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Full Length Research Paper

Influence of non-genetic factors on growth traits of Horro (Zebu) and their crosses with Holstein Friesian and Jersey cattle

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The present study was carried out to determine non-genetics effects on the growth performance (birth, weaning, one year weight and weight gains) of Horro cattle and their crosses (Friesian-Horro (FH) and Jersey-Horro (JH)) at Bako Agricultural Research center. The data used in the study included weight records of animals born between 1980 and 2008. Least squares means were analyzed using General Linear Model (GLM) of Statistical Analyses System (SAS). Apart from Breed effects, sex, year of birth and parity were the main non genetic effects that influenced birth weight (BW), weaning weight (WW), one year weight (YW), pre-weaning average daily gain (DG) and post-weaning average daily gain (PDG). The overall mean of birth, weaning and one year weight and pre-weaning and post-weaning average daily gains of Horro and their crosses were 19.6±0.16 kg, 43.8 ±8.5 kg and 84.8±21 kg, 407.4±20.6 g and 263.7±54.3 g, respectively. The least squares means birth weight, weaning weight and one year were: 18.34±0.14 kg, 39.8±0.39 kg and 70.5±1.14 kg for Horro, 22.13±0.14 kg, 47.5±0.38 kg and 94.7±1.14 kg for Friesian-Horro and 19.1±0.19 kg, 42.9±0.5and kg, 85.5±1.5 kg for Jersey-Horro breeds, respectively. From the results suggests that birth weight of the calves doesn't affect the weaning weight and the subsequence growth performance. This could point to an opportunity for much improved weaning and one year weight by improving the management practices of calves. The higher growth performance observed for the crossbred calves in comparison with the purebred Horro (Bos indicus) cattle.

Key words: Crosses, fixed, growth, Horro, non genetic, traits.

INTRODUCTION

Weight at birth is one of the first characteristics of an animal that can be easily measured and had been important in predicting weaning weight and rate of gain in growth (Mohamed, 2004). Genetic improvements through selection for growth traits are less desirable because the expected rate of genetic gain can be very low while crossbreeding is an alternative genetic improvement approach to improve traits with such low heritability (Hailu and Tadele, 2004). The growth traits of calves under tropical condition are affected by the genotype of the calf, season of birth, age of the dam and feeding and management condition. Holland and Odde (1992) reported that the variations of birth weight are the results of different growth rates during the prenatal development. Several works had reported that growth performance can be influenced by year and season of birth, age, lactation status (parity) and fertility of the dam, breed and sex of the calf (Mohamed, 2004). Birth weights of calves are affected by a variety of genetic and environmental factors (Habtamu et al., 2008). The observed average birth weight

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for these Horro and Horro-Jersey are smaller than the values reported for Arsi x Holstein-Friesian calves in Arsi (Kiwuwa et al., 1983), Boran x Friesian calves at Abernosa (Ababu et al., 2006) and Fogera x Friesian calves at Metekel (Addisu, 1999; Ababu, 2002). Horro crossbred calves were heavier at birth than pure Horro calves. Birth weight differences can also happen due to the differences in the pre-partum management of the cows, as the health and vigor of calves at birth depends on the nutrition of the cow during the last 60 days before freshening. During this period, approximately 70% of the birth weights of the calf develop and the cow must store nutrients for early lactation when milk production exceeds the cow's capacity for feed consumption (Kellems and Church, 1998). Therefore, the objective of present study is to determine non-genetics effect on growth traits of Horro and their crosses with Holstein Friesian and Jersey calves.

MATERIALS AND METHODS

Location

The data used in this study was generated from Horro cattle and their crosses kept at Bako agricultural research centre. The centre is located at about 250 km West of Addis Ababa at an altitude of 1650 m above sea level. The centre lies at about 09°6'N and 37°09'E. The area has a hot and subhumid climate and receives a mean annual rainfall of about 1220 mm, of which more than 80% falls in the months of May to September. Mean monthly minimum and maximum temperatures are about 14 and 28°C, respectively, with an average monthly temperature of 21°C. The daily mean minimum and maximum temperatures are 9.4 and 31.3°C, respectively.

Breeding system

At Bako Agricultural Research Center, heifers bred at least two years of age when they attained a body weight of 200 kg. Heat detection was done visually every day from 06:00 to 08:00 h in the morning and from 17:00 to 18:00 h in the afternoon by trained inseminator and during the grazing time by the herdsmen. Cows and heifers observed in heat were bred either naturally (local or crossbred bull) or inseminated with frozen semen (Friesian and Jersey) purchased from Kality National Artificial Insemination center within 24 h after heat.

Management of calves at Bako agricultural research center

Calves were separated from their dams at birth, weighed and fed colostrums from a bucket for the first five days of life. A total of 227 L of milk was fed to each calf and a concentrate mix (49.5% ground maize, 49.5% Noug seed cake and 1% Salt) were offered until weaning (three months), then after both calves (male and female) were kept indoors (day and night) until six months of age in individual pens except for about two hours of exercise in a nearby paddock every day. After six months of age, weaned calves were maintained on natural pastures for approximately eight hours a day and supplemented with silage or hay *ad libitum* during the night and were kept as a group (male and female separately), where concentrated supplemented heifer calves are only available. Vegetation cover of the area is woodland and open wood grassland types. The dominant grass species include hyperheniya (*Hyperhenia anamesa*) and sporobolus (*Sporobolus praminidals*) grass and the legumes include Neonotonia (*Neonotonia wights*).

Data collection and preparation

The data used for this study include weight records of animals born between 1980 and 2008. Data were extracted from various growth records (birth, weaning and one year weight) of Horro and its crossbred animals at Bako agricultural research center. The data entered were checked for entry and extraction errors using the univariate procedure of SAS (1999). A total of 2359 calves records were used in the analysis.

Traits considered

Birth weight (BW; weight taken within 24 h of birth); Weaning weight (WW; weight recorded at three months of age); Pre-weaning average daily weight gain (DG; gains from birth to three months); Post- weaning average daily weight gain (PDG; gain from three months to one year); and one year weight (YW; weight recorded at 12 month age). Daily gains were calculated by dividing the difference between the initial and final weight with the number of days.

Statistical analysis for estimation of non-genetic effects

In order to determine the effects of non-genetic factors such as breed, year of birth, parity and sex, the analysis were performed using the general linear models. Procedure of SAS (SAS, 1999). Duncan test is utilized for comparison of least square mean. Fixed effects for all growth traits include sex, year of birth, breed and parity while ages at weaning and one year were fitted as linear covariates in the analysis of weaning weight, pre-weaning average daily gains and one year weight and post-weaning average daily gain. In addition, for birth weights Julian birth day (JBD) (Date of birth of the calves as counted from 1st of January) was fitted as a linear covariate. This is due to the fact that seasonal categories can put calves born within a few days difference may be fall into different seasons, while JBD can avoid this problem (Solomon, 2002). Interaction effects of fixed factors (year by parity, year by sex, year by breed, parity by sex, parity by breed and sex by breed) were tested and had no significant effect on all the traits studied.
The following models were fitted for BW, WW DG, PDG and YW:

$$Y_{ijeno} = \mu + G_i + Y_j + + S_e + P_n + e_{ijmenlo}$$

Where: Y_{ijeno} =n^{th} records of the i^{th} breeds, j^{th} year, e^{th} sex, nth parity and μ = overall mean. G_i = fixed effect of the i^{th} breed. Y_j = fixed effect of j^{th} year of birth. S_e = fixed effect of e^{th} sex of calf. $P_{n\,=}$ fixed effect of n^{th} parity.e_{ijeno} = residual error.

RESULTS AND DISCUSSION

The summarized results from the analysis of variance for birth, weaning, one year weight, pre-weaning and post-

Table 1. Analysis of variance for birth, weaning, one year weight and pre-weaning and post-weaning average daily gains.

Source	DF	BW	WW	YW	DG	PDG
Breed	2	6059.44**	18477.9**	140158.5**	627216.0**	509699.1**
Parity	6	842.8*	1118.4*	4201.0*	198744.2*	12944.0*
Sex	1	590.6**	466.6*	27174.6**	269074.2**	179150.6**
Year	28	2694.3**	15233.7**	137621.8**	1535583.9**	1167330.5**
Age	1		5076.7**	1950.7*	322621.1**	21953.5**
Model	38	11830.0**	51715.4**	372831.7**	3601706.7**	2050086.4**
JBD		52.75*	-	-		
R^2 %		29	28	36	16	33
CV %		17.9	19.4	25.8	34	46

*, P<0.05; **, p<0.01.

weaning average daily gains, are presented in Table 1. All the factors in the model contributed significantly in explaining the variation in the growth traits. The coefficients of variation increased from birth weight to one year weight. The increase can be partly explained by reduction in number of observations as the age increase from birth to one year because of death loss and culling of some calves. Additionally it may be due to the differences between environments in particular age, management practices and inconsistencies in feed availability. The coefficients of variation from the current study are in agreement with those of Demeke et al. (2003b) who have reported 8.7 to 27.9% for growth traits of crossbred cattle.

The overall mean birth, weaning and one year weight and pre-weaning and post-weaning average daily gains of Horro and their crosses were 19.6±0.16 kg, 43.8 ±8.5 kg and 84.8±21 kg, 407.4±20.6 g and 263.7±54.3 g, respectively (Table 2). The mean values of growth performance in this study were lower than values reported for other Ethiopian cattle breeds (Addisu, 1999; Ababu, 2002; Demeke et al., 2003b, 2004b; Hailu, 2003; Addisu and Hegede, 2003; Aynalem, 2006). The low mean growth traits obtained in this study could be attributed to the calf rearing systems and environmental conditions of the production area. Similar findings were reported on growth traits of Horro by Mulugeta (2003), Demeke et al. (2003b, 2004b), Jiregna et al. (2006) and Habtamu et al. (2008). The results also correspond with Demeke et al. (2003a) reported that the lowest weaning weight of 88 kg due to bucket feeding. The one year weight observed in this study was lower than results obtained by Haile-Mariam and Kassa-Mersha (1995) which is due to artificial rearing of the calves where maternal effects on calf growth tended to die out earlier than naturally reared. The variation in the birth weight of calves over the years might be associated with the prepartum management of the cows and variation in management during the years. And also be related to nutritional and climatic conditions particularly rainfall patterns. Fluctuations in weaning and one year weights performance across the years depicted the sensitivity of calves to postnatal stress. Growth performance of calves could have been reduced due to exposure to prolonged nutritional stress. The coefficient of variation has shown slight increase with increases in age. This may indicate increased role of the environment in causing the variation.

Body weight at birth was significantly (p<0.05) affected by parity, where calves born from first parity being lighter at birth than those born from adult cows (Table 2). The difference was, however, only significant between first, second and third parity born calves. Similar works reported by Addisu and Hegede (2003) showed that calves born from first calver were significantly lighter than those calves born from second to fifth calvers of cows. Demeke et al. (2003b) reported that dam parity effects were significant sources of variation in birth weight, pre-weaning average daily gain, weaning weight and one year weight. This variation could be attributed to a good maternal environment provided by mature cows to the newly developing fetus, competition for nutrients between fetal development and maternal growth which is high in younger dams than older ones. Heavier weaning weight are expected in calves from older dams due to well developed mammary tissue relative to younger dams thus better maternal environment in terms of milk for the suckling calf (Wasike, 2006). This fact was not observed in current results due to the withdrawal of maternal environment at early ages. In agreement to the present finding, significant effects of parity were also observed in the performance characterization study of the Boran and Sahiwal cattle (Trail and Gregory, 1981). The lowest weaning and one year weights were recorded for calves from seventh parity and highest weaning and one year weight for calves from second and third parity.

Birth weight of the calves significantly (p<0.05)

Table 2. Least square means (± s.e) of birth, weaning, and one year weight and pre-weaning and post-weaning average daily gains for breeds, parity, sex, and regression coefficient of Julian birth date on birth weight, and age of weighing on weight and daily gain.

Effect	Level	N	BW (kg)	N	WW (kg)	N	YW (kg)	N	DG (gm)	N	PDG (gm)
Parity	1	709	18.8±0.15bc	577	43.6±0.39	451	83.6±1.2	577	309.8±4.7	451	112.5±2.8
	2	320	20.13±0.16a	441	44.07±0.43	352	85.5±1.3	441	299.4±5.3	352	116.7±3.1
	3	397	20.3±0.18a	318	45.3±0.50	236	87.2±1.5	318	312.0±6.02	236	118.1±3.6
	4	284	20.3±0.22a	205	43.5±0.63	161	84.0±1.8	205	289.3±7.5	161	113.9±4.5
	5	198	19.8±0.26ab	151	42.9±0.73	116	82.3±2.2	151	285.6±8.8	116	108.2±5.3
	6	130	19.8±0.33ab	93	42.8±0.93	66	81.9±2.8	93	287.3±11.1	66	111.5±6.8
	≥7	121	19.9±0.35ab	90	41.7±0.97	65	80.2±2.9	90	271.7±11.7	65	107.6±7.2
Sex	Male	1224	20.4±0.13a	931	42.9±0.4a	674	79.1±1.0b	931	281.2±4.3b	674	101.3±3b
	Female	1135	19.4±0.13a	944	43.9±0.4a	775	88.0±1.0a	944	305.8±4.3a	775	124.0±3a
Breeds	HH	1001	18.34±0.14[c]	726	39.8±0.39[c]	600	70.5±1.14[c]	726	270.8±4.7[c]	600	86.3±3[c]
	HF	961	22.13±0.14[a]	812	47.5±0.38[a]	597	94.7±1.14[a]	812	314.7±4.5[a]	597	132±2.8[a]
	HJ	397	19.1±0.19[b]	337	42.9±0.52[b]	252	85.5±1.5[b]	337	295.1±6.3[b]	252	119.7±4[b]
JBD			0.0014±0.0007								
Age					0.18± 0.21		0.13±0.063		-1.43±0.25		-0.43±0.2

[a-c] Means or least square means in the same row and with different superscripts are significantly different; BW=Birth weight; WW=Weaning weight; DG= pre-weaning average daily gain; PDG=post-weaning average daily gain; YW=one year weight; N=Number of observations; Age = Age (days) at weaning; JBD= Julian birth day.

influenced by sex, where male calves were heavier than females at birth. However, female calves were superior (p<0.05) at weaning and one year and also had faster growth rate than male calves. Pre-weaning and post-weaning daily gains for female calves were higher than males (Table 2). These findings were consistent with earlier reports on Horro cattle (Mulugeta, 2003; Jiregna et al., 2006; Habtamu et al., 2008) and on Fogera cattle and their crosses (Addisu and Heged, 2003). Males were 1 kg heavier than females at birth; however, females were 1 kg heavier than males at weaning and 8.9 kg heavier at one-year weight. The results is not in agreement with Aynalem (2006) who reported that males were 1.5 kg heavier at weaning, 7.5 kg heavier at one year, 8.5 kg heavier at eighteen months and 8.8 kg heavier at two years of age for Boran cattle. Also the present result is not in agreement with other reports (Banjaw and Hail-Mariam, 1994; Rege et al., 1994; Demeke et al., 2003b; Wasike, 2006). The possible reason for higher weight in females than in males at weaning and thereafter was that especial management was given to females to improve the growth rate of replacement heifers to enable them reach puberty and start production life earlier. This situation indicated that special management assigned to calves could result in improvement of their life weights production and reproduction. Birth, weaning and one year weight and pre-weaning and post-weaning average daily gains of calves were significantly (P<0.05) affected by breeds (Table 2). Horro calves had lower growth performance than the Friesian and Jersey crosses. This has also been confirmed previously (Mulugeta, 2003; Jiregna et al., 2006; Habtamu et al., 2008) on Horro cattle and their crosses with Frisian and Jersey and for other indigenous cattle breeds (Addisu, 1999; Ababu, 2002; Demeke et al., 2003b, 2004b; Hailu, 2003; Addisu and Hegede, 2003; Aynalem, 2006). Increase in birth weight with increasing level of exotic blood had been reported by Ahunu et al. (1993). Aynalem (2006) also reported that calves of Ethiopian Boran breed were consistently lighter than all the Ethiopian Boran-Friesian crosses at birth, weaning, six months, one year, eighteen months and two years of age. The reason is that different genotypes are not expected to perform similarly under all environments mainly due to genotype-environmental interactions (Bourdon, 2000). This implied that growth varies with the breed and environment. The superiority of the crossbreds over the Horro calves indicated the effect of heterosis as result of crossing with the Jersey and Friesian breed, since both groups bucket fed (artificially reared). The weaning and one year weights that were observed from this study are generally low compared with *Bos taurus* x *Bos indicus* crossbred animals raised through suckling in beef production systems in the tropics (Banjaw and Hail-Mariam, 1994). But these weights are also not uncommon for crossbred dairy animals reared artificially under low input systems in the tropics (Kebede and Galal, 1982; Thorpe et al., 1993; Rege et al., 1994; Hirooka and Bhuiyan, 1995; Demeke et al., 2003b). Age at weaning and one year were significantly influence weaning, pre-weaning, one year and post-weaning weights.

CONCLUSIONS AND RECOMMENDATIONS

The average birth, weaning and one year weight of Horro cattle and their crosses are relatively low in the present study as compared to other results. From previous studies on similar genotypes there is evidence of environmental influence on the growth performance. The significant effects of parity, sex, year and period of the year birth has taken place (Julian birth day) indicates the importance of considering these factors in the management of Horro cattle and their crosses with Friesian and Jersey for improved growth performance. Ofparticular importance are effect of year of birth which could be related to better nutritional and climatic environments mainly due to the difference in rainfall patterns and the direct effect on the availability and quality of nutrients. The significant regression of age at weight on weaning and yearling weight implies that adjustments for the number of days before or after the standard age need to be made on respective weights. Higher growth performance was observed for the crossbred calves in comparison with the purebred Horro cattle in this study. The crossing of Horro with the breeds involved in this study would have beneficial effect on growth. Based on the findings of this result Friesian crosses should be recommended for early growth rate under Bako and similar environmental conditions.

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