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GROWTH PERFORMANCE OF CROSSBRED DAIRY CATTLE AT ASELLA LIVESTOCK FARM, ARSI ETHIOPIA

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ABSTRACT: Genetic and non-genetic factors affecting growth traits and growth performance at 50% and 75% upgrading levels were studied, in the Arsi highland, Ethiopia. The traits studied were: weight at birth, 6, 12, 18, 24 and 36 months. The analyses were carried out using Harvey's Mixed Model Least-squares and Maximum Likelihood Computer Program. The breed groups compared were: 1/2 Friesian 1/2 Arsi (F1FA), 1/2 Friesian 1/2 Zebu (F1FZ), 1/2 Friesian 1/4 Jersey 1/4 Arsi (F(JxA)), 3/4 Friesian 1/4 Arsi (75%FA) and 3/4 Friesian 1/4 Zebu (75%FZ). The 75% FA were significantly heavier than F1FA at birth, 6 and 30 months. No significant differences were found between F1FZ and 75%FZ at all ages. The differences between F(JxA) and F1FA were not significant except at 6 months. The 75% FA were significantly heavier than the F(JxA) at birth, 30 and 36 months. However, 75% FA were significantly lighter than 75% FZ at 12 and 36 months. No significant effect of sex were observed at birth, though males were slightly heavier. Parity of the dam did not show significant influence on body weight except at birth and 24 months. Year of birth of the calf did not have significant effect except at 12 months. The effect of season of birth was significant at birth and 12 months. Animals born during the main rains were the heaviest at birth. Heritability estimates for weights at birth, 6, 12, 18 and 24 months were: 0.20 ± 0.15, 0.14 ± 0.23, 0.04 ± 0.21, 0.68 ± 0.34 and 0.33 ± 0.29, respectively. From the results obtained, it may be concluded that the management and feeding conditions at Asella Livestock Farm would warrant the limitation of upgrading level to 50% exotic inheritance. The smaller weights for the three-breed crosses, *i.e.*, (F(JxA), may be advantageous

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to the smallholder, as such animal could be maintained by smallholder farmers as they have lower maintenance requirement as compared to the larger animals.

Key words/phrases: Crossbred, dairy cattle, growth, heritability

INTRODUCTION

Poor genetic potential of indigenous cattle for milk production, low level of animal husbandry practices, inadequate feed supply and prevalence of a variety of diseases and high rate of mortality are among other factors that limit animal performance in Ethiopia.

The indigenous cattle are smaller in size and produce less milk and meat than European cattle. On the other hand, indigenous cattle often exhibit remarkable heat tolerance, has the ability to maintain body condition on poor quality feedstuffs and also exhibit a certain degree of resistance to diseases (Ansell, 1985).

In order to improve animal production, improvement of both genetic and environmental factors are important. To improve animal performance through genetic means, the breeder has two tools; either to carry out selection within indigenous breeds or crossbreed the indigenous breeds with the high yielding exotic animals.

It is generally agreed that genetic improvement through selection is a slow process. Even though all the selection pressure is put on milk yield and it is supported by well organised recording system and progeny testing, the progress will not be more than 1–2% per year and since this is too slow a task, other methods of breed improvement are often preferred (Brännäng and Persson, 1990).

Through crossbreeding milk yield per lactation could be increased considerably and age at first calving could often be reduced by one year or more in first crosses (Rendel, 1974). According to McDowell (1982), more than 60 phenotypic traits have been identified that could be improved through cross-breeding.

Optimum proportion of genes from temperate and tropical breeds may be different for various dairy production systems (McDowell, 1996). A low proportion of improved temperate breeds may be required to suit limited feed resource in traditional production systems (Sendros Demeke and Tesfaye Kumsa, 1998). Studies on smallholder farms in Ethiopia have shown that first generation between Friesian or Jersey and indigenous Zebu breeds had performed well under farmers' conditions in terms of milk yield and reproduction while maintaining good health (Tesfay Kumsa, 1993).

Since growth, milk production and reproduction are closely related traits, the required aim in dairy cattle production should be to improve all these traits. Growth studies based on body weight performance are especially important because they provide the basis for production traits such as milk, meat and work (Dhumal *et al.*, 1988).

Therefore, generating information on growth performance could help provide valuable documentation for developing a future national breeding policy. In order to achieve specific objectives and to assure full advantages of crossbreeding as well, evaluation of the performance of the crossbreeds, including different levels of exotic inheritance, is important.

It was with this justification that the present study was undertaken with the following objectives:

1. to compare the growth performance of crossbreeds with different levels of exotic inheritance;

2. to investigate genetic and environmental factors affecting growth traits.

MATERIALS AND METHODS

Description of the study area

The Asella Livestock Farm is located about 3 km south of Asella town at an altitude of 2400 m. The station has a mild sub-tropical climate, with maximum and minimum temperature ranging from +18 to +22°C and +5 to +10°C, respectively. The average annual precipitation from 1969–1982 ranged between 1013 to 1500 mm. The vegetation consists of annual legumes and perennial grasses. The natural pasture includes: *Chlorius gayana, Setaria sphacelata, Panicum coloratum* and legumes such as *Trifolium semipilosum, Glycine wightii and Trifolium burchellianum* (Kiwuwa *et al.*, 1983).

Seasonal classification

Systematic factors such as season and year of birth could cause variation in the performance of animals born in different seasons and years. Kiwuwa *et al.* (1983), who evaluated productivity of crossbred cows in the Arsi region reported significant influence of season of birth on milk production. The authors also reported significant influence of year of calving on reproductive performance of crossbred cows. In order to quantify the effect of year and season of birth on the growth traits, it was important to include them in the analyses. Based on the rainfall records and pasture condition, the months of the year were grouped into three seasons, short rains was defined as months from March to May, the main rainy season covered the months of June to September and the dry season was from October to February.

Herd management

Animals were grazed on natural pasture, and supplementary hay or concentrate consisting of 48% niger seed cake, 48% wheat bran, 3.5% bone meal and 0.5% salt were provided. Cows were fed 2 to 4 kg of concentrates per day depending on the level of milk yield. New born calves were separated from their dams immediately after birth and were bucket-fed up to weaning between 49 to 79 days of age. Colostrum and whole milk substitute were fed to calves twice daily at the rate of 1.0 kg to 2.5 kg of milk equivalent. All animals were vaccinated against anthrax, rinderpest, blackleg, pleuropneumonia and brucellosis and were regularly drenched against internal parasites (Kiwuwa *et al.*, 1983).

Data recording

All animals were ear tagged for identification. At each calving, the date, sire number, dam number, breed and sex of the calves were recorded. Birth weight was taken within 24 hours after parturition and subsequent weights were taken in three weeks interval. Unfortunately, there were periods when no weighing seemed to have been done and incomplete sets of growth data were excluded from the analyses.

Data preparation

Since most crossbred animals were produced from Arsi cattle, other crosses from the indigenous dam breeds, *i.e.,* Fogera, Borana and Barka were grouped as Zebu crossbreeds, because of the small number of crosses available during the study period. There were uneven distribution of crosses over the study period, since F1 crosses naturally appear at the beginning and crossbreeds with higher exotic inheritance were available during later years. As this could cause a confounding effect between years and breed groups, data from crossbreeds that have been taken during the same year have been used. For first generation (F1) animals, only parity of their dams recorded at the farm were considered. Neither age nor parities of local animals at the time of purchase were known. However, only rather young animals were bought.

Breed groups

The growth performances of five breed groups, namely 1/2 Friesian 1/2 Arsi(F1FA), 1/2 Friesian 1/2 Zebu(F1FZ), 3/4 Friesian 1/4 Arsi(75%FA), 3/4 Friesian 1/4 Zebu(75%FZ) and 1/2 Friesian 1/4 Jersey 1/4 Arsi(F(JxA)) were analyzed and compared.

Traits

Birth weight, 6, 12, 18, 24, 30, 36 month weights were analyzed using the following statistical model.

Statistical model

$Y_{ijklmno}$	=	$\mu + S_i + B_j + X_k + P_l + Y_m + E_n + e_{ijklmno}$
$Y_{ijklmno}$	=	the observation on weight at birth, 6, 12, 18, 24, 30 and 36 months
μ	=	a constant common to all observation (overall mean)
S_i	=	the random effect of i th sire normally and independently distributed with (0, σ^2s)
B_j	=	the fixed effect of j th breed group or grade

X_k = the fixed effect of kth sex**
P_l = the fixed effect of lth parity
Y_m = the fixed effect of mth birth year
E_n = the fixed effect of nth birth season
$e_{ijklmno}$ = the random error associated with $Y_{ijklmno}$th observation which is assumed to be normally and independently distributed with $(0,\sigma^2e)$

Preliminary analyses for all traits showed non-significant interactions (breed x year of birth and breed x season of birth), and therefore were excluded from the model. Harvey's Mixed Model Least-squares and Maximum Likelihood Computer Program (Harvey, 1990) was used for the analyses. Heritability estimates were from the sire component by using paternal half-sib correlation method (Harvey's Model 2).

RESULTS AND DISCUSSION

A comparative study was made among five breed groups, namely F1FA, F1FZ, F(JxA), 75%FA and 75%FZ crosses. The least-squares means with their standard errors for weights at birth, 6, 12, 18, 24, 30 and 36 months are presented in Tables 1 and 2. The analyses of variance for the above weight traits are shown in Table 3.

The coefficient of determination of the models explained between 56% and 69% of the variation in the body weights of the animals (Table 3). The breed group had a significant influence on body weights at birth, 6, 12, 30 and 36 months of age (Table 3). Regarding the birth weight, F1FZ, 75%FZ and 75%FA grades were significantly heavier than F1FA and F(JxA) crossbreeds (Table 1). Increase in Friesian inheritance tended to increase birth weight in Friesian-Arsi crossbreeds. This might be due to the better maternal environment provided by the F1 dams and also the increased proportion of Friesian genes. The present

** The effect of sex was included only for birth weight, for older weights, the analyses were exclusively based on female animals.

observation is in line with the observation of Taneja and Bhat (1972); Naryanswamy *et al.*, (1984) and Kano Banjaw and Mekonnen Haile-Mariam (1994). The F1FA and F(JxA) were comparable at birth. The 75% FA were significantly heavier than F1FA at birth, 6 and 30 months. Increase in Friesian inheritance tended to increase body weights up to 30 months. The relatively smaller differences at 36 months, might be due to unfavourable conditions for the 75%FA at later ages (Table 2).

The 75%FZ and F1FZ had comparable performance throughout as differences in body weights were not significant at all ages (Tables 1 and 2). Hence, increase in the Friesian inheritance did not increase body weights linearly. The lack of significant difference between those genetic groups suggests the management at the farm was more suited to the intermediate cross, i.e. F1FZ. The present results are, in agreement to the report of Taneja and Bhat (1972) and Singh *et al.*, (1985) who noted an increase in body weight of crosses of only up to 50% Friesian inheritance. Similarly, kano Banjaw and Mekonnen Haile-Mariam (1994) observed no significant difference in weaning weight between F1 and three-quarter crosses between Friesian and Borana cattle in Ethiopia. F1 calves grew 12.2% faster than Borana and had comparable growth rate with the three-quarter cross.

The three-breed crosses with 75% exotic inheritance, F(JxA) had comparable performance with F1FA at all ages, however, were heavier significantly only at 6 months of age suggesting that the management and feeding conditions were not optimum for animals with 75% exotic inheritance. It could also be due to an effect of different growth curves, as Jersey is known as early maturing breed (Tables 1 and 2). Saha and Parekh (1988) reported that Friesian x Gir were superior to Friesian-Jersey-Gir crosses between 3 to 24 months.

The 75%FA were significantly heavier than the F(JxA) grades, at birth, 30 and 36 months. Thus, reflecting the influence of Jersey germplasm on the growth performance. Under peasant management and feeding conditions, such apparent lower weights could be advantages, as they could be maintained more easily by small farmers. The 75%FA were significantly lighter than 75%FZ at 12 and 36 months. This trend was consistent at almost all ages, indicating heavier body weight of Zebu than of the Arsi animals (Tables 1 and 2).

Table 1. Least squares means (LSM) and standard errors (SE) of effects influencing body weight traits (kg).

Variable	n	Birth weight LSM ± SE	n	6 months weight LSM ± SE	n	12 months weight LSM ± SE	n	18 months weight LSM ± SE
Overall breed	347	23.7 ± 0.4	206	91.8 ± 1.4	213	160.2 ± 2.1	164	220.1 ± 4.3
F1FA	101	21.5 ± 0.5^{a}	73	80.6 ± 2.7^{a}	73	149.6 ± 4.5^{c}	63	207.7 ± 6.9^{a}
F1FZ	63	24.6 ± 0.5^{b}	36	94.3 ± 2.7^{b}	37	165.3 ± 4.4^{ab}	28	224.2 ± 6.6^{a}
F(JxA)	64	21.9 ± 0.6^{a}	34	93.4 ± 2.9^{b}	34	155.9 ± 4.9^{bc}	27	216.5 ± 7.0^{a}
75%FA	89	24.6 ± 0.6^{b}	47	93.4 ± 2.7^{b}	51	157.7 ± 4.6^{bc}	35	214.3 ± 7.4^{a}
75%FZ	30	25.7 ± 0.8^{b}	16	97.2 ± 4.1^{b}	18	172.4 ± 6.6^{a}	11	237.8 ± 10.0^{a}
Sex								
Male	120	23.9 ± 0.5^{a}	-	-	-	-	-	-
Female	227	23.4 ± 0.4^{a}	-	-	-	-	-	-
Parity								
1	149	22.9 ± 0.4^{b}	95	88.9 ± 2.0^{a}	98	152.8 ± 3.2^{a}	73	209.6 ± 5.4^{a}
2	82	23.5 ± 0.5^{ab}	47	90.6 ± 2.4^{a}	48	157.8 ± 4.0^{a}	35	216.5 ± 6.4^{a}
3	72	24.7 ± 0.5^{a}	38	90.3 ± 2.7^{a}	39	162.7 ± 4.3^{a}	34	226.9 ± 6.4^{a}
4+	44	23.6 ± 0.9^{ab}	26	97.2 ± 3.1^{a}	28	167.4 ± 5.1^{a}	22	227.4 ± 7.7^{a}
Birth year								
71	72	22.3 ± 1.0^{a}	64	92.5 ± 5.0^{a}	64	164.4 ± 8.4^{a}	53	229.7 ± 12.2^{a}
72	98	23.9 ± 0.6^{a}	49	98.2 ± 3.6^{a}	51	187.0 ± 5.9^{b}	47	239.2 ± 8.6^{a}
73	117	24.4 ± 0.6^{a}	65	94.4 ± 3.5^{a}	69	152.0 ± 5.8^{c}	37	214.1 ± 9.0^{a}
74	60	24.2 ± 1.0^{a}	28	81.9 ± 6.5^{a}	29	137.3 ± 11.1^{d}	27	197.4 ± 15.3^{a}
Birth season								
Short rains	121	23.2 ± 0.5^{a}	81	93.1 ± 2.1^{b}	84	163.2 ± 3.5^{a}	73	225.8 ± 5.6^{b}
Rainy season	87	24.5 ± 0.5^{b}	49	93.9 ± 2.4^{b}	50	168.0 ± 3.9^{a}	39	224.7 ± 6.1^{b}
Dry season	139	23.2 ± 0.5^{a}	76	88.3 ± 2.2^{b}	79	149.4 ± 3.5^{b}	52	209.7 ± 5.9^{b}

Within variables means followed by the same letter are not significantly different ($P>0.05$).

Table 2. Least squares means (LSM) and standard errors (SE) of effects influencing body weight traits (kg).

Variable	n	24 months weight LSM ± SE	n	30 months weight LSM ± SE	n	36 months weight LSM ± SE
Overall Breed	170	259.7 ± 3.3	157	278.0 ± 9.0	143	284.2 ± 4.5
F1FA	67	252.1 ± 5.6^{a}	59	259.4 ± 7.4^{b}	51	274.2 ± 8.7^{ab}
F1FZ	28	264.7 ± 5.9^{a}	28	292.4 ± 8.1^{a}	27	306.6 ± 8.7^{c}
F(JxA)	27	257.5 ± 6.1^{a}	29	260.5 ± 8.1^{b}	28	249.4 ± 9.2^{a}
75%FA	35	265.5 ± 5.9^{a}	33	289.6 ± 8.6^{a}	31	277.0 ± 9.1^{b}
75%FZ	13	258.8 ± 8.4^{a}	8	287.8 ± 15.4^{a}	6	314.0 ± 18.1^{c}
Parity						
1	81	248.0 ± 4.3^{c}	73	271.4 ± 6.0^{a}	68	287.7 ± 6.5^{a}
2	36	267.6 ± 5.3^{a}	33	280.3 ± 7.4^{a}	30	280.1 ± 8.4^{a}
3	31	257.1 ± 6.0^{abc}	30	274.9 ± 8.0^{a}	25	288.0 ± 9.2^{a}
4+	22	266.1 ± 6.5^{ab}	21	285.2 ± 9.1^{a}	20	281.2 ± 9.5^{a}
Birth year						
71	61	273.8 ± 9.9^{b}	55	278.8 ± 13.6^{b}	51	284.7 ± 15.5^{b}
72	40	276.4 ± 7.5^{b}	33	282.8 ± 9.7^{b}	24	301.1 ± 11.9^{b}
73	48	253.1 ± 13.1^{b}	51	277.3 ± 9.5^{b}	52	301.0 ± 10.6^{b}
74	21	235.1 ± 13.1^{b}	18	264.0 ± 18.2^{b}	16	250.1 ± 22.4^{b}
Birth season						
Short rains	71	261.9 ± 4.6^{a}	60	274.9 ± 6.1^{a}	60	280.0 ± 6.7^{a}
Rainy season	39	259.2 ± 5.2^{a}	34	280.6 ± 7.1^{a}	28	283.7 ± 8.4^{a}
Dry season	60	258.0 ± 4.9^{a}	63	278.4 ± 6.0^{a}	55	289.0 ± 6.7^{a}

Within variables means followed by the same letter are not significantly different ($P > 0.05$).

Table 3. Least squares analysis of variance for body weight traits.

Source of variation	Mean squares						
	Traits						
	Birth	6 m	12 m	18 m	24 m	30 m	36 m
Sire	13.9ns	228.2ns	600.8ns	1324.2*	879.3ns	1156.4ns	1232.5ns
	(39)	(35)	(37)	(36)	(34)	(34)	(36)
Breed	127.5***	910.4**	1631.7*	1652.3ns	661.4ns	4811.7**	8662.4**
	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Sex	15.3ns	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	(1)						
Parity	25.6*	343.0ns	1370.2ns	1995.5ns	2766.4**	754.8ns	343.3ns
	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Birth year	14.8ns	382.7ns	5720.1**	1810.5ns	1346.7ns	271.0ns	2315.1ns
	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Birth season	42.7*	363.2ns	3743.7**	2267.2ns	141.3ns	264.5ns	585.2ns
	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Remainder	10.0	193.3	576.3	749.9	641.8	1171.2	1253.2
	(294)	(158)	(163)	(115)	(123)	(110)	(94)
R^2	0.56	0.60	0.62	0.67	0.66	0.69	0.68

*, $P<0.05$; **, $P<0.01$; ***, $P<0.001$; ns, not significant ($P>0.05$); (), degrees of freedom; n.a., not available.

Due to the scarcity of information on male animals, which in the first year of the project were normally slaughtered at lower ages, the effect of sex could not be included in the model except for birth weights. Non-significant effect of sex was observed at birth (Table 3). Similar results were reported by various authors (Govindaijah *et al.*, 1979; Trail and Grègory, 1982; Nicholson, 1983; Maarof and Arafat, 1985; Sharma *et al.*, 1986 and Rege *et al.*, 1993). The results were, however, in contrast to other reports in which males were significantly heavier than females at birth (Ghosh *et al.*, 1979; Aman *et al.*, 1985; Saeed *et al.*, 1987 and Kano Banjaw and Mekonnen Haile-Mariam, 1994).

The effect of parity of the dam was found to have significant influence only at birth and 24 months (Table 3). At birth, animals born to the third parity were significantly heavier than those born to the first parity. At 24 months, animals born to the fourth and above parities were significantly heavier than those born to the first parity (Tables 1 and 2).

The year of birth did not contribute any significant variation at all phases of age, except at 12 months (Table 3). However, there was a clear trend at all ages that the weights go down from birth year 1972 to 1974. This trend may indicate a deterioration in management and feeding conditions over these years. The effect year of birth on body weights has been attributed to the wide variation in the availability of feed and fodder and management practices over the years in India (Naryanswamy *et al.*, 1984; Nautiyal and Bhat, 1989).

Season of birth had significant influence on weights at birth and 12 months (Table 3). Calves born during the main rains had the heaviest birth weight and were significantly different from those born in the small rains and dry seasons. At 12 months, calves born in the short and main rains were significantly heavier than those born in the dry season. Animals born during the rainy seasons were kept in door in the dry season and had the advantage or better chance of utilising pasture of good quality and quantity in the subsequent small and main rainy seasons. It is generally observed that season of birth had little effect at older ages, which is substantiated by the observations of Naryanswamy *et al.* (1984); Singh *et al.* (1985); Venugopal *et al.* (1986); Singh and Bhat (1987), who noted significant effect of season of birth on body weights between 6 to 12 months of age.

In order to estimate heritabilities of body weight traits, sires were included in the model as a random effect. All Friesian sires were not progeny tested bulls, however, brought from different sub-population in Kenya, Sweden and Israel. This will give estimates of heritabilities based on crossbred progeny, F1 and 75% upgraded offsprings. In cases where the aim is to establish a crossbred population, in which selection could be carried out for different traits, the estimation of genetic parameters is necessary for the population in question.

The variation associated with sire was only significant at 18 months (Table 3). Johnson and Gambo (1975); Naryanswamy *et al.* (1984), who reported non-significant effect of sire except at birth, concluded that sires were not important in enhancing the growth of their offsprings.

Heritability estimates for weights at birth, 6, 12, 18 and 24 months are presented in Table 4. The value for birth weight is lower than most values reported in the literature and so are heritabilities for 6 and 12 months. In general, the lower heritabilities for these traits may indicate lower additive genetic variation in this population. The estimates for 18 and 24 months were higher and agree well with the ranges reported in the literature. The increase in value with age is logical as the first part of the growth period is more affected by environmental variations than the older ages. Although the higher heritability estimates may suggest better scope of improvement through selection, the values showed high standard error mainly due to the small number of offsprings per sire. It is, therefore, necessary to verify the magnitude of the additive genetic variation of these traits on large crossbred population.

Table 4. Heritability estimates for different body weight traits.

Traits	$h^2 \pm SE$
Birth weight	0.20 ± 0.15
6 months weight	0.14 ± 0.23
12 months weight	0.04 ± 0.21
18 months weight	0.68 ± 0.34
24 months weight	0.33 ± 0.29

CONCLUSIONS

Increase in Friesian inheritance did not increase body weights linearly as expected, suggesting apparently unfavourable conditions for the genetically superior animals, *i.e.*, 75%FA and 75%FZ. Therefore, it may be concluded that management and feeding at Asella Livestock Farm would warrant limitation of level of upgrading to 50% of exotic inheritance.

The three-breed cross, F(JXA) had comparable body weights to F1FA. The positive effect of upgrading on growth performance was also not observed in this group. However, smaller weights of F(JXA) may be advantageous to smallholder farmers, as such animals could be maintained more easily than larger animals with higher levels of Friesian inheritance.

The implication of current results to smallholder dairy farmers in the region is that continuous upgrading may not lead to linear increase in production under farmers conditions, therefore, intermediate grades which can best fit into the available resources at farm level are more appropriate.

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