Results also show that farmers who cannot feed themselves solely from their agricultural production are those who perceive a shortening of the rainy season. Consequently, they adopt resilience strategies, notably increasing the number of cultivated fields (Number of fields: 0.012, p = 0.07804) to compensate for yield losses due to adverse climatic conditions. Moreover, the length of the dry season significantly influences farmers' perception of climate change (Length of dry season: 0.144, p = 0.03564). The longer the dry season, the more farmers feel its effects and consider it a sign of climate change.

Regarding extreme climatic events, results show that farmers who have experienced floods have a more nuanced perception of climate change (Flood experience: -0.044, p = 0.03742). This suggests that floods are sometimes perceived as isolated incidents rather than a global trend towards climatic variability.

Table 3: Variable Analysis

Variable	Coefficient	Significance	Interpretation
(Intercept) or Intercept	1.4307	***	Baseline value of the dependent variable when all other variables are zero.
Age	-0.0385	***	Each additional year of age is associated with a significant decrease in the dependent variable. The effect is strong and highly significant.
Food sufficiency of production	-0.0355	Not significant	No statistically significant effect detected.
Need for food supplement	-0.0622	. (weak)	Tendency toward a negative effect, but weak evidence. Should be interpreted cautiously.
Experience	0.0017	**	Positive significant effect, but small in magnitude. More experience slightly increases the dependent variable.

Education	0.0622	*	Moderate and significant positive effect: higher education level improves the dependent variable.
Length of dry season	0.1441	*	The longer the dry season, the significantly higher the dependent variable.
Labor	0.0022	Not significant	No statistically proven effect.
Mutual fund	-0.0047	Not significant	No significant effect.
Number of fields	0.0126	. (weak)	Weak positive tendency with limited evidence.
Origin	0.0449	Not significant	No significant effect detected.
Flood situation	-0.0442	*	Moderate and significant negative effect: flood situation reduces the dependent variable.
Gender	0.0279	Not significant	No significant effect.
Marital status	-0.0379	Not significant	No significant effect.

According to Table 3, education, experience, and length of the dry season have a significant positive impact on the dependent variable, indicating that increases in these factors tend to improve outcomes. Conversely, age and flood situation have a significant negative effect, meaning higher values of these variables are associated with decreases in the dependent variable. The need for food supplement and number of fields show some trends but with weak statistical support. Finally, food sufficiency of production, labor, mutual fund, origin, gender, and marital status do not have a statistically significant impact in this model.

The lack of significant correlation for certain variables can be attributed to several factors. Firstly, these variables may genuinely have only a marginal or no effect on the dependent variable within the studied context. For instance, variables such as "gender" or "marital status" may not influence the outcomes if social roles are relatively uniform across the sample. Secondly, limited variability in responses for example, if most households experience similar food sufficiency or access to mutual funds can reduce statistical power to detect an effect. Additionally, some variables may be affected by measurement error or self-reporting bias, which diminishes the reliability of their association with the dependent variable. Indirect effects may also be present: a variable might influence another intermediary factor without directly affecting the main outcome, which a linear model may fail to capture. These findings highlight that statistical significance depends not only

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on data quality but also on the socio-economic context and the type of model employed. Finally, statistical analysis confirms the robustness of the model. The model's p-value (2.2e-16 < 1%) strongly rejects the hypothesis of no significant relationship between variables. Thus, the model is overall significant. Additionally, the Pseudo R^2 (0.5058) shows that 51% of the variations in farmers' perception of climate change are explained by the independent variables considered. These results highlight the importance of experience, education, and lived climatic conditions in farmers' perception of climate variability in the rural commune of Sourgou.

4. DISCUSSION

The study of determinants of farmers' perception in Sourgou shows a strong grasp of climatic parameters by these farmers. According to Doumbia and Dépieu (2013, p. 4823), climate is the primary determinant of farmers' agricultural productivity, broadly influencing their food production and the economy as a whole. The analysis of farmers' perception of climatic variability in the study area aligns with scientific observations. Oumarou et al., (2017, p. 62) affirm that farmers' observations of rainfall disturbances concur with climatic data in the Sudano-Sahelian region. Kosmowski et al., (2015, p. 100) note the same in a study conducted in Niger and Senegal, where they found a strong alignment between rural populations' perceptions and rainfall observations regarding recent rainfall accumulation trends.

Farmers' perception of climate stems from ancestral knowledge passed down to new generations. Rural populations rely on these ancestral knowledges and their current observations to explain climatic variability. These facts are supported in the works of Diallo (2010, p. 27); Ozer and Perrin (2014, p. 12); Sanou et al., (2018, p. 7).

However, farmers' perceptions are not always consistent with scientific findings. West et al., (2008, p. 301) showed adequate perception of the long-term decline in rainfall observed since the 1970s in Burkina Faso, but not of the rainfall recovery that occurred in the late 1990s. Climatic parameters are evolving. Rainfall shows a slightly downward trend with a negative slope of -0.4498 according to the regression line equation. This result contradicts that of Loko et al., (2013, p. 18), who found an increase in rainfall in the arid north-west of Benin. In the study sites, farmers perceive the rainfall decline through reduced agricultural production and lower water levels in various reservoirs. The decline in rainfall considerably shortens the time devoted to agricultural activities, especially off-season crops.

Temperature is slightly rising, also confirmed by farmers' perception and the findings of Dubreuil et al., (2013, p. 2); Bambara et al., (2013, p. 8). In the study area, farmers note rising temperatures through wilting young plant leaves and drying flowers of some cultivated species. Wind speed and timing have also changed. Farmers observe that increased wind frequently destroys flowers, crop stems, and dries out the soil. Bambara et al., (2013, p. 8) found similar results.

Nevertheless, farmers' perceptions often do not coincide with scientific observations due to their subjective nature, potentially leading to overly general conclusions. Yet, given the strong congruence between perception data and climatic data, rural communities evidently retain a good memory of climatic parameters and past climatic events.

Regarding determinants of farmers' perception, the binary logistic regression analysis shows that age, need for food supplements, experience, education, length of the season, number of fields, and flood experience are the most significant parameters in the model. Similar results were found by Ouédraogo et al., (2018, p. 285; 2017, p. 148); Oyekale & Oladele (2012, p. 1); Ouédraogo et al., (2010, p. 90). The variable "length of the rainy season" was highlighted in several studies (Ouédraogo et al., 2018, p. 285; West et al., 2008, p. 299) as an important determinant of farmers' perception of climatic variability. The same observation was made by Ilboudo et al., (2020, p. 349) in Goué and Voaga localities in Burkina Faso, where 91% of farmers perceive climatic variability through shortening rainfall duration.

Gbaguidi et al., (2015, p. 2527) showed that determinants like age significantly influence producers' perceptions of climate change. According to Oyekale & Oladele (2012, p. 1) and Loko et al., (2013, p. 17), the older the individual, the better they master agricultural activities. Experience is also an important determinant. Doumbia and Dépieu (2013, p. 4824) describe traditional agricultural experience as practical knowledge built over time. They add that the older the producers, the more experienced they are, which should enable them to find strategies to mitigate the negative impacts of climate change. Agossou et al., (2012, p. 567) also note that experiences in agriculture related to climate can strengthen indigenous knowledge at the producer level and constitute potential knowledge in the face of ongoing changes.

The level of education is another major factor in farmers' perception, as more educated individuals have a better knowledge of techniques. These results are similar to those of Tazeze et al., (2012, p. 6), who show that education is important because it enables educated producers to make better decisions regarding crop management techniques. Babah-Daouda and Yabi (2021, p. 31) state that the best-educated producers are those who adopt adaptation strategies to reduce the effects of climatic variability, according to their study in Djougou and Tanguiéta in northern Benin. Oumarou et al., (2017, p. 62) observe a difference in perception between educated and uneducated farmers, attributing it to educated individuals' access to extension services and NGOs, which enhances their awareness of climatic variability effects.

Floods are recurring phenomena in farmers' perceptions. Ouédraogo et al., (2017, p. 148) show that for 52% of respondents, the impacts of rainfall variability are mainly floods that cause crop destruction by asphyxiation. According to Oumarou et al., (2017, p. 62), flood disturbance is better perceived in Guirvidig than other sites, due to recent floods devastating vast areas of farmland. According to Gbaguidi et al., (2015, p. 2527), floods and droughts are the main manifestations of climate change affecting the production and diversity of cowpeas and voandzou. In order to support future improvement, future research could expand the study area or conduct comparative analyses with neighbouring communes to identify spatial patterns. Additionally, collecting longitudinal data would allow for tracking changes in perceptions over time, providing deeper insights into evolving household behaviours and responses to environmental or socio-economic changes.

CONCLUSION

This study on the determinants of farmers' perception of climate variability highlights that farmers in the rural commune of Sourgou are acutely aware of the climatic changes affecting their environment. Their perception is primarily based on observations of rainfall fluctuations, rising temperatures, and changes in wind patterns. The results reveal that factors such as age, education level, agricultural experience, length of the rainy seasons, and extreme weather events "particularly flooding" significantly influence farmers' perceptions. Consequently, the most experienced and educated farmers are better able to identify and interpret the manifestations of climate change, enabling them to adopt more effective adaptation strategies. In light of these findings, it is essential that public policies addressing the impacts of climate variability incorporate local farmers' perceptions. A better understanding of the determinants of these perceptions would facilitate the development of strategies tailored to on-the-ground realities, thereby strengthening the resilience of rural communities. Furthermore, awareness-raising and climate education must be enhanced to enable agricultural producers to more effectively assess climate risks and adopt more sustainable farming practices.

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ISSN: 2455-6939

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