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## Characterisation of the agro-meteorological systems of family agriculture in Cameroon

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### Abstract

The study of variability in the agro-meteorological system of family agriculture in Cameroon is a gesture towards an understanding and a better management of rainfall in order to improve on agricultural output. The study rainfall data and temperature in different climatic zones reveal that some key processes and significant contrasts manifest in space management and their levels of productivity. Analysis and the determination of other hydroclimatic parameters allows for an evaluation of the extent of climatic variability in the agricultural zones of Cameroon that are already weakened by poverty, malnutrition, malnourishment and food insecurity.

**Keywords:** Variability, system, agro, meteorology, family agriculture

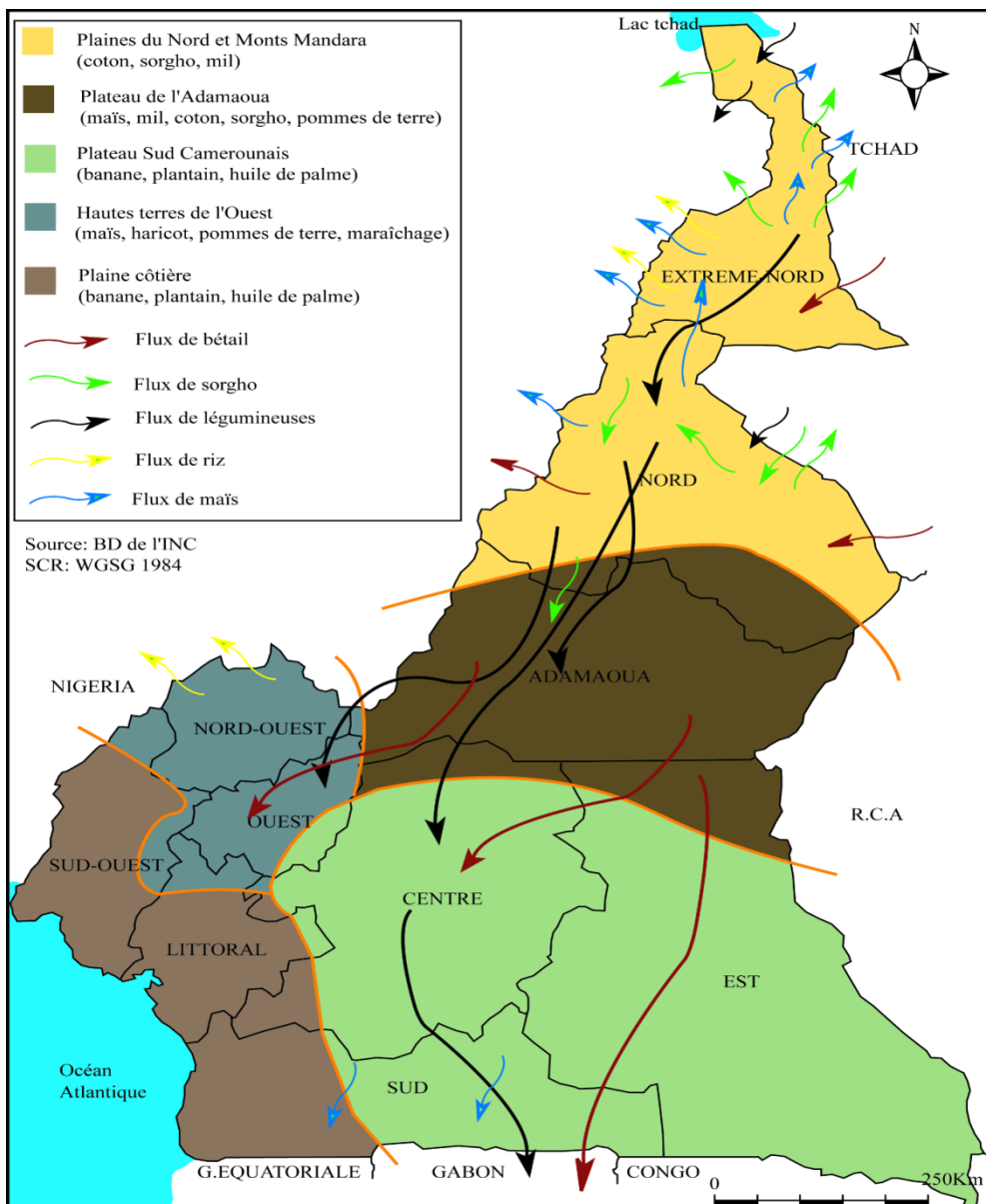
### Introduction

Family agriculture is an exploitation system of urban and rural areas for crop and animal production using modern and traditional methods and basically family labour with the prime objective being to ameliorate living conditions of families. Today, it occupies an important place in developing countries generally and in Cameroon especially. Arable land in Cameroon is estimated at 7.2 million hectares, but only 1.8 million hectares are actually cultivated (Anonymous; 2011). Agriculture is the sector that consumes 70% of worlds' water (Mokrani A.; 2013). The resulting rainfall uncertainty exposes rain fed agriculture to several problems such as reduction in output, the withdrawal of crops not adapted to the new rainfall system, discrepancy between peasant agricultural calendar and rainfall status, loss of seeds (Diomande et al., 2013). As concerns animal production, we observe the exploitation of small species besides unused houses in the urban area and close to inhabited houses in the rural areas and at time animals cohabit with people. Production at times does not satisfy the total annual needs. The populations thus turn to neighbours, the government and international organs. Several hindrances block the exploitation of this agriculture (ageing of agriculture, absence of modern agricultural equipment low integration of new farmers, absence of harmonized agricultural production policies). These hindrances are linked to limited expertise and financial means, less effective operational techniques, as well as a poor study of climatic variability that reduces output of populations already hit by food insecurity with 80% of the population being exposed food insecurity (Zanga A., 2012) and a very low standard of living.

### Materials and Methods

#### Study area

Cameroon is subject to a climatic diversity from the equatorial to the Sahelian (Sighomnou D., 2004). The study area concerns the five agro ecological zones of Cameroon situated between 1°40' and 13°05'N and 8°30' and 16°104E. The Cameroonian climate is characterised by a major diversity resulting from the influence of the sea, relief and the latitudinal expansion of its territory (MINEF, 1995). The different ecological zones (Figure 1) of Cameroon are: The northern plains and the Mandara Mountains, the Adamawa plateau, the south Cameroon plateau, the coastal plain, the western highlands.



**Fig 1:** Agro ecological zones and movements of agricultural products in Cameroon

Zone I or the Sudano-Sahelian zone is made up of the North and Far North Regions characterised by the tropical climate of the Sahelian type. Vegetation here is made up of savannah and steppes. This is a zone marked by low rainfall with the predominant activity being agriculture, rearing and tourism in natural parks. There is the intensive rain fed agriculture on the Mandara Mountains. In the modern agricultural production units, there is the co-existence of rain fed and irrigated agriculture. Beyond these areas described above, rain fed extensive agriculture is practiced. To the south of zone I is found zone II or the tall guinea savannah zone, which is found in the Adamawa region. This is a climatic transitional zone (tropical and equatorial climate). Zone II is influenced by a subtropical or Sudano-Sahelian climate. This region is characterised by savannah vegetation to the North and degraded forest south of the plateau. This is a zone characterised by average rainfall with dry and rainy seasons of almost the same duration. Agricultural activities and rearing are very important.

To the south of zone II, is found zone V or the bimodal humid forest zone that covers the Centre Region, the East and the continental portion of the South Region. This zone

is made up of degraded forest vegetation to the north of the plateau and a dense forest to the south. The climate here is that of the continental equatorial or the equatorial climate of the Guinea type. Precipitation is abundant with major remarkable rainy and dry seasons. Erosion is very pronounced in this milieu. A month can never pass by without rain falling. The predominant type of agriculture is the extensive slash and burn.

The unfair competition between perennial and cash crops greatly threaten food security that is precarious in some localities of the zone. To the west of the South Cameroon plateau is found zone IV or the humid forest zone with mono-modal rainfall. It is situated along the banks of the Atlantic Ocean and covers the Littoral Region, the coastal portion of the South and the South West Regions. It has an evergreen forest not only due to its proximity to the sea but also due to its abundant rainfall. The equatorial maritime climate is the type found here. Agriculture is carried out by big agro industrial enterprises such as CDC (Cameroon Development Corporation), PAMOL, SOCAPALM.

Small cultivators also develop small farms. This type of agriculture is destined for local consumption or for self sufficiency. However, rain fed slash and burn type of

agriculture is the most practiced here. To the North and North East of the coastal plain, is found zone III or Western High Plateaus made up of the West and North West Regions. It is a zone whose vegetation is made of degraded forest and rainfall is average. The zone is influenced by the mountain equatorial climate or the equatorial climate of the Cameroonian type. The population of the zone is mainly made of farmers who carry out rain fed extensive agriculture.

**Data treatment**

This work is based on temperature and precipitation data collected from the National Meteorological office of Cameroon. Missing data was completed using the Thiessen method. The collected data was regrouped according to climatic zones. Within the zone, several meteorological stations were chosen. Monthly data for the period of study (1971-2008) was first of all added and the sum was divided by the number of years in such a way have an average year of the station. Finally, the monthly data for all the stations were added and divided by the number of stations. Modulating these data permitted us to obtain the average year of the zone and to calculate other agr-meteorological parameters.

The procedure was to identify, qualify and present evolution of the parameters and hydro climatic factors so as to characterise the variability of the agro-meteorological systems in Cameroon. Some hydro climatic parameters such as potential evapotranspiration, which is the maximum quantity of water that can be evaporated under a given climate by a continuous and well watered vegetation cover, were needed. It is made up of evaporation from the ground and transpiration during a given period of time. This evapotranspiration is calculated in two ways: partly using

$$ETP(mm) = 16 \left[ \frac{10T}{I} \right]^\alpha \times F(\lambda)$$

the formula and  $5^0LN$  and the formula  $ETP (mm) = 270e^{0.0644T}$  between 5 and  $13^0LN$ , in the other hand; Relative humidity of the air (a) and water vapour contained in the air.  $at (\%) = \frac{P-ETP}{ETP}$ . The rainfall balance (RB) shows the conservation between

some two dates, of the quantity of water present or accumulated in the ground-plants-atmosphere system. This water is distributed between water stored in the ground and the plants partly and the flux entering and exiting from this reservoir on the other part  $RB (mm) = P-ETP$ . This study covers the period from 1971 to 2008.

**Results and Discussion**

**Analysis of meteorological elements**

**Precipitation**

Cameroon has five major climatic zones: the Sahelien type tropical climate that covers the Sudano-Sahelien zone, the subtropical climate found in the zone of the tall guinea savannah. The continental equatorial or the Guinea type equatorial climate found over the bimodal rainfall humid forest, the equatorial maritime climate over the mono modal rainfall humid forest and finally the high mountain equatorial climate or the Cameroonian equatorial type of climate on the western high plateaus. The monthly rainfall in the different zones is low and is bellow 100mm in all the regions from December to February. The annual rainfall volume is 923.35mm in the North and Far North Regions (Table 1).

The coastal plain is the rainiest zone of Cameroon with an average rainfall of 4163.7mm/year. The month of August is the rainiest with average precipitation of 831.3mm. The month of December registers the driest. It registers an average rainfall of 22.7mm.

The south Cameroon plateau registers an average rainfall of 2456.8mm per year and the western high lands register 3080.5mm. They appear as regions with average rainfall. There is always an incidence of rainfall every month. However, the months of November and February are considered as dry months with the volume of rainfall hardly going beyond 100mm.

These different rainfalls observed bare on the availability of water in the territory. This variability in rainfall in low altitudes can thus influence climate variability through a reduction in energy balance (Bigot S., 2004) that gives rise to the need to analyse evolution in temperatures.

**Table 1:** Distribution of rainfall in Cameroon

Period	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Z.S.S.	0	0	1,7	30,8	91,9	129,7	202,4	242,1	172,7	50,7	1,8	0
Z.H.S.G.	0,7	0,8	32,6	145,5	193,5	221,2	269,5	285,5	235,9	121,9	78	0,4
Z.F.H.P.B/	34,3	70,5	201,9	260,6	292,4	242,4	139,0	194,2	365,1	437,8	178,9	40,0
Z.F.H.P. M.	26,5	51,7	178,6	280,2	335,8	481,1	812,8	831,3	583,4	426,4	133,5	22,7
H.P.O.	17,8	43,0	180,6	253,1	268,4	362,3	453,2	502,2	557,7	359,8	67,4	15,2

Zone I: Soudano Sahelien zone  
Tall guinea savannah zone

Zone II :

Zone V: the bimodal humid forest zone IV: the humid forest zone with mono-modal rainfall Zone III: Western high plateau

**Temperature**

Northern plains and the Mandara Mountains are found in the sahelien area of Cameroon. Its location and the continentality of this region cause it to suffer the highest exposure level of Cameroon. The highest temperature at times reaches the maximum of 33°C and the lowest of 25.4°C (Table II). The thermal amplitude is very high and

as high as 7.6°C. Diurnal temperatures are very high while night temperatures are quite low.

On the contrary, the Western Highlands register the lowest temperatures of due to the altitudinal effects. It varies between 19.6 and 22.2°C. The annual average temperature is 20.6°C. The annual thermal amplitude is low and is found around 2.07°C.

Unlike for precipitation, the coastal plains and the South Cameroon plateau have average temperatures found around 25°C. The thermal amplitude along the coasts is 1.5°C while it is 2.3°C around the South Cameroon plateau.

**Table 2:** Distribution of temperature in Cameroon

Period	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
P. N.M.M.	25,4	28,1	31,6	33	30,8	28,6	26,9	26,3	26,9	28,3	27,7	25,7
P.A.	20,7	22,4	24,2	24,1	22,9	22	21,4	21,5	21,6	22	21,3	20,6
P.S.C	24,6	25,6	25,6	25,3	24,8	24,2	23,3	23,3	23,8	24,0	24,3	24,2
P.C	24,0	24,8	24,8	24,5	24,3	23,8	23,3	23,3	23,4	23,5	23,9	23,9
H.T.O.	20,4	21,5	22,2	21,7	21,2	20,4	19,6	19,6	19,9	20,3	20,5	20,2

### Evapotranspiration and air moisture in Cameroon

The meteorological situation in Cameroon is expressed by intense evapotranspiration in the Northern part of Cameroon. It is evaluated at 1669.53 mm of water per year (Table III). The atmosphere is filled with water vapour resulting from high evaporation accounted for by poor vegetation cover made up of steppes and savannah. This exposes streams to dryness. These are deficit zones as they receive less precipitation and send out much water vapour into the atmosphere.

On the contrary, the South Cameroon plateau and the coastal plains are zones where evaporation is not intense since there is found dense forest vegetation that protects the soil and streams against exposure to sunlight thus reducing the evaporation of water into the atmosphere. It is for this reason that these zones are considered as surplus because they receive more rainfall and release less water into the atmosphere.

The Western high plateau represents equilibrium between rainfall and evaporation. Altitude reduces temperatures.

The presence of mountains increases rainfall on the slopes exposed to winds from the Atlantic Ocean. Coastal areas facing these winds receive less rainfall. Different altitudes in certain localities create climatic uncertainties. This ties with the idea of Suchel (1972, 1987) according to which the climate of Cameroon varies over short distances. This regional climatic contrasts lead to the appearance of intra zonal differences. This is due to local factors that lead to localised rainfall since the climate of Cameroon even varies over short distances.

**Table 3:** of evapotranspiration and air moisture

Meteorological elements	Evapotranspiration (mm)	Atmospheric humidity (%)
P. N.M.M.	1669,53	- 0,44
P.A.	1117,76	0,35
P.S.C	911,9	1,69
P.C	865,77	3,81
H.T.O.	1020,08	2,02

**Tableau 4:** Synthesis of the meteorological situation of Cameroon.

Meteorological element	Annual precipitation (mm)	Temperatures (°C)	ETP (mm)	Atmospheric humidity (%)
Norther plains and Mandara	923,35	28,29	1669.53	- 0,44
Adamawa plateau	1515,3	22,06	1117.76	0,35
South Cameroon plateau	2456,8	24,4	911.9	1,69
Coastal plain	4163,7	24	865.77	3,81
Western highlands	3080,5	20,64	1020.08	2,02

### Rainwater assesement

Considering diversity in plants and their sensitivity to water shortages, the rainwater assessment varies according to agro ecological zones (Table V). This water assessment is the result of fluctuation in seasonal rainfall. This seasonal

instability affects the agricultural calendar while aggravating poverty since farmers, are the only group to have experienced increase in poverty between 2001 and 2007 (PAM, 2011).

**Tableau 5:** Rainwater assessment in Cameroon

Meteorological elements	Rainwater assessment (mm)
Norther plains and Mandara	-746,18
Adamawa plateau	397,54
South Cameroon plateau	1544,9
Coastal plain	3297,93
Western highlands	2060,42

It suffices to bring out the quantity of water available in plant rainwater for the study period during the vegetative period without recourse to water previously stored in the ground. These water volumes are negative in the North and Far North Regions. It is for this reason that rein fed family agriculture is dainty in these regions since certain climatic fluctuations can compromise agricultural output reason for which there is need for technological adjustments and all the other actions aiming at either adapting or reducing the adverse effects of climate change. It is for this reason that it is necessary make a combination of rain fed and irrigation agriculture. Regions where rainfall volume is more than

1000 mm of water and the rainwater assessment is more than 1000 mm of water are considered as suitable regions for rain fed agriculture.

### Characteristics of agronomic systems

#### Farming situation

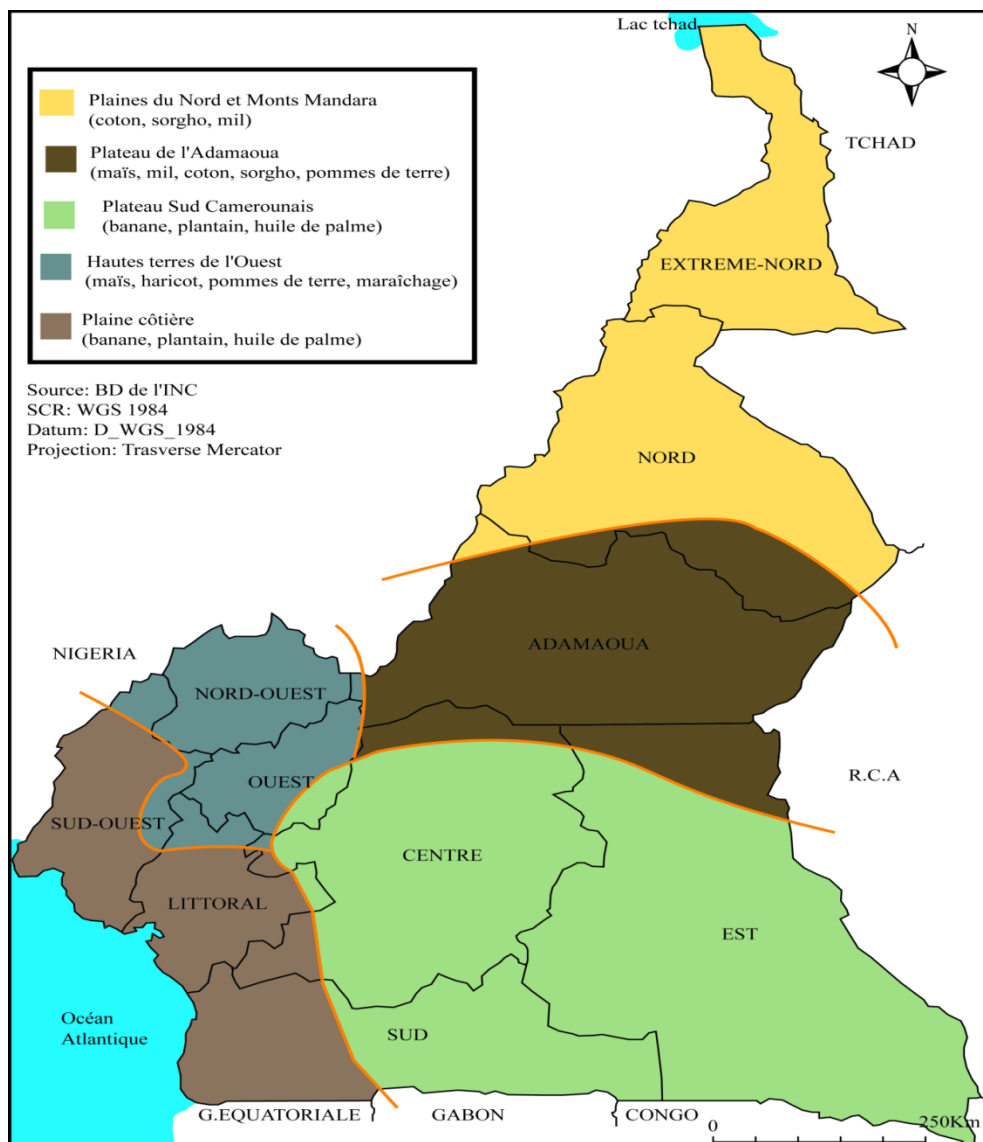
Current food production is constituted essentially of small farmers and family farmers who still have enormous productivity reserves. On the Northern plains and the Mandara Mountains, and on the Adamawa plateaus, the irregularity of rainfall and the appearance of devastators bring about and aggravate unfavourable factors such as

impoverishment of the soil, stagnation and reduction in agricultural production (ISRA/BAME, 2004). The rainy season starts in the month of June when the quantity of water starts to increase and reach a maximum in August and decline in September; leading to the need to chose the short cycle plants. The adapted crops include: millet, sorghum, maize, onions, and groundnuts. In other zones (bimodal rainfall humid forest, monomodal rainfall humid forest and the Western high plateau), there can be a double farming possibilities in the same farming year since the abundant precipitation is well distributed. Short and long term crops can be cultivated such as maize, cocoyam, cassava, oil palms etc. this study completes that carried out by the Ministry of Agriculture and Rural Development (MINADER) that defined speculations with high stakes for food security such as maize, sorghum, cassava, potatoes, sweet potatoes, plantains and oil palms (anonymous, 2013). This brings the need for the organization of the agricultural activities that is linked to the rainfall system. Results obtained in this work are similar to those obtained by (Fall, 2009) on the agricultural situation. It permits an establishment of parallels between the problems to be overcome by the agricultural populations of Senegal and those of Cameroon situated in almost similar climatic zones.

**Food situation**

The food security brings out a structural dimension that relates to the capacity of a population to satisfy their food needs, either through sufficient and sustained local production or by the possibility for them to continually generate revenue to them to acquire (Fall, 2009). This food situation is degrading in the world and was aggravated in 2008 leading to generalized inflation of the prices of agricultural produce. This crisis of food prices has not left Cameroon indifferent. The cereals inter-profession on millet, sorghum and maize has not functioned correctly due to lacunas in the control that the sectors experienced (Fall, 2008). To fill the food deficiency gap, they have to recourse to importation in order to feed its population. Its food crop production does not permit it satisfy all the food needs. The cereal deficit was about 640 000 tons in 2011 (MINEF, 1995).

Inhabitants in the rural areas are the most affected by this food insecurity. 9% of rural households are victims of food insecurity (Figure 2) while those of the urban represent 6.7% thus 33% of Cameroonian children suffer from chronic malnutrition, “which greatly hinders their growth”. The areas of the Far North, North and Adamawa are the hardest hit by this difficult access to food.



**Fig 2:** Situation of food insecurity in Cameroon

The evolution Cameroon population that at time surpasses food production makes it in a way that Cameroon is progressively losing its food sovereignty. This security is based on four fundamental principles: availability, accessibility, use and sustainability. The most hit zones by this insecurity are: the North and the Far North. On the contrary, the Adamawa and part of South Region are threatened by food insecurity, while the Centre, South West and North West are self sufficient in food. In 1995, the production of fresh tubers stood at 164 tons. The total production of cassava in Cameroon for the same year was 1.3 million tons giving a ratio per inhabitant of 98 kilos. It is the fifth in the world classification in vegetative food production after maize, rice, wheat and potatoes (FAO, 1996).

### Conclusion

Population growth in all agro-ecological zones that at times exceed agricultural production is leading to a new agricultural policy based on the development of plantations of food crops family agriculture. This rain fed family agriculture appears as an efficient answer to the fight against under nutrition, malnutrition, poverty, food insecurity and the increase in the standards of living of the population of Cameroon. Rainfall is low in the sudano-sahélien zone. The agricultural season lasts for four months (from June to September). The tall guinea savannah zone appears as a climatic transition zone separating the sahélien climate and the humid equatorial climate. The river water balance is tied to the rainfall system. Modernization of agriculture in Cameroon, the application of new production techniques, but also the mastery of the variability of the agro-meteorological system in Cameroon is very important.

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