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FACTORS INFLUENCING THE GROWTH PERFORMANCE OF CALVES FROM TERMINAL CROSSES OF THREE LOCAL BREEDS WITH SOME IMPORTED BREEDS IN THE WESTERN HIGHLANDS OF CAMEROON

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Abstract

The aim of this study was to investigate the effect of factors influencing growth performances (live weight and average daily weight gain) of 374 calves from terminal crossing between indigenous breeds (Gudali, White Fulani and Banyo) and three exotic breeds (Brahman, Brangus and Holstein). Data have been collected from 1993 to 2008 at the Agricultural Research Institute for Development (IRAD)-Bambui station western highlands of Cameroon. Growth performances were significantly influenced by several factors under study. Hence, pre-and post-weaning live weight and average daily gain (ADG) were significantly influenced by all the factors, excepted age and breed of dam, age and breed of sire for post weaning performance. Sex x breed interaction was significant at 90 days while season x breed interaction influenced all pre-weaning traits. Live weight varied according to season, month and year of calving. Calves born in the dry season were heavier than those born in the rainy season by 5.38% and 6.03% at weaning and 720 days respectively. Crossbred calves generally performed better than local breed for all traits considered. Male calves outperformed female by 5.48%, 5.19% and 12.66% at birth, weaning (205 days), and 720 days respectively. Middle-aged parents were found to account for heavier calves at both birth weight and final weight while very young and very old parents produced lighter calves for all growth parameters studied. ADG also showed the same tendency as live weight and varied with all the factors under study. The improvement of husbandry system may permit the calves to better express their growth potential in the western highlands of Cameroon

Keywords: Growth Performance; Terminal Crosses; Local Breeds; Western Highlands Cameroon.

Introduction

Human population rises, urbanization and economic development, will lead to a Significant increase in demand for livestock products (Delgado et al., 1999). The number of meat animals globally will have to increase to meet this demand (Steinfeld et al., 2006). The situation is crucial mostly in developing countries were livestock farmers had to rely entirely on imported material to establish herds of cattle (Scholtz, 2010). Currently some of the world's most rapid urbanization is taking place in West and Central Africa, where the population is poised to quadruple in size by the end of this century (UN, 2015). So there is a high need to improve the productivity of cattle in this region.

In this region conditions are often harsh with relatively low levels of natural nutrition. Terminal cross-breeding (all cross-bred progeny are slaughtered) with indigenous breeds may succeed in improving the output of beef cattle farming (Calegare et al., 2007). According to Long (1980) and Schoeman (1999), the fertility and calf viability of cross-bred cows is generally higher than that of the parent breeds whereas a high level of nutrition and management is required (Calegare et al. 2007).

In Cameroon, the great agro-ecological biodiversity which brings out a relative acceptable nutritional level, it seems helpful to try to improve the output of cattle farming by cross-breeding.

In fact in Cameroon, cattle account for 61.3% of meat production (Maikano et al., 1992) and represents an important source of revenue for about 30% of the rural population (Pamo, 2008). Unfortunately, the main factors associated with low productivity are genetic and environmental. In genetic terms, selection and cross breeding programs have been absent due to costs and complexity (Kamga et al., 2001). Some work were done at the station, but the objectives did not necessarily meet the requirements of the real environment (Njoya et al., 1998). Environmental factors are linked to food (degradation of rangelands due to overgrazing, climatic hazards ...), precarious sanitary conditions and socio-economic problems. In order to feed its population which is growing at a rate of 3.2% per year (FAO, 2009), increasing cattle productivity is urgently needed in Cameroon. This will have to go through the identification of major environmental constraints, possible means to eliminate or control these factors and by an assessment of the adaptability of animals to effects that are not easily controlled.

However, work on the effects of environmental factors on cattle production is still limited or fragmentary when studied (Ebangi et al., 2002). A knowledge of these constraints is essential for the modification of the improvement strategies and/or the establishment of the indices of adjustment of the animals for a better evaluation of their genetic potentialities.

So, the general objective of this study is to make a contribution on the increase of beef production in Cameroon, and more specifically by:

An assessment of the effects of the main factors influencing the growth performance of some high bovine genetic types in the Western Highlands of Cameroon, in order to deduce the main constraints and possible means of control.

Material and methods

Study site

The center of Bambui is located in the western highlands of Cameroon, which extends between latitudes 5 ° 20 'and 7 ° North and longitudes 9 ° 40' and 11 ° 10 'East. The climate is marked by a long rainy season from mid-March to mid-November and a short dry season from mid-November to mid-March. Rainfall varies from 1300 mm to 3000 mm with an average of 2000 mm. The minimum and maximum temperatures are respectively 15.5 ° C and 24.5 ° C (Bayemi et al., 2004).

Data collected

The data were extracted from the farm records kept at the IRAD Bambui research station. They involved 374 calves born and raised at the station from birth to two years from 1991 to 2008. The weight and weight gain parameters analyzed were birth weight (n = 374 calves), adjusted weaning weight at day 205 (n = 339 calves), the annual weight (360 days, n = 312 calves), and the weight at 720 days (n = 282 calves) and the average daily pre-weaning gain. For each calf, we noted the sire’s breed and age, the dam’s breed and age, the breed of the calf, the sex of the calf, the season, the year, the month of birth, and the weights at different ages.

Table 1. Crossing Scheme and population by genetic type.

Sire's genetic type	Dam's genetic type			
	BA	3/4BA	NG	WF
BR	6		51	
1/4BR		5		
BS			49	
HS			35	
NG			188	
WF				40

BR = Brahman; BS = Brangus; HS = Holstein; NG = Goudali of Ngaoundere; WF = White Foulani; BA = Banyo

Calculated parameters

The weaning weight was pre-corrected for age at 205 days following the formula used in the South African Beef Registration and Improvement Scheme (Bergh, 1999):

Where:

$$\mathbf{PSC}_{205} = \left(\frac{PS - PN}{\text{Age at weaning}} \right) \times 205 \text{ days} + PN +$$

PSC205 = Weaning Weight Corrected to 205 days

PS = Weight at Weaning;

PN = Birth weight

FC = Mother's Age Correction Factor

The average daily gain was calculated using the following formula:

$$ADG = \left(\frac{P_{i+1} - P_i}{D} \right)$$

Where Pi is the weight at age i and Pi + 1 is the weight at age i + 1. D is the time interval between the two weights

$$GMQ = \left(\frac{P_{i+1} - P_i}{D} \right)$$

Statistical analysis of the data

The effects of breed and sex of the calf, breed and age of parents, year, month, and season of birth, as well as race-by-sex, and race-to-season interactions on typical weights and ADG were analyzed with the SAS software (1991) according to the model below for performance before weaning:

$$Y_{ijklmnopqrs} = \mu + R_j + S_k + B_l + D_m + P_n + G_o + A_P + M_q + N_r + (R \times S)_{ij} + (R \times N)_{iq} + e_{ijklmnopqrs}.$$

For post-weaning performance, several non-significant effects were removed from the model.

These include interactions and age and breed factors of the parents.

The remaining model is:

$$Y_{ijkpqr} = \mu + R_j + S_k + A_p + M_q + N_r + e_{ijkpqr}$$

Where Yijklmnopqrs and Yijkpqrs are respectively the performance (weights and ADG) before or after weaning of calf i of breed j, sex k, dam's breed l belonging to age group m, sire's breed n, belonging to age group o, born during the season p, in the month q, of the year r.

μ is the average weight and the ADG of the population.

Rj: effect of race of the calf (j = 1-7)

Sk: effect of the sex of the calf (k = 1-2)

Bl: effect race of the dam (l = 1-5)

Dm: effect age group of the dam (m = 1-4)

Pn: effect race of the Sire (n = 1-7)

Go: effect age group of the Sire (o = 1-4)

Ap: effect season of birth (p = 1-2)

Mq: effect of the month of birth (q = 1-12)

Nr: effect year of birth (r = 1-18)

eijklmnopqrs is the residual error associated with weaning performance of calf i and eijkpqrs the residual error associated with weaning performance of calf i.

Comparisons of weight averages and daily earnings, where there was a significant effect, were made by the Student-Newman-Keuls test (Steel and Torrie, 1980)

Results and discussion

Live weight before weaning is significantly influenced ($P < 0.001$) by all the factors of variation considered. Similarly, ADG increases with age, which would justify the tendency of calves to free themselves from their mothers when they grow up. So, they become more subject to environmental factors.

Animals born between October and December are generally heavier from birth to weaning, while those born from January to March have a relative low birth weight. Calves born at the end of the rainy season have a higher birth weight than those born in the dry season, but the trend is reversed at weaning. The abundance of good quality forage in the rainy season allows cows to meet their nutritional needs for a good development of their fetus. With the return of the rains the calves born in the dry season take advantage of the young fodder, of the increased milk production of their mother, which would cause a high weight to the weaning.

Similarly, animals born during the rainy season have a very variable grazing period; the abundance of rains is the source of many parasitic diseases which, combined with a short supply of food and water due to fluctuations in grazing time, causing stunting in animals born during the rainy season.

Calf birth weight seems to be high when the dam and sire are 6 to 8 years old. The poor performance of calves issued from young parents (<4 years old) is explained by the fact that these parents use some of their reserve energy for their own growth added to the fact that the heifers have a low milk production (Meyer and Denis, 1999). On the other hand, in older females (> 8 years old) one could justify the low weight performances of their calves by a decrease in the ability to produce with the aging of the mother. These observations suggest that the parental effect is more pronounced when the parent is at optimum development.

It appears that the mother's breed has a low effect on calf birth weight ($p \leq 0.05$), but this effect becomes highly significant ($p \leq 0.001$) at weaning. Thus, in relation to our work, we could classify the breeds of mothers in the order Goudali, White Foulani, Banyo, however this classification could be more conclusive with more appropriate experiments. Indeed, Goudali has been used in several terminal crossings whereas White Foulani has not been crossed by exotic breeds. The same situation is observed with the fathers' races.

Sexual dimorphism has been to the advantage of males for the entire period. They exceed the females by 9 kg and 30 kg respectively at 360 days and at 720 days.

This difference in weight in favor of the males is explained by the hormonal mechanism that seems more accentuated in males (Shushma et al., 2006). It is expected since males are favored by an androgenic effect (Raff and Widmaier, 2004). In addition, cross-bred calves with the exception of 1/4 BR x 3 / 4BA perform better than calves of local breeds. Heterosis would explain the superiority of crossbred performance to that of local breeds. The low proportion of exotic blood in the ¼ BR x ¾ BA cross, could be at the origin of the poor performances recorded for these crossbred.

Animals born in the dry season behave better than animals born in the rainy season. The difference between the two groups is 10.81 and 13.02 kg at 360 and 720 days respectively. This difference may be because that environmental conditions change from season to season, resulting in variation in forage availability and disease incidence. 65% of dry season births are recorded in March (last month of dry season). As a result, most of the mothers who calved during this season would have conceived at the end of the dry season or at the beginning of the rainy season of the previous year.

At birth, these calves benefit from increased milk production of their mothers, for a fairly high weight at weaning, a benefit that is maintained after weaning. On the other hand, about 70% of rainy season birth occurs between April and June, meaning that females have conceived during the rainy season of the previous year. The design at this time allows the calves to have a high weight at birth, resulting from the good corporal and nutritive conditions of their mothers. However, as reported by Hohenboken and Brinks (1971), a very rich environment leads to a decrease in the maternal effect, resulting in low weight of calves at weaning, then at 360 and 720 days.

Crossbred generally outperform local types throughout the period. This superiority could be explained by their heterosis.

Table 2: Evolution of the pre-weaning weight by some influencing factors

Factors	n	Birth weight	n	ADG	n	weaning weight
Birth year						
1991	8	22,87 ± 1,42abcde	5	0,33± 0,02i	5	111,20 ±10,64f
1992	27	25,70 ± 0,53abcd	27	0,44+0,01de	27	145,70 ± 4,34bcde
1993	30	25,97 ± 0,69abc	30	0,41± 0,01ef	30	137,73 ± 4,58de
1994	16	23,12 ± 1,16abcde	15	0,45+0,02cd	15	144,93± 10,21bcde
1995	17	23,12 ± 0,73abcde	17	0,33± 0,01i	17	113,00 ± 5,52f
1996	29	23,69 ± 0,67abcde	29	0,38± 0,01h	28	125.03 ± 5,64ef
1997	40	24,70 ± 0,56abcde	37	0,44± 0,01de	37	144,51 ± 3,57bcde
1998	28	22,00 ± 0,49de	28	0,47± 0,02bc	28	148,21 ± 5,41abcde
1999	40	23,70 ± 0,48abcde	40	0,52± 0,01a	40	163,62 ± 5,02abc
2000	27	24,33 ± 0,57abcde	27	0,52± 0,11a	27	165,41 ± 5,89ab
2001	9	26,44 ± 0,71ab	9	0,48± 0,02d	9	157,22 ± 7,03abcd
2002	28	24,93 ± 0,65abcde	28	0,41± 0,01g	28	135,68 ± 4,67de
2003	8	22,62 ± 0,81bcde	6	0,42± 0,02efg	6	136,50 ±14,62de
2004	8	22,37 ± 0,89cde	6	0,48+0,03b	6	152,17 ±13,41abcd
2005	33	26,67 ± 0,80a	21	0,53± 0,02a	21	169,09 ± 7,55a
2006	14	24,07 ± 1,22abcde	12	0,43± 0,03def	10	141,00 ± 9,95cde
2007	6	21,50 ± 1,45e	2	0,43+0,02defg	2	141,00 ±14,04cde
2008	6	21,33 ± 1,20e	4	0,25± 0,02g	3	88,33 ± 6,34g
Birth month		***				***
Jan	12	23,00 ± 0,81c	12	0,42± 0.02e	12	136,83 ± 6,3bc
Feb	7	24,00 ± 1,50bc	6	0,45± 0,03d	6	145,50 ±12,13abc
Mar	64	22,91 ± 0,35c	63	0,48± 0,01c	62	151,61 ± 4,05ab
Apr	87	24,68 ± 0,42abc	82	0,48± 0,01bc	82	155,83 ± 3,40a
May	65	24,48 ± 0,44abc	56	0,44± 0,01d	55	144,67 ± 4,25abc
Jun	39	24,92 ± 0,63abc	36	0,40± 0,01f	36	132,17 ± 4,75abc
Jul	39	23,33 ± 0,60c	33	0,40± 0,01f	33	131,91 ± 3,50c
Agu	24	24,58 ± 0,48abc	20	0,40± 0,02f	20	131,95 ± 8,00c
Sep	15	24,33 ± 0,86abc	15	0,38± 0,02g	15	126,33 ± 7,02c
Oct	6	27,00 ± 2,69ab	4	0,47± 0,05c	4	152,75 ± 39,92ab
Nov	10	27,70 ± 0,68a	10	0,50± 0,02b	10	162,10 ± 9,49a
Dec	6	26,83 ± 1,34ab	5	0,51± 0,02a	4	163,25 ± 6,98a
Birth season		*				***
Dry	99	23,72 ± 0,36b	96	0,47± 0,01a	94	150,95 ± 3,12a
Rainy	275	24,50 ± 0,22a	246	0,44± 0,01b	245	142,82 ± 2,06b
Calf's genetic type		***				***

BRXBA	6	26,17 ± 1,66a	6	0,56± 0,02a	6	178,00 ± 6,06a
1/4BRX3/4BA	5	23,20 ±0,58ab	5	0,45± 0,02c	5	136,80 ± 8,29c
BRXNG	51	24,79 ± 0,44a	51	0,51± 0,02b	51	161,69 ± 4,75b
BSXNG	49	22,67 ± 0,59b	35	0,44± 0,02c	35	142,60 ± 5,36c
HSXNG	35	25,60 ± 0,66a	26	0,54+± ,02a	26	170,31 ± 4,42ab
NG	188	24,61 ± 0,26a	180	0,43± 0,01c	180	141,93 ± 2,08c
WF	40	22,85 ± 0,51b	36	0,35± 0,02d	36	117,08 ± 4,86d
Sex		***				***
male	178	25,01 ± 0,27a	165	0,46± 0,01a	163	149,09 ± 2,73a
female	196	23,64 ± 0,26b	177	0,43± 0,01b	176	141,35 ± 2,14b
Sire's breed		***				***
BR	51	25,76 ± 3,40a	57	0,56± 0,02a	51	139,37 ± 22,94ab
1/4BR	5	25,20 ± 3,03a	5	0,42± 0,03e	5	151,80 ± 27,47a
BS	49	23,6 1± 3,76b	37	0,44± 0,02d	48	127,69 ± 33,34c
HS	35	23,69 ± 3,37b	27	0,53± 0,01b	33	140,00 ± 29,93ab
NG	189	24,15 ± 5,52b	180	0,43± 0,01d	175	153,23 ± 30,49a
WF	39	24,79 ± 4,87b	36	0,35± 0,02f	24	146,54 ± 39,41ab
Dam's breed		*				***
1/2BA	9	22,86 ± 4,34b	6	0,56± 0,02a	6	100,75 ± 5,50b
3/4BA	5	25,20 ± 3,03a	5	0,42± 0,03c	5	151,80 ± 27,47a
NG	322	24,27 ± 3,58ab	288	0,46± 0,01b	305	145,75 ± 31,14a
WF	39	24,79 ± 4,87ab	36	0,35± 0,02d	24	146,54 ± 39,41a
Sire's age		**				***
<4	214	24,15 ± 0,27ab	199	0,43± 0,01b	196	139,97 ± 2,14b
4-6	75	23,81 ± 0,43ab	73	0,48± 0,01a	73	153,11 ± 4,13a
6-8	74	25,40 ± 0,35a	67	0,47± 0,01a	65	153,77 ± 3,58a
>8	11	22,82 ± 1,35b		0,34± 0,06c	5	114,60 ± 17,52c
Dam's age		***				***
<4	184	24,36 ± 0,26ab	177	0,43± 0,01c	177	141,20 ± 2,20b
4-6	89	23,62 ± 0,33b	86	0,48± 0,01a	85	152,46 ± 3,81a
6-8	84	25,30 ± 0,81a	68	0,45± 0,01b	67	148,19 ± 3,98ab
>8	17	22,06 ± 1,03c	11	0,41± 0,03d	10	130,00 ± 10,08c
Sex x breed		ns				ns
Season x race		*				***

Table 3. Evolution of the post weaning weight by some influencing factors

Factor	records	Weight at 360 days	records	weight at 720 days
Birth year		***		***
1991	8	131,00 ± 9,36de	7	232,28 ±9,16bc
1992	25	171,00 ±4,61a	17	239,76 ± 9,02b
1993	30	151,33 ±4,57abcd	30	212,63 ±5,16e
1994	15	159,20 ±9,38abcd	15	212,27 ± 11,2e
1995	15	121,73 ± 4,96e	11	201,82 ±10,46f
1996	27	135,00 ± 5,36cde	18	171,22 ± 8,98g
1997	28	154,25 ±3,64abcd	27	180,07 ±4,37 g
1998	19	156,63 ± 6,72abcd	26	171,19 ±5,46g
1999	40	165,62 ±4,56ab	36	257,80 ± 7,56a
2000	27	163,33 ± 4,60abc	24	225,29 ±7,76cd
2001	9	165,78 ± 6,95ab	7	230,71 ±7,03bc
2002	27	141,74 ± 5,23abcde	22	223.91 ±6,67cd
2003	8	159,50 ±6,82abcd	8	221,62 ±7,52cde
2004	7	156,71 ± 11,15abcd	8	195,87 ± 17,38f
2005	14	163,57 ± 8,05abc	15	223,60 ±8,05cd
2006	6	139,33 ±11,16bcde		
2007	6	170,50 ± 8,52a	6	160,50 ± 11,17h
2008	5	91,20 ±7,78f	5	218,20 ± 22,84de
Birth month		***		***
Jan	10	162,50 ± 8,80ab	8	231,50 ± 11,88c

Feb	5	154,80 ± 9,62ab	2	253,00 ± 2,01ab
Mar	56	159,20 ± 3,77ab	58	190,38 ± 5,01g
Apr	72	156,24 ± 3,51ab	66	209,33 ± 5,63ef
May	50	151,26 ± 3,93ab	43	226,37 ± 7,09cd
Jun	36	145,58 ± 5,44ab	35	212,74 ± 6,62ef
Jul	35	141,94 ± 4,74b	30	203,23 ± 9,33f
Aug	19	148,68 ± 7,23ab	19	231,05 ± 7,36c
Sep	13	143,08 ± 8,45b	8	216,87 ± 10,49de
Oct	4	155,50 ± 22,5ab	5	246,00 ± 8,58b
Nov	7	173,00 ± 9,39a	5	246,40 ± 9,15b
Dec	5	162,80 ± 9,90ab	3	259,00 ± 5,57a
Birth season		***		***
Dry	83	160,71 ± 2,96a	76	215,77 ± 3,09a
Rainy	229	149,90 ± 1,99b	206	202,75 ± 4,80b
Calf's genetic type		***		***
1/2BRX1/2BA	6	191,17 ± 5,58a	6	238,83 ± 10,17b
1/4BRX3/4BA	5	163,01 ± 4,74bc	4	227,75 ± 11,53c
BRXNG	50	161,87 ± 4,26bc	47	228,96 ± 5,52c
BSXNG	30	148,53 ± 5,69c	35	204,97 ± 6,55d
HSXNG	26	169,92 ± 4,41b	20	275,20 ± 9,01a
NG	162	151,44 ± 2,14bc	146	202,50 ± 3,31d
WF	33	127,39 ± 4,78d	24	187,87 ± 7,67e
Sex		***		***
male	152	157,24 ± 2,63a	123	228,57 ± 4,02a
female	160	148,54 ± 2,06b	159	199,64 ± 3,12b

Conclusion

Environmental factors may mask genetic differences between animals during breeding and genetic merit cannot be determined accurately. Thus, before classifying animals and making a selection or a reform, it is necessary to put them on an equal footing by correcting the raw performances for the effects of the environmental factors that influence them by using the appropriate correction coefficients. Depending on whether the considered factor has an unfavorable or favorable influence on the character of the study, the absolute value of its effect can be added or subtracted from the average performance of the population.

Animals born in the dry season, although less heavy at birth than those born in the rainy season, have the advantage of growing faster and already weigh more than the others at weaning. Males are still more successful than females because of sexual dimorphism.

Birth weight depends on the father's race. So, the adult size of the father's race indicates the final live weight of the calf.

The best growth performance is obtained when parents are between 4 and 8 years old. The pre-weaning performance of the calf is more affected by the genetic type of the mother. Thus, the selection of lactating mothers maximizes pre-weaning growth.

The year, season and month of birth have a significant impact on live weight and ADG.

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