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Determination of the critical period for cattle farming in Cameroon

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The study was carried out between 2006 and 2009 to determine the critical period for cattle farming in Cameroon. Data were collected on-farm using diachronic observations of cattle herds and pastures for 24 months. These data analysed with descriptive and Duncan multiple range test statistics, permitted to show that the period from December to April was critical. This period was characterized by poor forage quality in the pastures: 33.3 g crude protein/kg DM (dry matter), 72.8 g minerals/kg DM and 364.9 g crude cellulose/kg DM against 61.3, 93.1 and 326.7 g/kg, respectively found in the rainy season (considered as a better cattle farming period); continuously decreased animals performances: An average monthly weight loss of 13.25 kg against an average weight gain of 14.45 kg in the rainy season and an average monthly calving rate of 2.31% against 5.21% in the rainy season. It was found that this drop in animal's performances was equivalent to an economic loss of 247,682,998,000 FCFA (378,141,982 euros) per year. These results could serve as decision making tools for livestock sector improvement in Cameroon and other African countries.

Key words: Critical period, diachronic observation, poor forage quality, decreasing performance, economic loss.

INTRODUCTION

The Adamawa Region of Cameroon, because of its favourable environmental condition (Rippstein, 1985; Boutrais, 1999), is the major livestock farming region in Cameroon. Cattle production in the region represents about 86.6% of domestic livestock population and more than 28% of the national cattle head estimated at about 10 million (MINREX-CD, 1984; IRZ/GTZ, 1989). This region contributes to about 38% of national beef production (IRZ/GTZ, 1989). In 1987, the production/

demand ratio of meat in the Adamawa was estimated at 288.7% (Letenneur, 1988), showing that the region is a net exporter of beef. Adamawa dominates domestic cattle supply with about 32.4% of the national cattle sales (IRZ/GTZ, 1989).

With the above statistics, it is evident that Adamawa is the cradle of cattle farming in Cameroon. However, natural pastures remain the only major source of feed for cattle in this region (Pamo, 1989). Consequently major problems are bound, especially in the area of pasture degradation; this problem has become crucial compared to that of animal health which, thirty years ago, was reported to be the major constraint to livestock farming

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(IRZ/GTZ, 1989; Djamen, 2003). The main cause of pasture degradation is overstocking and poor forage management which reduce the available supply of pastoral resources (Monnier and Piot, 1964; MINPAT and PNUD, 2000).

Overstocking linked to other factors has caused a lot of pastoral degradation which can be easily perceived by livestock farmers themselves. Sixty five percent of the farmers confirmed that a great change has occurred in the grassy stratum of their pastures, with naturally palatable forage species gradually being replaced by non nutritious types. Gradually extinct species include amongst others: *Hyparrhenia spp., Panicum maximum* and *Setaria sphacelata* (IRZ/GTZ, 1989). This problem of pasture degradation is aggravated by the yearly variations of pastoral resources due principally to climatic fluctuations that affect the quantity and the quality of natural forage. The resulting effect of these variations is a significant decrease in production performance (beef and milk) in the dry season (Rippstein, 1985) thereby constituting an important obstacle to the socioeconomic development of the country. This could explain the low national production/demand ratio of meat in Cameroon (68.5%) and the low per capita meat consumption (14.67 kg/year) as compared to the minimum of 45 kg/year recommended by FAO (World Bank, 1987). With respect to milk, the per capita consumption in Cameroon was about 10 kg in 1986 for an annual domestic production estimated at 5.1 kg per inhabitant (Von Massow, 1986; MINPAT and PNUD, 2000), with production deficit usually compensated with dairy products imports. In 1992, milk imports were 11,480 tons for a total cost of 10 billion CFA francs (Teuscher and Salah, 1992); in 1995, national milk production was estimated at 100,000 tons and dairy imports were 30,260 tons for a total cost of 24 billion CFA francs (MINEPIA, 1995).

In spite of these socioeconomic shortcomings and the increasing scarcity of forage in the Adamawa region, livestock farmers continue to use the little available palatable forage with less care (uncontrolled bush fire, non adoption of pasture and forage improvement technologies). The consequence of this poor forage utilisation is the acute shortage of forage in some periods of the year, leading to poor cattle performance and high production cost. However, it is difficult to convince the farmers for a change or to carry out an effective pasture improvement programme or even an effective feed supplementation programme because of lack of reliable scientific data on the exact period of acute forage shortage, the magnitude of this shortage (quantitative and qualitative) and its socioeconomic consequences. These data can only be available if the critical period for cattle farming is determined.

Rzozi et al. (1998) defined the critical period between a crop and the associated adventitious plants as the period during which the presence of the adventitious plants can cause a significant yield loss. According to Robert (2007),

a critical phenomenon is that which brings an important change, dangerous, grave and difficult. For this study, the critical period for cattle farming will be defined as the period during which forage production and/or quality in the rangeland is minimal and cause significant losses in cattle performances and/or high cost of cattle production.

The major objective of this study is to determine the critical period for cattle farming in the Adamawa, Cameroon. Its specific objectives are:

(1) To delimitate in time the period of acute shortage of forage (quantity and/or quality).
(2) To assess the average critical characteristics (yield and chemical composition) of forage in the rangeland.
(3) To assess the average critical cattle performance (weight gain, calving rate, milk production).
(4) To estimate the financial and economic consequences of the critical period.

MATERIALS AND METHODS

The study area: Situation, climate, vegetation and economic activity

The Adamawa region of Cameroon is situated in Central Africa between the 6th and 8th degrees of latitude north and the 10th and 16th degrees of longitude east. It covers a surface area of about 62,000 km^2, with altitude ranging between 900 and 1500 m. Its climate is of sudano-guinean highland type with an annual rainfall of 1600 to 1800 mm distributed over 7 months and the relative humidity is between 40 - 60%. The annual average temperature is 23°C (Pamo and Yonkeu, 1986; Enoh et al., 1999; Bring, 2003). Grass species such as *Hyparrhenia, Panicum* and *Setaria* dominate natural pastures found on granitic and basaltic parent rock-based ferralsols (Enoh et al., 1999). The woody vegetation is mainly composed of *Lophira* and *Daniella sp.* These characteristics are favourable for pastoral activities. Cattle farming with three major cattle breeds (Gudali, red and white Fulani) is the main economic activity. Gudali is the predominant breed in the Adamawa since it is raised by more than 82% of the livestock farmers (IRZ/GTZ, 1989).

Sampling procedure

Selection of a representative pasture sample

This selection was based on the study of rangeland made by Forgiarini and Klein (2004) in the Adamawa. This two researchers classified the Adamawa rangeland in six floristic groups: The less grazed grassy savannah (found on dry season pastures or on protected areas), the grazed grassy savannah, the grazed grassy savannah with copse shrubs, the shrub savannah, the wooded savannah and the forest (Figure 1). Using the map of theses floristic groups (Figure 1), a rapid field appraisal of these groups was done by a pluridisciplinary team of researchers comprising a zootechnician, an agropastoralist and a botanist. From the result of the appraisal, the four first floristic groups were selected to represent the effective pasture of the Adamawa. The other two (wooded savannah and forest) were discarded because of non existence (or almost) of the grassy stratum in these groups. It is worth nothing that the grassy stratum represents the major cattle feed source in the Adamawa (Dulieu and Rippstein, 1980). At the level of each floristic group selected, one representative community
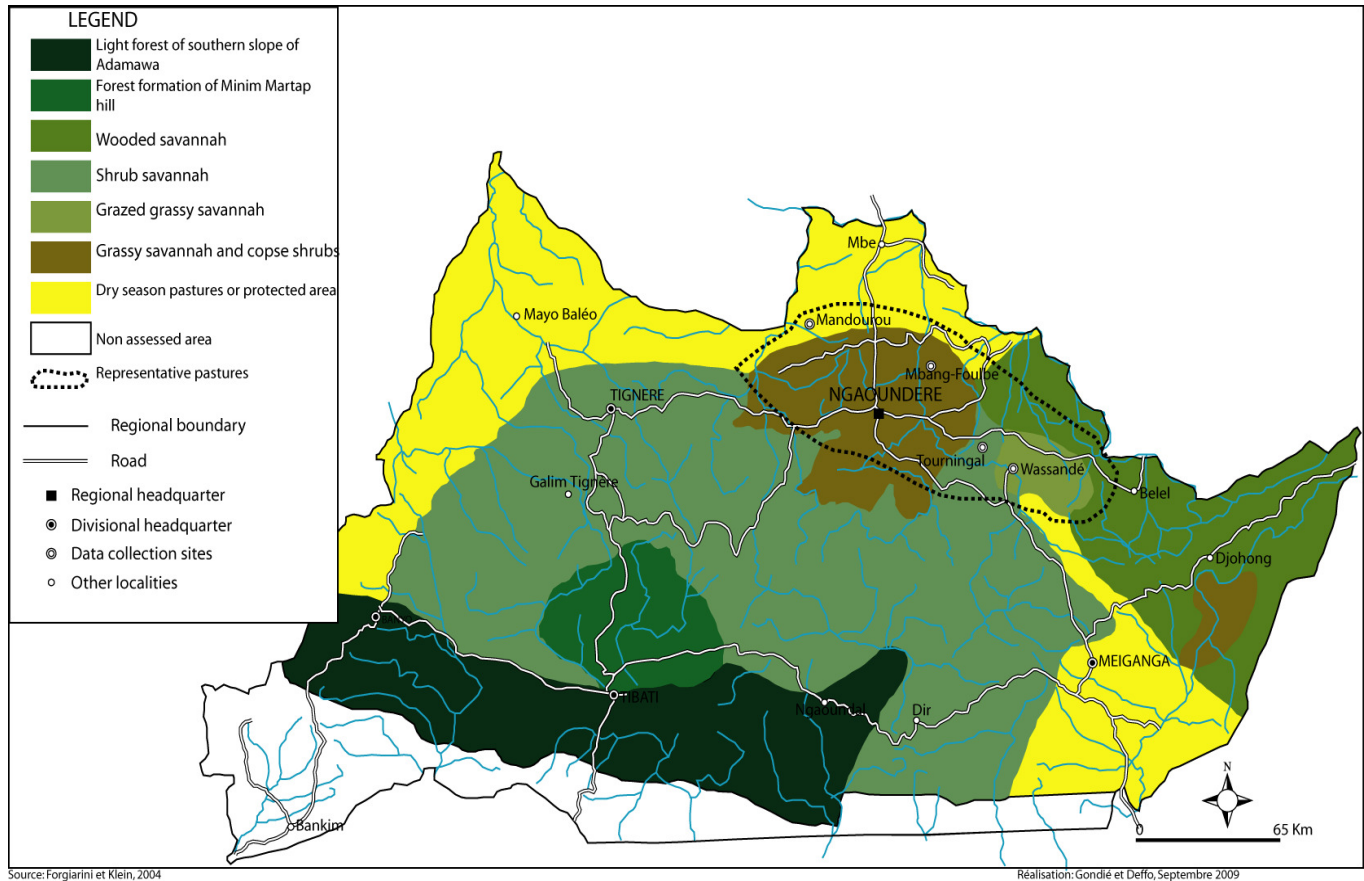
Figure 1. Map of different floristic groups in the Adamawa (Cameroon) and localisation of the representative pasture area. Source: Adapted from Forgiarini and Klein, 2004.

or territory (area with more than one community), preferably, the one having the highest cattle population, was chosen to represent the group. Therefore, Mandourou, Wassande, Mbang-Foulbe and Tourningal communities, representing the less grazed grassy savannah (dry season pastures or protected areas), the grazed grassy savannah, the grassy savannah with copse shrubs and the shrub savannah respectively, were chosen (Figure 1) as representative sample pasture of the Adamawa. It is worth noting that all these sites were purposely chosen in the Vina division since this division is quite representative of the Adamawa in terms of forage and cattle production. In terms of forage production, the division comprises all the main types of pastures found in the Adamawa (Figure 1); the rainfall pattern of the division, which is the main factor affecting forage growth and quality, is also representative of the region since Bring (1999), demonstrated that in general, rains start in all the 5 five divisions in march and end between the month of october and november and that the total annual rainfalls were not significantly different in these divisions. In terms of cattle production, Vina is the cradle of the Gudali cattle breed, the most prominent and predominant breed of the region (Djamen, 2003).

Selection of a representative cattle herd

Stratified random sampling techniques was adopted in selection of the representative animals samples as follows: At the level of the first stratum (community), the list of names of all the cattle farmers

was collected from the head of the local zootechnical centre; from this list, 5 to 7 cattle farmers were randomly selected; from the herds of each cattle farmer selected (one cattle herd contains averagely about 64 animals and each farmers owns more than one herd (Mingoas et al., 2006)), one sedentary cattle herd was randomly selected; from this herd comprising many cattle breeds, 5 to 7 head, all of Gugali breed, that is, 36 animals in average per type of pasture (or community) were randomly picked using a successive drawing with remittal and after numbering all the animals in the herd. Thus, the total sample size for the study was 144 cattle. These animals (male and female) of three to four years old, were marked using ear-tags. The selection of sedentary cattle herds and the Gudali breed was purposive in that the Gudali breed is the dominant and prominent breed in the Adamawa (IRZ/GTZ, 1989) and most of the cattle farming systems are evolutive towards the sedentary livestock system (that is intensification of the systems) (Djamen, 2003).

Data collection technique

Primary and secondary data sources were used for this study. Secondary data were collected from published and unpublished records and files of the local zootechnical centres. Primary data on cattle and forage production/productivity were collected as follows:

Data collection on cattle farming activity: Data   on cattle Production performance   were   collected using diachronic

observations (CIRAD-GRET, 2003), that is, continuous observations or herds follow up as follows: The marked animals (five to seven per herd) were followed up daily by herdsmen who were trained and paid for this purpose. They were assisted by the Chief of local zootechnical Centre (local representative of the Ministry of Livestock).Data were collected on animal feed other than forage (type of feed, quantity and costs), animal health (diseases, type of treatment and cost), production (calving, milking) and any other incidence occuring on the animals or on pastures around the village. This work was completed by a monthly follow up by a researcher (assisted by a technician) whose role was to perform measurements of thoracic perimeter using a measuring tape or a weighing band. The researcher also recorded the daily data collected by the herdsmen. Weight of the animals was then estimated by barymetry using the following Njoya et al.(1998) barymetric formula developed in Garoua, Cameroon (about 300 km from Adamawa):

- For males: Weight (kg) $= 100.64 - 2.641TP + 0.0251TP^2$ ($R^2 = 0.96$)
- For females: Weight (kg) $= 124,69 - 3.171TP + 0.0276TP^2$ ($R^2 = 0.96$) ($p < 0.0001$)

where TP is the thoracic perimeter in cm.

It is worth noting that four cattle breeds (Gudali, White Fulani (Akou), Red Fulani and Arabe Choi) were used for the development of the above formula. This implies that the variable breed had no significant effect on the cattle weight estimation and the above formula could be used for each of the above 4 breeds. Also, the location or region of the trial was not pointed out as a significant variable. It is for the above reasons that the formula could be used for this study in the Adamawa region.These data were collected for a period of 24 months

Data collection on forage production and quality: As for the cattle production, the four pasture types were evaluated monthly, using the pasture sampling and forage quantification methods described by Gounot (1969), Levang and Grouzis (1980) and Fourrier et al. (1982). At the level of each choosen community (representing the pasture type) 20 forage quadrats (forage biomass samples from 1 m² area) were randomly collected each month by the researcher using a one metre squared (1 m²) iron rod (biomass square) randomly thrown in the pasture along a transect across the pasture. It is worth noting that these samples were taken with the assistance of one or two herdmen whose major role was to identify and remove from each sample collected non palatable grassy species.The samples were weighed on-farm using a 20 kg scale (d = 50 g) to determine the fresh forage yield. These samples or at least one kilogramme of each were dried in an oven and weighed to assess the dry matter yield of the forage. The 20 dried samples were then thouroughly mixed and 500 g of this mixture were sent to the laboratory for analysis. This analysis was done to assess the chemical composition (or quality) of the forage in terms of organic matter, ash, crude proteins and crude cellulose contents (in g/kg of dry matter). These data were also collected for a period of 24 months.

Data analysis

For data analysis, descriptive statistics such as means and percentages were highly used. For the delimitation of the critical period, Duncan multiple range statistics were used to compare the months of the year according to forage production, forage chemical composition and cattle performance and production cost.

RESULTS AND DISCUSSION

Delimitation of the critical period for cattle farming in the Adamawa, Cameroon

Table 1 presents the results of Duncan multiple range tests comparing the months of the year according to the average monthly yield and chemical composition of forage. From these results and using the definition of the critical period as presented in the introduction, the critical period was delimited starting by analysing the evolution of the different elements of the chemical composition of forage throughout the year as follows: Considering the crude protein concentration in forage (Table 1), the result shows that the month of February has the lowest forage concentration in crude protein. This result also shows that there is no significant difference between the month of February and that of December, January, March and April. The period of December to April could therefore be the critical period for the protein concentration in forage. This result is very important for cattle feed complementation in the Adamawa, since protein complement (in the form of cotton-seed cake) is the most limiting element for cattle feeding in the region, that is, the one having the highest demand and on which farmers spend most money for the maintenance of their animals at the period of forage scarcity (Deffo et al., 2009). The same period is maintained concerning the minerals (ash) concentration in forage, the month of April being the most critical of the year with 70.2 g of ash /kg DM against an average annual content of 83.6 g/kg (Table 1).

The fact that there is no significant difference between the month of April and the months of May, October and November suggests the necessity of mineral complementation beyond the critical period (December to April); it should be started earlier, preferably at the end of September up to the month of May of the following year. The critical period (December to April) is more and more confirmed when analysing the evolution of other components of the chemical composition of forage; taking for example, the crude cellulose concentration, it is evident with Duncan test results (Table 1) that this period is the one having the highest concentration, indicating a high lignification of forage and therefore its low digestibility for cattle. It had been demonstrated that, during their maturity, forages are characterized by high fibre content with high lignification and low protein concentration (Enoh et al., 2005). These changes of forage quality are particularly high in the tropical climatic conditions (case of Adamawa) due to physiological differences between these forages and those of temperate zones and the higher rate of photosynthesis related to the higher intensity of solar adiations in the tropics (Nelson and Moser, 1994). As in the case of minerals, the month of April is also the most critical with an average crude cellulose concentration of 380 g/kg against an annual average of 344 g/kg (Table 1). This implies that, notwithstanding the relatively high yield of

Table 1. Comparison (by Duncan test statistic) of months according to average monthly yield and chemical composition (crude protein, minerals, crude cellulose and water concentration) of forage found in the pastures within the month.

Forage yield		Crude protein concentration		Minerals concentration		Crude cellulose concentration		Water concentration	
Yield (t DM/ha)	Months	Crude protein (g/kg DM)	Months	Minerals (g/kg DM)	Months	Crude cellulose (g/kg DM)	Months	Water (g/kg DM)	Months
2.31^a	11	71.1^a	6	103.9^a	6	377.2^a	4	814.5^a	6
2.29^{ab}	2	65.5^{ab}	7	98.9^a	7	371.6^{ab}	3	795.5^a	7
2.26^{ab}	10	61.9^{ab}	8	93.9^{ab}	8	366.1^{abc}	2	720.6^{ab}	8
2.15^{ab}	1	60.3^{ab}	9	89.7^{abc}	9	358.6^{abc}	1	674.2^{bc}	9
2.12^{ab}	3	58.7^{ab}	10	87.0^{abcd}	5	351.1^{abcd}	12	667.2^{bc}	5
2.09^{ab}	12	50.2^{bc}	5	85.8^{abcd}	11	347.9^{abcde}	5	597.5^c	10
1.87^{ab}	9	49.0^{bc}	11	85.5^{abcd}	10	343.7^{bcdef}	11	443.9^d	11
1.78^{ab}	4	39.4^{cd}	12	76.3^{bcd}	12	336.5^{cdef}	10	344.8^{de}	12
1.26^{bc}	8	34.8^{cd}	1	74.2^{cd}	1	325.5^{def}	9	299.0^{ef}	1
0.78^c	5	31.3^d	4	72.2^{cd}	2	318.6^{ef}	6	260.9^{ef}	4
0.6913^c	7	30.8^d	3	71.1^{cd}	3	316.6^{ef}	7	235.0^{ef}	2
0.4713^c	6	30.4^d	2	70.2^d	4	314.5^f	8	200.2^f	3

Legend: 1:January, 2:February, 3:March, 4:April, 5:May, 6:June, 7:July, 8:August, 9:September, 10:October,11:November, 12:December. DM: Dry Matter.NB.: Means with the same letter are not significantly different. Level of significance P = 1%.

forage registered this month and even this period (1.78 t/ha to 2.29 t/ha) (Table 1), against an average annual yield of 1.67 t/ha, this forage is of very poor quality and then less or not palatable by cattle.

Similar trends of forage dry matter yield and quality were registered in the Adamawa by Enoh et al. (2005). Analysing the nutritive value of *Hyparrhenia* native grasses, they found an average dry matter yield of 2017 kg/ha at 12 weeks regrowth and noted that this yield was significantly affected by length of growing period. The dry matter yield at 12 weeks regrowth was significantly higher by 24% compared to 8 weeks. They also found an average crude protein content

of the pasture of 5.3% and noted that pasture regrowth lengths significantly influenced the nutrient content of the pastures; as the harvesting interval was delayed from 8 to 12 weeks, the crude protein declined by 23% while the fibre fraction (CF, NDF, ADF) and ADL increased by 20 and 4%, respectively. Similar observations was done by Lima et al. (2008) studying the effect of harvesting period on the nutritive value of rice grass hay in Brazil. Rippstein et al. (2000), analysing the nutritive value of various natural grasslands at the lower eastern plain of Colombia, also found an annual biomass of 2 to 3.5 t/ha and a total crude protein content of fodder of 5 to 11% of the dry matter depending of the season and

phonological stage.

Although, the study of Enoh et al. (2005) in the Adamawa showed similar trends of forage dry matter yield and quality and even no significant difference in nutrients contents of forage with this study, it was not enough for the determination of the critical period since it was carried out only on 12 weeks (about 3 months) and one forage specie. The above result suggests the necessity of calories supplementation from a better quality forage other than the one found on the rangeland or from other calories sources. It is worth noting that the crude cellulose concentration of the month of May is not significantly different to that of April (Table 1). This could be explained by the

infiltration of the remainders of the previous dry season forage in the forage samples collected in May; these remainders being, in general, not consumed by cattle, the effective crude cellulose concentration in forage grazed in May is quite lower than the one shown by the laboratory results.

Considering the humidity of forage, it is between December and April that this humidity rate is the lowest (Table 1), 20 to 34.5% against an average annual rate of 44.36%. This shows that one important characteristic of the critical period is the absence of the photosynthetic activities in forage plants, since these activities start when the humidity rate in plants' leaves reaches at least 70% (MINCOOP, 1993). With the above observations, we can conclude that the period from December to April is critical according to the chemical composition of forage.

Concerning the cattle performances, the Duncan test results presented in Table 2 show that the period from December to April is a period of highest weight losses with the month of April being the one of highest morbidity for cattle (Table 2). The highest weight loss in April could be explained by the blunt stop of protein complement (in the form of cotton-seed-cake) by farmers with the first rains (in early April) while the new growing forages are still difficult to be grazed by the animals. For the other performances like the calving rate and therefore the milk production, the period of December to April seems to be maintained as critical, the lowest calving rate being registered in December (Table 2). For this performance, the month of April seems to be out of the period, but without significant difference.

For the cattle production cost and more precisely the feeding cost, there is no doubt that the expenditures are the highest during the period from December to April and particularly between the months of January and April (Table 2). Notwithstanding these high expenditures in the critical period, they remain insufficient to stop the negative effect of forage degradation on animal's performances. Concerning the animal health care cost, the period of December to April is rather favourable for cattle health. This could be explained by the fact that, the major cattle diseases in this region, that is, the trypanosomiasis and the foot-and-mouth disease, are less severe in the dry season (November to March).

From the above analysis, we can conclude that the period from December to April is the critical period for cattle farming in the Adamawa (Cameroon). It is worth noting that this period is quite different to the dry season period (November to March) (Bring, 2003) which had long been mistakenly considered as the critical period for livestock farming in the Adamawa.

Characteristics of the critical period

Some of these characteristics have already been revealed in the last section. More detailed characteristics of this period are given.

Average yield and chemical composition of forage in the critical period

The yield and chemical composition of forage in the critical period are presented in Table 3. According to this table, the critical period for cattle farming in the Adamawa is characterized by a relatively higher dry matter forage yields in the rangeland. But as explained earlier, this forage is not produced in this period; it is just the remaining forage produced in the rainy season (May to October) and which, because of the poor quality (low digestibility, very low protein and mineral content) (Table 3), is abandoned by the animals. A great part, if not all of this forage remaining in the critical period is destroyed by bush fire set by herdsmen at the end of each dry season to clean the rangeland for new forage growth. This result reveals that there is an important need to look for a method to save this extra forage and use it profitably in the critical period.

Average cattle performance in the critical period

Table 3 presents the evolution of cattle weight gain/loss and calving rate in the critical period (Table 3). It also shows the details components of cattle production costs (Table 3). These results show that during this period an average weight loss of 13.25 kg is registered per month against an average annual weight gain of 1.86 kg per month (Table 2) and against an average monthly weight gain of 14.45 kg in the rainy season considered as better period for livestock farming in the region (Table 2) (Mingoas et al., 2006). As for calving, the average rate is 2.34% per month against an annual rate of 3.37% per month (Table 2) and against a rainy season rate of 5.19% per month. This result on calving is similar to that of Mingoas et al. (2006) which showed that the peak of cattle calving in the peri-urban zone of Ngaoundere (Adamawa) was found between the months of March and July corresponding to interbreed occurred during the previous rainy season when pastures have abundant and good quality forage. The access to better feed in the rainy season could favour early heath and acquisition of extra energy necessary for coupling.

Another factor explaining the high effect of the critical period on calving is that, calving in Adamawa are natural, that is, unplanned, making the periods of high demand coincide with the periods of low production (November to March). This positive relation between forage production and cattle performance could be explained by the fact that, when there is less or low quality forage on pasture, cattle travel more to feed and therefore lose more energy than when there is abundant and/or high quality forage on the same pasture. Rippstein (1980), showed that

Table 2. Comparison (by Duncan test statistic) of months according to cattle average monthly performances (weight gain/loss, calving rate) and production costs (feeding and health care costs).

Weight gains/losses		Calving rates		Feeding cost		Health care costs	
Gain/loss (kg)	Months	Rate (%)	Months	Costs (FCFA/cow)	Months	Costs (FCFA/cow)	Months
21.62^a	6	5.38^a	8	807.00^a	2	253.63^a	7
18.75^{ab}	5	4.97^{ab}	9	590.00^b	3	246.88^{ab}	6
14.12^{abc}	7	4.73^{ab}	5	449.00^{bc}	4	111.00^{abc}	8
13.00^{abc}	9	4.38^{ab}	4	361.00^c	1	72.00^{bc}	2
11.87^{bc}	8	4.13^{ab}	6	210.00^d	5	70.00^{bc}	10
7.37^{cd}	10	4.13^{ab}	7	168.00^d	12	53.13^c	5
1.86^d	11	3.43^{ab}	10	142.00^d	6	50.00^c	9
-10.44^e	2	2.50^{ab}	2	131.13^d	11	39.00^c	4
-10.62^{ef}	12	2.00^{ab}	3	129.00^d	9	36.00^c	11
-11.06^{ef}	1	1.96^b	11	122.13^d	10	29.00^c	12
-16.00^{ef}	3	1.95^b	1	117.88^d	8	25.25^c	3
-20.50^f	4	0.89^b	12	117.38^d	7	17.00^c	1

Legend: 1:January, 2:February, 3:March, 4:April, 5:May, 6:June, 7:July, 8:August, 9:September, 10:October,11:November, 12:December. NB.: Means with the same letter are not significantly different. Level of significance p = 1%.

Table 3. Characteristic parameters of the critical period for cattle farming in the Adamawa (Cameroon).

Months of the critical period	Forage characteristics at the critical period						Cattle performances at the critical period		Cattle feeding costs at the critical period		Cattle health care costs at the critical period
	Forage yield (t DM/ha)	Organic. Matter (g/kgDM)	Crude Protein (g/kg DM)	minerals (g/kg DM)	Crude cellulose (g/kg DM)	Water (g/kg DM)	Weight gain/loss (Kg)	Calving rate (%)	Amount (FCFA/cow)	Total production (FCFA) (%)	Amount (FCFA)
December	2.09	923.7	39.4	76.3	351.1	344.8	-10.62	0.89	168	85.28	29
January	2.15	925.7	34.8	74.2	358.6	299.0	-11.06	1.95	361	95.50	17
February	2.29	927.7	30.4	72.2	366.1	235.0	-10.44	2.50	808	91.71	73
March	2.12	928.7	30.8	71.1	371.6	200.2	-13.62	2.00	590	95.47	28
April	1.78	929.8	31.3	70.2	377.2	260.9	-20.50	4.38	449	92.01	39
Average	2.09	927.1	33.3	72.8	364.9	268.0	-13.25	2.34	475	92.77	37

DM: Dry matter.

3 years old bulls maintained in zero grazing situation in the dry season and fed with native forage hay (about 2.5 kg DM/100 kg live weight)   hadsignificant more daily weight gain than those of the same age left on the pasture (1TBU/ha stocking rate) with the same level of feed complement. This is evidence that more displacement of cattle looking for forage could lead to a decrease in performance. Moreover, abundant forage on pasture also makes it easier for cattle to select good quality forage leading to higher performance than in a pasture having less forage production.

Financial and economic consequences of the critical period

The analysis of the cattle production cost (feeding + health costs) shows that, in the critical period, the feeding cost represents 92.77% of the total monthly production cost per cow against 77.07% of the annual monthly production cost and against 60.93% in the rainy season (Table 2). This means that, comparatively to the rainy season, the critical period causes about 31.84% increase in the production cost, that is, about 165.89 FCFA (0.25 euro) extra money spent per cow per month in the critical period. This extra expenditure represents an economic loss of 464,492,000 FCFA (709,148 euros) per month and then 2,322,460,000 FCFA (3,545,740 euros) per year, for the 2.8 million cattle found in the Adamawa.

The economic loss is more than the above while considering the weight loss and the calving loss during the critical period. For the weight loss, comparatively to the rainy season, the critical period causes a monthly average loss of 27.7 kg per cow, which, for the 2.8 million cattle in the region, represents 77,560,000 kg and then 387,800,000 kg per year. Evaluating with the current average market price of about 600 FCFA/kg live weight, this corresponds to an economic loss of about 232,680,000,000 FCFA (355,236,641 euros) per year. Considering the calving loss, still comparatively to the rainy season, the critical period causes an extra calving rate loss of 2.85% per month giving 14.25% per year for the five months critical period. Extrapolating this result to the cattle population in the Adamawa and giving the herd structure of 46% females and 54% males in the Adamawa (Mingoas et al., 2006) and the calves mortality rate of 7% (MINCOOP, 1993), this effect of the critical period on cattle calving corresponds to about 170,692 calves lost per year. To assess the monetary value of this loss, the value of a calf at birth was estimated equal to the amount of money spent for the maintenance (feeding + health care) of the mother cow from the previous calving up to the new calving (18 months), that is about 6,516 FCFA according to Table 2, plus the cow depreciation cost (evaluated at the current market price of about 200 000 FCFA for a 3 years old cow) over an economic life span of 11 years (MINREX-CD, 1984), that

is about 27 273 FCFA, which corresponds to a total of 33 789 FCFA (51.59 euros) per calf. Therefore, the decrease in calving due to the critical period represents an economic loss of about 5,767,511,988 FCFA (8,805,362 euros) per year. To these calves losses, should be added the loss of consumption milk by daily milking; this has been estimated to about 1.5 L of milk per day per cow (Mingoas et al., 2006), giving a total quantity of 256,038 L/day for the 170,692 cows and   then 46,086,840 l for 6 months milking. When evaluating this at the farm gate price of 150 FCFA/L, it gives en economic value of 6,913,026,000 FCFA (10,554,238 euros) per year.

The critical period for cattle farming in the Adamawa results to a total economic loss of about 247,682,998,000 FCFA (378,141,982 euros) per year. It is worth noting that the economic consequence of the critical period could be higher than the above if the effect of this period on milk production by suckling cows representing about 40.44% of the female cattle (Table 2) was considered. But this was purposely left out since it was not useful for the determination of the critical period.

Conclusion

The objective of this study was to determine the critical period for cattle farming in the Adamawa (Cameroon). This objective has been achieved using a diachronic observation of a representative rangeland and cattle herd for a period of 24 months. The period ranging from December to April has been delimited as the critical period for cattle farming in the Adamawa. This period is characterized by many factors among which the absence of photosynthetic activities in forage plants, the poor quality of forage found in the rangeland, a continuous decreasing cattle performance and the high cost of cattle feeding. Concerning the forage yield and its quality, the critical period is characterized by a relatively high quantity of forage in the rangeland (2.09 t/ha) against and annual monthly yield of 1.67 t/ha. But this forage is not consumed by the animals because of its poor quality. For the cattle performance, the critical period is characterized by an average weight loss of 13.25 kg/month against an average weight gain of 14.45 kg/month in the rainy season. The calving rate decreases from an average of 5.19% per month in the rainy season to 2.34%per month in the critical period. Added to the above characteristics, is the feeding cost which represents the highest part (92.77%) of the cattle production cost during the critical period.

The critical period so determined, with all its effects on forage and animal performance, results to an important economic loss estimated at about 247,682,998,000 FCFA (378,141,982 euros) per year. These results could serve as a decision making tool for livestock sector improvement in the Adamawa region and even in Cameroon and other

regions of Africa. For instance, farmers could rely on this to plan their feed complementation through out the year and therefore improve on their cattle performance. Government can also use this as an important tool for its priorities setting in investment decisions making. The critical period and especially its characteristics could also serve as baseline data for further studies or projects related to rangeland management or cattle performance improvement in the Adamawa (Cameroon).

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REFERENCES

Boutrais J (1999). cow or power. Fulbe and Mbororo of Adamawa. In: Botte R., Boutrais J. Schmitz J. (Directed by). Peulhs Faces. Karthala: Paris, pp. 247-271.

Bring (1999). Variability and evolution of annual rainfall on the Adamawa Plateau. Annales of the Faculty of Arts, Lett. Hum. Sci., 4: 47-56.

Bring (2003). Evaluation of the atmospheric water resources in the north of Cameroon using conventionnal and satellitals methods. Ph.D. Thesis in Geography, Ngaoundere, FALSH (University of Ngaoundere), p. 358.

Deffo V (2011). Pastures degradation in the Adamawa (Cameroon): Bio-economic analysis and sustainable solutions, works progress report, IFS/IRAD Project N° B/3698-1 and B/3698-2, IRAD-Wakwa, Cameroon.

Deffo V, Ottou JFB, Messine O, Ebangi AL, Djoumessi M (2009). Socioeconomic factors affecting the use of agro-industrial by-products for dry season cattle fattening in the Adamawa, Cameroon. Biotechnol. Agron. Soc. Environ., 13(3): 349-357.

Djamen NP (2003). Mutations and Challenges: State of cattle farming in the Vina (Cameroon). DEA thesis; University of Paris VII-INAPG, Paris, France, p. 69.

Dulieu D, Rippstein G (1980). Vegetation and pastoralism in the Adamawa (Cameroon). IEMVT/LRVZ N'Djamena (ed), Maisons-Alfort: Paris, France.

Enoh MB, Kijora C, Peters KJ, Yonkeu S (2005). Effect of stage of harvest on DM yield, nutrient content, in vitro and in situ parameters and their relationship on native and Brachiaria grasses in the Adamawa Plateau of Cameroon. Livestock research for Rural Development, 17(1). www.cipav.org.co/lrrd/lrrd17/1/enoh17004.htm. (29/11/2008).

Enoh MB, Yonkeu S, Pingpoh DP, Messine O, Maadjou N (1999). Yield and composition of fodder banks on Adamawa Plateau of Cameroon. Revue Elev. Méd. Vét. Pays Trop., 51(1): 55-62.

Forgiarini G, Klein HD (2004). Cartography of soil and natural pastures occupation of the three northern provinces of Cameroon: Coloured map at 1/500000. CIRAD-EMVT: Montpellier (France).

Fourrier A, Hoffman O, Devineau JL (1982). Variation of the herbaceous phytobiomass along a toposequence in the sudano Guinean zone. FAO: Ouango-Fitini, Cote d'Ivoire.

Gounot M (1969). Methods of on-station vegetation analysis, in: Proceeding of the seminar on: The methods of phyto-ecological and Agronomic inventory of permanent grassland held on the 25th and 26th March 1969 at Montpellier, France, Ph. Daget (ed). National Centre of Scientific Research: Montpellier, France, pp. 1-10.

IRZ/GTZ (1989). Livestock Farming Systems in Adamawa, Research Report No 1, Wakwa (Cameroon), IRZ/GTZ, p. 96.

Letenneur I (1988). Needs identification and research programmes propositions concerning livestock farming in the Base-Centre Project zone Garoua SEB.III (North-Cameroon). Maisons-Alfort: Paris, France.

Levangg F, Gouzis M (1980). Measure of forage biomass and covering. In: Planning of the dry tropical zones natural forests. FAO conservation guide No 32, Department of forests, FAO: Roma. (www.FAO.org/docrep/w4442f/).

Lima LD, Kozloski GV, Bonnecarrère Sanchez LM, Ruggia Chiesa AP, Härter CJ, Oliveira L, Cadorin Jr RL (2008). Effect of harvesting period on the nutritive value of rice grass (Echinochloa sp) hay given as sole diet to lambs. Small Rumin. Res., 75 (2-3): 217-225.

MINCOOP (1993). Memento of Agronome (4th ed.), Collection «Rural Technique in Africa», Ministry of Cooperation (MINCOOP): Paris, France, p. 1635.

MINEPIA (1995). Study of livestock sector. Ministry of livestock, Fishing and Animals husbandry. MINEPIA: Yaounde, Cameroon, p. 158.

Mingoas KJP, Gambo H, Ottou JFB, Ebangi AL, Domwa M (2006). Herds structure and management of Ngaoundere periurban cattle farming in Cameroon. Bull. Anim. Health Prod. Afr., 54: 53-65.

MINPAT (1986). Sixth Five years Cameroon economic and socio-cultural development plan (1986 - 1991). National Printing Press: Yaounde, Cameroon, p. 323.

MINPA , PNUD (2000). Regional socioeconomic studies of Cameroon. Poverty eradication, social data improvement. Adamawa Province. PNUD-OPS CMR/98/005/01/99 Project: Tunis, Tunisia, p. 96.

MINREX-CD (1984). Memento of Agronome (3rd ed.). Rural Technique in Africa. Ministry of External Relations-Cooperation and Development (MINREX-CD): Paris, France, p. 1604.

Monnier F, Piot J (1964). Pasture problems in the Adamawa (Cameroon). Revue Bois et Forêts des Tropiques, 97: 3-16.

Nelson CJ, Moser IE (1994). Plant factors affecting forage quality. In: Forage quality evaluation and utilization, Fakey GC (ed.), Madison: Wisconsin, USA, pp. 115-142.

Njoya A, Bouchel D, Ngo Tama AC, Planchenault D (1998). Factors affecting birth weight, growth and viability of calves in traditional livestock farming in the North of Cameroon. Revue Elev. Méd. Vét. Pays Trop., 51(4): 335-343.

Pamo TE (1989). Rangeland response to low levels of nitrogen fertilization and cutting intensities on the Adamawa Plateau, Cameroon. Revue Elev. Méd. Vét. Pays Trop., 42(4): 591-598.

Pamo TE, Yonkeu S (1986). Study of the evolution of some climatic parameters of the pastoral environment of Wakwa, Adamawa, Cameroon. Sci. Technol. Rev., Anim. Sci. Series, Cameroon, 2(3): 19-34.

Rippstein G (1980). Comparing dry season maintenance feeding regimes of zebus on pasture in the Adamawa (Cameroon). Revue Elev. Méd. Vét. Pays Trop., 33(4): 417-426.

Rippstein G (1985). Study on Adamawa vegetation. Evolution, conservation, regeneration and improvement of a grazed ecosystem in Cameroon. Studies and syntheses of IEMVT N° 14. Maisons Alfort: Paris, France, p. 367.

Rippstein G, Allard G, Corbin J (2000). Fire management of Natural Grasslands and Cattle Productivity in the Lower Eastern Plains of Colombia. Revue Elev. Méd. Vét. Pays Trop., 53(4): 337-347.

Robert P (2007). « Le nouveau petit Robert de la langue française », New edition. Robert, Paris (France), p. 2837.

Rzozi SB, Bouhache M, Hamal A, Saffour K (1998). Critical period of competition between Brome grass and strong wheat. BTT No. 41, Rabat (Morrocco), Hassan II Agronomic and Veterinary Institute, Web document, Downloadable on: www.vulgarisation.net/02-41.htm. (Accessed on 12/09/2009).

Teuscher T, Bahm A, Salah JNS (1992). Livestock Research Development and Policy in Cameroon: Analysis and Reform Proposals. Report, IRZ/GTZ: Yaoundé, Cameroon.

Von Massow VH (1986). Dairy import into sub-Saharan Africa, development and policies. Working Paper No 4. ILCA LPV: Addis Ababa, Ethiopia.

World Bank (1987). Socioeconomic study of traditional livestock farming system. In: World Development Report, 1987. Oxford University Press.

World Bank (1987). Socioeconomic study of traditional livestock farming system. In: World Development Report, 1987. Oxford University Press.