



Climate Perceptions of Small Ruminant Farmers in the Mouhoun Province of Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijecc/2024/v14i54184>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/117075>

Original Research Article

Received: 07/03/2024

Accepted: 11/05/2024

Published: 18/05/2024

ABSTRACT

Perception is all about taking in, taking for oneself, taking hold of. Thus, a false perception of climate change can lead to a lack of adaptation or to maladaptation. Climate change represents a threat to the livestock farmers of the MP, whose main source of income is the exploitation of natural and animal resources. The problematic of this study is based on the good perception of the stockbreeders which were necessary to them to adapt to the climatic crises already occurred. The aim of this study is to analyze the perception of climate change by small ruminant breeders in the

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Cite as: Zan, A., Sawadogo, B., Bonkougou, J., & Some, Y. S. C. (2024). Climate Perceptions of Small Ruminant Farmers in the Mouhoun Province of Burkina Faso. *International Journal of Environment and Climate Change*, 14(5), 233–243. <https://doi.org/10.9734/ijecc/2024/v14i54184>

Mouhoun Province of Burkina Faso. To this end, 286 breeders, including agro-pastoralists and agro-pastoralists, i.e. 22 breeders per village, were surveyed. In addition, a focus group was held in each village, for a total of thirteen (13). Phinks software was used to process the individual survey data. The results indicate a drop in rainfall intensity (78.7%), a rise in temperatures (90.7%), a withdrawal from grazing areas (86%), a drop in milk production (81.3%) and lactation duration (86%). In summary, it appears that the population has a good perception of the climate in their locality. In addition, although it is difficult to integrate research evidence into development policy and practice, the results of this research could guide policy in making decisions about the climate perception of small ruminant farmers in the Mouhoun Province. This study leads to the conclusion that the changes perceived by farmers are relevant to the development of climate change adaptation strategies.

Keywords: Breeders; ruminants; climate change; perceptions; Burkina Faso.

1. INTRODUCTION

Climate change is a major constraint to the socio-economic development of rural populations [1]. On a global scale, it is leading to a rise in temperature and a poor spatiotemporal distribution of rainfall [2]. In this global context, sub-Saharan Africa, where agriculture is the main source of employment and income for the majority of the population, appears to be the region of the world most exposed to climate change [3].

Burkina Faso, a Sahelian country with an arid and semi-arid climate, is a rural country (82.5% of the population) with a poverty index of 40.1% in 2014 and a human development index (HDI) of 0.420 [4]. Located in the Boucle du Mouhoun region, Mouhoun Province (MP) is divided between the Sudano-Sahelian sector with average annual rainfall of 700 to 900 mm and the Sudanian sector with average annual rainfall of over 900 mm. Although livestock farming is the 2nd most important activity after agriculture, the sector is heavily dependent on spontaneous pastoral resources, and suffers the effects of climatic variations, the corollary of which is a drop in livestock productivity [5].

This article therefore analyses the climate perception of ruminant farmers in the MP, in a context marked by a downward trend in climatic parameters.

Data was collected in thirteen (13) villages in the province, with a total of 286 livestock farmers, including agro-pastoralists and agro-pastoralists, i.e. 22 farmers per village. In addition, a focus group was carried out in each village, i.e. thirteen (13) in total. Phinks software was used to process the individual survey and focus group data.

The aim of this study is to analyse the perception of climate change by small ruminant breeders in the Mouhoun Province of Burkina Faso. The hypothesis is that the latter have good climate perceptions, which have been necessary for them to adapt to the climatic crises that have already occurred.

2. METHODOLOGY

2.1 Presentation of the Study Area

Mouhoun Province is located in the north-western part of Burkina Faso between longitudes 2° 26' and 4° 38' West, and between latitudes 11° 15' and 13° 44' North [6]. It is bordered to the east by the province of Sanguié; to the north by the province of Nayala; to the north-west by the province of Kossi; to the west by the province of Banwa and Houet; and to the south by the province of Balé (Fig. 1). The Mouhoun belongs to the Sudano-Sahelian climate zone, with three (3) variations: In the north, the South-Sahelian sector with average annual rainfall of 500 to 700 mm; In the centre, the Sudanian sector with average annual rainfall of 700 to 900 mm. It extends over the southern part of Kossi province, the whole of Nayala province and the northern parts of Mouhoun, Balé and Banwa provinces; in the south, the southern Sudan sector, with average annual rainfall of 1,000 to 1,400 mm [7].

The average maximum temperature recorded during the hot period (March to May) is 40°C and the average minimum temperature recorded during the cold period (December to February) is 24°C [8]. Livestock farming is the second most important economic activity for people in the area, some of whom come from pastoral communities (Peulhs). It is characterised by its extensive nature and is practised at the same time as agriculture by most households. The

livestock is made up of cattle, sheep, goats and donkeys. Large herds are entrusted to Fulani herdsmen [6].

This is traditional extensive livestock farming, which plays a savings role for households. However, because of the more or less favourable climatic conditions, there are large quantities of plant biomass, attracting many herders from the interior of the country as well as from neighbouring countries such as Mali. One of the sector's biggest problems remains climate variability and change, combined with insecurity linked to the presence of unidentified armed groups.

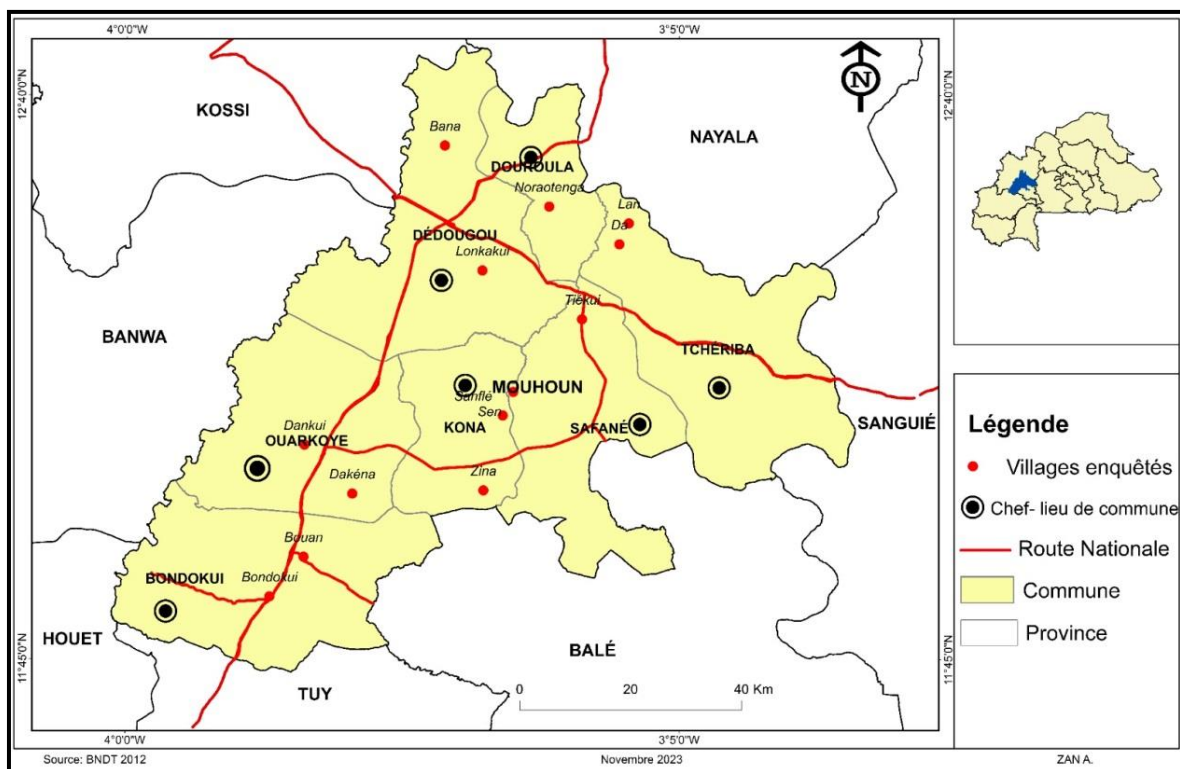
2.2 Data Collection and Analysis

Data were collected in thirteen (13) villages in the province. On the basis of criteria (accessibility and number of ruminant breeders in the village) defined with local technicians, the villages of Tiékui and Sin were identified in the commune of Safané; the villages of Lan and Dah in the commune of Tchériba; the villages of Fakena and Dankuy in the commune of Ouarkoye; the village of Tiékui in the commune of Tchériba; and the village of Tiékui in the commune of Tchériba; the villages of Fakena and Dankuy in the

commune of Ouarkoye; the village of Noraogtenga in the commune of Douroula; the villages of Bondokuy and Bouan in the commune of Bondokuy-rural; and the villages of Zina and Sanflé in the commune of Kona. In each commune, two villages were identified, except in the commune of Douroula, where only one village was identified and surveyed because of accessibility problems linked to insecurity.

The age group of people concerned by this survey is 50 and over. This age group is able to provide us with the necessary information on climate change (CC), changes in pastoral resources and ruminant farming in the study area. The choice of villages to be surveyed was based on the following criteria: the geographical location and accessibility of the locality (aspects linked to insecurity), and its representativeness in terms of the desired typology (transhumant, sedentary and nomadic).

A total of 286 livestock farmers, including agro-pastoralists and agro-pastoralists, were surveyed, i.e. 22 farmers per village. In addition, a focus group was carried out in each village, for a total of thirteen (13). Phinks software was used to process the individual survey and focus group data.



Map 1. Location map of the study area and survey sites

Table 1. Province du Mouhoun

Commune	Village 1	Effectif de la population village 1	Village 2	Effectif de la population village 2
Bondokuy-rural	Bondokuy	5 138	Bouan	1 356
Dédougou	Bana	495	Lonkakuy	437
Douroula	Noraogtenga	1 013	-----	4 259
Ouarkoye	Fakena	4 792	Dankuy	1 185
Kona	Zina	368	Sanflé	875
Safané	Tiékuï	439	Sin	1 690
Tchériba	Lan	1 867	Dah	672
Total enquêté	13 villages x 22 =	286		

Sources : INSD, 2019

2.3 L'identification Des Villages

On the basis of criteria (accessibility and the number of ruminant breeders in the village) defined with local technicians, the villages of Tiékui and Sin were identified in the commune of Safané; the villages of Lan and Dah in the commune of Tchériiba the villages of Fakena and Dankuy in the commune of Ouarkoye; the village of Noraogtenga in the commune of Douroula; the villages of Bondokuy and Bouan in the commune of Bondokuy-rural and finally those of Zina and Sanflé in the commune of Kona.

2.4 L'identification Des Eleveurs

For this study, we surveyed a total of 286 herders, including agro-pastoralists and agro-pastoralists, representing 22 herders per village. We selected them at random from among farmers who met the following two conditions: they were farmers and were at least 50 years old. Livestock farming was selected as the main activity in order to distinguish between the people interviewed, as the climatic realities do not affect farmers in the same way as livestock farmers. The reason for selecting this age group (50) was our desire to go back 30 years in order to analyse the data on climate change.

2.5 L'échantillonnage

The survey mainly concerned local people, environmental services, agriculture, livestock farming and local authorities. The age group concerned by this survey is 50 and over. This age group is able to provide us with the necessary information on the evolution of pastoral resources and ruminant livestock in the study area. Table 1 shows the breakdown of the demographic sample. It should be noted that the sampling technique was not probabilistic but rather of convenience due to the unavailability of

a complete database of the agro-pastoralist and pastoralist population of the MP. A total of 286 herders, including agro-pastoralists and agro-pastoralists, or 22 herders per village, were surveyed.

3. RESULTS AND DISCUSSION

Climate change is perceived by farmers in the MP as an increase in temperature and a decrease in rainfall. This study thus highlights a trend towards an increase in extreme climatic events (intense rainfall, temperature rises, violent winds) in recent years in the MP. Analysing farmers' perceptions of climate change is a useful way of understanding how people behave in the face of these problems. In addition, several studies conducted on farmers' perceptions of the climate have taken these parameters into account [9,1,11], etc.

3.1 Farmers' Perceptions of Changes in Rainfall

CC is closely linked to weather conditions, although there are subtle differences between the two [11]. In Mouhoun province, for example, local people remember abundant, regular rainfall in the past and longer rainy seasons. The majority of respondents, i.e. 78.7%, believe that the intensity of rainfall has been decreasing (Fig. 2 and 3). In fact, only 20% of respondents thought that the rains were getting heavier, compared with 1.3% who thought that they were getting lighter. This proportion suggests that some respondents are unfamiliar with the phenomenon of rainfall variability. In addition, 46.7% of respondents thought that the seasons were getting shorter, compared with 29.3% who thought that they were getting wetter and shorter. A further 12% confirmed that the seasons are rainy and long. This wide range of responses

reflects the great inter-annual variability in rainfall.

This wide range of responses reflects the great inter-annual variability of rainfall. This variability is confirmed by the processing of meteorological data and the work of [12] from the ORSTOM Centre.) Although they worked on different climatic zones, the results of Nouhou [13] show that the proportion of people surveyed who have the impression that cumulative rainfall is decreasing is 83% in Damana, 93% in Farié Haoussa and 92% in N'Dounga. These results are supported by a study on the Evaluation and management of climatic risks to agro-pastoral systems: the case of the communes of

Say and Tamou in Niger, conducted by Zika [14], which reached the same conclusions regarding rainfall. In addition, Djohy et al [15], having worked on : 'Perception et adaptation des éleveurs de bovins aux changements climatiques dans le bassin de l'Ouémé Supérieur au Bénin'

shows that for almost all the cattle farmers surveyed (99.7%), climate change is a reality in the Ouémé Supérieur basin in Benin. Falling rainfall was observed by 46% of respondents. In addition, on page 13, the author points out that among the livestock farmers surveyed, deforestation (94%) and divine punishment (6%) are the main causes of climate change in the communes of Tchaourou and Djougou in Benin. Moreover, according to Kabore et al (2019), local people remember abundant and regular rainfall in the past and longer rainy seasons. Currently, local people are noticing a change in the rainy season (76.7% of respondents). The current rains are heavier and last only a few moments during the day, which is not the opinion of the majority of our respondents (78.7%). In Burkina Faso, (Kabore, et al., 2019), have shown that the irregularity of rainfall and the reduction in the number of rainy days, as well as the reduction in the amount of rain, are indisputable indicators of climate change if this persists over time.

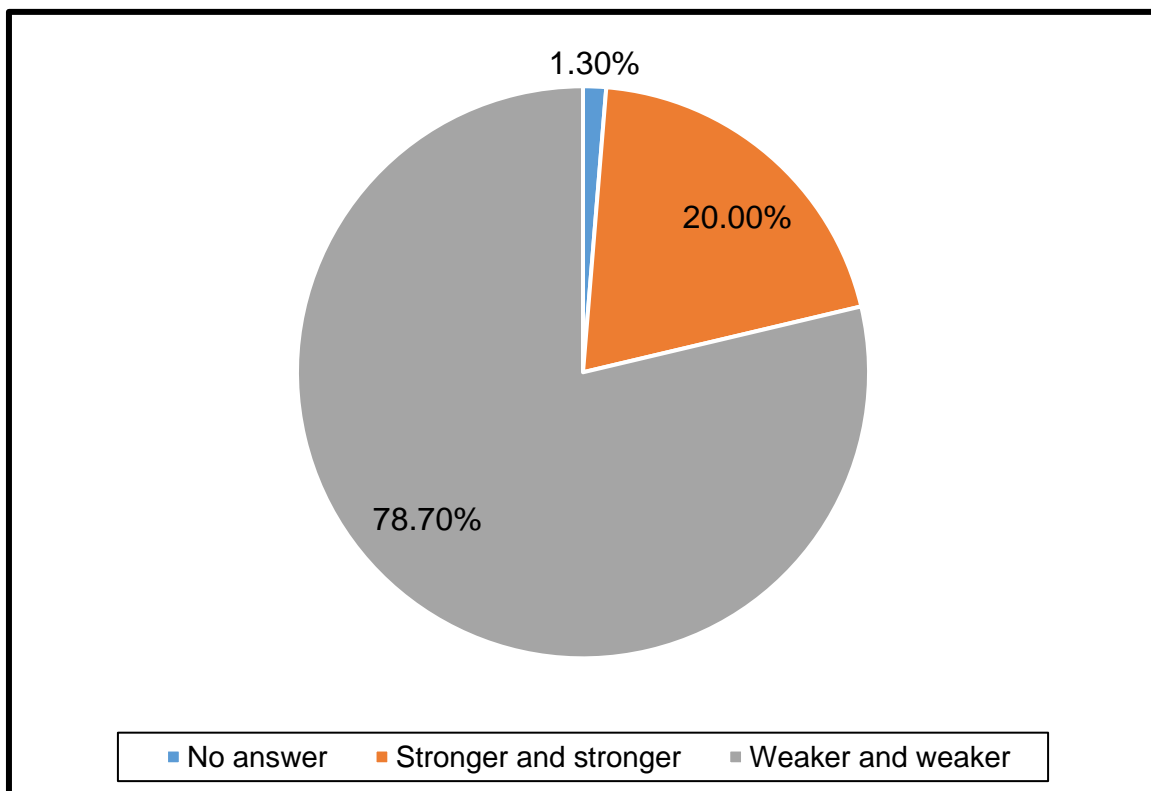


Fig. 1. Rainfall intensity
Source: Field survey, 2022

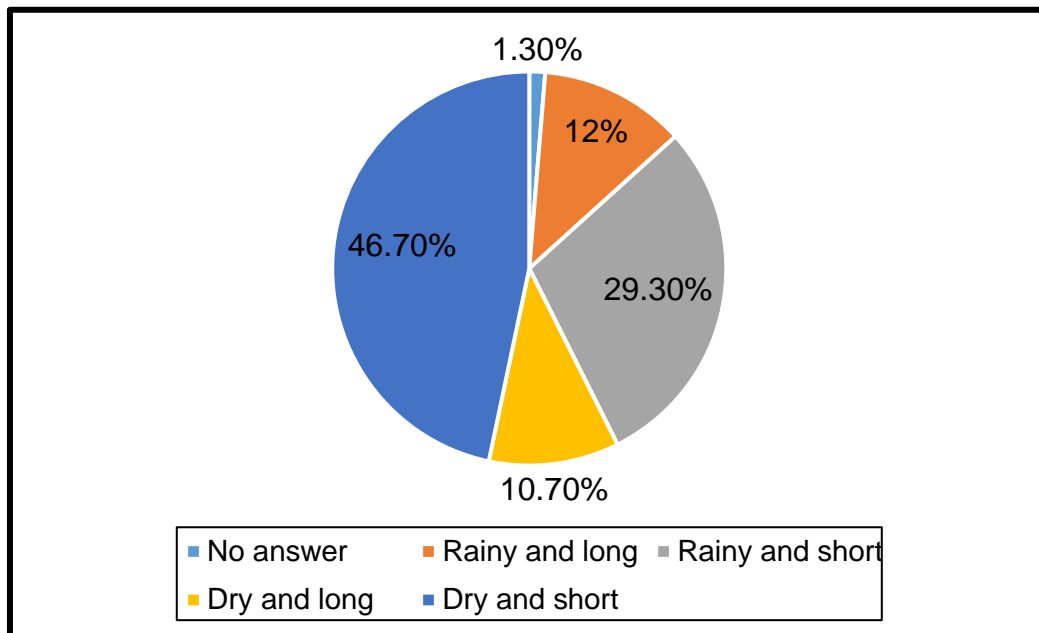


Fig. 2. Wintering characterisation
 Source: Field survey, 2022

3.2 Farmers' Perceptions of Temperature Change

Farmers' perceptions of temperature change are measured through the sensation of ambient heat (VISSIN E W, et al. 2015);cited by OUANDE [16]. The survey on the perception of climate variability at the level of livestock stakeholders in Mouhoun Province resulted in an almost unanimous opinion (90.7%) of respondents who stated that the increase in temperature is unequivocal, with hot, dry winds whose speed has decreased and which are unbearable by weakened animals. Only 8.0% agreed that the heat had decreased and 03% had no response (Fig. 4a).

Our findings indicated hot, dry winds that decreased in speed and were unbearable for the weakened animals. Only 8.0% felt that they had experienced a drop in heat and 03% did not respond. Farmers' perception of temperature changes was measured through the sensation of ambient heat (Vissin E W, et al., 2015; cited by Ouande M [16]. This perception is in perfect agreement with the analysis of meteorological data from the study area. This positive perception by farmers of atmospheric warming has also been revealed by the findings of several researchers in the country [17,18,15]. Temperatures are rising more and more, and it is hot both during the day (98.3%) and at night

(85%). Analysis of historical data therefore corroborates the results obtained from the population's perception that temperatures are constantly rising. The survey on perceptions of climate change, particularly temperature, is in line with meteorological observations and the literature on climate variability and change.

The heat is getting hotter and the rainy seasons are getting drier. For 50% of respondents in Damana, Nouhou [13] found that the current temperature has risen compared with the past. However, the proportion of respondents who shared this opinion was lower in Farié Haoussa (38%) than in N'Dounga (22%). Local perceptions highlighted the fact that the classic cold season of yesteryear (December to February) is getting warmer (71.3% of respondents) and tending to get shorter (85% of responses). They perceive warmer temperatures through their impact on their activities (Kabore, et al., 2019), and production through low yields. These findings are in line with our own, although the rate of perception is slightly low.

Lastly, the perception of climate change by the populations of the Mouhoun region through the decrease and irregularity of rainfall, the late start of the rainy season, the early cessation of rainfall and the higher frequency of dry spells is confirmed by previous studies [19,9], (Kosmowski et al., 2015).

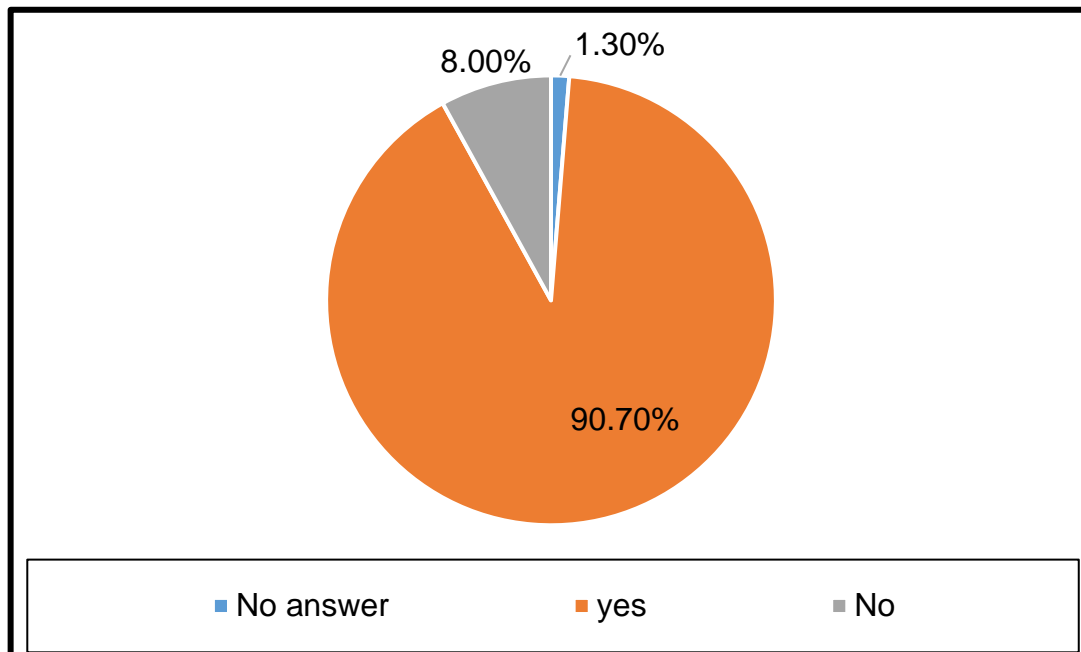


Fig. 3. The State of the heat

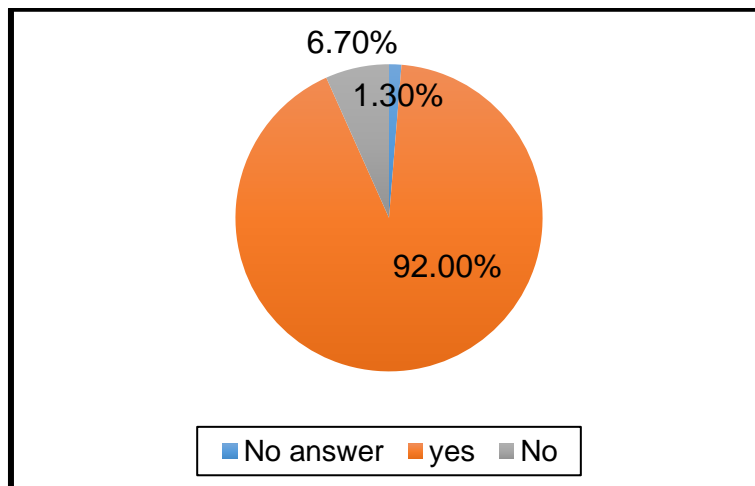
Source: Field survey, 2022

3.3 Perceptions of the State of Grazing Areas

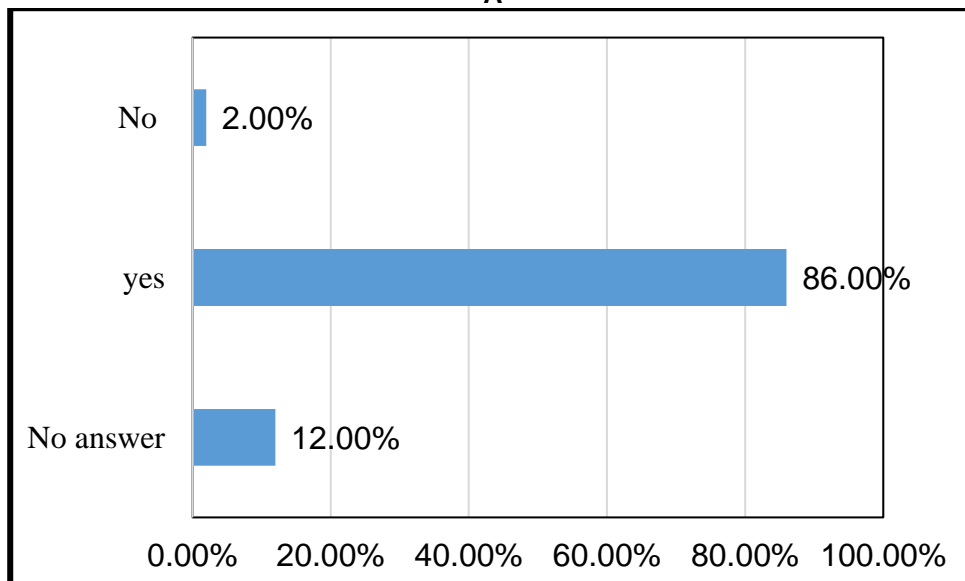
Fig. 4b shows the state of withdrawal from grazing areas and the invasion of rangelands. The availability of fodder is threatened above all by the existence of invasive species such as *Andropogon Pseudapricus*. This situation has increased tensions between farmers and breeders, and even between breeders themselves, and is weakening the health of the animals. This is one of the reasons why 86% of farmers said that the productivity of grazing areas had fallen. 92.0% of those interviewed said that rangelands had been invaded. This situation is due to the combined effect of urbanisation and CC. All of which has led to an increase in conflicts between farmers and herders. All (100%) of the respondents interviewed noted a deterioration in the fodder supply from natural rangelands.

However, according to Mouhous [5], there has been no significant increase in forage area. The author estimated that the surface area of natural fodder is 15,545.7 ha and that the peak was reached in 2 011 with 19,365 ha. Moreover, 92.0% of those interviewed noted that rangeland had been invaded. This situation is due to the combined effect of urbanisation and CC. All of which is leading to an increase in conflicts between farmers and herders. All (100%) of the

cattle farmers surveyed noted a deterioration in the fodder supply from natural grazing lands. According to Djohy et al [15], for the cattle farmers surveyed, palatable species are becoming increasingly rare on rangelands because of the expansion of fields (43%), the drop in rainfall (29%), the proliferation of invasive species (15%) and demographic pressure (13%). The proliferation of invasive species, notably *Mesosphaerum suaveolens* and *Chromolaena odorata*, is not to be outdone. According to the results of Kiema et al (2014), the main reasons for transhumance in Burkina Faso are to find pasture (51.2%), water to drink (39%) and a salt cure (4.3%). This strong perception of the need for pasture illustrates the decline in locally available fodder, and is in line with our conclusions, which show that 86.0% of transhumant herds are withdrawn from pasture. Moreover, according to the same author, indicators of pasture degradation are steadily increasing according to 80% of those surveyed, and are consistent with the conclusions of various other authors (San Emeterio, et al., 2013); [20]. In contrast, analysis of land-use dynamics on the farms surveyed shows a stability in areas under forest and an increase in improved pasture, according to the findings of Bonin, et al., (2017). This improvement is mainly due to the seeding and division into parks of areas that were previously natural pasture.



A



B

Fig. 4a and 4b. Invasion of rangelands and withdrawal of grazing land

Source: Field survey, 2022

3.4 Perceptions of the Frequency of Twin Births

Fig. 5 shows the frequency of twin births, which was around two years, i.e. approved by 56.0% of the farmers surveyed, compared with four (4) years for 25.3% of the respondents. Only 2.7% of respondents gave no answer. The rate of twin births is related to the state of the livestock's diet. The better fed the animals, the higher the rate of twin births. This is confirmed by HASSAN, [21].

The average farrowing rate for all goat farms surveyed was 151% [5], which is much higher

than our results of 56.0%. Twin births were reported but only one farmer recorded a low farrowing rate of 50%. The average fertility rates recorded were 123% and 144% respectively. Goats are still bred by free-rearing. However, twin births have become an extraordinary phenomenon, even for goats. According to the author, in the opinion of breeders, 74% indicates a decrease in the frequency of twin births [21]. Contrary to our findings and those of Mouhous [8], the overall average farrowing rate on the goat farms monitored was 56% and 151% respectively. This difference could be explained by climatic factors, but also by the quality of the

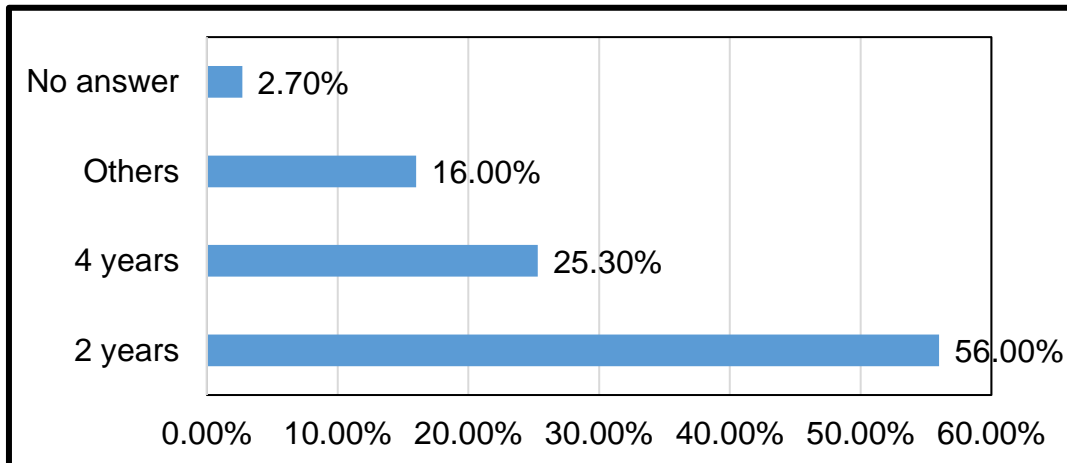


Fig. 5. Frequency of twin births

Source: Field survey, 2022

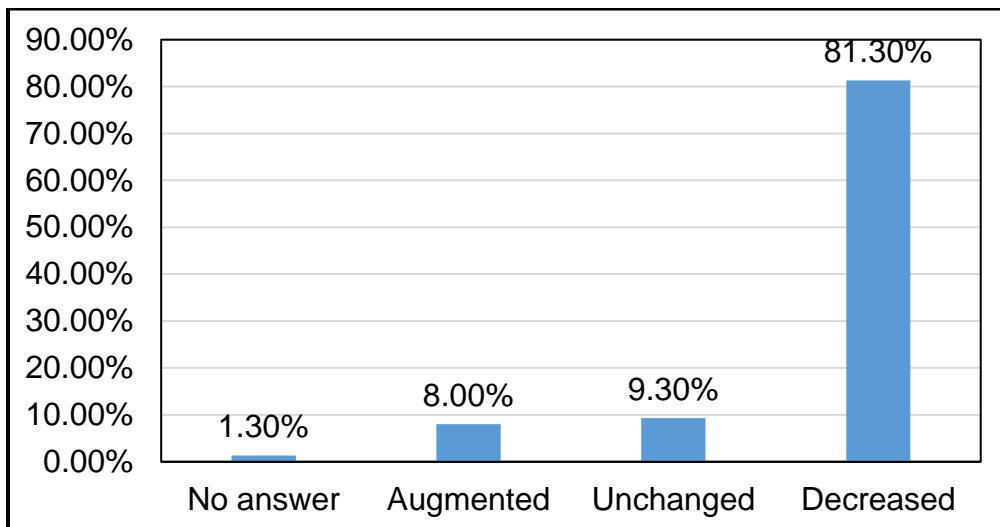


Fig. 6. lactation length

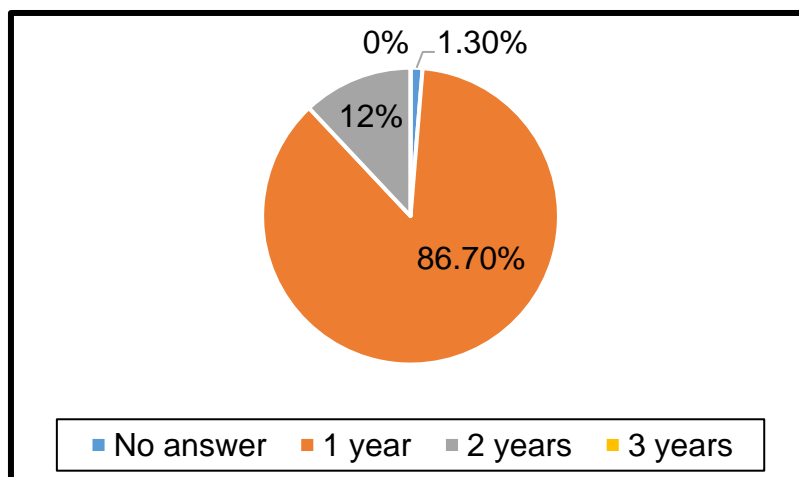


Fig. 7. Milk production and lactation length

Source: Field survey, 2022

fodder available. In addition, the findings of Ndiaye et al [22] indicate that, during the 12 months preceding the study, 240 births were recorded out of 222 ewes bred, including 204 single births (91.89%) and 18 twin births (8.11%). Breeders reported 217 single births (85.79%) and 27 twin births (14.21%) out of a total of 190 goats.

3.5 Farmers' Perceptions of Milk Production and Lactation Length

Good nutrition is the key to prolific small ruminant farming. However, when the animals are free-ranging, they feed on almost anything, including paper or plastic. In general, they graze on grass, thorny plants, green plants and tree branches. Any change in food quality also has an impact on milk production and reproduction. As a result, the interval between births is increasingly prolonged, due to the poor quality of the diet of the females in particular and the livestock in general. Low fodder production in grazing areas has an impact on the calving interval. For most respondents (87%), the calving interval has increased. In addition, 81.3% of respondents reported a drop in milk production compared with 8.0%. In addition, 86.7% saw a decrease in lactation length.

As a result, livestock farming is exposed to the harmful effects of climate change in this region because of the lack of water, which leads to a drop in the frequency of daily watering of animals and milk production, and an increase in morbidity and the abortion rate (Diallo, 2004). According to Zika [14], milk production is normally reduced by various factors. This drop in milk production can vary from 10 to over 25%. Nouhou, [13], adds that production is currently down by 47% in normal times (in the absence of drought) in Damana, 65% in Farié Haoussa and 30% in N'Dounga.

4. CONCLUSION

The results of this study show that farmers in the MP are aware of climate change. However, they need to be compared with meteorological data. In addition, although people in the MP are well aware of climate change through the increasingly short seasons (46.7%) and temperature rises (97.7%), they are also aware of it through the interval between births (87%) and the time between births (87%). But also through the interval between births (87%) and the invasion of rangelands (92.0%). What's more, the majority of

respondents (78.7%) felt that the intensity of rainfall had been decreasing. These climatic hazards have a negative impact on the biophysical environment, with repercussions on fodder resources, animal health, milk production and lactation period. It is therefore vital to build the adaptive capacity of the province's livestock farmers through training and awareness-raising [1,14].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. ZAN, A. Impact of Climate Change on Ruminant Breeding in the Lake Bam Watershed. Ouagadougou, Burkina Faso, master's thesis in Geography, Joseph Ki-Zerbo University.2019;114.
2. FAO. Supporting low emission development of the pastoral and agro dairy sectors, Food and Agriculture Organization of the United Nations, New Zealand Agricultural Greenhouse Gas Research Centre, Rome. 2019;32.
3. FAO Edited by Assouma, M.H. and Mottet, A. FAO: Animal Production and Health Guidelines. Rome. 2020(22). Available :<https://doi.org/10.4060/ca9111fr>, Estimation forage balances in the Sahel region of West and Central Africa. 50.
4. PNDES. National economic and social development plan (PNDES). Study Report, Ouagadougou. 2016-2020;88.
5. Mouhous A. Ruminant breeding systems in mountain areas and dynamics of adaptation of breeders. case of the Tizi-Ouzou region (Algeria). Doctoral thesis, National Higher Agronomic School EL - HARRACH (Algeria). 2015;271.
6. Traore M. Floristic analysis of the riparian formations of the Corridorforestier of the Boucle du Mouhoun, Thesis for obtaining the Diploma of Rural Development Engineers, Option: Agricultural Extension, NAZI BONI University, Ouagadougou. 2018;60.
7. RGPH. Monograph of the boucle du mouhoun region. Study Report, Ouagadougou. 2006;174.
8. MATDS. Feasibility study for the development of the mouhoun sourou river banks. ouagadougou, ministry of territorial administration, decentralization and

- security. State Report of Degradation of The Banks of Mouhoun and Sourou, Ouagadougou. 2011;55.
9. Ouedraogo B. Adaptation strategies of agropastoralists to climate variability in the yacouta watershed (Burkina Faso). Unique doctoral thesis in geography, University of Ouagadougou. 2015 ;248.
 10. Manoli C. The herd and the means of securing pastoral camps A study of the management of herds in the Rural Community of Tessekre, in the Senegalese Ferlo. Doctoral thesis, University of Montpellier. 2012 ;189.
 11. IPCC. Climate Change 2007, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Pachauri R.K. IPCC, Geneva, Switzerland. 2007;103.
 12. Pouyaud B. Climatological observation at the Saint-Paul, Kongoussi and Bam stations. ORSrOMCenter of Ouoadououou. 1973;119.
 13. Nouhou KM. Agriculture facing climate change in the Tillabéri region: what adaptation strategies? Case of the villages of Farié Haoussa, Damana and N'Doung, Master in Climate Change and Sustainable Development, Abdou Moumouni University, Niamey. 2012 ;72.
 14. Zika M. Assessment and management of climate risks on the agropastoral system: case of the communes of Say and Tamou. Master's Thesis in Climate Change and Sustainable Development, Centre Regional Agrhymet, Niamey. 2012 ;81.
 15. Djohy GL, Bouko BS, Dossou PJ, Boni Y, Afouda J. Perception and Adaptation of Cattle Breeders to Climate Change in the Upper Ouémé Basin in Benin Cotonou. 2022 ;3(4) :6-28.
 16. Ouande M. Impact of Climate Variability on the Natural Habitat of Carpa Procera in the Cascades Region: case of the rural commune of Béregadougou. master's thesis in geography, Joseph KI-ZERBO University, Ouagadougou. 2015 ;153.
 17. Yanogo IP. Population adaptation strategies to climatic hazards around Lake Bagré (Burkina Faso). Unique Doctorate Thesis in Geography, University of Abomey Calavi (Benin). 2012; 302.
 18. Ouoba AP. Climate change, vegetation dynamics and peasant perception in the Burkinabè Sahel. Unique Doctorate Thesis in Geography, University of Ouagadougou, Ouagadougou. 2013 ;305.
 19. Sarr B, Kafando L, Atta S. Identification of climatic risks of maize cultivation in Burkina Faso. International Journal of Biological and Chemical Science, Agrhymet Regional Center, Training and Research Department, BP 11011, Niger, Niamey. 2011;1660-1675.
 20. Ouoba-IMA S. Caractéristiques socio-démographiques et dynamique de la transhumance des bouviers peuls de la Nouhao au Burkina Faso. VertigO, La revue électronique en sciences de l'environnement. 2018;18(2). Available :<https://id.erudit.org/iderudit/1059926ar>, Université du Québec à Montréal, 25p.
 21. Hassan HR. Assessment of the vulnerability and adaptation of the small ruminant breeding system to climate change, case of the Say department, Tillabéry region - Niger. Niamey, Master II thesis in Climate Change and Sustainable Development, Abdou Moumouni University of Niamey, Niamey. 2012;75.
 22. Ndiaye B, Diouf MN, Sambe BS, Dayo GK, Diop M, Sembene M. Dynamique des Troupeaux de Petits Ruminants Sahéliens dans Les Exploitations Rurales au Senegal. European Scientific Journal. ISSN: 1857 – 7881 (Print) e - ISSN 1857-7431. 2019 ;15(30) ;183-200.

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