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Climate Change Challenges for Cattle Farmers in Fundong Sub- Division, North West Region, Cameroon

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Abstract

This study assessed the vulnerability of cattle production to climate variability in Fundong Subdivision, with a focus on understanding the specific climatic risks faced by cattle farmers. To achieve this, a mixed research approach was adopted. Rainfall and temperature data from the Fundong sub-divisional delegation for Agriculture was used to established the actual state of climate variability in the area from 1981-2023. A total of 80 questionnaires were successfully administered to purposively selected rearers and interviews conducted with stakeholders in the Agro-pastoral sector. Both descriptive and inferential statistics were employed for data analysis. Findings revealed that climate variability is high. The inter-annual rainfall stands at 170 mm, with a declining trend. Rainfall has been on a downward trend since 2000, and the trend appears irreversible as the rainfall has been unreliable during the 2011-2021 decade. This is associated with a decreasing average number of rainy days. In the same light, the mean annual temperature has been increasing temperature trend in Fundong since 2001. Between 1981 and 2023, the mean temperature has increased by 7.8^{o}C, much higher than the global mean of 1.5^{o}C. Rising temperatures against a backdrop dropping rainfall has negative impacts on crop production systems and other sources of livelihoods. Farmers perceived that their output has been decreasing as a result of climate and other production factors. The impacts of climate variability on the Fundong rangeland are pasture degradation, outbreak of climate related diseases, invasion by noxious plants species, reduction in the volume of water courses, conflict between rearers and farmers over resources as well as the modification of the agro-pastoral calendar. To reduce the effect of climate variability and change, pastoralist should incorporate different water harvesting and irrigation technologies with their local adaptation strategies

Keywords: cattle farming, climate change, Vulnerability

Introduction

Climate change has turned out to be the most critical issue at the global, regional, and local levels to such a point that it is considered the severest challenge for mankind in the present century (Doe, 2020). Consequently, there is an emergent concern that climate variability and change, coupled with other environmental, political, and social pressures, may overpower the resilience of pastoral grazing today (Smith, 2016). Thus, it poses serious threats to cattle production through changes in rainfall patterns, increased temperatures, increased frequency of extreme weather events, and reduction in water availability (WMO, 2019). These are expected to adversely affect cattle production and productivity around the world, both directly and indirectly (FAO, 2017). Climate change has caused a global average surface temperature increase of about 0.6°C during the twentieth century (IPCC, 2021). The change in the global climate system is now undeniable and is human-induced, as concluded by scientists during the past decades due to increases in temperature. Rainfall has already become variable and unpredictable, and the strength of related climate extreme events, such as drought and flooding, is likely to increase in the future.

The United Nations Development Programme (UNDP, 2018) reports that, in Cameroon, the average annual temperature has increased by 0.7°C from 1960, and the average annual precipitation is dropping at 2.9 mm each month since 1960. These are expected to adversely affect cattle production and productivity around the world, both directly and indirectly (FAO, 2017). Sub-Saharan Africa, which is already affected by social, economic, political, and ecological challenges, is one of the zones highly impacted by rising temperatures due to climate change and climate variability (Smith and Jones, 2022). Cattle production plays a vital role in global food security, livelihoods, and the economy (FAO, 2020; Herrero et al., 2016). According to Nyuymenka et al. (2015), traditional grazing dominates, with more than 95% of Fulani's practicing extensive cattle rearing that depends solely on natural pasture growth.

However, the sustainability and productivity of this sector are increasingly threatened by climate variability and change, which pose significant challenges to the livestock sector, particularly cattle production, which is vulnerable to environmental changes. According to studies carried out in recent years (Jones et al., 2017; Thornton et al., 2018; Smith et al., 2019), climate variability also affects the availability and quality of forage, which are crucial for cattle nutrition. Intense rainfall events followed by extended dry periods can adversely affect pasture

growth and lead to the scarcity of grazing resources (Smith et al., 2019). These changes can lead to undernutrition, poor body condition, and higher susceptibility to diseases.

The vulnerability of cattle production is particularly evident in the Northwest Region of Cameroon. This area is known for its rich agricultural resources and significant reliance on cattle rearing for economic and food security purposes (Nkem et al., 2017). However, the region is also experiencing changes in climate patterns, including rising temperatures and unpredictable rainfall, which are impacting cattle production. The vulnerability of cattle production to climate is a significant concern for cattle reader's and livestock producers. Climate variability, including changes in temperature, precipitation, and other weather conditions, can directly impact pasture productivity, water availability, and the risk of diseases and parasites. These effects can lead to decreased cattle performance, poor health, and increased mortality rates.

2.0. Materials and Methods

2.1. Study Area

Fundong is located within the grassland savannah area of the mountainous Western highland region of Cameroon. It is found between latitude 6°4' and 6°20' north and between longitude 10°11' and 11°30' east of the Greenwich meridian. It is surrounded by Wum Sub Division to the west and to the East by Noni Sub Division while to the North it is bounded by Fungom Sub Division and to the south by Njinikom Sub Division (Figure 1). The entire Sub Division covers a land surface area of about 519 square kilometers and has 26 main villages and numerous quarters. Fundong is a town located in the northwest region of Cameroon, surrounded by rolling hills and verdant valleys, the physical milieu of Fundong is characterised by breath taking natural beauty. Located at an elevation of 1562.84 meters (5127.43 feet) above sea level, funding has a tropical monsoon climate that is generally cold, windy and wet. Sometimes it is warm, sunny with dry spells. Temperature ranges from 15°C to 38° C with average temperature of 24.5 to 29.7°C. Average annual rainfall stands at 2400mm per annum and humidity of 82% with two seasons, the rainy season begins from mid-march to mid-October and a dry season that extends from mid-October to mid-march. However, with the current dispensation of climate change, the weather patterns are becoming more unpredictable, with unreliable rainfall, high wind speed, high intensity of sun, and extreme dryness.

Fundong like most part of the western highland region of Cameroon falls within the mount Cameroon volcanic ridge. The relief is characterized by gentile undulating slops, steep hills

and deeply incised valleys. The topography ranges between 40-70 degrees slopes. The highest point is the Ijim hills. Various physical features such as plateaus, plains, isolated massifs and hills are clearly visible**.** All these are evidences of ancient volcanic and tectonic activities. The major rivers found within Fundong are Nkoini which also serves as the natural boundary between Fundong and Njinikom sub Divisions; juaffief, which flows from Ijim forest crossing through Fundong town and down to Menchum in the west, Jua Ngwa which runs from Ijim via Muteff, Abuh, Ngwa and Meli which separate Fundong from Bafmeng. Other streams of significant value are Jua Ibolem, Jua Mboh which both flow from Ijim forest to into Jua Ngwa. Also found are prominent springs and water falls like '' Tchimni'' in Fundong centre and the Laikom, Akeh and Ajung waterfalls.

Fundong falls within the tropical grasslands or humid savannah with predominantly forest woodland and re-growth savannah with grass and shrubs. There is also a gallery forest found in Mbam and a re-growth savannah found around the neighboring Mentang village. Some species which are being exploited by local populations for carving and medicinal purposes are indigenous species known by their local names as ''Aghang'', ''Feshuo'', Prunus Africa and Raffia-palm also common. The richest and the densest ecosystems are the Kom Wum Forest Reserve and the Ijim Mountain Forest reserve. There are exotic species such as eucalyptus, cypress, and fruits trees. The soils are dominantly volcanic with laterites, sands and loams in depressions. In most low lying areas, soils are thick and rich in humus example sedimentary warm humus rich/fertile soils. Generally, the dominant soil types within Fundong are lateritic and ferralitic soils.

Animal rearing is one of the key economic activities of the local population. The method of animal rearing is traditional, as it depends largely on natural pastures and the practice of transhumance. The species of animals are mostly local breeds that have adapted to the natural environment and appear to be disease-resistant. Local farmers rear animals such as sheep, goats, and cattle. Cattle rearing is carried out by Mbororos, who live in isolated rural settlements where land is available for grazing. They are mostly found in Mentang, Ngwa, Meli, and Bolem. A good number of livestock farmers are gradually adapting to modern and more profitable farming ventures, such as ranching, in which animals are confined in fences.

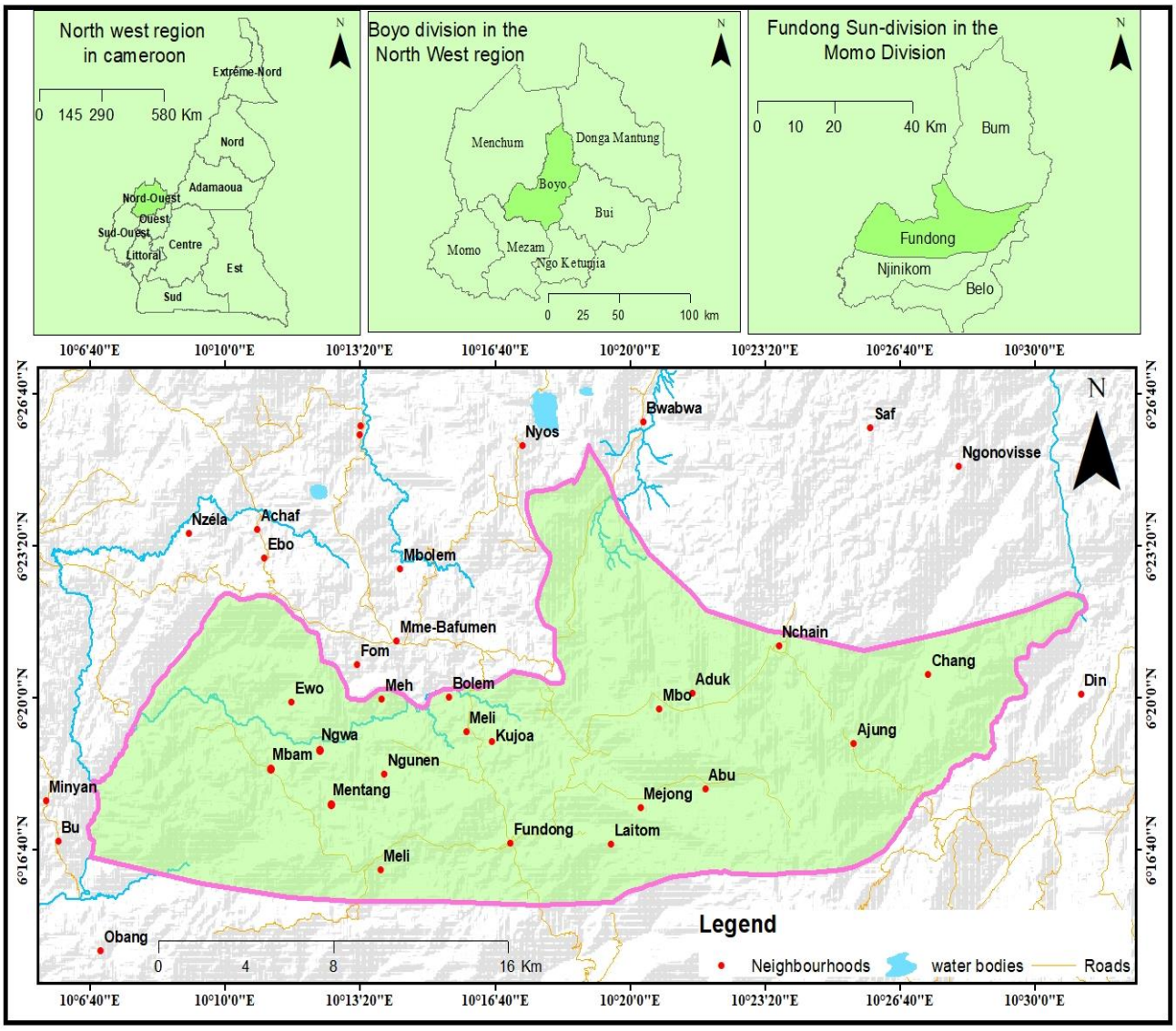

Figure 1: location of Fundong Subdivision in Boyo Division, North West Region, Cameroon
Source: Fundong Council

2.2. Research Design

The study was exploratory, employing a mixed-methods approach to investigate the impacts of climate variability on cattle farming operations. Both qualitative and quantitative methods were used to gather holistic insights. The research involved conducting structured surveys among cattle farmers to understand their perspectives on the impacts of climate variability on their operations. These surveys included questions about specific climatic events experienced and their perceived impacts on cattle production.

2.2.1. Data Collection

Data for this study were generated from two main sources: primary and secondary sources. Primary data, or firsthand data, related to this research was obtained using several research

instruments, including field observations, questionnaires, and interviews. All the questionnaires and instruments were validated. Secondary data were generated from library sources, institutional sources, and internet sources using search engines such as Google. Climatic data on annual rainfall and minimum and maximum temperatures for Fundong were collected from the Sub-Divisional Delegation for Agriculture for a period of 42 years (1981-2023).

2.2.2. Study Area Population and Target Population

The study populations included pastoralists, Fundong council authorities, the Sub-Divisional Officer (SDO) for Boyo, and the Regional Delegate of Livestock and Animal Husbandry for the North West region. The target population involved pastoralists found in the following quarters in Fundong: Mentang, Mbam, Bolem, Meli, and Ngwa. These quarters were selected randomly and comprise a target population of 193 livestock farmers. The randomization of this particular sampling gave the correspondents equal chances of selection and ensured a fair representation of the population in the community on which generalizations were made.

2.2.3. Sample Size and Sampling Procedure

Purposive sampling was the strategy employed, which involved selecting participants in proportion to the population magnitude of pastoralists in each quarter of Fundong. Areas with more pastoralists had a larger sample size, while areas with fewer pastoralists had a smaller sample size. This approach helps ensure that the sample is representative of the population distribution. This research utilized two subcategories of purposive sampling: expert sampling and snowball sampling. A snowball sampling method was applied for the selection of households for the interview as there was no prior list of pastoralists available. Snowball sampling involves identifying someone who meets the criteria in the study. Snowball sampling is useful when trying to reach a population that is inaccessible or hard to find.

2.2.4. Questionnaire Administration

The administration of questionnaires followed a zonal random procedure and a systematic random sampling whereby each household was selected for the administration of questionnaires. Prepared questionnaires with a set of questions relevant to the study objectives were used to collect data from selected pastoralists. A structured questionnaire with both open and closed-ended questions was used to obtain information on stated objectives and was designed to collect both qualitative and quantitative data from cattle herders. A total of 80

questionnaires were administered to randomly sampled households in the different villages that were chosen as samples (Table 1).

Table 1: Distribution of questionnaires in various grazing zones

Names of grazing zones	Total population of livestock farmers per village	Number of questionnaires	Percentages (%)
MENTANG	58	24	30
MBAM	47	19	24
BOLEM	38	16	20
MELI	28	12	15
NGWA	22	9	11
Total	193	80	100

Table 1 shows the distribution of questionnaires in various grazing zones. The number of questionnaires was not the same for all the zones. It was in relation to the number of cattle population for each zone. The highest number of questionnaires was administered in Mentang, as it contains the highest cattle population followed by Mbam which is second, and followed by Bolem while Meli and Ngwa are the least zones of cattle population. A total of 75 questionnaires were retrieved from the field.

2.2.5. Data Analyses and Presentation

The questions were coded and input into SPSS software. Qualitative data were analyzed using both descriptive and inferential statistics with the help of Microsoft Excel software. Inferential statistics were analyzed using SPSS (Statistical Package for Social Sciences) version 26. Descriptive statistics are represented in the form of tables, graphs, frequencies, and percentages. Inferential statistics helped establish linear regression and correlations. Climate variability was computed statistically using the coefficient of variation (CV). To calculate CV, we computed the mean, variance, and standard deviations of rainfall at different time series. The Standard Precipitation Index (SPI) is a tool developed primarily for defining and monitoring drought and floods. It is also used to determine periods of anomalously wet events that can cause floods. Developed by McKee et al. (1993), SPI is a method for assessing climatic

variability. Conceptually, SPI is the number of standard deviations by which the precipitation values recorded for a particular location differ from the mean over certain periods.

3.0. Results and Discussion

3.1. State of Climate Variability knowledge in Fundong

The analysis of pastoralist perceptions of climate change shows that respondents agreed there has been a change in climatic parameters in the area. Those under 42 years old said they were told by their elders that rainfall patterns have always fluctuated, even before they were born. Given their perception, it was essential to determine the rate of change they have observed (Figure 2).

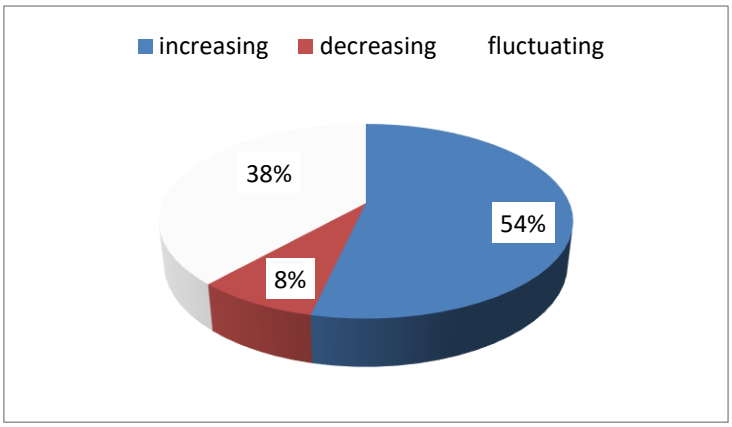

Figure 2: Pastoralists perception rate on changing climate parameters

Although the pastoralists all attest to a change in climatic parameters (Figure 2), they had different observations on the changing rate of rainfall patterns, including increasing, decreasing, and fluctuating rates. Over the aforementioned years, 54% observed an increase in climate variability, 8% a decrease, and 38% a fluctuation.

3.2. Actual Climate Variability Indices

The analysis of data from the Sub-Divisional Delegation of Agriculture (a body responsible for climatic data) in Fundong confirms that climate variability is a reality in the Fundong highland. There have been significant fluctuations in rainfall patterns as well as temperature in Fundong, causing great variability in climate. This variability is characterized by spatio-temporal variability in rainfall events and thermic variability on monthly and yearly bases over the years (1981-2023). The majority of pastoralists in this area are aware of the presence of climate variability, as most have perceived it in different ways. This variability has a direct impact on cattle production in the area, making pastoralists vulnerable.

3.2.1. Yearly Average Rainfall of Fundong

Rainfall is one of the complex indicators of climate variability across the globe. Its variation is as a result of climatic changes which has continuously affected a variety of human aspects. The annual rainfall in Fundong has been fluctuating. From 1981, the annual average rainfall was just 190mm of average rainfall over that year, and increasing to 210mm in the years 1983. In the 80s, rainfall variability was less witness in the domain of change but mostly of variations and fluctuating precipitation. This is seen as in the early 1990s average rainfall pattern in Fundong witness a drastically increase averaging to 190mm to almost 230mm in that decades. Fast-forwarding this aspect to the early 2000s, average rainfall in Fundong witness a drastically decrease as it falls back to almost 170mm average rainfall. This was the beginning of rainfall variability and climatic changes in rainfall with serious impacts on cattle production. Across the years 2001, 2003, 2005, 2007, and 2009 average rainfall was drastically low ranging from 170mm to 190mm. This explains the drastic drop in cattle production and catering in this locality. This variation in climatic indicators of rainfall has continually averaging between 160mm to 200mm as of recent in this locality. The average rainfall has drastically affected aspect that concerns cattle production such as land use change which reduces cattle rearing space as subsistence agriculture activities around these places are increasing and but crop and cattle rearing space decreasing. Figure 3 shows this average rainfall pattern across the years in Fundong.

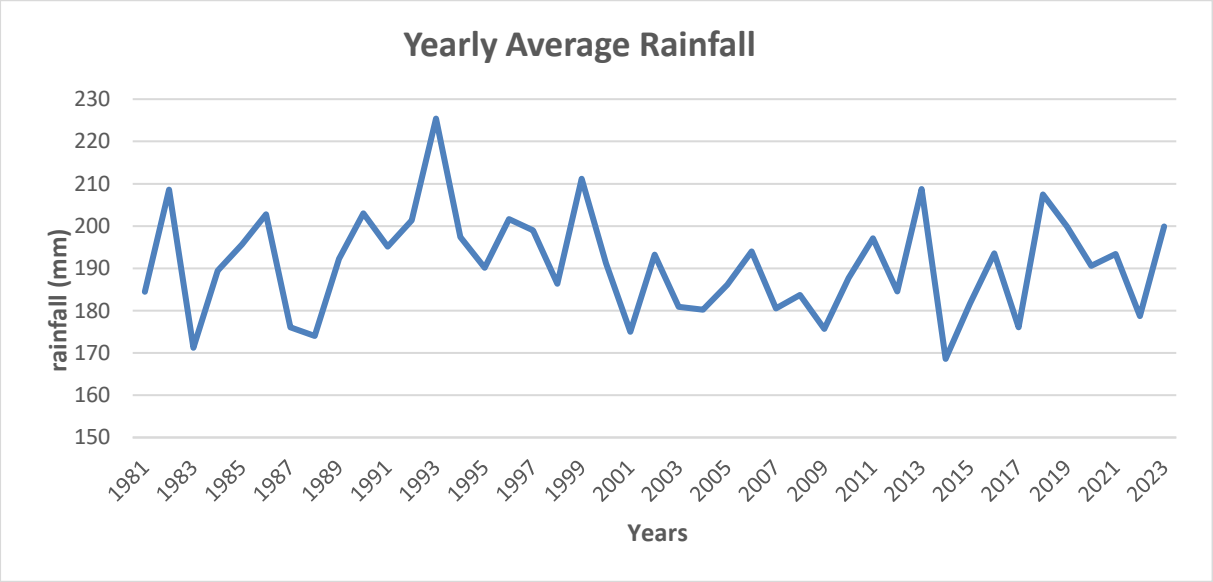

Figure 3: Yearly averagely rainfall of Fundong

Source: Fundong sub delegation of agriculture

3.2.1.1 The SPI Analysis of Rainfall in Fundong

The SPI (Standardized Precipitation Index) represents measurements of rainfall variability over time in Fundong. The early years (1984-1990) show fluctuations in SPI values, indicating variability in rainfall conditions. The early 1990s show slightly wetter conditions in some years, while between 1991-1999, notable spikes suggest periods of above-average rainfall, possibly leading to favorable conditions for agriculture. From 2000-2005, a more pronounced dip indicates potential drought conditions in some years, followed by peaks suggesting wet conditions. Between 2011-2013, sharp spikes and dips indicate extreme weather events or significant variability, such as floods or droughts affecting the area. In recent years (2014-2023), values exhibit continued variability, with some years showing both positive and negative anomalies. The relatively flat trend line indicates that while there's variability, there's no consistent long-term trend in either drying or wetting conditions. Figure 4 demonstrates significant annual fluctuations in rainfall, affecting water availability for cattle.

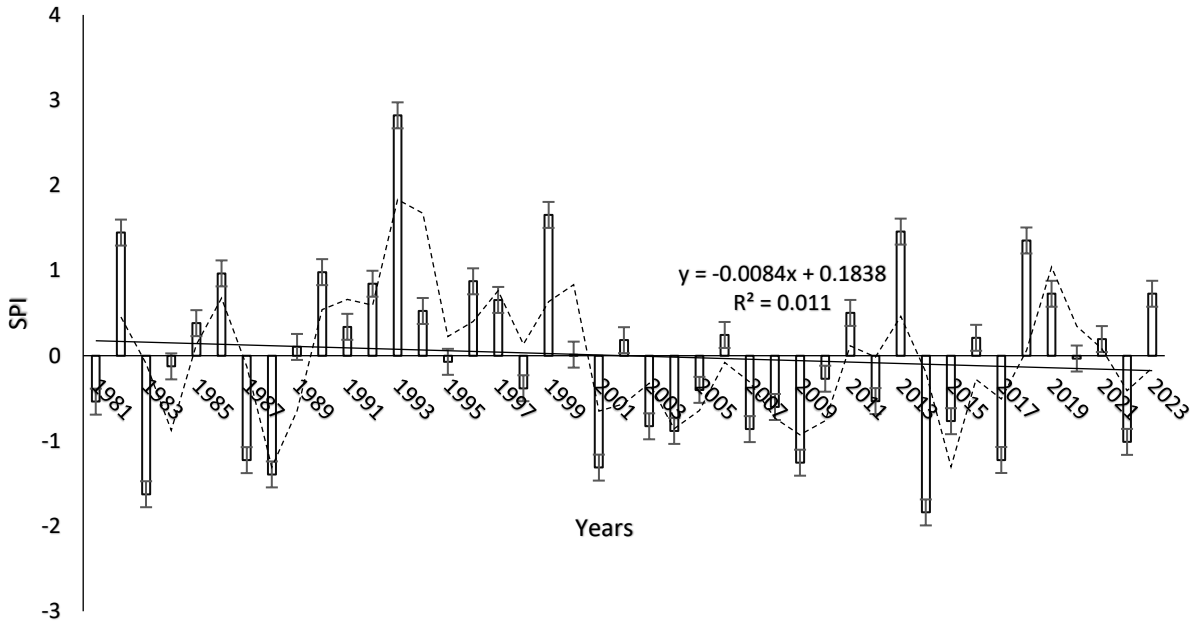

Figure 4: SPI analysis of rainfall pattern in Fundong

3.2.1.2 The Anomaly Rainfall Pattern of Fundong

In Fundong, the rainfall pattern has been deviating over specific periods. This is evident, especially in the years 1981-1990, where rainfall anomalies fluctuated, with fluctuations reaching negative -20mm in 1998, indicating mild deviations in certain years. A slight positive anomaly in 1991 indicates average or slightly above-average rainfall, supporting agriculture and cattle rearing. The rainfall pattern variability extended to 1993, reaching 30mm, with a

significant peak in positive anomaly, indicating exceptionally high rainfall in Fundong. This high rainfall contributed to abundant pasture for cattle. Between 1994-1999, anomalies varied, with both positive and negative values, reaching -5mm in 1995 and 20mm in 1999, illustrating a fluctuating pattern reflecting changing climatic influences, affecting water availability for farming and cattle rearing. This marked the beginning of severe climatic changes in the locality, as indicated by the rainfall pattern between 2000-2005, with exceptional cases of critically low rainfall, visualizing the continuity of climate change in Fundong. In 2001, the rainfall anomaly dropped to almost -20mm, leading to a drastic decrease in cattle rearing production.

Moving to 2013-2023, the anomaly rainfall pattern has continued to change. In conclusion, rainfall anomalies have been deviating and fluctuating, impacting the communities of Fundong, particularly in agriculture and cattle rearing, as pastures degrade. Figure 5 shows the anomaly rainfall pattern and deviation of Fundong.

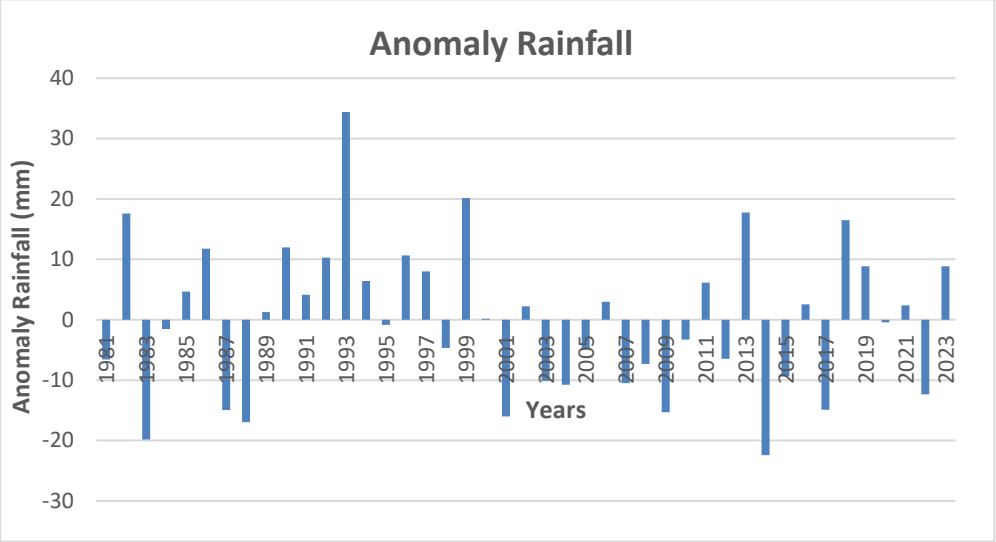

Figure 5: Rainfall Anomaly in Fundong

2.2.2 Temperature Variability in Fundong

Temperature, like rainfall, is an important climatic element in the study of climate variability. It refers to the degree to which an area is hot or cold at a particular point in time. Data for this study include the minimum and maximum temperatures of Fundong from 1981-2023, collected from the Sub-Divisional Delegation of Agriculture for Fundong.

2.2.1 Trends in Maximum Temperature in Fundong Sub-Division from 1981-2023

Maximum temperatures during the study period were collected and analyzed in Fundong. The analysis shows fluctuations in maximum temperature from 25.8°C to 33.6°C between 1981-2023. This analysis is presented in Figure 6.

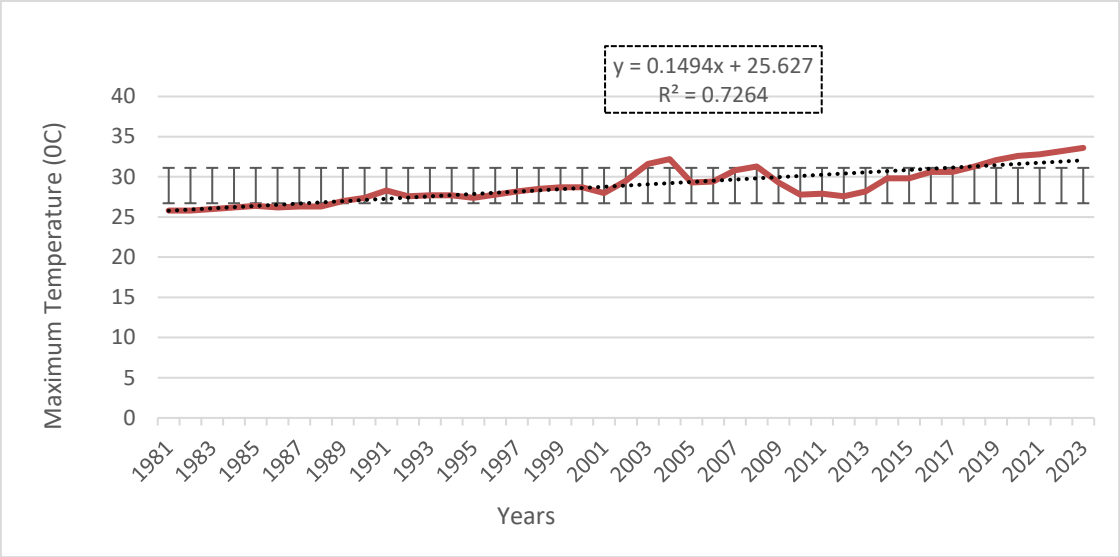

Figure 6: Maximum Temperature in Fundong Sub-division from 1981-2023

From Figure 6, the average maximum temperature (point of origin) over the study period is at 25.8^{0}C, and occurred in 1981 and 1982. On the figure, it is observed that there are four (4) outstanding maximum peaks of temperature which occurred in 2020 (32.6^{0}C), 2021 (33.8^{0}C), 2022 (33.2^{0}C) and 2023 (33.6^{0}C). On the other hand, the lowest maximal over the period of study occurred in 1981, 1982 (25.8^{0}C) and 1983 (26^{0}C). Figure 6 shows that the maximal temperature has been changing at a rate of 0.1494. The change in temperature have manifold effects on cattle production High temperatures directly cause elevated cattle body temperatures, leading to heat stress, which in turn suppresses appetite and reduces feed intake. This can decrease milk production and weight gain in cattle. Heat stress also impacts fertility, with decreased conception rates and potential reproductive issues (West, 2010). Additionally, high temperatures can increase water consumption, adding pressure on limited water resources in the region. Overall, these direct effects of heat stress on cattle production in Fundong result in lower productivity and economic losses for grazers.

2.2.2. Trends in Minimum Temperature in Fundong Sub-division from 1981-2023

Minimum temperatures under the period of study were observe and analyzed. The analysis indicates that, minimum temperatures have been fluctuating in the same way as maximum

temperatures. The data indicates that the lowest temperature in Fundong Sub-division over the study period ranged from 16.3^{0}C to 19.8^{0}C (Figure 7).

In Figure 7, the highest minimum temperatures in Fundong Sub-division were observed in 1991 (19.2^{0}C) while the lowest minimum temperature at 16.3^{0}C occurred in 1983. Over the period of study, average minimum temperature is observed at 17.2^{0}C (point of origin) as indicated in the regression line at y=0.0248x + 17.212 determined from Rs=0.1701. The changes in minimum temperatures in the study area has an influence on cattle production. For instance, low temperatures can impact cattle production significantly. Lower minimum temperatures may lead to colder conditions, affecting cattle health and feed intake. This can result in decreased weight gain and milk production. Ultimately, these temperature fluctuations can disrupt the overall well-being and productivity of cattle in Fundong.

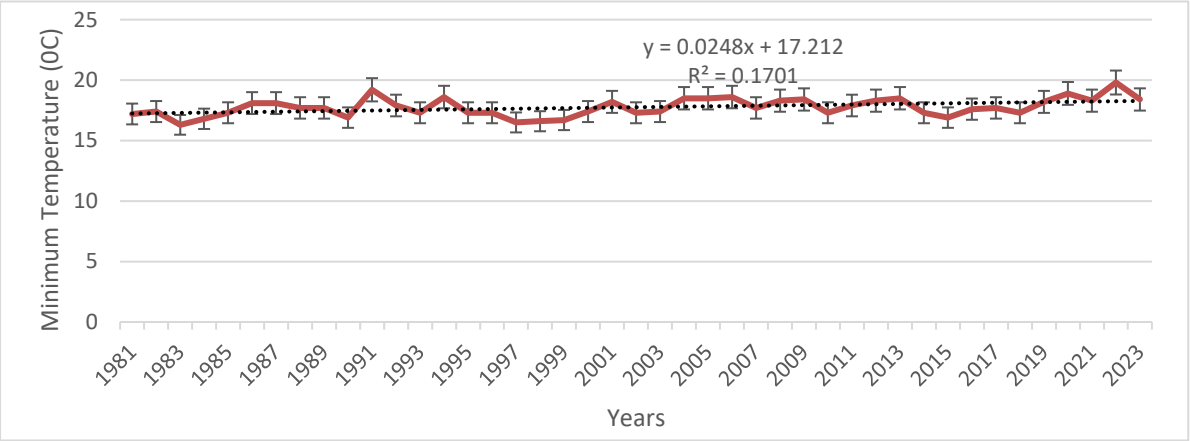

Figure 7: Minimum Temperature in Fundong Sub-division from 1981-2023

2.2.3 Trend Analysis of Mean-Annual Temperature in Fundong Sub-division (1981-2023)

The mean annual temperature for Fundong Sub-division was observed and analyzed. The mean annual temperature (MAT) was important in explaining the hottest and coldest years under the period of study. From observation, temperature variation in Fundong Sub-division is high, with some years outstanding above the line of regression (25^{0}C $_{+)}$ and some having MAT below the trend line of regression (Figure 8).

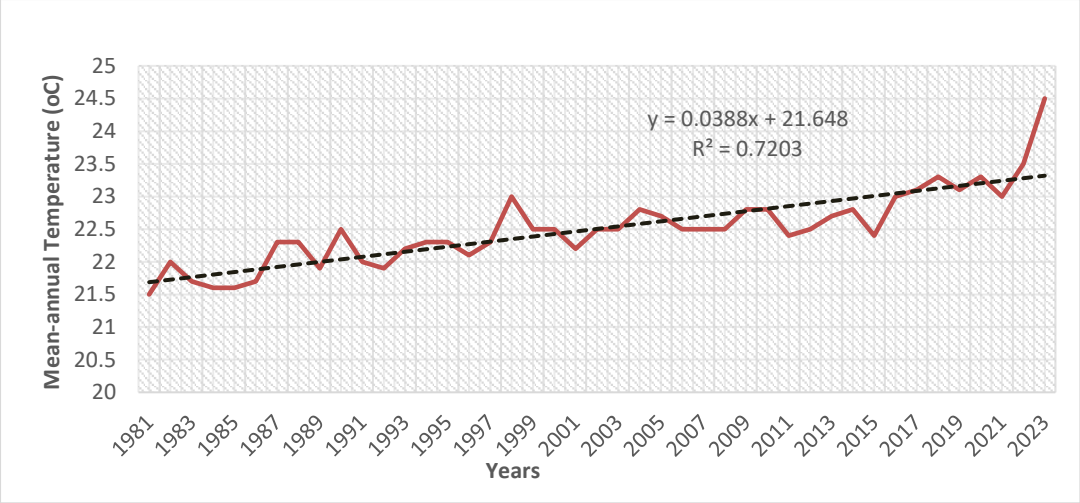

Figure 8: Mean-annual Temperature in Fundong Sub-division from 1981-2023

2.3 Effects of Change in Climate Parameters on Cattle Production

The impact of climate change on cattle production has become a critical concern in recent years, as shifting weather patterns and extreme environmental conditions directly influence various aspects of livestock and overall well-being of cattle population.

2.3.1 Changes in the Availability of Pasture for Cattle Grazing in Fundong

Climate change alters temperature and rainfall, which negatively impacts pasture growth and the nutritional value of forage, leading to cattle malnutrition and reduced weight gain from a lack of quality grazing land (Bashir et. al, 2024) Table 2, presents the responses indicating changes in the availability of pasture for cattle grazing in Fundong in recent years.

Table 2: Changes in the availability of pasture for cattle grazing in Fundong

CHANGES	Frequency	Percent
Yes, there has been a decline in available pasture	59	78.7
No, the availability of pasture has remained constant	7	9.3
I have observed an increase in available pasture	9	12.0
Total	75	100.0

Table 2, shows that 78.8% of respondents observe a decline in available pasture for cattle, a minority of 9.3% noted that the availability of pasture remained constant while 12.0% reported

an increase in available pasture for cattle grazing. Based on this data, it seems there is a significant concern about declining availability of pasture for cattle grazing in Fundong, which could have implications for the local cattle industry and ecosystems.

2.3.3 Health and productivity of the cattle in Fundong

Increasing temperatures can lead to heat stress in cattle that reduces feed intake, lower productivity, and can lead to heat related illnesses and deaths in extreme cases.

Table 3: Health and Productivity of the Cattle in Fundong

VARIABLES	Frequency	Percent (%)
Health and productivity have declined significantly	50	66.7
There has been minimal impact on health and productivity	20	26.7
Health has improved but productivity has decreased	5	6.7
Total	75	100

As seen in Table 3, the health and productivity among cattle reveals a concerning trend, with majority of respondents indicating a significant decline in both variables 66.7% suggests a declining health and productivity which have a far reaching implications. For instance, a smaller proportion of respondents 26.7% reported a minimal impact on the health and the productivity of the cattle while a minority of respondents 6.7% stated that while health has improved, productivity had decreased. This response highlights a situation where health outcomes have shown progress but productivity related factors are lagging behind.

Changes in precipitation patterns can led to water scarcity, affecting the availability of water for cattle. This can result in dehydration, reduced milk production, and overall poor health of the cattle. As shown in Figure 9, 64% of respondents assert that rainfall patterns indeed have a significant influence on cattle productivity, highlighting the pivotal role of inadequate rainfall in this domain. 24% of participants argue that there is no connection between rainfall patterns and cattle productivity while 12% of respondents believe that rainfall patterns do impact cattle productivity.

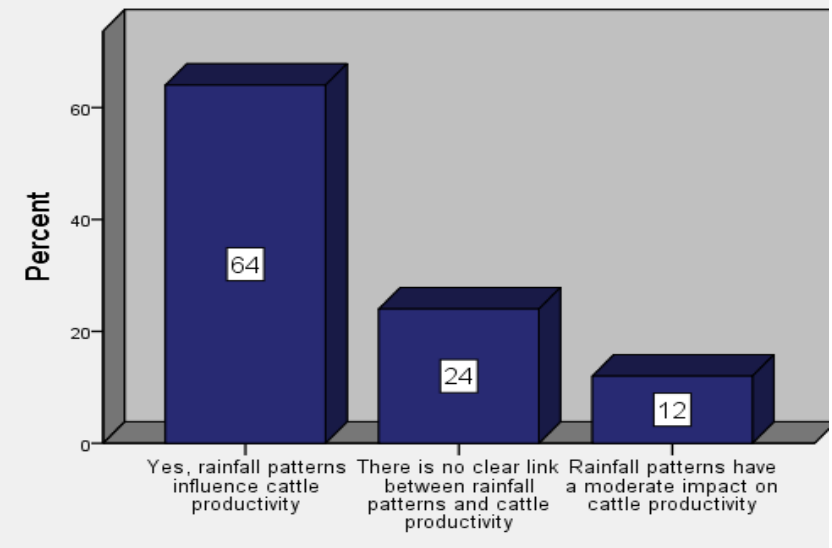

Figure 9: Relationship between rainfall patterns and cattle production

2.3.4. Adjustment of cattle feeding in relation to climate variations

The analyses of adjustments made in cattle feeding practices in response to climate variations reveals a mixed landscape (Figure 10).

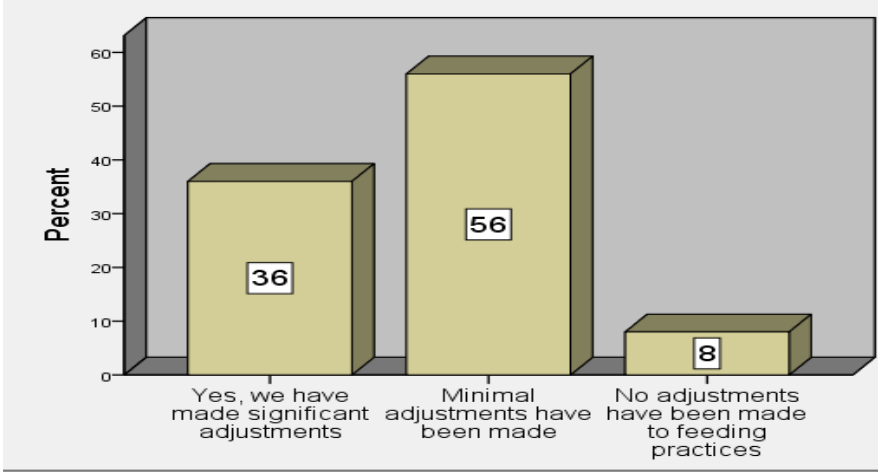

Figure 10: Adjustment of cattle feeding in relation to climate variations

From Figure 10, 36% of respondent have reported making significant adjustments, showcasing a proactive approach to aligning feeding practices with changing climatic conditions while 56% has made only minimal modifications. This suggests a potential gap between awareness and action in adapting feeding strategies were as 8% of respondents have made no adjustment at all.

2.3.5. Challenges Encountered in Relation to Cattle Production as a Result of Climate variability.

Climate variability can significantly impact cattle production in various ways, presenting challenges for pastoralists (Figure 11).

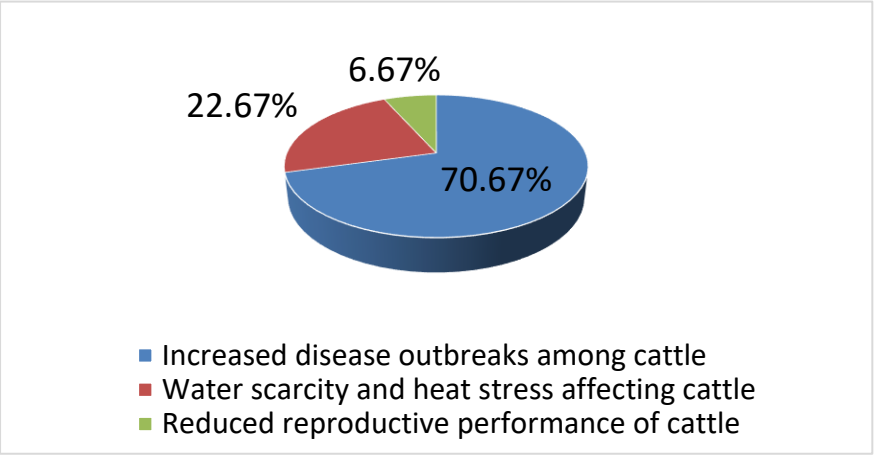

Figure 11: Challenges encountered in relation to cattle production as a result of climate variability

From Figure 11, a notable impact is the surge in disease outbreaks, affecting a substantial 70.67% of cattle populations. These fluctuations in climate can create environments conducive to the proliferation of pathogens, endangering the health and well-being of the animals. Also, the escalating issue of water scarcity and heat stress, affecting 22.67% of the livestock, intensifies the struggle for adequate resources to sustain the cattle. The scarcity of water coupled with rising temperatures not only leads to dehydration but also exacerbates heat stress, further compromising the animals' health. Furthermore, the reduced reproductive performance of 6.67% of cattle signifies a concerning trend that could hinder the long-term sustainability and productivity of cattle production systems.

Field results have equally revealed that there is a significant variation in the volume and the quantity of the water sources. 22.67% of the respondents perceived that the issue of water scarcity is affecting livestock. Some water sources have completely dried up while others have significantly reduced in their volumes. This drying up of water drinking points for cattle is one of the main reasons behind the practice of transhumance in Fundong as pastoralists are forced to move their cattle to the lower valley's marshy zones of Mbongkisu as these zones hardly experience water shortages during these harsh months of the year.

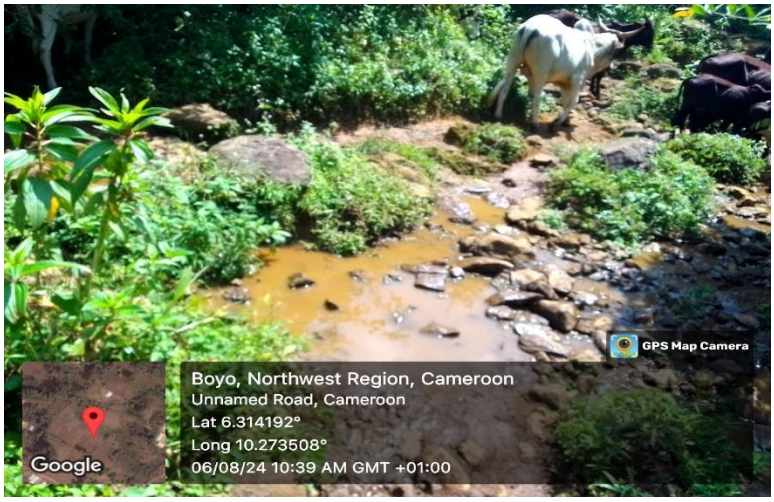

Photo 1: A stream in Fundong during the dry season

2.4 Discussion of findings

The discussion of findings reveals that temperature shows increasing trends, while rainfall amounts are fluctuating, resulting in the rangeland experiencing some ameliorated climatic conditions. These results are related to the work of the United Nations Development Program (2018) on climate change projection, which points out that the average annual temperature has increased by 0.7°C since 1960, and the average annual precipitation is dropping at 2.9mm each month since 1960. This result is also related to the report of FAO (2018) and IPCC (2016) in their assessment reports, where they point out that rainfall has been very unreliable in terms of onset, duration, and termination due to the present trend of climate change.

Climate variability has negatively affected cattle production in this area, leading to the degradation of its resources and thus reducing cattle growth, as well as productivity. Climate variability is the main cause of different ecological changes that we are experiencing, such as the invasion of unwanted plant species in this area, which is negatively affecting pastoral activities as well as their livelihoods. This result is in conformity with the findings of Seo and Mendelsohn (2006); *Doti, (2010),* who revealed that climate variability is a major environmental problem affecting mankind today at the global scale and severely in Cameroon. According to them, changes in climatic conditions and ecological systems have influenced the outbreak and distribution of cattle pests and diseases.

Conclusion

This study assessed the vulnerability of cattle production to climate variability in Fundong. Climate variability is seen as a major problem to pastoralists. Rising temperatures against a backdrop dropping rainfall has negative impacts on crop production systems and other sources of livelihoods. This however has made pastoralists vulnerable to the impacts of climate variability as pastures degrades, water volume in river courses reduces as some even dry up, and also trigger the outbreak of cattle diseases, and noxious invasion. To improve on the livestock rearing system in Fundong, pastoralists should work in synergy among themselves as well as with the institution put in place in managing this domain of activity. Associations like MBOSCUDA and LEFIDEP should carryout sensitization campaigns in order to educate the pastoralists on the modern ways of managing pastures and ecosystem sustainability. To reduce the effect of climate variability and change, pastoralist should incorporate different water harvesting and irrigation technologies with their local adaptation strategies

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