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The Influence of Sire and Dam Genotype on Pre and Post Weaning Weight of Horro (Zebu) and Their Crosses with Holstein Friesian and Jersey cattle

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Abstract
The influence of sire and dam genotypes on birth weight (BW), weaning weight (WW), pre-weaning average daily gain (DG), post-weaning average daily gain (PDG) and one year weight (YW) in calves of Horro and crosses of these indigenous with *Bos Taurus* (Holestian Friesian and Jersey) were investigated from data collected from Bako Agricultural Research center during the year 1980-2008. Least squares means were analysed using General Linear Model (GLM) of Statistical Analyses System (SAS). Sire and dam genotype, sex, dam age, parity and Julian birth date were considered in the fixed effects model with addition of age at weight measurement as a covariate. Calves sired by pure Holstein Friesian bulls 3.8kg heavier than the sired by Horro bulls and 1.2 kg heavier the calves sired by Holestian Friesian-Horro at birth. The no difference in BW of calves by the Jersey, Jersey-Horro and Horro bulls. The influence of dam genotypes on the pre and post weaning weight of calves was highly significant ($P<0.05$). Holestian Friesian-Horro dams produced the heavier ($P<0.05$) calves at weaning than Horro and Jersey- Horro dams, whereas at one year weight no significant difference between Horro and Holestian Friesian-Horro dams. The result also indicated that pre and post weaning weight of the calves sired by pure Holestian Friesian bulls were superior ($P<0.05$) to others.
Keywords: Dam genotype, Holstein Friesian, Horro, Jersey, sire genotype

Introduction

Ethiopia has more domesticated animals than any other country in Africa and agriculture is the mainstay of the Ethiopian economy. The total livestock population of the country is estimated to be 56.7 million cattle, 29.3 million sheep, 29.1 million goats, 2 million horse, 7.4 million donkey, 0.4 million mule, 1.2 million camel and 56.9 million poultry. Out of this total cattle population, about 98.7 % are indigenous breeds while hybrid and exotic breeds accounted for about 1.2%and 0.14%, respectively (CSA, 2014). Livestock production in general generates 45% of the Ethiopian agricultural GDP, 25% of total GDP (IGAD, 2010) without considering the contribution of livestock in terms of manure and transport services and more than 85% of farm cash income (Benin et al., 2006).

Low genetic merit for milk production and growth of the indigenous cattle breeds have been identified as one of the constraints to dairy development in Ethiopia (Alberro and Haile-Mariam 1982). Therefore, genetic improvement of the indigenous cattle, through crossbreeding combines two or more breeds selected to optimize growth and milk production and simultaneously the use of heterosis and breed differences (Long, 1980; Bourdon, 2000). As described by Bourdon (2000) the important questions concerning improving production in the future are what breeds should be used in different crossbreeding systems in different production conditions. This is also a great fear in Ethiopia. Bako Agricultural Research Center produces (Jersey x Horro and Holestian Friesian x Horro) crossbred heifers to boost milk production in the region (Jiregna et al 2006). Gizaw et al (2009) reported that crossbred cows produced three times more milk than that of Horro cow's on-farm and farmers had benefited economical and nutritional. The genotype of sires and dams used in crossbreeding are influence pre and post weaning weight of their offspring. Birth weight has been studied thoroughly primarily because of its association with dystocia and subsequent reduction in productivity (Smith et al., 1976 ; Notter et al., 1978). Breed type also has a pronounced influence on weaning weight of calves. Weaning weight is approximately two-third the result of milking ability of the dam and one-third the result of the inherent growth potential of the calf (Harwin, 1989). Farmers need information concerning the productivity of breeds and breed combinations under a wide range of production conditions. The reason is that different genotypes are not expected to perform similarly under all environments mainly due to genotype-environmental interactions (Bourdon, 2000). According to Hailu (2003) revealed that the relative productive performances of breed and breed combinations should be evaluated in different feeding systems as well as environments. The aim of this study therefore was to investigate the influence of sire and dam genotypes on pre and post weaning weight of cattle under sub-humid environment of Ethiopia.

Materials and Methods

Study site

The data used in this study was generated from Horro cattle and their crosses kept at Bako Agricultural Research Centre during the year 1980-2008. 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 sub humid 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°C and 28°C, respectively, with an average monthly temperature of 21°C. The daily mean minimum and maximum temperatures are 9.4°C and 31.3°C, respectively. The vegetation cover of the area is woodland and open wood grassland type. The dominant pasture species include Hyperhenia (*Hyperhenia anamasa*) and Sporobolus (*Sporobolus prraminmidalis*) grasses and the legume Neonotonia (*Ninotonia wighti*) (cited by Habtamu, 2010).

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 hours in the morning and from 17:00-18:00 hours 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 (Holstein Friesian and Jersey) purchased from Kality National Artificial Insemination center within 24 hours 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 liter 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 the calves were maintained on natural pastures for approximately eight hours a day and supplemented with silage or hay *adlibitum* during the night and were kept as a group (male and female separately),where concentrate were supplemented to heifer calves only on availability.

Data Collection and Preparation

The data used for this study include pedigree and 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 (2004). A total of 2359 calves' records were used in the analysis. A total of 184 sires were used during the whole experimental year along with 710 dams.

Fixed Effect

Sire genotype, dam genotype, sex, dam age, parity and Julian birth date were considered in the fixed effects model with addition of age at weight measurement as a covariate.

a. **Sire genotype:** Sire genotypes were formed based on Horro, Jersey, Holstein Friesian, Holstein Friesian-Horro and Jersey-Horro genotypes.

b**. Sex:** Male and Female

c. **Age of calves**: Age at weight measurement was included as a covariate to account for age difference on date of weight measurement.

d. **Parity**: Parity was fitted as fixed effect to account for its effect. Parity is coded as 1, 2, 3, 4, 5, 6 and ≥7. All parities above seven were pooled together because the available number of cows under this category was too small to constitute separate groups.

e. Dam Age: Dam age was fitted as fixed effect to account for its effect. Dam age is grouped as 2.5-4.5, 4.6-6.5, 6.6-8.5, 8.6-10.5, 10.6-12.5 and ≥12.6 ages.

f. **Dam genotype**: Dam genotypes were formed based on Horro, Holstein Friesian-Horro and Jersey-Horro genotypes

Statistical Analysis

The pre and post weaning weight of Horro and their crosses were analyzed include birth weight, pre-weaning average daily gain,weaning weight, post-weaning average daily gain and one year weight. Fixed effects for all growth traits include sex, dam age, sire and dam genotypes 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, 2003). Interaction effects of fixed factors were tested and had no significant effect on all the traits studied. Hence, all interaction effects were excluded from the final model used to estimate the parameters. For all of the analytical models used in this study the effects fitted are summarized in Table 1-2.

The following models were fitted for BW, WW, DG, PDG and YW:

$Y_{ijmeno} = \mu + G_i + Y_j + D_m + S_e + P_n + e_{ijmeno}$

Whereas:

Y_{ijeno} =nth records of the ith dam age, jth sire mth Dam, eth sex, nth parity

μ = overall mean

G_i = fixed effect of the ith dam age

Y_j = fixed effect jth sire

D_m = fixed effect m^{th} dam
S_e = fixed effect of e^{th} sex of calf
P_n = fixed effect of n^{th} parity
e_{ijmeno} = residual error.

Results

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

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
Sire reed	4	2146**	6942**	52180**	391**	176**
Parity	6	115*	737*	382*	153*	183*
Dam breed	2	578**	138**	172*	574*	111*
Sex	1	289**	25.0*	7545*	719*	575*
Dam age	5	113*	868*	783*	833*	478*
Age	1		411**	523*	658*	721*
Model	19	547**	164**	764**	779*	299*
JBD	1	1.74*				
R^2 %		27	24	19.6	96	12
CV %		19	18	26	31	49

*=P<0.05; **= p<0.01

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; one year JBD= Julian birth date

Table 2. Least square means (± s.e) of birth, weaning and one year weight and pre-weaning and post-weaning average daily gains for sire and dam breeds, parity, sex, dam age, Julian birth date, age at weaning and at one years

Effect	Level	N	BW (kg)	N	WW (kg)	N	YW (kg)	N	DG (gm)	N	PDG (gm)
Overall		973	20.9±0.3^{cd}	800	45.5±8	617	88.1±23	800	382±29	617	119±59
Sire genotype	Horro	359	19.6±0.3^{cd}	274	41.4±0.8	230	74.7±2.3	274	272±8.8	230	95.4±6.1
	Friesian-Horro	196	22.5±0.4^{ab}	165	44.5±0.9	116	86.7±3.3	165	278±11	116	117±8.6
	Jersey-Horro	116	19.5±0.7^{cd}	100	45.1±1.2	71	88.9±4.2	100	315±11	71	119±10.9
	Pure Friesian	208	23.7±0.4^{a}	174	49.5±0.8	132	99.4±2.7	174	323±9.8	132	140±6.9
	Pure Jersey	94	19.4±0.5^{cd}	85	46.4±1.1	68	93.3±3.5	85	336±13	68	133±9.1
Parity	1	292	20.3±0.4	235	47.1±0.8	180	94.6±2.6	235	334±9.8	180	133±6.9
	2	237	21.3±0.4	204	46.1±0.8	153	93.7±2.6	204	313±9.3	153	133±6.6
	3	179	20.8±0.4	154	45.2±0.8	117	90.0±2.7	154	306±9.7	117	124±6.9
	4	111	20.9±0.4	84	43.7±1.0	62	89.3±3.2	84	285±11	62	125±8.4
	5	73	20.8±0.3	60	44.4±1.1	50	84.2±3.5	60	291±13	50	112±9.2
	6	44	21±0.6	33	47.2±1.5	30	86.9±4.5	33	328±17	30	114±11
	≥7	37	21.2±0.7	30	43.8±1.7	25	81.6±5.3	30	276±19	25	10613.7

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; one year JBD= Julian birth date

Discussion

Sire genotypes

The coefficients of variation from the current study are in agreement with work of Demeke et al. (2003b) who have reported 8.7% to 27.9% for growth traits of crossbred cattle. The effects of sire genotypes on all growth traits were highly significant (P<0.001) Table 1. Similar studies reported the significant influence of sire genotypes on growth traits of calves (Hailu 2003). Calves sired by pure Holstein Friesian bulls 3.8kg heavier than the sired by Horro bulls and 1.2 kg heavier the calves sired by Holstein Friesian- Horro at birth. The no difference in BW of calves by the Jersey, Jersey-Horro and Horro bulls. The lowest BW found was 19.6.kg for calves sired by Horro, Jersey-Horro and Jersey. At weaning and one year weight the calves were sired by pure Holstein Friesian and Jersey bulls heavier than the calves sired by Horro and Holstein Friesian-Horro and Jersey- Horro. No evidence was available from the data, but it may reflect the direct additive effect of the Holstein Friesian bulls. However, the different genotypes are not expected to perform similarly under all environments mainly due to genotype-environmental interactions (Bourdon, 2000). Smith et al. (1976), Laster et al. (1973) and Hailu (2003) found that calves sired by Jersey bulls had lower BW than calves sired by other *Bos Taurus* sire breeds. The reason for this could be related to the large direct additive effects of the Holstein Friesian sires. Direct additive effect contribution for BW, WW and YW were positive and high for Holstein Friesian than Jersey (Habtamu, 2010) while Cunninghum and Magee (1988) reported a negative direct genetic effect for BW relative to the breeds with which it was compared. In agreement with, Cunninghum and Magee (1980) also reported a positive estimate for direct effect for Holstein Friesian. Several crossbreeding studies revealed that high BW is associated with high incidence of dystocia (Laster et al 1973; Smith et al 1976; Burfening et al 1978; Tawnezvie et al 1988) and subsequent reduction in productivity, which is undesirable. Because of this, sire genotypes effects on BW should be carefully evaluated before initiating large-scale use of large *Bos Taurus* sire breeds in crossbreeding systems, particularly on *Bos indicus* dams (Hailu, 2003). Inspiringly, Hailu (2003) reported that the differences between sire genotype mated to Barka, Boran and crossbred dams indicate differences in direct additive effect exhibited in the crossbred offspring and environmental influences.

Dam genotypes

The influence of dam breeds on the growth traits of calves was highly significant (P<0.05) (Table 2). This is in agreement with the results of Paterson et al. (1980) and Van Zyl (1990). Maternal influences were larger for WW, DG, PDG, and YW than BW whiles the influence of sires was larger for BW. Similarly, Hailu (2003) reported that the maternal effects of Barka, Boran and crossbred dams were larger for post-weaning average daily gain and WW than BW while the influence of sires were larger for BW. At birth, the progeny of Holstein Friesian -Horro and Jersey- Horro dams were significantly (P<0.05) larger than the Horro dams. They are non-significance of differences between the calves from the Holstein Friesian-Horro and Jersey- Horro at birth. However, birth weight of results were lower than the report of Hailu (2003) for the Boran and Barka dams, even when calves were sired by *Bos taurus* breeds. Holstein Friesian-Horro dams produced the heavier (P<0.05) calves at weaning than Horro and Jersey- Horro dams, whereas at one year weight no significant difference between Horro and Holstein Friesian-Horro dams. This suggests that Holstein Friesian-Horro dams were high and positive in maternal additive, indicating better suitability as maternal line for such crossbreeding (Habtamu, 2010). No other explanation for these results due to all the calves reared by bucket feeding. Vostry` et al. (2008) reported that maternal effects were as important as direct effects during the early pre-weaning development and that they got smaller as the calf was growing up.

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) 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 7 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. Similarly, 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. Dam age none significantly affect the birth and weaning weight of the, however, at one year weight the calves born from older dam higher growth performance than youger dams.

Conclusion

Overall the results of this study show that the significance larger birth weight Holstein Friesian sire. Differences between Holstein Friesian and Jersey sires mated to the same dam genotypes may reflect differences in direct effects and individual heterotic effects exhibited in the crossbred calves. Holstein Friesian-Horro dams produced the heavier calves at weaning than Horro and Jersey-Horro dams, whereas at one year weight no significant difference between Horro and Holstein Friesian-Horro dams. This suggests that Holstein Friesian-Horro dams were high and positive in maternal additive, indicating better suitability as maternal line for crossbreeding. The crossing of Horro with the breeds involved in this study would have beneficial effect on pre and post weaning weight. Based on the findings of this result Holstein Friesian crosses should be recommended under Bako and similar environmental conditions of Ethiopia

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