Short communication

Sex of calf and age of dam adjustment factors for birth and weaning weight in Tswana and Composite beef cattle breeds in Botswana

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Abstract

Records on 2 257 Composite and 5 923 Tswana calves born between the period of 1988 and 2006 in Botswana were used to calculate additive correction factors for the effects of sex of calf and age of dam on birth weight and weaning weight. The mature age group in both breeds for the two growth characteristics was 5 - 12 year old dams. Male calves were heavier than their female contemporaries throughout the pre-weaning growth period. The sex of calf adjustments for birth and weaning weights were 2.75 and 8.21 kg in the Tswana while the corresponding values for the Composite were 2.84 and 10.11 kg. Both birth and weaning weights increased with advancing age of dam, reaching a peak in mature dams and declined when dams reached an old age. Age of dam adjustment factors for birth weight in the 3, 4 and 13+ year age groups were, respectively, 1.74, 0.96 and 1.87 kg in the Tswana. Corresponding values for the Composite were 2.28, 0.94 and 2.06 kg, respectively. Age of dam adjustment factors for WW were respectively 10.36 and 5.46 kg for age groups 3 - 4 and 13+ years in the Tswana. Adjustment factors for weaning weight in the Composite breed were 13.84, 3.20 and 9.58 kg for age groups 3, 4 and 13+ years, respectively. These results indicate that adjustment factors for birth and weaning weights should be considered separately for sex of calf and age of dam in these breeds, and also, that these adjustments need to be applied within the breed from which they were derived.

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Adjustment factors are important in beef cattle genetic evaluations because they allow for a fair comparison of animals. For beef cattle, birth weight and weaning weight records are traditionally adjusted for sex of calf, age of dam and the age of calf at weaning for weaning weight before the data are subjected to genetic analysis (Dzama *et al*., 1997).

The average weights of bull and heifer calves differ at all ages regardless of having been raised under similar environmental conditions, with males always being heavier than females. According to Rumph & Van Vleck (2004) the need for adjustment factors for sex and contemporary group 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. Nelsen & Kress (1981) found that the average WW of bull calves is higher than that of their heifer contemporaries. Correction factors for sex in weights can either be additive or multiplicative.

The correction of birth weight and weaning weight records for age of dam is equally important. It is well established that both birth and weaning weights are affected by the age of the dam (BIF, 2002). Since first-calf heifers are not mature both physically and biologically, the nutrients they consume are not only partitioned into lactation, maintenance and gestation, but also channelled towards their own growth (Muchenje *et al*., 1998). First calvers therefore generally give birth to and wean smaller calves, which have a disadvantage if they are to be compared to their contemporaries bred from older dams. Likewise, cows will reach peak production at their mature age and will decline in efficiency when they reach old age. They will consequently have smaller calves than earlier in life. Elzo *et al.* (1987) hypothesized that mature dams, aged 5 to 8 years, have a greater ability to provide nutrients and an optimal uterine environment for the foetus compared to younger dams which are still developing themselves, while old cows may also show diminishing uterine environmental effects.

Even though a great deal of research has been done to estimate appropriate age of dam adjustment factors for birth weight and weaning weight in beef cattle, most of the research was conducted in temperate environments and on beef breeds adapted to those conditions. The paucity of information on adjustment factors is especially evident for tropical cattle; thus emphasizing the need for developing such values for beef breeds such as the Tswana and the Botswana Composite. The purpose of the present study was therefore to develop adjustment factors for birth weight and weaning weight for the Tswana and Botswana Composite cattle breeds.

The data used in the study was collected at Musi ranch in Botswana, located at latitude 25°35'S and longitude 25°13'E. The ranch is managed by the Animal Production and Range Research Division of the Department of Agricultural Research of Botswana. The data were collected from a Composite breed and the Tswana breeds. The Composite breed was developed in a controlled breeding programme using the Simmentaler, Brahman, Tswana, Tuli and Bonsmara breeds. Further details of the ranch conditions, breeds used and their management have been described by Raphaka (2008).

A total of 2 257 performance records of the Composite breed and 5 923 of the Tswana breed were available for analysis. The data were recorded from 1988 to 2006. The information contained in the data set included birth date, birth weight, sex, breed type, previous parous state (PPS), cow parturition weight (CPW), weaning weight, date of weaning, 18 month weight (18MW) and the interval in days from weaning to 18 months.

The General Linear Models (GLM) procedure in the Statistical Analysis Systems (SAS, 2004) was used to analyse the data. Specifically the effects of sex of calf, age of dam, month and year of birth, previous parous state, cow parturition weight on birth weight and weaning weight were tested for both breeds in a linear fixed effects model. For the modelling of weaning weight, birth weight was included as a covariate. In order to derive at age of dam adjustment factors, pair-wise comparisons were done, using the Tukey's test. This facilitated the development of different aged dam groups by pooling together aged dams that did not differ significantly. Age of dam adjustment factors for birth weight and weaning weight to a mature basis was derived from least square constants. The adjustment factors were computed as deviations of other age of dam groups from the mature age group (base). Sex of calf adjustments was computed by taking the least squares mean differences between male and female calves.

The sex of calf, age of dam, month and year of birth and cow parturition weight affected ($P < 0.05$) birth weight and weaning weight in both the Tswana and Composite breeds. However, previous parous state did not affect ($P > 0.05$) either birth weight or weaning weight in the Composite breed but did in the Tswana breed ($P < 0.05$). In both breeds birth weight and age of calf at weaning were significant when fitted as covariates for weaning weight.

Sex of calf x age of dam interactions did not affect ($P > 0.05$) weaning weight in both breeds. These results are in agreement with older pioneering research in this area by Cunningham & Henderson (1965), and Cardellino & Frahm (1971). A significant sex of calf by age of dam interaction effect would indicate a need for separate additive age of dam correction factors within each sex.

The effects of age of dam on birth weight and weaning weight were curvilinear and concurred with well established trends. There was an increase in birth weight from 3 year to 6 year old dams in the Tswana. A peak was reached between the dam ages of six and nine years, whereafter it tended to decrease with an advancing age. Swiger *et al.* (1962) estimated that calves produced by 8 to 9 year old dams had the heaviest birth weights. Similarly, in the Composite breed birth weight increased as age of dam increased but unlike the Tswana, the highest birth weights were obtained at dam ages of 11 and 12 years.

Younger dams and older dams gave birth to lighter calves when compared to mature dams. According to Elzo *et al.* (1987) this trend is probably a reflection of a greater ability of mature cows to provide the foetus with the necessary nutrients and environmental conditions for its development. It also suggests a reduction of this ability in both younger and older cows: Since first-calf heifers are not physically or biologically mature and still developing themselves, the nutrients they consume are partitioned not only into lactation, maintenance and gestation, but also towards their own growth (Rumph & Van Vleck, 2004). Likewise, as cows become older, their ability to provide an adequate environment to the calf may diminish.

Age of dam adjustment factors for birth weight to a mature basis derived from least squares means for the Tswana and the Composite breeds are presented in Table 1. For both breeds the age of dam groups were similar, i.e. 3, 4, 5 - 12 and 13 years and older. In both the Tswana and Composite breeds mature cows were considered to be 5 - 12 years old. These results are similar to those reported by Dzama *et al.* (1997) for the

Hereford and Sussex breeds in Zimbabwe. In the same study they observed that mature cows were 5 - 13 years for the Mashona, a breed with a common ancestral origin to the Tswana. The Beef Improvement Federation (BIF) denotes mature cows to be between ages 5 and 10 years for birth weight in the United States (BIF, 2002). Adjustment factors for the Composite were larger than those for the Tswana for ages 3 and 13+ years but were lower for dams belonging to the 4-year old group.

Age of dam adjustment factors for age groups 3, 4 and 13+ years for the birth weight of the Composite breed were respectively 2.3, 0.9 and 2.1 kg. Unlike the Tswana, these results show that younger dams (three and four years of age) gave birth to lighter calves than older dams (13+ years). The age of dam adjustment factors for age groups of three and four years were similar to those in the U.S.A. (BIF, 2002).

Table 1 also shows the age of dam adjustment factors for weaning weight to a mature basis for the two breeds. In both breeds the mature cows were between the ages of 5 - 12 years. The mature cow basis for weaning weight (5 - 12 years) was similar to that for birth weight. In the Tswana the category for younger cows was, however, represented by 3- and 4-year old dams pooled together, and therefore the categories for adjustment factors based on age of dam were 3 - 4, 5 - 12 and 13+ years. Three and four year old cows, however, weaned calves which performed significantly differently (P <0.05). As a consequence, age of dam adjustment factor categories in the Composite were 3, 4, 5 - 12 and 13+ years for weaning weight, age groups similar to those obtained for birth weight.

Table 1 Additive adjustment factors for age of dam (kg ± s.e.) for birth and weaning weights in the Tswana and Composite breeds

Age of dam	Birth weight (kg)	± s.e.	Age of dam (years)	Weaning weight (kg)	± s.e.
Tswana					
3	1.74	± 0.31	3 – 4	10.36	± 1.32
4	0.96	± 0.22	5 – 12	0.00	± 0.00
5 – 12	0.00	± 0.00	≥13	5.46	± 1.58
≥13	1.87	± 0.46			
Composite					
3	2.28	± 0.62	3	13.84	± 2.93
4	0.94	± 0.33	4	3.20	± 1.77
5 – 12	0.00	± 0.00	5 – 12	0.00	± 0.00
≥13	2.06	± 1.09	≥13	9.58	± 5.66

In general, the adjustment factors were on average lower than those obtained in other studies (Cardellino & Frahm, 1971; Nelsen & Kress, 1981; Sharma *et al*., 1982; Dzama *et al*., 1997). On the other hand, the adjustment factor for dams of 13 years and older was comparable to that obtained by Dzama *et al.* (1997) for the Sussex (5.4 kg) and by Cundiff *et al.* (1966) for the Angus (5.6 kg). In the Composite breed, age of dam adjustment factors for age groups 3, 4 and 13+ years were, respectively, 13.8, 3.2 and 9.6 kg. Considering the average differences between male and female calves, the BIF (2002) adjustment factors for 3-year old dams in the Angus and Charolais breeds were comparable to those computed in the present study. The adjustment factors for 4-year old dams were generally lower compared to those reported by Rumph & Van Vleck (2004). For cows of 13 years and above, Dzama *et al.* (1997) found an adjustment factor of 10.6 kg for the Hereford in Zimbabwe.

The differences in weight between sexes are presented in Table 2. Differences in weight between male and female beef calves are well documented (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. The adjustment factors for sex of calf were higher for the Composite than for the

Tswana breed. The adjustment factors for birth weight and weaning weight in the Composite were 2.84 and 10.11 kg, respectively. Corresponding adjustment factors for the Tswana were 2.75 and 8.21 kg, respectively.

Table 2 Least squares means (kg ± s.e.) indicating sex of calf differences in birth weight (BW) and weaning weight (WW) of the Tswana and Composite cattle breeds of Botswana

Breed		Males	± s.e.	Females	± s.e.	Contrast
Tswana	BW (kg)	33.9	± 0.11	31.2	± 0.12	2.75
	WW (kg)	180.1	± 0.60	171.9	± 0.62	8.21
Composite	BW (kg)	35.0	± 0.20	32.2	± 0.20	2.84
	WW (kg)	194.6	± 0.88	184.5	± 0.90	10.11

The sex of calf adjustment for birth weight in the Tswana was higher than adjustment factors reported by Kars *et al.* (1994) for Nguni cattle in South Africa (1.86 kg) and Tawonezvi (1989) for Mashona cattle in Zimbabwe (1.0 kg). Tswana, Nguni and Mashona cattle are all Sanga type cattle found predominantly in southern Africa. The differences in the correction factors therefore underline the fact that correction factors can vary significantly within the same breed group of cattle in the same geographical region. The correction factor for weaning weight (8.21 kg) obtained for the Tswana was closer to the correction factor of 8.0 kg derived for the Mashona by Tawonezvi (1989). The sex of calf adjustment factors for the Composite were lower than the adjustment factor of 16.5 kg reported by Newman *et al.* (1993) for a composite line of beef cattle.

There is a large body of data on adjustment factors developed mostly in the temperate beef producing zones of North America. Differences in adjustment factors reported in several studies are probably due to the differences in climates between regions, and in management and other environmental effects. In addition, the genetic differences of the populations may also have played a role. This underlines the fact that adjustment factors need to be developed for the specific environment where they are to be used. In addition, adjustment factors need to be re-evaluated every few years in order to improve their accuracy. With the advent of faster computing resources, it has become easier to adjust for non-genetic factors simultaneously with breeding value estimations. Where computing resources are limited, as would be the case in genetic evaluation programmes in most developing countries, it would be advisable to pre-adjust data using relevant adjustment factors before genetic parameters and breeding values are estimated.

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