Short Communication

Genetic parameters for cow weight at calving and at calf weaning in South African Simmental cattle

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Abstract

A study was conducted to compare mature cow weight in the South African Simmental population when defined as the weight of the cow at calving or the weight of the cow at weaning of the calf. Data included in the analysis were 14458 records for cow weight at calving (CWT-C) representing 6534 cows and 18871 records for cow weight at weaning (CWT-W) representing 8395 cows. All cows were born between 1968 and 1996, while all calves were born between 1977 and 1998. The following effects had a significant influence on the traits and were included in the genetic analysis: Cow age in years fitted as a covariate term (linear and quadratic) and contemporary group fitted as a fixed effect. Contemporary group was defined as the unique combination of herd, birth year of calf, month of weighing, breeder-defined management group code for the calf and supplementary feeding code for the cow (for CWT-W). All analyses were done using ASREML, first fitting uni-trait and then bi-variate animal models that made provision for up to four weights per cow. The estimated genetic correlation obtained between the two cow weight traits was 0.95 ± 0.03, with a residual correlation of 0.61 ± 0.02. The heritability estimates for CWT-C and CWT-W from this analysis were 0.29 ± 0.04 and 0.37 ± 0.04, respectively. From a breeding perspective, these results confirm that little benefit is to be gained from weighing cows at calving if cows are to be weighed at weaning. If cow weights are to be recorded for an indication of cow maintenance costs, then weight at weaning is the more reliable and practical measure to record.

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Cow weight in South Africa is an important measurement which is used to control mature size. It is also applied in selection for efficiency where mature weight has a major influence on the feed requirements of the cow (Garrick, 2006). Mature body weight and milk production are the two most important components that determine efficiency of beef cows (Dickerson, 1970; McMorris & Wilton, 1986; Montaño-Bermudez *et al.*, 1990; Miller & Wilton, 1999). The high maintenance costs associated with large mature cows is a problem in any breeding programme (Fiss & Wilton, 1992; López de Torre *et al*., 1992). Records for cow weight at calving and at calf weaning have been maintained by the Simmentaler Cattle Breeders' Society of Southern Africa (SCBS) since the late 1970's. With the implementation of a new performance database in 2001, only those records relating to cow weight at weaning were retained on the SCBS database for subsequent inclusion in the BREEDPLAN multi-trait genetic evaluation (Graser *et al.*, 2005). Cow weights at calving, in contrast, were assumed to be highly correlated with cow weight at calf weaning and deemed unnecessary for inclusion in the evaluation. As a result, cow weights at calving were no longer recorded by the Society and the historic records were not carried over to the new database. However, discussion continues as to the merits of recording cow weights at calving in addition to those weights recorded on cows at the weaning of their calves. The aim of this study was to investigate the heritability of the two cow weight traits, as well as the genetic correlation between them using simple repeatability models.

The data were supplied by the SCBS, either directly from the SCBS database (for cow weight at weaning) or from archived ASCII data files (for cow weight at calving). The archived data only included calvings up to, and including, 1998 and as such the present study was confined to the period in which both

observations (cow weight at calving and at weaning) were available. The final data set included 4214 records of calving weight only (i.e. cow not re-weighed at weaning of calf), 9941 records of weight at weaning only (i.e. cow not weighed at birth of calf), and 21932 records with a weight at calving and a corresponding weight at weaning.

The SCBS pedigree database was then used to edit the data set. During editing, cows without a date of birth, cows without pedigree (i.e. sire and/or dam missing), cows with embryo transfer calves, cows and calves that differ in ownership (i.e. breeder herds different), and cows with calves without a birth weight (for cow weight at calving) or weaning weight (for cow weight at weaning) were deleted.

After editing, there were 14458 records for cow weight at calving (CWT-C) representing 6534 cows, and 18871 records for cow weight at weaning (CWT-W) representing 8395 cows. All cows were born between 1968 and 1996, while all calves were born between 1977 and 1998. A small number of records were removed due to extremes for age and/or weight of cow. The bulk of the calving and weaning records were taken from 1988 onwards. The frequency distribution is quite similar for both traits. Approximately 43% of cows had only one record, 23 - 24% had two records, 14 - 15% had three records, 8 - 9% had four records and 10 - 11% had five or more records. Because of this sharp decline in cow numbers as the number of records increased it was decided to include only the first four records of an animal.

Table 1 provides summary statistics of cow age and weight at calving and weaning respectively. Less than 3% of calving weights and <1% of weaning weights were taken on cows older than 10 years of age.

Table 1 Summary statistics for observations at calving and weaning

Trait	Average	SD	Min	Max
Cow weight at calving:				
Weight (kg)	543.3	87.3	259	910
Age (days)	1663.5	842.2	587	6293
Age at first observation	1154.5	580.3	587	5830
Calf weight (kg)	39.7	4.8	17	60
Cow weight at weaning:				
Weight (kg)	535.5	82.3	254	990
Age (days)	1913.3	810.9	613	6247
Age at first observation	1395.9	538.7	613	5738
Calf weight (kg)	244.9	48.5	75	485
Calf age (days)	211.7	28.0	130	290

Figure 1 shows the quadratic relationship between age of cow (in years) and cow weight at calving and at weaning. Note that all cows older than 10 years of age were included in age class 10. Cow weights at calving and at weaning increased rapidly with age up to around six years, after which the rate of change with age decreased. Contemporary group effects (herd, year, month, management group) were accounted for in the model, using PROC GLM in SAS v9.1 (SAS, 2004).

The BREEDPLAN analysis of beef cattle performance records includes mature cow weight, defined as the weight of the cow when the calf is weighed for a 200-day weight. The model allows for repeated records, with up to four weights possible per cow. In general, the method of choice for analyzing mature cow weights is random regression models. This method is, however, computationally much more demanding than a simple repeatability model. Although the accuracy for selection will be higher with such models, simple repeatability models render an acceptable approximation for the prediction of breeding values for selection purposes (Nephawe, 2004).

Single trait animal model BLUP analyses were undertaken for each trait (CWT-C and CWT-W) using ASREML (Gilmour *et al.*, 2006). The first of these made use of the first observation recorded for each cow, with cow age in years fitted as a covariate term (linear and quadratic) and contemporary group fitted as a fixed effect. Contemporary group was defined as the unique combination of herd, birth year of calf, month of

weighing, breeder-defined management group code for the calf and supplementary feeding code for the cow (for CWT-W). The influence of sex of calf as a fixed effect, julian days at calving as a covariate (for cow weight at calving) and age of the calf at weighing as a covariate (for cow weight at weaning) were also examined. The second series of analyses used all records for cow weights, fitting a repeated records model. Single cow contemporary groups were excluded from all single trait analyses.

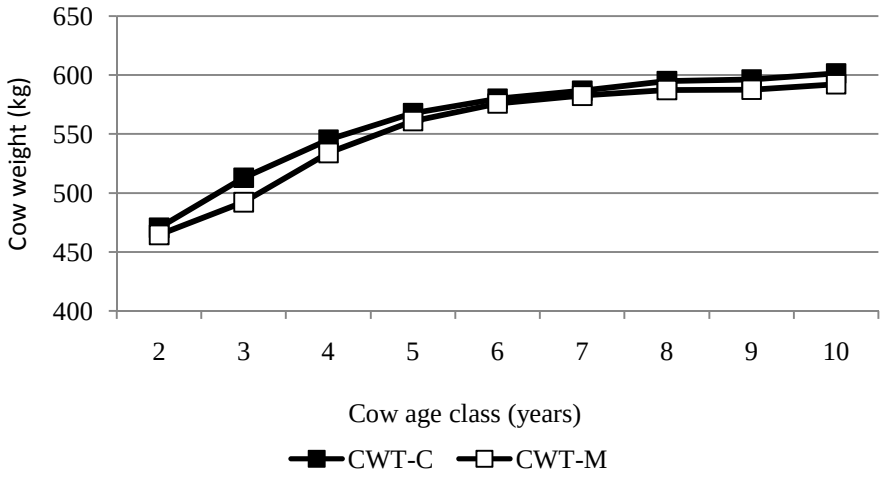

Figure 1 The relationship between cow age class (in years) and cow weight at calving (CWT-C) and at weaning (CWT-W).

A two-trait analysis of cow weight at calving and cow weight at weaning was also undertaken using ASREML. This was based on a single record per cow with both a calving weight and a weaning weight recorded for the same calf. The first occurrence of a "paired observation" was used for each cow. In all ASREML analyses four generations of pedigree information was used.

There was no significant effect of sex of calf on the weight of cows at calving or weaning. In contrast, age of cow was a significant source of variation in cow weight at calving and weaning ($P < 0.01$). The relationship of cow age to cow weight was positive and quadratic, with age effects being greatest at younger ages and diminishing at older ages. Julian days at calving (i.e. days from start of the year to calving) did not

Table 2 Variance components and ratios for cow weight at calving, based on analysis of first observation records only or a repeated records model (units, kg^2)

Variance component or ratio	Single record (first observation)	Repeated records
σ^2_A	637.6	970.6
σ^2_E	1843.4	1369.8
σ^2_{PEV}	-	580.7
σ^2_P	2481.0	2921.1
h^2	0.26 ± 0.04	0.33 ± 0.03
Repeatability	-	0.53 ± 0.01

Where σ^2_A = Direct variance, σ^2_E = Error variance, σ^2_{PEV} = Permanent environmental variance, σ^2_P = Phenotypic variance, h^2 = Direct heritability.

influence the data significantly. Age of calf at weighing was also significantly associated with cow weight at weaning ($P < 0.01$). The latter relationship was quadratic, with cow weights decreasing as calf age increased up to around 200 days in age, after which cow weights generally increased with calf age.

Table 2 summarizes the variance components and ratios estimated from the analysis of first observation records only, and also from the repeated records model. There were 5513 cows with a first observation record analyzed, representing 805 sires.

Table 3 summarizes the variance components estimated from the analysis of first observations only for cow weight at weaning, and also from the repeated records model. There were 7386 cows with a first observation record analyzed, representing 1002 sires.

A total of 4611 cows with a paired observation for weight at calving and weight at weaning were included in the two trait analysis (Table 4).

Table 3 Variance components and ratios for cow weight at weaning, based on analysis of first observation records only or a repeated records model (units, kg^2)

Variance component or ratio	Single record (first observation)	Repeated records
σ^2_A	763.4	962.0
σ^2_E	1505.4	994.4
σ^2_{PEV}	-	655.5
σ^2_P	2268.9	2611.9
h^2	0.34 ± 0.03	0.37 ± 0.02
Repeatability	-	0.62 ± 0.01

Where σ^2_A = Direct variance; σ^2_E = Error variance; σ^2_{PEV} = Permanent environmental variance; σ^2_P = Phenotypic variance; h^2 = Direct heritability.

Table 4 (Co)variance components from the two trait analysis of cow weight at calving and cow weight at weaning, based on analysis of the first observation of paired records (units, kg^2)

Variance component or ratio	CWT-C	Co-variances	CWT-W
σ^2_A	689.7	730.0	863.4
σ^2_E	1731.0	976.0	1504.0
σ^2_P	2420.7		2367.4
h^2	0.29 ± 0.04		0.37 ± 0.04
r_A		0.95 ± 0.03	
r_E		0.61 ± 0.02	

Where σ^2_A = Direct variance; σ^2_E = Error variance; σ^2_P = Phenotypic variance; h^2 = Direct heritability; r_A = genetic correlation; r_E = Environmental correlation.

Both cow weight at calving and cow weight at weaning were shown to be repeatable and moderately heritable in Simmental cattle. These estimates are similar to the repeatability of 0.61 and heritability of 0.36 for cow weight at weaning reported by Suarez & Crook (2007), their study being based on approximately 25000 weight records for Simmental (of which the current data comprised a subset). It is also similar to the results obtained by Urioste *et al.* (1998) in pasture-fed Uruguayan beef cattle as well as those of Nephawe (2004) in Bonsmara cattle using random regression models. The estimates are, however, lower than those

obtained by Mwansa *et al.* (2002) in Hereford cows and Nephawe *et al.* (2004) in Hereford Angus cows. It is also lower than the average of the estimates listed by Koots *et al.* (1994) in a review article.

At the genetic level, the two cow weight traits can be considered as different expressions of the same trait. A genetic correlation of 0.95 indicates that any attempts to modify cow weight via selective breeding will achieve a similar outcome irrespective of whether selection is based on cow weights taken at calving or at weaning. However, the higher repeatability and heritability for cow weight at weaning indicate that this is the more reliable measure of the two cow weight traits. It is also the more practical measurement, given that all cows and calves in the management group are being handled and weighed together, as opposed to weighing single cows in the calving group over a period of time when cow weight at calving is recorded. Weighing cows at calving also has the added problem of greater stress to the postpartum cows.

From a breeding perspective these results confirm that little benefit is to be gained from weighing cows at calving if cows are to be weighed at weaning. If cow weights are to be recorded, then the weight at weaning is the more reliable and practical measure to record.

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