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Original article

Non genetic factors affecting calf growth traits in mashona cattle

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A R T I C L E   I N F O

A B S T R A C T

The objective of this study was to evaluate the effects of sex of calf, year of birth, age of calf and age of dam on growth traits of indigenous Mashona calves. The growth traits under study were weaning weight (W2), yearling weight (W4) and 600day weight (W6). Data from 1834 purebred Mashona calves were employed, which included calf identity, year, sex, age, sire and dam, as well as age of dam. The data was analysed using the General Linear Models (GLM) procedure of the Statistical Analysis System. Tukey's multiple range tests were performed for testing differences between least square means. Weaning weight increased as dam age increased up to 10 years after which growth tended to decline. Post-weaning compensatory growth was apparent in calves of young dams. Male calves grew faster and were heavier at all stages than female calves. Sex of calf and age of dam significantly affected calf weaning, yearling and 600day weights. A number of years showed a significant difference from each other for all the traits measured. Records of these traits should always be adjusted for sex of calf, year effects and age of dam so as to increase the accuracy of estimation of breeding values as well as rate of genetic gain per generation of selection.

1. Introduction

Mashona are part of the Sanga group of cattle of south-central Africa which have developed over thousands of years to be thoroughly adapted to their local environment. Tswana, Tuli, Nguni and Mashona cattle are all Sanga type cattle found predominantly in southern Africa. Tswana are found in Botswana, Nguni in both South Africa and Zimbabwe and Mashona are found in Zimbabwe as well as Mozambique. Their resistance to high temperatures, ticks and flies, and their ability to maintain reproductive efficiency in the semi- arid African climate, have moulded their unique characteristics (Khombe et al 1995). In the large beef crossbreeding project conducted at Matopos Research station over the period 1974 to 1992, the Mashona was found to be the most productive genotype out-performing 22 other purebred and crossbred genotypes (Khombe et al 1995).The efficiency of reproduction remains a most important economic trait in beef production. Wider use of Mashona cattle in commercial beef enterprises can be expected to increase calving and weaning percentages. In turn, this will lead to increased beef off take from both the commercial and the communal farming sectors.

Starting with this foundation of exceptionally well-adapted cattle, the Mashona Cattle Society, established in 1954, has applied advanced breeding methods such as herd performance testing, central and on-farm bull testing, and the use of reference sires and more recently the introduction of a nucleus breeding herd to improve the breed. The estimation of genetic parameters requires appropriate accounting of non-genetic influences. In Zimbabwe knowledge of effects of non-genetic factors on growth traits of Mashona calves is limited, with some information provided by studies by Buvanendran (1990) and Tawonezvi (1989). Knowledge of the effects of non-genetic factors is required in genetic improvement programmes where adjustment of data is necessary to increase selection accuracy, which would in turn increase rate of genetic gain per generation of selection. The objective of this study was to evaluate the effects of sex of calf, year of birth, age of calf and age of dam on growth traits of indigenous Mashona calves. The growth traits under study were weaning weight (W2), yearling weight (W4) and 600day weight (W6).

2. Materials and methods

2.1. Study site

The data used in this study was collected from a Mashona Pedigree Breeding farm situated in Agro ecological zone 2b, characterised by high rainfall (750-1000mm) at an altitude of 1200-1500m above sea level and ambient temperatures ranging from 15-20°C . The climate is characterised by wide fluctuations in the quantity and distribution of rainfall within and across seasons. Rainfall normally occurs between October and March, followed by a long dry season.

2.2. Data collection

Growth traits records of 2034 Mashona calves of January 1985 to December 1989 were used. The data included calf identity, sex, age, sire and dam, as well as age of dam. The growth traits recorded for the study were weaning weight (W2), yearling weight (W4) and 600day weight (W6).

2.3. Data editing

Edits were based on lack of proper identification, lack of date birth of calf and the dam, lack of weights and weighing date. The data was initially entered into Herd MASTER V4TM® and was then exported to Microsoft Excel TM ® for pre-analysis before exported into SAS (1996) for final analysis. Databases were created for each growth trait studied. Scatter plots were constructed so as to see the spread of the data and identify the outliers. The dam age ranged from 3-19years old but due to limited observations on dams greater than 13 years, dam age was reclassified to 13 years dam age class. After recoding, dam age classes ranged from 3-13 years old classes (Table 1).Repeated measurements and outliers were also deleted. After all the editing, growth records on 1821 calves where available for analysis using SAS (1996).

2.4. Statistical analysis

Statistical analysis was for weaning weight (W2), yearling weight (W4) and 600day weight (W6). The following model was employed for the analyses of fixed effects on growth traits;

Yijk=μ + Si+Tj + b1 (D) +b2 (D) 2+b3 (Xijk-xμ) + b4 (Xijk-xμ)2+ Eijk

Where:

  Yijk = vector of observations

  μ =overall constant level of the weight trait (W2, W4 and W6)

  Si =fixed effect of ith Sex of calf (i = 1, 2)

  Tj =fixed effect of jth year of birth (j= 1, 2…………, 5)

  b1, b2, b3 and b4 where regression coefficients of the covariable on the observation

  (D) And (D)2 where linear and quadratic effects of dam age

  (xijk-xμ) and (xijk-xμ)2 = linear and quadratic effects of calf age deviated from average age for W2, W4 and W6 (xijk= calf age and xμ= mean calf age)

  Eijk = the residual error effect N~ (0, σ2)

The data was analysed using the General Linear Models (GLM) procedure of the Statistical Analysis System (SAS, 1996).

Table 1

Number of records on dam age for weaning weight after editing.

	Dame age class											
Year	3	4	5	6	7	8	9	10	11	12	13	Total
1985	0	34	21	37	14	9	12	13	2	10	13	165
1986	0	13	43	19	30	9	10	10	9	3	11	157
1987	0	0	22	36	18	24	7	9	9	10	13	148
1988	25	0	0	30	34	12	25	7	7	7	18	165
1989	22	23	0	0	19	26	8	17	7	6	18	146
Total	47	70	86	122	115	80	62	56	34	36	73	781

3. Results

The descriptive statistics for the different growth traits under investigation are shown in Table 2.

Table2

Measures of central tendency and dispersion for the growth traits.

Variable	N	Mean	SD	CV (%)	Minimum	Maximum
Age at weaning (days)	766	211	19.5	9.2	120	294
Age at yearling (days	526	413	19.2	4.6	321	483
Age at 18months (days)	529	590	16.5	2.8	512	678
Dam age (years)	766	7.6	3.2	42.1	3	13
Weaning weight (kg)	766	168	21.8	12.9	70	255
Yearling weight (kg)	526	184	21.6	11.7	100	285
600day weight (kg)	529	273	31.7	11.6	170	378

3.1. Effects of year of birth on growth traits

Year of birth had a significant influence on all traits studied (P<0.001) and this is presented in Figure 1. Calves born in 1987 were heavier than those born in any other year for all traits studied. The lightest calves were born in 1985. The heaviest calves at weaning were those born in 1987/88, whilst at 12 and 18months of age were those born in 1986/87 and 1987/88. The yearly fluctuations may be due to the variation in quality and quantity of available forage, changes in management techniques and genetic progress leading to corresponding differences in animal growth. The significance of year effects on these traits indicate the importance of taking year into consideration in analyses of records collected over several years. The findings in this study significantly concurred with those in literature where it is reported that year of birth has been found to significantly influence growth traits throughout the life of the calf (Sushma et al 2006).
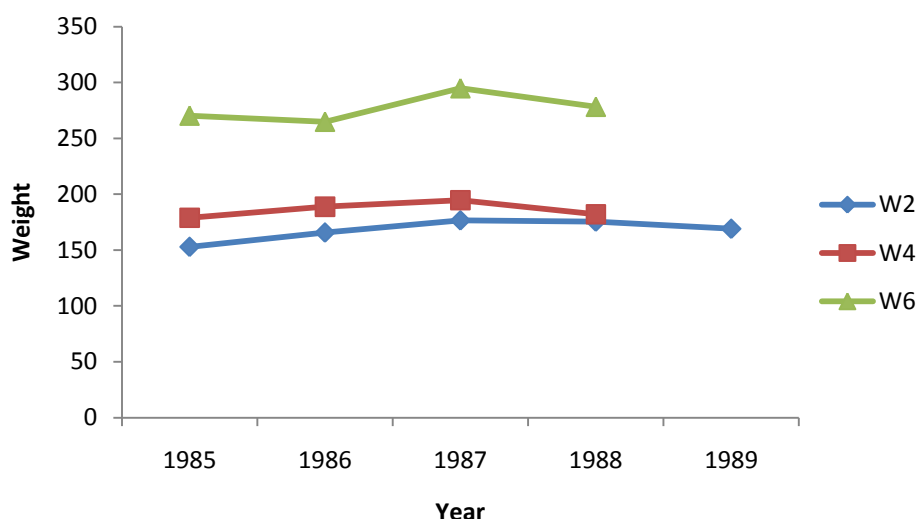
Fig. 1. Effect of year of birth on growth traits.
weaning weight (W2), yearling weight (W4) and 600day weight (W6)

3.2. Effects of sex of calf on calf growth traits

Male calves were heavier at weaning (178.1vs157.8kg), at one year of age (195.3vs177kg) and at 18months of age (290.8vs263.2kg) than their female counterparts as shown in Table 3. Differences in weight between male and female beef calves are well documented (Leighton et al 1982; Tawonezvi 1989, Newman et al 1993; Carvalheira et al 1995; Plasse et al 1995; Melka 2001). These researchers indicated that throughout their growth period male calves were heavier than female calves.   Nelsen & Kress (1981) also found that the average weaning weight of bull calves is higher than that of their heifer contemporaries. Villalba et al (2000) also found male calves to be 6.4% heavier at birth than females. These differences have been attributed to hormonal difference between sexes and their resultant effects on growth (Sushma et al 2006). This difference of weight gain is expected since weight of male animals is favoured by androgenic effects (Raff & Widmaier, 2004). According to Rumph & Van Vleck (2004) the need for adjustment factors for sex effects is obvious because bull calves generally grow faster than heifer calves and therefore it is not valid to compare heifers to their male counterparts without adjustments. Sex effects are not passed to the progeny with certainty, hence are considered to be non inheritable and as such records must be adjusted for sex effects to get a fair comparison which is based on the additive genetic merit of the individual animals.

Table 3
least square means for effect of sex of calf on growth traits

Growth trait	Male	± sem	Female	± sem	P value
W2	178.1	1.15	157.8	1.07	0.0001
W4	195.3	1.51	177.0	1.20	0.0001
W6	290.8	2.23	263.2	1.78	0.0001

W2 is weaning weight, W4 is the yearling weight and W6 is weight at 600days

3.3. Effects of age of dam on calf growth traits

Both Linear and quadratic effects of age of dam significantly affected all calf growth traits studied. Growth traits of calf increased as the age of dam increased up to 10 years and then decreased as dam age increased from 10 to 13 years for all the traits (Table 4).

Table 4
Least – square means for effect of age of dam on growth traits

Dam age	W2		W4		W6	
	Mean	SE	Mean	SE	Mean	SE
3	169.3	±3.34	179.6	±5.83	265.6	±9.56
4	160.4	±2.74	175	±3.51	264.4	±5.13
5	159.6	±2.51	176.9	±2.71	270.1	±4.01
6	165.9	±2.00	185.1	±2.18	272.2	±3.19
7	169.8	±2.00	186.3	±2.42	276.7	±3.54
8	169.8	±2.43	192.9	±3.19	287.4	±4.73
9	176.4	±2.77	196.8	±3.15	295.6	±4.73
10	172.8	±2.88	196.9	±4.00	283.7	±5.92
11	176.3	±3.67	191.2	±4.39	280.1	±6.52
12	176.9	±3.57	191.5	±4.21	285.6	±6.13
13	162.7	±2.50	183.8	±3.14	274.4	±4.60

The trend was the same as reported for the Tswana breed (Dzama and Raphaka 2009). It is well established that both birth and weaning weights are affected by the age of the dam (BIF 2002). This is also be supported by Van Vleck and Cundiff (1998) who similarly hypothesized that cows will reach peak production at a mature age and then decrease in performance as measured by weight of their calves. These old cows are no longer as efficient as they were at younger ages and consequently their calves born at older ages would have lighter weights than calves born earlier in their life. Elzo et al (1987) also hypothesized that mature dams which they defined as being 5 to 8 years of age had a greater ability to provide the necessary nutrients and uterine environment for developing foetus than do younger cows that are still developing themselves (Muchenje et al 1998). Similarly, as cows become older, their ability to provide an adequate uterine environment may diminish (Rumph and Van Vleck 2004). Calves out of young and old dams are born smaller than calves out of mature dams. Weaning weight also increased with age of dam until dams reached maturity at 5 to 6 years of age and then decreased for cows older than 10 years of age. In this study calf weight increased as dam age increased to 10 years and then started to decline and this can be attributed due to the fact that Mashona cows have longer productive life. In breeding value estimation calf growth traits need to be adjusted for age of dam effects if the comparisons are to be fair and effective.

3.4. Effect of calf age on growth traits for calf growth

Linear effect of calf age was significant on growth traits studied whilst the effect of quadratic function was insignificant to W4 and W6.

4. Conclusion

Sex and age of calf, age of dam and year of birth have been shown to significantly affect calf weaning, yearling and 600day weights, hence there is need to adjust records of these traits so as to increase the accuracy of estimation of breeding values as well as rate of genetic gain per generation of selection.

Acknowledgement

References

BIF., 2002. Guidelines for uniform beef improvement programs. Beef Improvement Federation (BIF), Georgia, USA.
Buvanendran, V., 1990 Adjustment factors for weaning weights of Mashona cattle in Zimbabwe. J. Agr. Sci. Cambridge., 114, 35-40.

Carvalheira, J.G., Blake, R.W., Pollak, E.J., Van Soest, P.J., 1995. Comparison of Landim and Afrikaner cattle in Southern Mozambique: Body weights and growth. J. Anim. Sci., 73, 3519-3526.

Dzama, K., Raphaka, K., 2009. Sex of calf and age of dam adjustment factors for birth and weaning weight in Tswana and Composite beef cattle breeds in Botswana. S.Afr. J.Anim. Sci., 2009, 39 (4).

Elzo, M.A., Quaas, R.L., Pollak, E.J., 1987. Effects of age-of-dam on weight traits in the Simmental population. J.Anim. Sci., 64, 992-1001.

Khombe, C.T., Hayes, J.F., Cue, R.I., Wade, K.M., 1995. Estimation of direct additive and maternal additive genetic effects for weaning weight in Mashona cattle of Zimbabwe using an individual animal model. Anim. Sci., 60, 41-48.

Leighton, E.A., William, R.L., Berger, P.J., 1982. Factors influencing weaning weight in Hereford cattle and adjustment factors to correct records for these effects. J.Anim. Sci., 54, 957-963.

Melka, H.D., 2001. Genetic parameter estimates for weaning traits in a multi-breed beef cattle population, MSc. (Agric) thesis, University of Stellenbosch, Stellenbosch, S. Afr.

Muchenje, V., Mhlanga, F.N., Makuza, S.M., 1998. Adjusting lactation milk yield of Zimbabwean Holstein dairy cows for the joint effects of age at calving and month of calving. J. Appl. Sci. South. Afr., 4, 35-42

Nelsen, T.C., Kress, D.D., 1981. Additive and multiplicative correction factors for sex and age of dam in beef cattle weaning weight. J.Anim. Sci., 53, 1217-1224.

Newman, S., McNeil, M.D., Reynolds, W.L., Knapp, B.W., Urick, J.J., 1993. Fixed effects in the formation of a composite line of beef cattle: II. Pre and postweaning growth and carcass composition. J. Anim. Sci., 71, 2033-2039.

Plasse, D., Fossi, H., Hoogensteijn, R., Verde, O., Rodriguez, R., Rodriguez, M.C., Bastidas, P., 1995. Growth of F1 Bos taurus x Bos indicus vs Bos indicus beef cattle in Venezuela. I. Weights at birth, weaning and 18 months. J. Anim. Breed. Genet., 112, 117-132

Raff, H., Strang, K.T., Widmaier, E.P., 2004. Blood and hemostasis. IN Human physiology: The mechanisms of body function 9th Edition. E.M. Watnick. McGraw-Hill Companies Inc. New York, USA.

Rumph, J.M., Van Vleck, L.D., 2004. Age-of-dam adjustment factors for birth and weaning weight records: A review. Genet. Mol. Res., 3 (1), 1-17.

SAS, 1996. Statistical Analysis System Manual. The SAS system. SAS Institute Inc. Cary, North. Carolina, USA.

Sushma, G., Ramesh, Gupta, B., Vinoo, G.V., Reddy, N., Reddy, S., 2006. Influence of genetic and non-genetic factors of body weights and body measurements of Ongole cattle. Indian J. Anim. Sci., 75, 228-235.

Tawonezvi, H.P.R., 1989. Growth of Mashona Cattle on range in Zimbabwe.l. Environmental influences on liveweight and weight gain. Trop. Anim. Health. Prod., 21, 37-42.

Van Vleck, L.D., Cundiff, 1998. Expected phenotypic response in weaning weight of beef calves from selection for direct and material genetic effects. J Anim. Sci., 44, 360-367.

Villalba, D., Casasus, I., Sanz, A., Estany, J., Revilla, R., 2000. Pre-weaning growth curves in Brown Swiss and Pirenaica calves with emphasis on individual variability. J. Anim. Sci., 78, 1132-1140.