Variations in Rainfall and Food Insecurity in the Sahel Region: The Case of the Far North Region of Cameroon, 1985-2009

Of Cameroon's ten regions, the Far North Region which is entirely located in the Sahel is the most affected by food insecurity. Factors such as locust attack on crops, grain loss to grain-consuming birds, and crop destruction by flocks of elephants have been advanced as some of the causes of the recurrent food crises in this region and the whole of the Sahel (Abdourahmane et al 2002). Even though many factors may be responsible for this frequent food insecurity, unreliable rainfall characterized by recurrent droughts is the key. For example in 2000, the sudden end of the rainy season was accompanied by a deficit of 160000 tons of cereals, representing a 50% reduction in yields. In 1998, the significant drop in food production was largely attributed to the droughts that affected Sahel region (Wamba et al, 2002). The questions that this study seeks to answer are:- 1)**What are the effects of variations in precipitation on food security in the Far North Region of Cameroon and by extension the whole of the Sahel?** 2) **How do household characteristics such as the sex and age of the household head, the household size, the number of household members employed in agriculture, the use of farm inputs, possession of farmland, etc modify the effects of rainfall variables on food insecurity in this region?** To answer these questions, this study uses rainfall statistics collected in the region, statistics collected during Cameroon Household Surveys and agricultural statistics to establish the relationship between variations in household food security as a result of variations in rainfall in the presence of other variables such as characteristics of the household head, characteristics of the household and access to agricultural innovations.

Data and Methods

1.1 Presentation of the Study Area

The area for this study is the far North Region of Cameroon. It covers the whole of the Sahel region of Cameroon and extends from latitudes 10 degrees to 13 degrees north and from longitudes 13”15 to 15”50 covering a surface area of 34262km2. According to the last General Population and Housing Census of Cameroon carried out in 2005, this region had 3,111,792 inhabitants, therefore being Cameroon's most populated region. It is equally the poorest region with 55.5% of the population living in poor households in 2007. 86.5% of the population of this region are farmers who depend almost entirely on rain-fed agriculture and 39.9% own cattle that are reared extensively (MINEPAT et PNUD, (2001) ; INS (2007)

1.2 Data

This study uses statistics on the production of cereals and tubers from agricultural posts, rainfall statistics from meteorological stations in the area and information collected during the Cameroon House Surveys of 2001 and 2007 by the National Institute for Statistics.

1.3 Methods

1.3.1 Measurement of Annual Abnormities in Rainfall

In order to bring out inter-annual variations in total precipitation, the following is used:

$$Y_i = \frac{X_i - \bar{X}}{\sigma}$$

Where
- Y_i= reduced standard variation or a year's standard variation I;
- X_i= Total Rainfall for given year i ;
- $\bar{X}$= mean annual ranfall i;
- σ = standard deviation of annual rainfall

In order to better understand inter-annual variations, we eliminate minute variations and only work with noticeable variations by using the following formula:

$$X'_i = 0{,}06X_{i-2} + 0{,}25X_{i-1} + 0{,}38X_i + 0{,}25X_{i+1} + 0{,}06X_{i+2}$$

Où
- X_{i-2} = total rainfall of the second before the year i
- X_{i-1} = total rainfall of the first year before year i
- X_i = total rainfall of year i;
- X_{i+1} = total rainfall of the first year after year I
- X_{i+2} = total rainfall of the second year after year i
- X'_i = centralised or weighted index for a year i.

The indices for the two first terms of the series and the last two terms are calculated as follows:

$$\begin{cases} X_1 = 0{,}54X_1 + 0{,}46X_2 \\ X_2 = 0{,}25X_1 + 0{,}5X_2 + 0{,}25X_3 \\ X_{n-1} = 0{,}25X_{n-2} + 0{,}50X_{n-1} = 0{,}25X_n \\ X_{n-2} = 0{,}54X_n + 0{,}46X_{n-1} \end{cases}$$

This filter was used by Assani (1999) in a study of rainfall variations in Lubumbashi. This method is useful for the measurement of annual rainfall abnormalities.

2.3.2 Classification of Daily Rainfall

Up to today, the classification established by Carbonnel in 1983 to characterize daily rainfall in Central and West Africa is the mostly commonly used. It has been used by authors working in these regions. This classification uses three categories of daily rainfall patterns:

- P_1 = daily rainfall of below 20mm ;
- P_{20}= Daily rainfall of between 20 and 50mm ;
- P_{50}= Daily rainfall greater than 50mm.

The contribution of each of these daily rainfall categories is calculated for accumulated monthly rainfall of P50 or more.

2.3.3 Determination of Dates for the Unset and End of Rainfall and the Lengths of the Rainy Season

The dates of the start and the end of the rainy are determined using two criteria:-the climatic and agronomic criteria.

Date for the Start and End of the Rainy Season According to the Climatic Criteria

According to this criterion, the rainy season starts with the first rains of the year and ends with the last.

Dates for the Start and the End of the Rainy Season according the Agronomic Criterion

According to the agronomic criterion, the rainy season starts when rainfall reaches 20mm in three days after the first of May. This start is effective when there is no dry episode of more than seven days in a month. This is to avoid any false start of the rainy. Then end of this season is the 20^{th} Day without rainy after September Ist (Maud Balme et al, 2005). This technique enables us to determine the late start and early stop of rainfall.

Length of Rainy Seasons

The length of the rainy season is the period between the start of the rainy season and its end in a year.

2.3.4 Measurement of Risks of Food Insecurity

In order to meet the objective of our study, the risk of food insecurity is examined at two levels:-regional and household levels

Regional Level

The linear relation between the food needs met and each rainfall variable (mean daily rainfall, the contribution of daily rainfall greater or equal to 50mm (P50), the length of the pre-rainy season and the length of the agronomic rainy season). This linear relationship is described by the equation**:**

$$Y = \beta 0 + \beta_1 X_1 + \varepsilon$$

This equation seeks to show the linear relationship that exists between rainfall variables X1, X2…Xn and the rate of expected food production met Y

- Y = rate of food(cereal) need met ;
- $\beta_0, \beta_1 \ldots\beta_n$ are parameters of the model ; The represent the increase in the average value of the dependent variable Y when the *jth independent variable is increased by a unit while other variables remain unchanged.*
- $X_1 \quad X_2, \ldots X_k$ are independent variables, rainfall parameters which are the number of rainy days, daily mean rainfall amounts, the contribution of P50, the length of the pre-season and the length of the agronomic rainy season
- ε = the random error when (E (ε)=0) and the variance is equal to a constant σ^2 (var (ε)=σ^2).

Due to the existence of multiple independent variables both the multiple regression and simple regression model are used.

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Household Level

To measure the exposure of households to food insecurity, the study considers the total cereal production of households, the equivalent of tuber production, household savings and other household goods. Households that suffer from food insecurity are those whose cereal and other agricultural productions for the year under consideration, that of the previous year, savings and income from secondary activities cannot enable them to meet their food needs.

This level of analysis leads to the examination of the associations that exists between annual rainfall variations and the risk of household food insecurity controlled by explanatory variables. This is done through the examination of the Chi Square « $\chi2$ » statistic. This statistic only measures the existence of an association but do not measure the force of this association. [1] NB *(The annual food needs for an individual is estimated at 190 kg with a corrective coefficient for children and the elderly)*

Summary of Findings

This study reveals the following:

-A reduction in total annual rainfall leads to an increase in food insecurity (1986-2002). At a 5% significant level, a milliliter increase in annual rainfall leads to 0.01% reduction in food insecurity;

-There is a stronger relationship between the average number of days of rainfall in a year and the total annual rainfall amount. At 5% significant level an average increase of one milliliter of rainfall after 15mm per day leads to 2.05% reduction in food insecurity;

As the number of days with rainfall of more than 50mm in a year increases, food insecurity increases. A one day increase in the number of days with rainfall of more than 50mm leads to 0.57% in food insecurity;

There is little variation between the length of the rainy according to the agronomic criterion and food insecurity. When the period of the agronomic rainy season increases by a day, food insecurity reduces by only 0.02%.The highest coverage of food needs occurs when the agronomic period of rainfall stretches from 100-150days;

-The higher the length of the dry season, the higher the risk of food insecurity. A unit’s increase in the length of the dry season leads to an increase of 0.63% in the risk of food insecurity;

-Apart from rainfall variables, household characteristics such as the sex and age of the household, the household size, the number of household members employed in food production, the possession of land, use of farming equipment, use of innovative farming methods and farm inputs and the sale of part of the farm products also affect food the degree of food insecurity in this region. During years of droughts many households with surplus food production fall into food insecurity.

Brief Conclusion

For many years, the population of this region has been suffering from food insecurity as result of climatic hazards such as abrupt ends to the rainy season, droughts, poor rainfall distribution, unexpected intense rainfall, etc. This population needs assistance in terms of inputs, adapted seeds, farm equipment in order to produce more food in this increasing hostile environment.