

## Impact of climate change on bean cultivation in Foubot, West region of Cameroon.

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### Abstract

Beans, a highly nutritious food, are ubiquitous in Africa as a significant food source of vegetable protein, despite the absence of certain sulfur amino acids. However, this plant faces challenges linked to climatic disturbances, notably excessive rainfall. In 2023, in the Foubot production basin in the west region of Cameroon, abundant rainfall amount was recorded, peaking in July with 282 mm and in September with 272 mm. These figures correspond to the beginning of the semi-month, just after the corn harvest. This overabundance of rain led to seed rot and leaf diseases. For four months, we conducted a study in four villages, observing and surveying 188 randomly selected farm managers. Our results indicate that farmers who sowed their beans early (60%) recorded yields of less than one tons per hectare, while those who sowed late (40%) achieved yields of 2 tons per hectare. July was the rainiest month on record, favoring plant diseases and pests. Above certain temperature thresholds (25 to 31°C), crop yields fell for the first farmers, as the accelerated plant growth process was accompanied by the production of rotten grains. Up to 70% of bean yields were lost due to early sowing, leading to a significant increase in the market price of this commodity, from 1,000 FCFA to 1,500 FCFA/kg depending on the variety.

**Keywords:** Climate, Bean, Food insecurity, West Cameroon

### Introduction

Cultivated in all regions of Cameroon according to adapted varieties, beans, depending on the agricultural calendar, require an average rainfall ranging from 500 to 1750 mm and a temperature between 20 and 37°C, spread over the cultivation period, with an ideal relative humidity of 30 to 60% (IRAD, 2016; Abdoulay Mfewou, et al., 2020). Favored for cultivation in September, after the cereal harvest, in the West region Cameroon, an important agricultural production basin, in particular the Foubot area with its rich volcanic soils, rich in organic matter and minerals, proves to be conducive to the cultivation of beans (red, white). Second only to groundnuts among legumes in urban market production, beans come in several varieties, including common, azuki, coco rose, pinto, and rice beans, as well as new improved varieties (NUV-109-2, NUA-99, PNN, BGG, DOR-701, Editor's note), with yields of up to three tons per hectare when rainfall is regular.

For classic varieties, yields can reach an average of 600 kg per hectare, or even double that. Highly prized by consumers in Africa's major cities for its nutritional value in terms of vegetable protein, the price of beans has doubled in the West

region of Cameroon, due to their scarcity on the market as a result of reduced yields caused by bean rots. On markets in the West region, a 15-liter bucket of beans will fetch between 6,000 and 9,000 F Cfa in 2022, and depending on the variety, the price will fluctuate between 15,000 and 18,000 F Cfa in 2023.

However, since 2023, rainfall cycles have become more variable and abnormal marked by flooding. These natural changes have disrupted the agricultural calendar, directly impacting crop yields throughout the rural world, and more particularly in West region of Cameroon, especially in Foubot, which is a major production basin for cereals and (gardening) legumes such as beans, cowpeas, soybeans and groundnuts. Beans, which are one of the main cash cereals after groundnuts, have been affected by rot and disease caused by the rains, resulting in rotten kernels and compromising the yields needed to achieve food self-sufficiency in plant proteins. Cameroon beans are widely exported to countries such as Congo, Gabon, and the Democratic Republic of Congo.

Diluvial rains have caused rots and diseases such as anthracnose, blight, and moniliosis (Allen, D. J., 1996; Chebil, A., et al., 2011), resulting in low yields due to

abundant rainfall anomalies (Caubel, J., 2012; Mbeugang, D. L., et al., 2017). The constant growth in consumer demand has led to a shortage of beans on the market, resulting in soaring prices that sometimes force consumers to turn to the consumption of cereals such as maize and rice. Climatic variability has also favored the appearance of pests such as aphids, mealybugs (Ntahimpera, N., et al., 1989; Mbikayi, N. T., et al., 1992), and mildew, weakening plants, damaging foliage and flowering, and compromising bean production. What is the impact of climate change on these crops and their changing environment? This study analyses the direct impact on food security for consumers, particularly as beans are important source of protein. The analysis also focuses on producers' strategies for adapting to climate shocks.

### Materials and methods

Over a four-month period, field surveys and observations were carried out in the Foubot production basin among 188 farmers randomly selected according to the following criteria: being a farmer growing cereals, beans, or both. The survey also covered the agricultural production system, the varieties used, the agricultural yield per hectare, and the surge in market prices. Data on the impact of soil fertility degradation and erosion caused by flooding were collected by the Institute of Research and Agricultural Development (IRAD). The climatic data used came from the institute of the climatic data, reflecting local variability in rainfall and temperature. These parameters influence production conditions, notably due to the increased frequency of abnormal rainfall recorded. Data on farmers' endogenous adaptation strategies in the face of climatic hazards were also collected.

### Presentation of the study area

In the West region of Cameroon, located at latitude 5°30'28" North and longitude 10°37'57" East, at an altitude of 1,054 meters above sea level, the commune of Foubot was administratively created on September 27, 1959. Nestled in the heart of naturally fertile volcanic soils, it constitutes a vast agricultural production basin. Mainly inhabited by farmers of diverse origins, the population of the commune of Foubot is growing at a rate of 2.6%. However, each village or community within the Foubot territory has its own specific history.

### Results and discussion

The beans (*Phaseolus vulgaris*), a member of the vast family of seed legumes, more precisely the Fabaceae family, thrives in both humid and Sahelian zones. Its growth cycle varies from 90 to 100 days, depending on climate and variety (Hamida Sabrina, B., 2022). The main production regions are in the west and north-west of Cameroon. In a production system, beans are generally grown after the harvest of cereals such as maize. The farming process begins with clearing the land, preparing the soil, plugging to a depth of 20 to 25 cm, forming ridges, and finally sowing 3 to 5 beans per stake. The major agricultural season in Foubot generally starts in mid-July and lasts until mid-December, with a period of intense harvesting starting in November.

Compared with 2022, 2023 is considered the rainiest year, spanning 9 months and 8 days, from February 12 to December 5, with an average of 13 millimeters of rain over a sliding period of 31 days. The wettest month in Foubot is September, with an average of 268 millimeters of rain and temperatures ranging from 18°C to 27°C. Heavy rains in September-October favored the proliferation of fungi on the beans and the presence of harmful parasites.

The earliest sunrise occurs at 06:02 on May 23, while the latest sunrise occurs 32 minutes later at 06:34 on February 3. The earliest sunset occurs at 17:58 on November 10, followed by the latest sunset 38 minutes later at 18:35 on July 16. The average hourly wind speed at Foubot shows a moderate seasonal variation throughout the year. The windiest period extends over 4 months and 1 day, from November 9 to March 12, with average speeds exceeding 7.6 kilometers per hour. January stands out as the windiest month of the year at Foubot, with an average hourly wind speed of 9.0 kilometers per hour. However, heavy rains in September, when the first bean plants began to flower in the fields of the first farmers who had sown in the first week of July, led to the appearance of foliar diseases and fungi, causing the bean seeds to rot. These conditions led to huge losses, in some cases of the order of 60% in yield, for farmers who started the crop season early in July.

**Table: Number of bean-growing farmers surveyed**

	≤ 1ha	2ha	3ha	4ha	≥ 5ha	Total (%)
<b>Doubaine Village</b>	7,97	19,46	6,46	1,59	0,532	24,46
<b>Village Fousset</b>	6,91	14,46	8,46	2,65	1,06	23,40
<b>Pamassier Village</b>	13,29	11,46	3,46	1,06	0,53	23,40
<b>Baïgom Village</b>	15,95	13,46	2,46	2,13	1,59	28,72
<b>Total (%)</b>	<b>44,13</b>	<b>60,46</b>	<b>22,46</b>	<b>7,45</b>	<b>3,72</b>	<b>100</b>

**Source:** survey of 188 farm managers in the villages studied

The data in this table show that 44% of farmers cultivate areas of less than or equal to one hectare, while 60% work on farms of 2 hectares dedicated to bean cultivation. This distribution in terms of cultivated hectares varies according to land acquisition and available financial resources. Only a few farmers (3.72%) farm more than 5 hectares. Regular adherence to the farming calendar, in line with the technical data sheet, often enables farmers to achieve the highest yields per hectare.

However, early sowing in July, combined with heavy rains extending into September 2023, had a direct impact on yields, resulting in a reduction of around 1 tons per hectare, compared with the 2-3 tons per hectare obtained in 2022. Harvested bean seeds have a relatively lower marketable quality in 2023 for farmers who started sowing just after the maize harvest in July. Indeed, those who opted for late sowing in early September achieved optimum yields, averaging 3 tons per hectare, with better quality beans produced for the market.

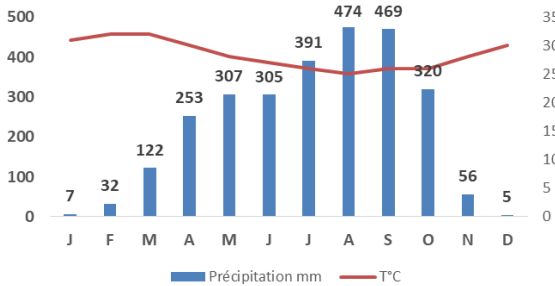


Figure 1: Data collected over a 30-year period

In this climate table, data collected over a 30-year period have been used as the basis for calculating a monthly average. Although significant variations can occur from one year to the next, this climate table provides an overall view of weather conditions in Foubot for each month. During these periods, warmth predominates, with almost no precipitation. In February, the average temperature peaks at 32°C, while in August it reaches a low of 25°C.

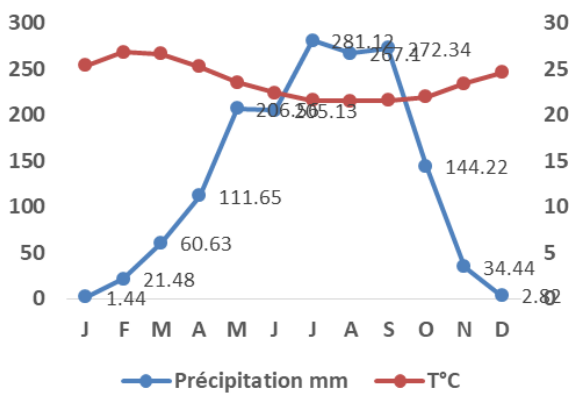


Figure 2: Data collected over a period in 2023

This figure shows average monthly precipitation and temperatures, both day and night, in Foubot. It also provides an overview of average annual precipitation (rainfall) and the number of rainy days per month in Foubot. Rainfall peaked at 281.12 mm in July, and continued until September, resulting in flooding that has a direct impact on crops and housing. In both figures (1 and 2), the rainy season is characterized by dense, cloudy weather, while the dry season is partly cloudy. The climate remains warm throughout the year. The average temperature generally fluctuates between 15°C and 29°C, rarely below 13°C or above 31°C throughout the year.

**Varieties of beans grown in Foubot, west region of Cameroon**

Plants of the *Vigna* genus, belonging to the Fabaceae family, include various varieties such as the azuki bean (*Vigna angularis*), also known as the "kidney bean". There's also the rice bean (*Vigna umbellata*), also red, which is medium-sized and ranges in hue from pink to dark red. The coco rose, or borlotti bean is brown with dark red veins. Other varieties include the pinto bean, closely related to the kidney bean, and the white bean, of maximum size and bright white color.



Common kidney bean



Azuki bean (*Vigna angularis*)



Pink coco bean



Common pinto bean

Traditional bean varieties give average yields of 870 kilograms per hectare, while new varieties (NUV-109-2, NUA-99, PNN, BGG, DOR-701, NDLR) can give yields of up to three tons per hectare (IRAD, 2016).

**Climate change and its impact on bean production**

The impact of climate change on bean production is manifold. It is important to note that the presence of humidity leads to a phenomenon known as 'bean grease', which is particularly harmful to young plants. This excessive humidity is also responsible for various diseases such as fungus, rot, and mosaic.



bean grease, rot, rust...

The months of September and October, marked by intense rainfall measured at least 1 millimeter, see an accumulation of water. The probability of rainy days in Foubot varied considerably over the course of 2023. The wettest season spans 7 months and 5 days, from March 21 to November 6, with a daily probability of precipitation exceeding 46%. September holds the record for the highest number of rainy days in Foubot, with an average of 26.6 days showing at least 1 millimeter of precipitation. The driest season covers 4.5 months, from November 6 to March 21, 2022. According to this ranking, the most frequent form of precipitation during the year is exclusively rain, with a probability reaching 89% on October 2. During this period, temperatures generally range from 15°C to 29°C, rarely dipping below 13°C or rising above 31°C.

The high rainfall recorded in Foubot this year in 2023, combined with the flooding observed in the region, has favored the proliferation of the main parasitic insects, such as aphids. These small insects, black or green in color, sting plant tissues to suck sap. They are generally found in groups on new shoots and under leaves (IRAD, 2021). These insects weaken bean plants, causing leaf deformation on young shoots. In addition, they secrete a sweet substance called honeydew, which is conducive to the development of fumagine, a blackish fungus that covers the leaf surface and limits photosynthesis (IRAD, 2021). In the villages studied, intense humidity conditions also favored the presence of mealy bugs, small stinging-sucking insects that attach themselves firmly to plants to feed on their sap.

#### Climate change and environmental change in agriculture

Heavy rains between July and September 2023 in the Foubot production basin led to soil erosion and degradation. This erosion is the main cause of degradation, leading directly to the loss of essential soil qualities needed for their natural water and nutrient storage functions. This process of soil degradation manifests itself in uprooting, transport, and sedimentation, impacting soil fertility and reducing bean crop yields. In neighboring areas, heavy rains have led to flooding, forcing farmers to occupy the slopes and creating land tensions between the various stakeholders. These impacts of climate change are also having an effect on people and farm capital, increasing farmers' vulnerability. Falling yields are weakening the agricultural market economy, impacting all players in the sector. This decline has led to a rise in bean prices, averaging between 1,000 and 1,500 FCFA per kilogram, depending on the variety.

#### Farmers' adaptation and endogenous strategies

Farmers have responded to the challenges by adopting more adapted farming practices. The mobility of farmers towards the slopes and the return to traditional varieties are evidence of this adaptation. They are now opting for hardier, disease-resistant seeds. Farmers are implementing efficient cultivation practices, notably the creation of high ridges, regular adherence to the cropping calendar, and the use of fertilizing inputs.

### Conclusion

In Foubot, the increase and intensification of extreme weather events linked to climate change, particularly between July and September with intense rainfall, have severely disrupted bean production for a large proportion of the farming population. These farmers planted their beans at the beginning of July, just after the maize harvest. The torrential rains recorded during this period in 2023 had a direct impact on bean yields. This low yield had serious consequences for farmers' lives, forcing them to adapt by resorting to endogenous strategies, such as the use of traditional seeds and the practice of agricultural mobility on the slopes.

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