



## Determination of the best forage production period for cattle farming in the Adamawa Region of Cameroon

Victor DEFFO<sup>1\*</sup>, Etienne TENDONKENG PAMO<sup>2</sup>, Michel TCHOTSOUA<sup>3</sup>, Médard LIEUGOMG<sup>4</sup>, C. J. ARENE<sup>5</sup> and Ethelbert C. NWAGBO<sup>5</sup>

<sup>1</sup> Institute of Agricultural Research for Development (IRAD), Regional Research Centre of Wakwa, P.O.Box 65 Ngaoundéré, Cameroon.

<sup>2</sup> Department of Animals Production, University of Dschang, P.O.Box 222 Dschang, Cameroon.

<sup>3</sup> Department of Geography, University of Ngaoundéré, P.O.Box 454 Ngaoundéré, Cameroon

<sup>4</sup> Department of Geography, National Higher Teachers Training College, University of Yaoundé I, P.O.Box 47Yaoundé, Cameroon.

<sup>5</sup> Department of Agricultural Economics, School of Postgraduate Studies, University of Nigeria, Nsukka, Nsukka, Enugu State, Nigeria.

\* Corresponding author, E-mail: [vdeffo@yahoo.fr](mailto:vdeffo@yahoo.fr)

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### ABSTRACT

A study was carried out to determine the best forage production period for cattle farming in the Adamawa (Cameroon). Data were collected on-farm using diachronic observations of cattle herd and pasture for 24 months. These data, analysed with descriptive and Duncan statistics, permitted to show that the period from May to November was the best period. This period was characterized by many factors such as relatively high average monthly forage quality in the pastures with 5.89% crude protein, 9.21% minerals and 32.90% crude cellulose against 3.53%, 7.42% and 36.14% respectively in the dry season. There was also a continuous increase in animal performances (average monthly weight gain of 12.66 kg against an average weight loss of 10.73 kg in the dry season, and an average monthly calving rate of 3.82% against 1.86% in the dry season). It was found that the increase in animal performances, compared to the dry season, was equivalent to an economic gain of 289,562,859,416 FCFA (that is, 443,607,418 euros) per year. The best period, so delimited, could serve as a decision making tool for livestock sector improvement in the Adamawa region and even Cameroon and other countries with similar climatic conditions and livestock farming systems.

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**Keywords:** decision making tool, diachronic observation, high forage quality, cattle performance, economic gain.

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### 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 (MINEPIA, 1995; MINPAT and PNUD,

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2000). This region contributes to about 38% of national beef production (MINPAT and PNUD, 2000). 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.

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). Currently, these pastures are highly degraded; the main cause of the degradation being the overstocking and poor forage management. The extent of this problem had been reported by Monnier and Piot (1964) who estimated that, from the 6 million hectares of grazing land in the Adamawa plateau, only 3 million hectares could be considered as effective pasture; the rest being occupied by forests and rocks, or infested by tsetse flies (one third). They also estimated the stocking rate at about 750,000 cattle, corresponding to a density of 25 cattle per km<sup>2</sup> or 0.25 Tropical Beef Unit (TBU) per hectare of effective pasture. They then concluded that there was globally no overstocking on the Adamawa plateau for the 600,000 to 800,000 head of cattle that grazed then. Today, the same conclusion cannot hold as the cattle population is on a steady increase and has been estimated at about 2.8 million head (MINEPIA, 1995; MINPAT and PNUD, 2000), giving a density of about 93 cattle per km<sup>2</sup> (0.93 TBU/ha) of effective pasture with a cattle population growth rate of 2.5% without any visible improvement of pastures. The government of Cameroon, through the "Mission Special d'Eradication des Glossines", attempted to solve this problem by reconquering the areas infested by tsetse flies by massive spraying; but this action was not successful since there is a re-infestation of the areas gained after mass spraying and this is facilitated by the current reforestation of pastures (Cuisance and Boutrais, 2005).

This problem of pasture degradation is aggravated by the yearly variations of pastoral resources due principally to the cyclic climatic

fluctuations that affect both the quantity and quality of natural forage. As a result, significant decrease in cattle production performances (weight gain, calving and milk) are observed (Rippstein, 1985) thereby constituting an important obstacle to the socioeconomic development of the region and of the country in general. 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 5.1kg per inhabitant (Von Massow, 1986; MINPAT, 1986), with production deficit usually compensated with massive dairy products imports (Teuscher et al., 1992; 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 favouring reforestation, continuous increase of herd size without considering the production capacity of the rangeland and non or low adoption of pasture or forage improvement technologies developed by research are some of the main characteristics of the livestock system in the Adamawa (Rippstein, 1985). 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 (Rippstein, 1985; Mingoas et al., 2006). 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, although some studies had been carried out relative to the period of forage shortage (dry season) in the region (Rippstein, 1985), there is lack of reliable scientific data on the exact period of highest forage production (quantitative and/or qualitative) as opposed to period of forage

shortage, the magnitude of this production and its socioeconomic consequences. These data, which could serve as baseline for pastures/forage improvement and management and for cattle feed supplementation, etc., can only be available if the best forage production period for cattle farming is determined.

For this study, the best forage production period for cattle farming was defined as the period during which, forage production and/or quality in the rangeland was maximal and led to the highest cattle performances and lowest cost of cattle feeding by farmers.

The major objective of the study was to determine this period in the Adamawa, Cameroon. The specific objectives were to delimitate in time the period of highest forage production (quantity and/or quality) in the Adamawa, Cameroon; measure the best forage yield and chemical composition in the region; assess the best cattle performances (weight gain, calving rate) in the region and estimate the financial and economic consequences of the best period.

## MATERIALS AND METHODS

### The study area: situation, climate and economic activity

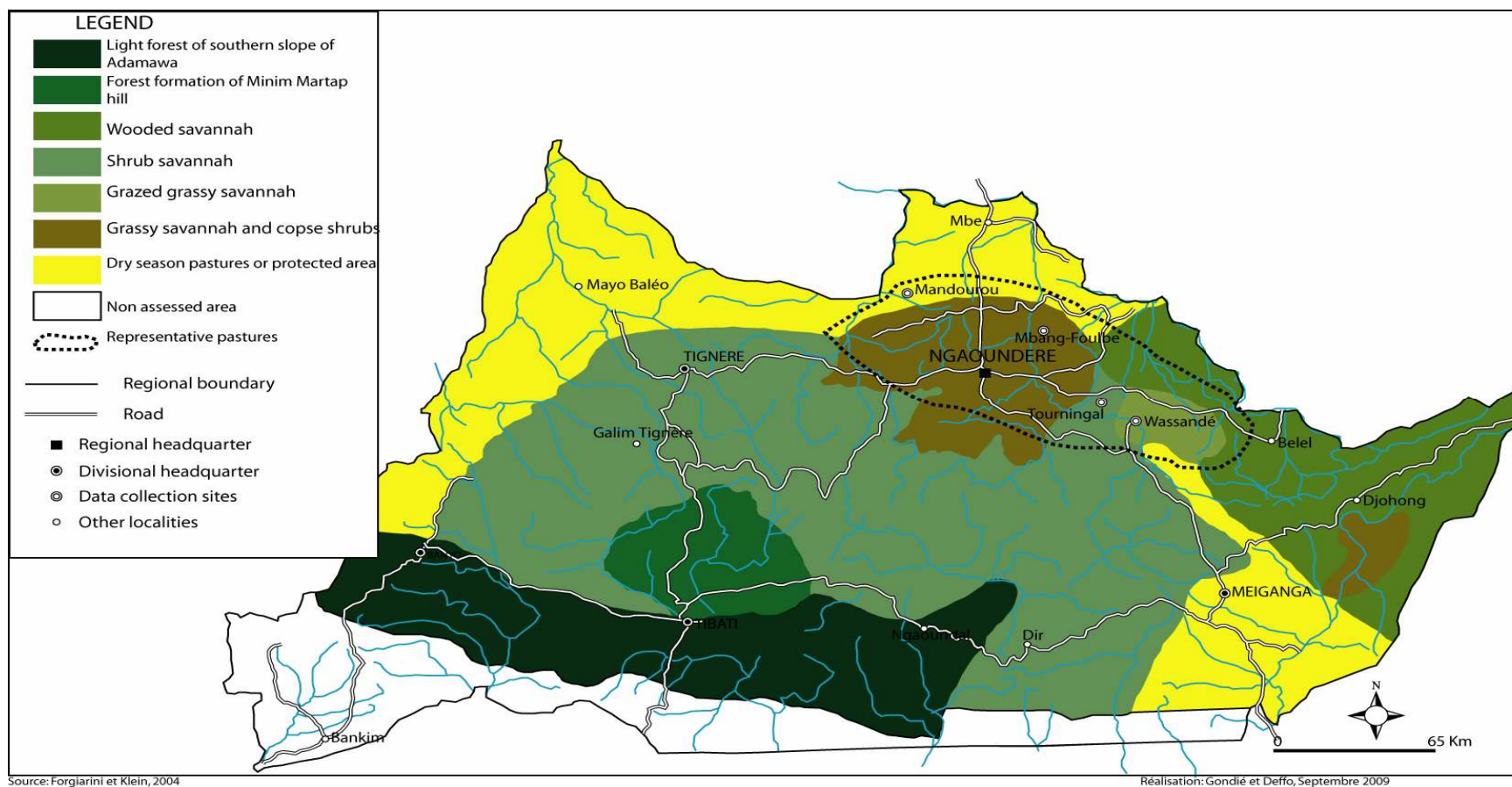
The Adamawa region of Cameroon is situated in Central Africa between the 6<sup>th</sup> and 8<sup>th</sup> degrees of latitude North and the 10<sup>th</sup> and 16<sup>th</sup> degrees of longitude east. It covers a surface area of about 62,000 km<sup>2</sup>, with altitude ranging between 900 and 1500 m. Its climate is of sudano-guinean highland type with annual rainfalls of 1600 to 1800 mm distributed over 7 to 8 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, 1999). Grass species such as *Hyparrhenia*, *Panicum* and *Setaria* dominate natural pastures found on granitic and basaltic parent rock-based ferralsols; the woody vegetation is mainly composed of *Lophira* and *Daniella* sp. (Enoh et al., 1999). 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 reared by more than 82% of the livestock farmers (Djamen, 2003).

### 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. These 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 these floristic groups (Figure 1), a rapid field appraisal of these groups was done by a pluridisciplinary team of researchers comprising an animal scientist, an agropastoralist and a botanist. From the results 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 (almost) absence of the grassy stratum in these groups. It is worth noting 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 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-Foulbé and Tourningal communities, representing the less grazed grassy savannah (dry season pastures), the grazed grassy savannah, the grassy savannah with copse shrubs and the shrub savannah respectively, were chosen (Figure 1) as representative sample pastures 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



Source: Adapted from Forgiarini and Klein, 2004

**Figure 1:** Map of different floristic groups in the Adamawa (Cameroon) and localisation of the representative pasture area.

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 were adopted in the selection of the representative animal samples as follows: at the level of the first stratum (community), the list of names of all the cattle farmers of the area was collected from the head of the local veterinary centre. From this list, 5 to 7 cattle farmers were randomly selected; from the herds of each cattle farmer selected (one cattle herd contains on average about 64 animals and each farmer owns more than one herd (Mingoas et al., 2006)), one sedentary cattle herd was randomly selected; and, from this herd usually comprising many cattle breeds, 5 to 7 heads of the Gudali breed, were randomly picked using a successive drawing with remittal and after numbering all the animals in the herd. Thus, 35 animals per type of pasture (or community) brought the total sample size for the study to 140. These animals (male and female), aged three to four years, were identified using ear-tags.

The selection of sedentary cattle herds and the Gudali breed considered the fact that the Gudali breed is the dominant and prominent breed in the Adamawa 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 veterinary 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, that is, continuous observations (herd follow up): the five to seven animals marked in each herd were followed up daily by herdsmen who were trained and paid for this purpose. They were assisted by the Chief of the local Veterinary 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 occurring 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 a formula developed in Garoua, Cameroon (about 300 km from Adamawa) by Njoya et al. (1998):

- For males:  $\text{Weight (kg)} = 100.64 - 2.641TP + 0.0251TP^2$  ( $R^2 = 0.96$ )

- For females:  $\text{Weight (kg)} = 124.69 - 3.171TP + 0.0276TP^2$  ( $R^2 = 0.96$ )

( $p < 0.0001$ )

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 these breeds had no significant effect on the cattle weight estimation and the above formula could be used for each of the above 4 breeds.

These data were collected over a period of 24 months between 2006 and 2009.

#### **Data collection on forage production and chemical composition**

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 chosen community (representing the pasture type) 20 forage quadrats (forage biomass samples from 1m<sup>2</sup> area) were randomly collected each month using a one metre squared (1m<sup>2</sup>) iron rod (biomass square) randomly thrown along a transect across the pasture. It is worth noting that these samples were collected with the assistance of one or two herdsman whose major role was to identify and remove from each sample collected the non palatable grassy species. The samples were weighed on-farm using a 20 kg scale (d = 50 g) to determine the fresh forage yield. At least one kilogramme of each sample was dried in an oven and weighed to assess the dry matter yield. The 20 dried samples were then thoroughly mixed and 500 g of this mixture sent to the laboratory for analysis. This analysis was done to assess the chemical composition of the forage in terms of organic matter, ash, crude proteins and crude cellulose contents (as a percentage of the dry matter). These data were collected for a period of 24 months between 2006 and 2009.

#### **Data analysis**

For data analysis, descriptive statistics (means and percentages) were 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, cattle performances and production cost.

## **RESULTS**

### **Delimitation of the best forage production 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 in the Adamawa region. From these results and using the definition of the best forage production period as presented in the introduction, the best period was delimited starting by analysing the evolution of the different elements of the chemical composition of forage throughout the year. Considering the crude protein concentration in forage (Table 1, 2<sup>nd</sup> column), the month of June seems to be the best month for forage concentration in crude protein. This result also shows that there is no significant difference between the months of June, July, August, September and October. The period from June to October is therefore the best period for the protein content of forage. However, the month of November could be added to this period because of the relatively high production of forage registered in this month (Table 1, 1<sup>st</sup> column) compensating its relatively low protein content (Table 1, 2<sup>nd</sup> column). Moreover, there is no significant difference between November's forage protein content and that of the months of July to October previously considered as being part of the best period. The month of May also merits to be part of the best period for, notwithstanding the relative low crude protein content (Table 1, 2<sup>nd</sup> column) and the relative high crude cellulose content (Table 1, 4<sup>th</sup> column) registered, these contents are not significantly different from those registered in June and July. Moreover, the relatively good cattle performances during this month (Table 2, 1<sup>st</sup> and 2<sup>nd</sup> column) confirm its inclusion in the best forage production period. Concerning the mineral content of forage, the period from May to November remains the best; the Duncan ranking (Table 1, 3<sup>rd</sup> column) shows that during this period forage has the highest mineral content. Statistically, there is no significant difference between the mineral contents of forage during these 7 months (Table 1, 3<sup>rd</sup> column). Analysing the crude cellulose content of forage, the best period is maintained; the minimal crude cellulose contents being registered between May and

**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.

| Comparison according to forage yield |        | Comparison according to crude protein concentration |        | Comparison according to minerals concentration |       | Comparison according to crude cellulose concentration |        | Comparison according to water concentration |        |
|--------------------------------------|--------|---|--------|--|-------|---|--------|---|--------|
| Yield (t DM/ha)                      | Months | Crude protein (g/kg DM)                             | Months | Minerals (g/kg DM)                             | Month | Crude cellulose (g/kg DM)                             | Months | Water (g/kg DM)                             | Months |
| A 2.31                               | 11     | A 71.1  | 6      | A 103.9  | 6     | A 377.2   | 4      | A 814.5                                     | 6      |
| BA 2.29                              | 2      | BA 65.5   | 7      | A 98.9   | 7     | BA 371.6  | 3      | A 795.5                                     | 7      |
| BA 2.26                              | 10     | BA 61.9   | 8      | BA 93.9  | 8     | BAC 366.1   | 2      | BA 720.6                                    | 8      |
| BA 2.15                              | 1      | BA 60.3   | 9      | BAC 89.7                                       | 9     | BAC 358.6   | 1      | BC 674.2                                    | 9      |
| BA 2.12                              | 3      | BA 58.7   | 10     | BDAC 87.0                                      | 5     | BDAC 351.1  | 12     | BC 667.2                                    | 5      |
| BA 2.09                              | 12     | BC 50.2   | 5      | BDAC 85.8                                      | 11    | EBDAC 347.9   | 5      | C 597.5                                     | 10     |
| BA 1.87                              | 9      | BC 49.0   | 11     | BDAC 85.5                                      | 10    | EBDFC 343.7   | 11     | D 443.9                                     | 11     |
| BA 1.78                              | 4      | DC 39.4   | 12     | BDC 76.3                                       | 12    | EDFC 336.5  | 10     | ED 344.8                                    | 12     |
| BC 1.26                              | 8      | DC 34.8   | 1      | DC 74.2  | 1     | EDF 325.5   | 9      | EF 299.0                                    | 1      |
| C 0.78                               | 5      | D 31.3  | 4      | DC 72.2  | 2     | EF 318.6  | 6      | EF 260.9                                    | 4      |
| C 0.6913                             | 7      | D 30.8  | 3      | DC 71.1  | 3     | EF 316.6  | 7      | EF 235.0                                    | 2      |
| C 0.4713                             | 6      | D 3.04  | 2      | D 70.2   | 4     | F 314.5   | 8      | F 200.2                                     | 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.

**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).

| Comparison according to weight gains/losses |        | Comparison according to calving rates |        | Comparison according to feeding costs |        | Comparison according to health care costs |        |
|---|--------|---------------------------------------|--------|---------------------------------------|--------|---|--------|
| Weight gain/loss (kg)                       | Months | Calving rate (%)                      | Months | Costs (FCFA/cow)                      | Months | Costs (FCFA/cow)                          | Months |
| A 21.62                                     | 6      | A 5.38                                | 8      | A 807.00                              | 2      | A 253.63                                  | 7      |
| BA 18.75                                    | 5      | BA 4.97                               | 9      | B 590.00                              | 3      | BA 246.88                                 | 6      |
| BAC 14.12                                   | 7      | BA 4.73                               | 5      | CB 449.00                             | 4      | BAC 111.00                                | 8      |
| BAC 13.00                                   | 9      | BA 4.38                               | 4      | C 361.00                              | 1      | BC 72.00                                  | 2      |
| BC 11.87                                    | 8      | BA 4.13                               | 6      | D 210.00                              | 5      | BC 70.00                                  | 10     |
| DC 7.37                                     | 10     | BA 4.13                               | 7      | D 168.00                              | 12     | C 53.13                                   | 5      |
| D 1.86                                      | 11     | BA 3.43                               | 10     | D 142.00                              | 6      | C 50.00                                   | 9      |
| E -10.44                                    | 2      | BA 2.50                               | 2      | D 131.13                              | 11     | C 39.00                                   | 4      |
| FE -10.62                                   | 12     | BA 2.00                               | 3      | D 129.00                              | 9      | C 36.00                                   | 11     |
| FE -11.06                                   | 1      | B 1.96                                | 11     | D 122.13                              | 10     | C 29.00                                   | 12     |
| FE -16.00                                   | 3      | B 1.95                                | 1      | D 117.88                              | 8      | C 25.25                                   | 3      |
| F -20.50                                    | 4      | B 0.89                                | 12     | D 117.38                              | 7      | C 17.00                                   | 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.



November (Table 1, 4<sup>th</sup> column). This implies low lignin content of forage and therefore a better digestibility at the best period compared to the other periods of the year (Nelson and Moser, 1994). As for the water content of forage, the best period is maintained (Table 1, 5<sup>th</sup> column) with water content ranging from 44.39% to 81.45%. This shows that during this period and precisely in June, July and August, photosynthetic activities occur in forage plants, since these occur when the rate of humidity in forage plants leaves is at least 70% (MINCOOP, 1993).

Duncan test results presented in Table 2 show that the period from May to November is a period of highest weight gains (1.86 kg to 21.62 kg per month), the month of June being the best of the year (Table 2, 1<sup>st</sup> column). For the other performances like calving and therefore milk production, the best period is still maintained, the highest calving rate being registered in August (Table 2, 2<sup>nd</sup> column). For the cattle production cost and more precisely the feeding cost, there is no doubt that the expenditures are the lowest during the period from May to November (Table 2, 3<sup>rd</sup> column). Concerning the animal health care cost, the best period is rather not favourable for cattle health since the highest significant expenditure for animals health is done in July. This could be explained by the fact that, the major cattle diseases in this region (like dermatophilosis, tick-borne diseases and foot-and-mouth disease), are very severe during the rainy season (April-October). However this relative high health care cost in July has no significant effect on the delimitation of the best period, since it represents only 31.5% of the highest cost of feeding registered in February (Table 2, 3<sup>rd</sup> and 4<sup>th</sup> columns).

From the above results, it can be concluded that the period from May to November is the best forage production period for cattle farming in the Adamawa region.

It is worth noting that this period is significantly different to the rainy season which starts in March and end in October in the Adamawa region (Bring, 1999).

The characteristics of this period (average forage yield and chemical composition, cattle performances, feeding and health care cost) are presented in Table 3. According to this table, best forage quality, good cattle performances and lowest cost of feeding are registered during this period.

## DISCUSSION

### Characteristics of the best period

#### *Average yield and chemical composition of forage at the best period*

The best forage production period in the Adamawa is characterized by a continuous increase of forage productivity in the rangeland (Table 3, 2<sup>nd</sup> column). It is during this period and more precisely in the months of October and November that the highest dry matter yield of forage is obtained. This result is not surprising because, as explained above (section 3.1.), all the photosynthetic activities responsible of the manufacturing of the forage dry matter occur between May and September. It can be noted that the forage yield in May, which was expected to be lower than that in June and July is instead a bit higher (Table 3, 1<sup>st</sup> column); this could be explained by the infiltration of the remainders of the previous dry season forage in the forage samples collected in May. Although all the forage biomass is produced during the best period, it is worth noting that the average dry matter yield in the dry season (October – March) is higher (2.12 t/ha) than that of the best period (1.38 t/ha). This could be explained by the fact that the quality of forage in the Adamawa follows a negative trend as the length of growing period prolongs (Enoh et al., 2005); the excess forage biomass produced towards the end of the best period, being of poor quality and then less or not palatable by cattle, remains through out the dry season. This is also confirmed by the evolution of other chemical elements of forage in the best period: the crude protein content of forage decreases from 7.11% in June to 4.48% in November with an average monthly value of 5.89% (Table 3, 3<sup>rd</sup> column) against 3.53% in the dry season; the minerals

**Table 3:** Characteristic parameters of the best period for cattle farming in the Adamawa, Cameroon.

| Months of the best period | Forage characteristics at the best period |                       |                      |                 |                        | Cattle performances at the best period |                  |                  | Cattle feeding cost at the best period |                         | Cattle Health care costs at the best period |
|---------------------------|---|-----------------------|----------------------|-----------------|------------------------|--|------------------|------------------|--|-------------------------|---|
|                           | Forage Yield (t DM/ha)                    | Organic matter (% DM) | Crude protein (% DM) | Minerals (% DM) | Crude cellulose (% DM) | Moisture (% DM)                        | Weight gain (Kg) | Calving rate (%) | Amount (FCFA/cow)                      | % total production cost | Amount (FCFA/cow)                           |
| May                       | 0.78                                      | 91.31                 | 5.02                 | 8.70            | 34.79                  | 66.72                                  | 18.75            | 4.73             | 210                                    | 79,85                   | 53  |
| June                      | 0.47                                      | 89.65                 | 7.11                 | 10.39           | 31.86                  | 81.45                                  | 21.62            | 4.13             | 142                                    | 36,50                   | 247   |
| July                      | 0.69                                      | 90.12                 | 6.55                 | 9.89            | 31.66                  | 79.55                                  | 14.12            | 4.13             | 118                                    | 31,72                   | 254   |
| August                    | 1.27                                      | 90.60                 | 6.19                 | 9.39            | 31.45                  | 72.06                                  | 11.87            | 5.38             | 118                                    | 51,53                   | 111   |
| Sept.                     | 1.87                                      | 91.02                 | 6.03                 | 8.97            | 32.55                  | 67.42                                  | 13.00            | 4.97             | 129                                    | 72,07                   | 50  |
| Oct.                      | 2.26                                      | 91.44                 | 5.87                 | 8.55            | 33.65                  | 59.75                                  | 7.37             | 3.43             | 122                                    | 63,54                   | 70  |
| Nov.                      | 2.31                                      | 91.90                 | 4.48                 | 8.58            | 34.37                  | 44.39                                  | 1.86             | 0.00             | 131                                    | 78,44                   | 36  |
| <b>Average</b>            | <b>1.38</b>                               | <b>90.86</b>          | <b>5.89</b>          | <b>9.21</b>     | <b>32.90</b>           | <b>67.33</b>                           | <b>12.66</b>     | <b>3.82</b>      | <b>139</b>                             | <b>54.30</b>            | <b>117</b>                                  |

DM: Dry matter

content of forage decreases from 10.39% in June to 8.55% in November with an average monthly value of 9.21% against 7.42% in the dry season. This same trend is observed with the water content of forage in the best period which decreases from 81.45% in June to 44.39% in November around an average monthly value of 67.33% against 29.73% in the dry season. Concerning the crude cellulose content in the best period, this increases from 31.86% in June to 34.37% in November against 36.14% in the dry season.

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 months, 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.(2005) 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, found an annual biomass of 2 – 3.5 t/ha and a total crude protein content of fodder of 5 – 11% of the dry matter depending of the season and phenological 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 best period since it was carried out only on 12 weeks (about 3 months) and one forage species.

From the above analysis, it can be concluded that the quality of forage in the best period is significantly better than that in the dry season. Moreover, the month of June is the best month of both the period and of the year concerning the forage quality.

This result is very important for cattle feed supplementation in the Adamawa, since protein supplement (in the form of cotton-seed cake) and minerals supplement (in terms of sodium chloride and calcium nitrate) are the most limiting elements for cattle feeding in the region, that is, the ones having the highest demand and on which farmers spend most money for the maintenance of their animals during the period of forage scarcity (Mingoas et al., 2006; Deffo et al., 2009).

#### ***Average cattle performance in the best period***

The results on cattle performance (Table 3, 8<sup>th</sup> and 9<sup>th</sup> columns) show that during this period, an average monthly weight gain of 12.66 kg is recorded against an average annual weight gain of 1.86 kg per month (Table 2) and against an average monthly weight loss of 10.73 kg in the dry season which is generally considered as a difficult period for livestock farming in the region (Mingoas et al., 2006). As for calving, the average monthly rate is 3.82% against an annual rate of 3.37% per month (Table 2) and against a dry season monthly rate of 1.86%. This result is similar to that of Mingoas et al. (2006) which showed that the peak of calving in the peri-urban zone of Ngaoundere (Adamawa) was between the months of March and July corresponding to breeding that occurred during the previous rainy season when pastures have abundant and good quality forage. Another factor explaining the high effect of the best period on calving is that, calving in Adamawa are natural, that is, unplanned, making that the periods of high demand coincide with the periods of low production (November - March). Djoko et al. (2003) also noted that inter annual variations in milk production by cattle were attributed to fluctuation in feed (pastures) availability and quality through seasons.

The above findings support our on-farm observations that, when the quantity or quality of forage increases, there is a corresponding increase in the production performance (weight gain, milk production) of the cattle grazing on that pasture. 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 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) had significant more daily weight gain than those of the same age left on the pasture (1 UBT/ha stocking rate) with the same level of feed supplement. 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 to cattle to select good quality forage leading to higher performance than in a pasture having less forage production.

#### ***Financial and economic consequences of the best period***

The analysis of the cattle production cost (feeding + health costs) shows that, in the best period, feeding cost represents 54.30% of the average monthly production cost per cow (Table 3, 11<sup>th</sup> column) as against 77.07% of the total average monthly production cost per cow registered through out the year and against 91.74% in the dry season (Table 2). Compared to the dry season, there is a 37.44% decrease in the feeding cost (about 167.73 FCFA = 0.252 euro); less money is spent per cow per month in the best period. This saving represents an economic gain of 469,644,000 FCFA (717,014 euros) per month and 3,287,508,000 FCFA (5,019,096 euros) per year for the 2.8 million cattle of the region and the 7 months best period. The economic gain would be higher than above if taking into consideration the weight and calving gains during this period.

In terms of weight gain, when compared to the dry season, the best period causes a monthly average gain of 23,39 kg (12.66 kg – (- 10.73 kg)) per cow, which for the 2.8 million cattle in the region, represents 65,492,000 kg and thus 458,444,000 kg per year. Evaluating with the current average market price of about 600 FCFA/kg live weight, this weight gain corresponds to an economic gain of about 275,066,400,000 FCFA (419,948,702 euros) per year. Considering the calving gain, still compared to the dry season, the best period causes an extra calving rate of 1.96% per month giving 13.72% per year for the seven months best period. Extrapolating this result to the cattle population in the Adamawa and given the herd structure of 46% females and 54% males in the Adamawa (Mingoas et al., 2006) and the calf mortality rate of 7% (MINCOOP, 1993), this effect of the best period on cattle calving corresponds to about 164,344 calves gained per year. To assess the monetary value of this gain, the value of a calf at birth was estimated to be 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. To this value is added 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, to obtain a total of 33,789 FCFA (51.59 euros) per calf. Therefore, the increase in calving due to the best period represents an economic gain of about 5,553,019,416 FCFA (8,477,892 euros) per year. To this calving gain, should be added the gain in milk consumption by daily milking. This has been estimated to be about 1.5 l of milk per day per cow (Mingoas et al., 2006), giving a total of 246,516 l/day for the 164,344 cows and then 44,372,880 l for 6 months milking. When evaluating this at the farm gate price of 150 FCFA/l, it gives an economic value of 6,655,932,000 FCFA (10,161,728 euros) per year.

Therefore, the best forage production period for cattle farming in the Adamawa, when compared to the dry season, results in a total economic gain of about 289,562,859,416 FCFA (443,607,418 euros) per year.

It is worth noting the above assumption used in the assessment of the value of a calf is only useful when the main objective of cattle farming is calves production as it is the case in the Adamawa.

### Conclusion

The main objective of this study was to determine the best forage production period for cattle farming in the Adamawa (Cameroon). This objective has been achieved using diachronic observations of a representative rangeland and cattle herd for a period of 24 months. This has been identified to be from May to November. The period is characterized by high photosynthetic activities in forage plants, the best forage quality in the rangeland, the highest cattle performance and the lowest cost of cattle feeding. The best period so determined, with all its effects on forage and animal performance compared to the dry season, results in important economic gain estimated at about 289,562,859,416 FCFA (443,607,418 euros) per year in the Adamawa Region of Cameroon.

The best period, so delimited with its characteristics, could serve as an important decision making tool for livestock sector improvement in the Adamawa region and even Cameroon and other tropical countries with similar climatic conditions and livestock farming systems. For instance, farmers could rely on this to plan their feed supplementation through out the year and therefore improve on their cattle performance and their revenue. Government can also use this factor as an important tool for its priority setting in decisions making. The best period and especially its characteristics could also serve as baseline for further studies or projects related to rangeland management or cattle performance improvement in the Adamawa (Cameroon)

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