INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

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# GENETIC AND NON-GENETIC FACTORS AFFECTING BIRTH WEIGHTS OF CROSSBRED DAIRY CALVES IN THE WESTERN HIGHLANDS OF CAMEROON

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## ABSTRACT
The aim of this study was to evaluate effect of genetic and non-genetic factors on birth weights of Jersey-White Fulani and Holstein- Gudali crossbred dairy calves in the Western Highlands of Cameroon. The data retained for the analysis were those covering the period from 1987 to 1998. Each experimental animal was identified such that the animal records would give complete information on calf germplasm, calf sex, dam parity, calf birth weight, calving month, calving season and calving year. The General Linear Models procedures of SPSS 23 for windows were used to statistically analyze the data. Whenever a significant effect was found, the Tukey's multiple rang tests was used. The overall mean of birth weight for Jersey-White Fulani and Holstein- Gudali crossbred dairy calves was 26.67 ± 0.41 kg. Crossbred dairy calf's birth weight was significantly affected ($p<0.0001$) by genetic group, calving month, calving season, calving year and dam parity ($p<0.05$). Sex of calf on the other hand, did not seem to have a significant effect ($p>0.05$) calf's birth weight. Holstein-Gudali crossbred dairy calves were significantly ($p<0.0001$) heavier than Jersey-White Fulani crossbred dairy calves. They registered the highest birth weight values for the three different ranges (≤ 20, >20-30 and >30 kg birth weight ranges). Season of calving had a significant effect ($p<0.05$) on calves birth weight, with calves born in rainy season had higher birth weights (27.46kg) compared to those born in the dry season (25.88kg). Increase of calf birth weight with parity was not linear though there was a significant difference ($p<0.05$) between the birth weights at third parity (27.40 ±0.51kg) compared with other parities. Cows at their third parity produced calves of highest birth weight as compared with heifers (26.61 ± 0.48 kg) and cows at the parity 7 (26.49± 0.57 kg) while oldest cows (parity 5 and 7) produced calves of lowest birth weight. The effects of months of birth on birth weight have been shown to be variable ($p<0.05$) and inconsistent throughout the study. Due to non-systematic factors such as the introduction in later years of supplementary feeding in the form of cottonseed cake and rice bran in the dry season months, higher birth weight were observed both during the raining season (27.07 ± 0.70 kg in October) and during the dry season (27.71 ±0.76 kg in November). It is therefore advantageous to have calving during the end of the dry season and start of the rains because of supplementary feeding may not be necessary.

**KEY WORDS**: crossbred, dairy calves, genetic and non-genetic factors, birth weight, western highlands, Cameroon

## INTRODUCTION
Cross breeding is an established method used in cattle breeding to increase productivity. This productivity could be measured in calves by their birth weight (Akbulut *et al.,* 2011a). Birth weight in farm animals is the characteristic that influences lifetime yields (Karakus *et al.,* 2010). Greenwood *et al.* (2006) reported that the body substance deposited daily is proportional to weight of the growth mass; as consequence the small birth weight, the lower absolute daily gain of given age up to weaning. It is demonstrated that calves having too small live weight at birth may lack vigor and tolerance to external condition, whereas various degrees of dystocia may occur in calves that are too large at birth. Besides these extremes, cattle having high birth weight grow fast and produce more milk (Bakir et *al.,* 2004). In addition dams with heavier calves produce more milk (Brown *et al.,* 2006). Birth weight is an economically important production trait that is mostly influenced by additive and non-additive gene action of the calf and the dam (Njoya *et al.,* 1998). Specification and potential quantification of the influence of factors affecting calf birth weight are useful for formulating management and selection decisions. This requires that non-genetic and genetic factors influencing the accuracy of predicted birth weight values be either controlled experimentally or eliminated statistically (Van Wyk *et al.,* 1993).
Therefore the objective of this study was to evaluate the genetic and non-genetic factors affecting birth weights of Jersey-White Fulani and Holstein-Gudali dairy crossbred dairy calves in the Western Highlands of Cameroon.

## MATERIALS AND METHODS

### Description of the study area

The study was carried out at the dairy cattle research section of the Institute of Agricultural Research for Development Bambui Regional Centre. The Bambui Regional Centre is located at latitude 5°20' and 7°N, longitude 9°40' et 11°10' E. Research activities of the Centre cover the West and North West regions which form the Western highlands of Cameroon. The Western highlands of Cameroon also known as Western High Plateau cover an area of 31,150 km$^2$, which is equal to 6.6% of the national territory. It is a hilly complex with altitudes ranging from 300 m for the lowest areas to above 3000 m above the sea. Weather is described as tropical. Annual rainfall varies from1500 to 3000 mm with a mean of 2000 mm/year. Mean relative humidity for the dry season is 52% and 70% for the rainy season, with an absolute minimum of 22%. The rainfall has a unimodal pattern and runs from mid-March to October. The dry season is fresh from November to December, then hot until mid-March. Soils are largely volcanic (Bayemi *et al.*, 2005). The Centre has managed pastures with natural or improved (exotic) areas of vegetation. Natural vegetation is made of elephant grass (*Pennisetum purpureum*), Kikuyu grass (*Pennisetum clandestinum*), *Hyperrhenia* sp. and *Sporobolus africanus*, which are common. *Leguminosae* include *Stylosanthes guyanensis*, *Stylosanthes scabra* and *Desmodium* sp. Among exotic *Gramineae* species introduced are: *Brachiaria ruziziensis*, *Panicum maximum* and Guatemala grass (*Trypsa cumlaxum*).

### *Experimental Animal Management*

The farming system was semi-intensive and breeding was done by artificial insemination (AI). The six animal genotypes used in this study were the results of crosses between exotic males Jersey (J) and Holstein (H) breeds with local White Fulani (WF) and Gudali (G) female breeds as follows: Jersey-White Fulani (50%Jx50%WF) and Jersey-White Fulani backcrosses (75%Jx25%WF, 87.5%Jx12.5%WF); Holstein-Gudali (50% Hx50% G) and Hostein-Gudali backcrosses (75% Hx 25% G, 87.5%Hx 12.5% G). During the rainy season (mid-March to October) animals were put on natural or improved pastures while in the dry season (November to mid-March), alongside grazing they were mainly fed silage made of Guatemala grass and *Pennisetum*, together with *Brachiaria* hay. Milking was essentially performed with milking machines twice a day, at 6 AM and 5 PM. During milking and immediately after, cows received 4kg (2kg in the morning and 2kg in the evening) of concentrate diet.

### Nutrition of cows

Feeding consisted of forage (*Pennisetum clandestinum*, *Stylosanthes and Bracharia sp*) and hay, which was distributed *ad libitum* to animals when they were not on pasture. During the rainy season (mid-March to mid-November), herdsmen grazed cows in rotation on pastures from 9 AM to 4 PM. In the dry season (mid-November to mid-March), in addition to grazing, cows received Guatemala silage and elephant grass. They also received hay from *Brachiaria ruziziensis*. Administration of water was *ad libitum* in concrete water troughs placed in pasture or in shed. Lactating cows each received 4kg of concentrate made of 38% of corn, 30% rice or wheat bran, 30% cotton seed cake, 1% bone meal and 1% common salt. The feed was distributed in the morning (8 AM) and in the evening (5 PM).

### Nutrition of calves

After calving, calves received colostrum at their mother's discretion for the first four days. After this period, they were separated from their mothers and placed in individual boxes where they each received 2 to 4 liters of milk per day, this according to their birth weight. One week after parturition, the concentrate was introduced gradually (up to 2 kg per day) afterwards; forage and water were served *ad libitum* at two weeks of age.

### Herd health management

Vaccination program of IRAD Bambui research centre covered the following pathologies: pasteurellosis and anthrax. Animals were de-wormed against ticks once a month in the dry season and twice a month during the rainy season. Gastrointestinal and pulmonary parasitism in cattle is common diseases in the region. Panacur dewormers (fenbendazole) were administered every two months. The fight against ticks that transmit heartwater, babesiosis and anaplasmosis was done with Supona (chrophenvinphos, organophosphorus). Daily cleaning of livestock premises and disinfection were the other aspects of prophylaxis.

### Collection of data

Information in a period of 11 years (1987-1998) obtained from the database of IRAD Bambui Research Center were used in this study. These include data on birth, mortality, reproduction and milk production. These data were used to distribute animals according to their reproductive and dairy production performances.

### Data analysis

Data for birth weight were subjected to analysis of variance of fixed e ects using the General Linear Model (GLM) procedures of SPSS version 23. Tukey's multiple range test was used for testing the differences between least squares means between sub-classes at p<0.05.

***Model used to analyze calf birth weight was:***

$$\mathbf{Y_{ijklmno} = \mu + B_i + S_j + S_k + W_l + P_m + Y_n\, e_{ijklmno}}$$

Where $Y_{ijklmn}$ is the observation on birth weight; µ is the overall mean,

$B_i$ is the fixed effect of calf blood level (i=50%Jx50%WF, 75% Jx25%WF, 85.5%Jx12.5%WF, 50%Hx50%G, 75% Hx25%G) $S_j$ is the fixed e ect of sex of the calf born (j=female, male), $S_k$is the fixed e ect of calving season (k =dry season, rainy season) or $S_k$ is the fixed effect of month of calving (k = January to December), $W_l$ is the fixed effect of birth weight of calf born (l=1 to 3), $P_m$ fixed e ect of dam parity (m=1 to 7), $Y_n$ is the fixed effect of calf birth year (n=1987 to 2016) $e_{ijklmno}$ is the residual effect assumed to be independent and randomly distributed with a mean of zero and variance $\sigma^2$.

## RESULTS

The overall least square means and standard errors observed for dairy calf birth weights of Jersey-White Fulani and Holstein-Gudali crossbred was 26.67 ± 0.41 kg (Table1). There was no significant difference (p>0.05) in birth weight among Jersey-White Fulani crossbred dairy calves although dairy calves with 75% of blood Jersey blood had a mean birth weight (26.18 ±0.49kg) higher compared with other crossbreds. Results also showed that, birth weight was significantly higher ($p<0.0001$) between Holstein-Gudali crossbred dairy calves with dairy calves with 75% of blood Holstein blood having the higher birth weight (28.25 ±0.97 kg) compared with calves with 50% (26.72 ±0.50 kg) and 85.5% (27.51 ±0.54 kg) of Holstein blood respectively.

Sex of the calf had a slight influence on calves' birth weight; with males heavier than females which is classic but, the difference (0.35 Kg) was not significant ($p>0.05$).

Results showed a significant difference ($p<0.05$) between months of calving. Results on table 1 reveals that, crossbred calves birth weight increased from October (27.07 ± 0.70 kg) to March (27.02 ± 0.59 kg). The highest birth weight was recorded in November (27.71 ± 0.76 kg) and the lowest birth weight recorded in August (25.96 ± 0.74 kg) and September (25.96 ± 0.74 kg) respectively. Season of calving had a significant effect ($p<0.05$) on calves birth weight of Jersey-White Fulani and Holstein-Gudali crossbred with a difference of 1.58kg between calves born during the rainy season (27.46 ±0.46 kg) as compared with birth weight (25.88 ± 0.88 kg) of calves born during the dry season.

Calves birth year although not consistent over time was found to be a significant ($p<0.05$) source of variation for birth weight of Jersey-White Fulani and Holstein-Gudali dairy crossbred. The years 1993, 1994, 1995, 1996 had 26.37 ± 0.50 kg; 28.16 ± 0.52 kg; 26.35 ± 0.54 kg; 27.84 ± 0.60 kg of birth weights respectively.

Dam parity had a significant ($p<0.05$) effect on calves birth weight. Although there was a significant difference between the birth weights at third parity (27.40 ±0.51kg) compared with other parities, increase of calf birth weight with parity was not linear. Cows at their third parity produced calves of highest birth weight as compared with heifers (26.61 ± 0.48 kg) and cows at the parity 7 (26.49± 0.57 kg). Oldest cows (parity 5 and 7) produced calves of lowest birth weight, with a difference ($p<0.05$) of 1.14 and 0.91 kg respectively as compared with calves birth weight from cows at parity 3.

**TABLE 1:** Least-squares means (± SE) for birth weight (kg) of crossbred dairy calves in the Western Highlands of Cameroon

| Source of variation | N | Means ± SE |
|---|---|---|
| Over all | 455 | 26.67 ± 0.41 |
| Genetic group | | *** |
| 50%Jx50%WF | 116 | 25.74 ± 0.50$^{a}$ |
| 75%Jx25%WF | 119 | 26.18 ± 0.49$^{a}$ |
| 87.5%Jx12.5%WF | 108 | 25.64 ± 0.51$^{a}$ |
| 50%Hx50%G | 45 | 26.72 ± 0.50$^{ab}$ |
| 75%Hx25%G | 57 | 28.25 ± 0.97$^{c}$ |
| 87.5%Hx12.5%G | 10 | 27.51 ± 0.54$^{b}$ |
| Sex | | NS |
| Male | 247 | 26.80 ± 0.43 |
| Female | 208 | 26.55 ± 0.43 |
| Month of birth | | * |
| January | 28 | 27.05 ± 0.70$^{a}$ |
| February | 35 | 27.62 ± 0.78$^{ab}$ |
| March | 50 | 27.02 ± 0.59$^{abc}$ |
| April | 43 | 26.02 ± 0.65$^{abcd}$ |
| May | 42 | 26.04 ± 0.65$^{bcde}$ |
| June | 29 | 26.55 ± 0.69$^{cde}$ |
| July | 26 | 26.32 ± 0.65$^{cde}$ |
| August | 46 | 25.96 ± 0.74$^{def}$ |
| September | 52 | 25.96 ± 0.74$^{ef}$ |
| October | 36 | 27.07 ± 0.70$^{ef}$ |
| November | 35 | 27.71 ± 0.76$^{ef}$ |
| December | 33 | 26.82 ± 0.73$^{e}$ |
| Season of birth | | * |
| Dry | 150 | 25.88 ± 0.88$^{a}$ |
| Rainy | 305 | 27.46 ± 0.46$^{b}$ |
| Year of birth | | * |
| 1987 | 57 | 26.01 ± 0.41 |
| 1988 | 56 | 26.30 ±. 040 |
| 1989 | 47 | 25.38 ± 0.44 |
| 1990 | 56 | 26.32 ± 0.41 |
| 1991 | 46 | 25.95 ± 0.45 |
| 1992 | 47 | 26.05 ± 0.43 |
| 1993 | 35 | 26.37 ± 0.50 |
| 1994 | 33 | 28.16 ± 0.52 |
| 1995 | 32 | 26.35 ± 0.54 |

| | | |
|---|---|---|
| 1996 | 24 | 27.84 ± 0.60 |
| 1997 | 12 | 25.40 ± 1.13 |
| 1998 | 10 | 26.80 ± 2.74 |
| Parity | | * |
| 1 | 96 | 26.61 ± 0.48[a] |
| 2 | 90 | 26.39 ± 0.47[a] |
| 3 | 74 | 27.40 ± 0.51[b] |
| 4 | 61 | 26.64 ± 0.52[a] |
| 5 | 45 | 26.26 ± 0.58 [a] |
| 6 | 40 | 26.93± 0.59[ab] |
| 7 | 49 | 26.49± 0.57[a] |

*a,b,c,d,e:Values carrying different superscripts within the cell are significantly different*
*N=number of observations*
*J= Jersey, WF=White Fulani, H=Holstein, G= Gudali*
**** = Very highly significant (P < 0.0001); * Significant (P < 0.05); NS = Non significant (p >0.05)*

Average distribution for birth weight (Kg) per ranges of Jersey and Holstein crossbred dairy calves is represented in the figure 1. In the Jersey crossbred dairy calves groups, calves with 75% of exotic blood (75%Jx25%WF) showed the highest birth weight 18.68; 24.59 and 36.5kg respectively for the ≤ 20, >20-30 and >30 kg birth weight ranges. Meanwhile, in the Holstein crossbred dairy calves groups, calves with 75% and 87.5% of Holstein exotic blood (75% Hx 25%G and 87.5% Hx12.5% G) did not have birth weight lower than 20 kg and were then represented only in the second (>20-30 kg) and third (>30 kg) range with 75%Hx 25%G having the highest birth weight (26.5 kg) for the second range and 87.5% Hx12.5%G having the highest birth weight (37 kg) for the third range.

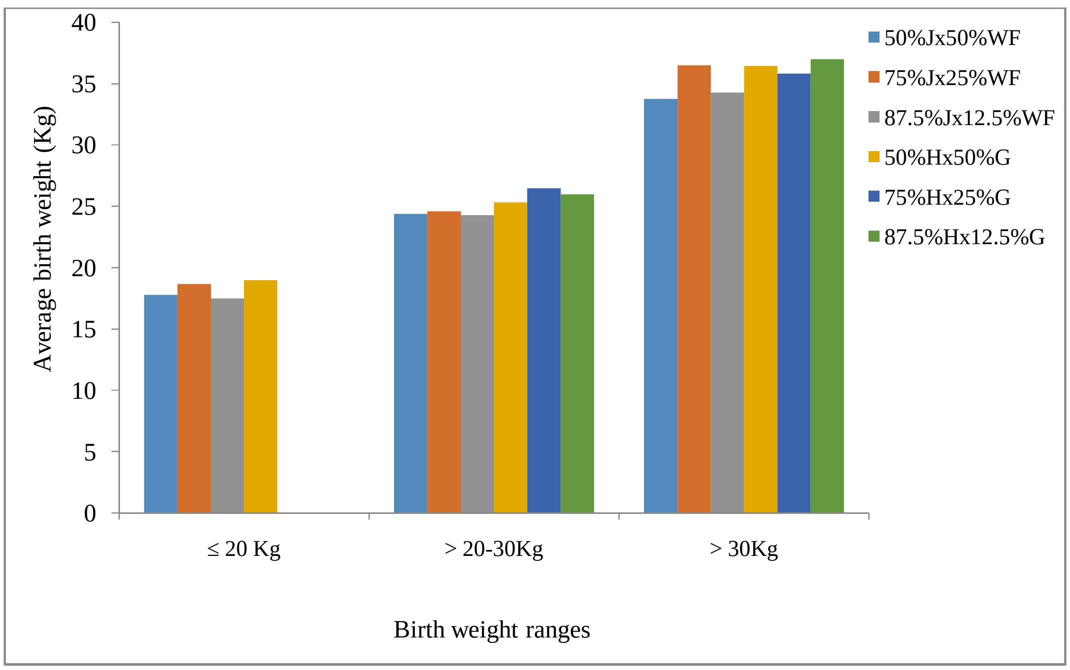


**FIGURE 1:** Average distribution for birth weight (Kg) ranges of crossbred dairy cattle in the Western Highlands of Cameroon

Though the majority of the calves used during this study was born during the rainy season and were 1.58 kg heavier than those born during the dry season, effects of season and month of birth on birth weight have been shown to be variable and inconsistent between the different groups of calves involved in this study. Calves for all the different groups that were born at the mid-rainy season (from June to September) and those born at the late rainy season (October) and mid-dry season (December) got heavier, with the maximum weights achieved respectively by 50%Hx50%G during the months of June (33.25 kg), July (36.6 kg), September (33 kg), October (33 kg) and by 75%Hx25%G in December (33 kg) (Figure 2). The month of March recorded the lowest (18 kg) calf birth weight performed by 87.5%Jx12.5%WF crossbred dairy calves (Fig. 2).

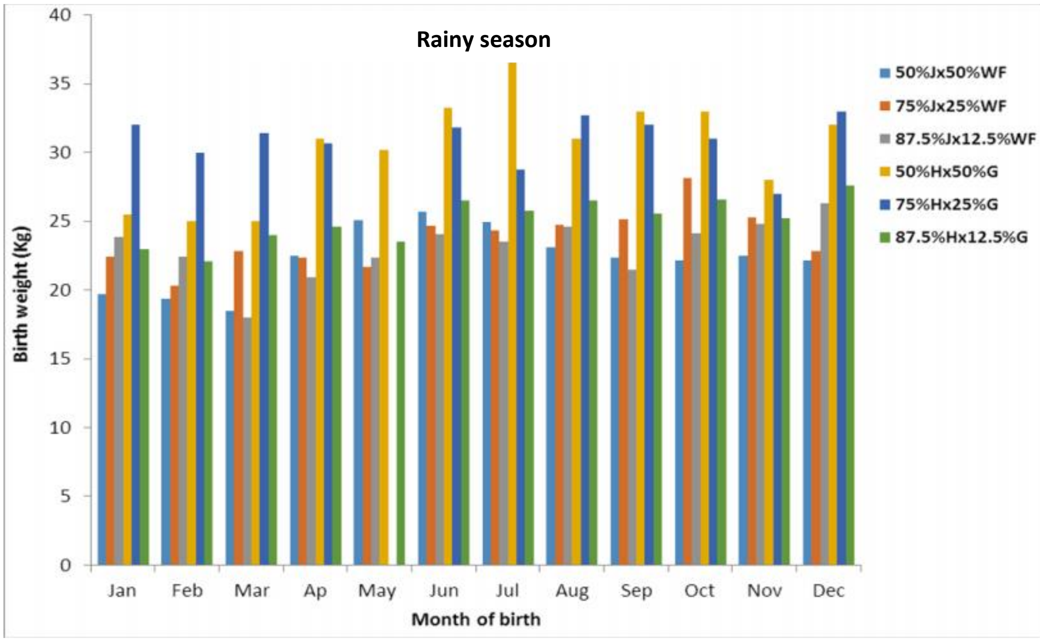


**FIGURE 2:** Effect of month and season of calving on calves' birth weight of crossbred dairy cattle in the Western Highlands of Cameroon

Females with higher parity had consistently calves with higher birth weight (Fig. 3). Though, birth weight increases were not linear from 1st to 7th parity, cows which calved for the first and second time had the lightest ($p < 0.05$) calves at birth than the other higher parities whereas most cows had the heaviest birth weight on their third parity. Even though cows with higher parity had consistently calves with higher birth weight, the effect of dam parity on calves' birth weight of crossbred dairy cattle in the Western Highlands of Cameroon fluctuated between the different groups of animals taken in consideration in this study. The, 50%Jx50%WF, 75%Jx25%WF, 87.5%Jx 12.5%WF and, 50%Hx 50%G, 75%Hx 25%G and 87.5%Hx 12.5%G had calves with higher birth weight at the 5th (23.09 kg), 3rd (26.4 kg), 4th (24.2 kg), and 7th (37 kg), 6th (39 kg) 3rd (39.5 kg) respectively. The lowest (20.8 kg) birth weight value was recorded with 50%Jx50%WF crossbred dairy calves at the parity 6.

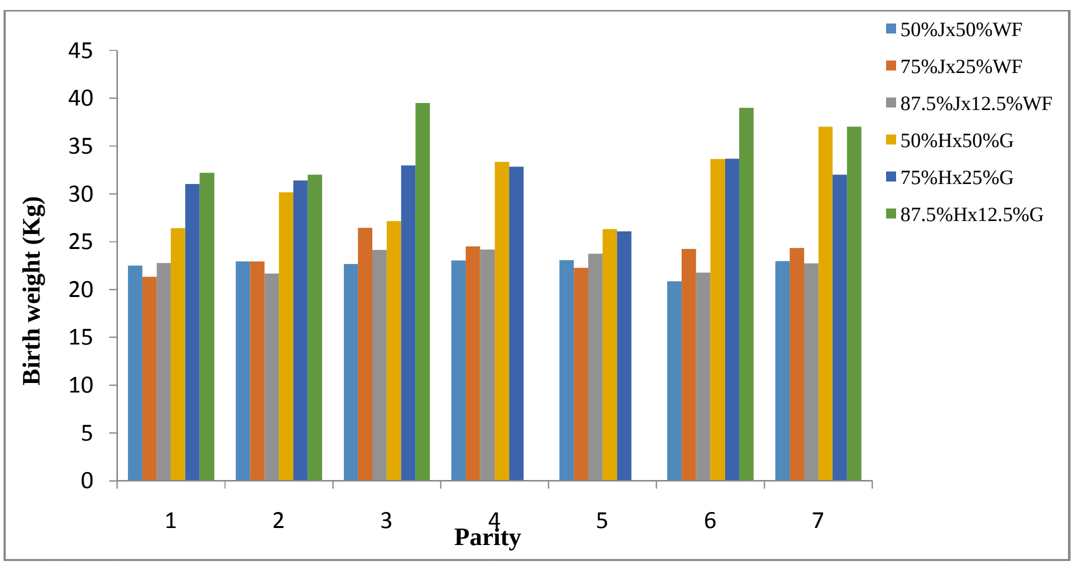


**FIGURE 3:** Effect of dam parity on calves' birth weight of crossbred dairy cattle in the Western Highlands of Cameroon

## DISCUSSION

Average birth weights (26.67 ±0.41 kg) obtained in this study for Jersey-White Fulani and Holstein-Gudali crossbred dairy calved were higher than values reported for White Fulani calves (Njoya *et al.*, 1998), Gudali and Wakwa calves (Ebangi *et al.*, 2002; Ndofor-Foleng *et al.*, 2011) and values reported by Kouamo *et al.* (2014) with both Gobra- Holstein and Gobra-Montbeliard crossbred. Birth weight obtained in this study demonstrated that crossbred dairy cattle have a birth weight generally higher than local breeds birth weight (Leroy *et al.*, 2001b).

**Effect of genetic group**

There was no significant difference (p>0.05) in birth weight among Jersey-White Fulani crossbred dairy calves although dairy calves with 75% of blood Jersey blood had a mean birth weight (26.18 ±0.49kg) higher compared with others crossbred. Birth weight was significantly higher (p<0.0001) among Holstein-Gudali crossbred dairy calves with dairy calves with 75% of blood Holstein blood having the higher birth weight (28.25 ± 0.97 kg) compared with calves with 50% (26.72 ± 0.50 kg) and 85.5% (27.51 ± 0.54 kg) of Holstein blood respectively. Figure-1 revealed that Holstein-Gudali crossbred dairy calves had the highest birth weight values for the three different ranges (≤ 20, >20-30 and >30 kg birth weight ranges). Calves having 75% and 87.5% of Holstein exotic blood (75% Hx25%G and 87.5% Hx12.5%G) did not have birth weight lower than 20 kg. The differences observed with the two genetic groups (Jersey and Holstein) could be attributed to the differences in genotypic and phenotypic conformation of these two groups of crossbred dairy cattle, as Holstein cattle are bigger than Jersey cattle. Thus this inheritance of Holstein was transmitted to their crossbreds.

Effect of calf's sex

Although sex did not significantly influence (p>0.05) the birth weight of Jersey-White Fulani and Holstein-Gudali crossbred, males were however heavier of than females which is classic. The effect of sex on calves' birth weight has also been reported in several studies (Ndofor-Foleng *et al.,* 2011; Mekonne *et al.,* 2011; Kouamo *et al.,* 2014 and Bayou *et al.*, 2015). The effect of sex on calves' birth weight obtained in this study is dissimilar to the results reported by Getinet *et al.* (2009) for Ogaden cattle breed of Ethiopia, by Ndofor-Foleng *et al.* (2011) for Gudali and Wakwa cattle breed in Cameroon and by Bayou *et al.* (2015) for Sheko cattle in Southwest Ethiopia. However, similar results were reported by Tawah *et al.* (1993), Njoya *et al.* (1998), and Kouamo *et al.* (2014) who did not find any sex effects on calves' birth weight. The difference (0.35kg) observed between males and females may be attributed to the fact that males grow more rapidly and reach a greater mature weight while females have slower rate of growth and reach maturity at smaller size due to the effect of hormonal differences in their endocrinological and physiological functions, and to selection pressure that was more intense on males than female calves (Koger and Knox, 2009).

**Effect of season of calving**

Season of calving had a significant effect (p<0.05) on calves birth weight of Jersey-White Fulani and Holstein-Gudali dairy cattle crossbred. This significant seasonal variation may be due mainly to variations in feed and fodder availability as well as disease incidence (Bell, 2006) in different seasons. Calves born in rainy season had higher birth weights (27.46kg) compared to those born in the dry season (25.88kg). The reason being that, dams which calved in rainy season would have better pastures and consequently results in weight increase and better body condition of the pregnant dams during calving. Low birth weights observed with dry season could be attributed to the fact that, during the dry season, pastures are usually depleted, lignified and less nutritious. This state generates a nutritional stress resulting in weight loss and poor body condition of the pregnant dams thereby affecting fetal growth and development. The inherent nutritional stress is then reflected in the calf by a lower weight at birth in the dry season. These results are in agreement with those of Ebangi *et al.* (2002) and Ndofor-Foleng *et al.* (2011) who reported heavier birth weights for Gudali and Wakwa calves born in rainy season. Other studies, however, (Bayou *et al.,* 2015; Melaku *et al.,* 2011) reported higher birth weights for cows which had calved during the dry season. Ebangi *et al.* (2002) reported a highly significant effect of season on weight at birth and attributed it to seasonal variations in the total physical environment due to changes in the weather, which affected feed availability and disease incidence.

**Effect of months of calving**

Calves born during the months of November (27.71± 0.76), January (27.05 ±0.70) and February (27.62 ±0.78) showed a higher birth weight. The effects of months of birth on birth weight have been shown to be variable (p<0.05) and inconsistent throughout the study with calves for all the different groups born at the mid-rainy season (from June to September), those born at the late rainy season (October) and mid-dry season (December) showed a heavier birth weight. Higher feed availability and quality during the middle of rainy season puts the present results obtained in agreement with those reported by Ndofor-Foleng *et al.* (2011) showing that improved nutrition in the last trimester of pregnancy increases foetal growth. On the other hand, most of the rainy season calving occurred between April and October. Most of the dams that calved in the rainy season were conceived either in the latter part of the dry season or earlier part of the rainy season of the previous year. The pregnant dams, therefore, benefited from better nutrition that resulted in better body conditions. The comparative advantage is passed on to the calf during prenatal development. The inherent advantage is subsequently reflected in a higher birth weight during the rainy season months (Ebangi *et al.,* 2002). The fact that heavier calves were born towards the end of the rainy season (October) indicated that such calves benefited from better maternal (uterine) environment, as the gestating dams had better nutrition from the abundant and relatively rich pastures. Higher birth weight was observed during the dry season (November, December and January) when pastures are usually used up in nutritious. To face this situation, during the dry season (November to mid-March), cows were grazing but were mainly fed silage made of Guatemala grass and *Pennisetum*, together with *Brachiaria* hay and supplements of fresh Guatemala grass which could influence the birth weight observed for the month of December. Higher birth weight observed during late dry season month (February) may be due to the fact that, late dry season cows are, however, exposed to the earlier part of the rainy season, characterized by young nutritious pastures, favorable for their better body condition. The consequence is a higher fetal growth leading to a higher birth weight. It is therefore advantageous to have calving during the end of the dry season and start of the rains because of supplementary feeding may not be necessary (Ndofor-Foleng *et al.,* 2011).

**Effect of year of calving**

The significant ($p < 0.05$) year effect obtained in the present study is in agreement with reports by Youssao *et al.* (2000) for Borgou calves, Ebangi *et al.* (2002) for purebred and two-breed synthetics calves, Messine (2003) for Gudali calves, and Gbangboche *et al.* (2011) for Lagune calves. The significant effect of year on birth weight may be explained in terms of rainfall pattern in the Western Highlands of Cameroon. There were fluctuations in the annual rainfall, which generally affected the quality and quantity of forage available for dam and fetuses. The quality and quantity of forage usually influences the development of dam and thus of fetuses. Non-systematic factors such as the introduction in later years of supplementary feeding in the form of cottonseed cake and rice bran in the dry season could be responsible for fluctuations in birth weight patterns (Ebangi *et al.,* 2002). The effect of year includes several environmental factors as climatic changes, pastures availability, management and administration policies such as proper feeding. Improvement in pastures and herd management as a result of improvement in herdsman skills over the years could equally contribute to the significant year effect (Tawah *et al.,* 1993)

**Effect of dam parity**

Dam parity had a significant ($p<0.05$) effect on calves birth weight. Cows which calved for the first time had lightest ($p<0.05$) calves at birth than the other higher parities whereas cows on their third parity had the heaviest birth weight. This variation could be attributed to competition for growth of the young dam and the fetus for the available nutrients, and dams as first time calves may produce less milk than average whereas mature cows provided a good maternal environment to the developing fetus (Bayou *et al.,* 2015). In comparison with matured cows (parity 3 and 4), oldest cows (parity 7) usually produce calves of lower birth weight as production ability decreases along with the increasing of age dam. The significant ($p<0.05$) effect of parity on birth weight of Jersey-White Fulani and Holstein-Gudali crossbred dairy calves obtained in this study is in accordance with the findings of Tawah *et al*. (1993), Abassa *et al.* (1993) and Ndofor-Foleng *et al*. (2011) with Gudali and Wakwa breeds and is in agreement with research conducted by Mekonnen *et al.* 2011) and Bayou *et al.* (2015) who found lightest ($p<0.01$) calves on birth weight of Horro and Sheko calves at first parity respectively. However, some studies (Ebangi *et al.,* 2002; Melaku *et al.,* 2011; Addisu *et al.,* 2010)] reported non-significant effects ($p>0.05$) of parity on birth weight.

## CONCLUSION

There was no significant difference in birth weight among Jersey-White Fulani crossbred dairy calves meanwhile birth weight significantly different among Holstein-Gudali crossbred dairy calves. Birth weights in Jersey-White Fulani crossbred dairy calves and Holstein-Gudali crossbred dairy calves were significantly affected by the month and year of calving and parity of the dam. The effects of months of birth on birth weight have been shown to be variable and inconsistent throughout the study with calves for all the different groups born at the mid-rainy season (from June to September), those born at the late rainy season (October) and mid-dry season (December) showed a heavier birth weight. Non-systematic factors such as the introduction in later years of supplementary feeding in the form of cottonseed cake and rice bran in the dry season could be responsible for fluctuations in birth weight patterns observed over years. The general trend in calves birth weight although not linear, were increased as the parity increased from the first parity to the third parity after which there was a declining trend to the fifth parity implied that these traits attain their maximum at the third parity. Cows which calved for the first time had lightest calves at birth than the other higher parities, whereas cows on their third parity had the heaviest birth weight. Although sex did not significantly influence the birth weight of Jersey-White Fulani and Holstein-Gudali crossbred, males were however born heavier than their female counterparts.

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