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Genetic Parameters for Cow Weight in Pasture Fed Hereford Cattle

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ABSTRACT: Genetic parameters for weaning weight (WW) and cow weight (CW) at different ages, CW1 to CW5 (24-42, 43-54, 55-66, 67-78, 79 to 120 months respectively) were estimated through a multiple trait model for the Hereford breed in Uruguay. Data consisted of 17875 WW, 7235 CW1, 6483 CW2, 4805 CW3, 3133 CW4 and 4038 CW5. Posterior mean marginal estimates were obtained using Bayesian inference with the GIBBSF90 program. WW heritability was 0.13±0.03 using a dataset of 17875. Estimated heritabilities for CW1 through CW5 were 0.39±0.07, 0.48±0.04, 0.68±0.05, 0.59±0.06 and 0.47±0.08. Genetic correlation between CW1 and CW2, CW2 and CW3, CW3 and CW4, CW4 and CW5 were 0.93±0.06, 0.69±0.09, 0.90±0.04, and 0.90±0.05 respectively. Correlations are high but not consistent through all ages, so using several CW might improve estimation of mature weight.
Keywords: beef cattle; mature weight; genetics

Introduction

Mature weight (MW) has been considered an important trait in genetic improvement programs due to its effects on economically relevant traits like maintenance requirements, reproduction, and other physiological traits (Koots et al., (1994)). There are several procedures by which MW can be estimated, repeatability model where weight at the different ages is assumed to be the same trait, random regression models where growth is attempted to model and multiple trait analysis where weights at different ages are considered different traits (Bullock et al., (1993); Costa et al, (2011) ; Meyer, (2001)). Multiple-trait models seem to be a good alternative to start with because of their robustness and ability to account for differences in the (co)variance and correlation structure along the growth curve (Costa et al., (2011)).

Adjusting cow weight (CW) for body condition score (BCS) accounts for the ratio of protein to fat in an animal's body; however doing so is questionable since BCS is assigned to an animal based on the observer's opinion and can be unreliable. Several studies have reported that the phenotypic variance of MW was reduced when adjusting for BCS while the fraction of variance due to additive genetic effects was increased by adjusting MW for BCS (Northcutt et al. (1992), Choy et al. (2002)).

On the other hand, BCS has also been reported to have little or no effect on MW (Arango et al. (2002); Williams (2007)).

The objective of this study is to determine genetic parameters for cow weight at different ages, where they are treated as different traits, adjusting for BCS. Since the age at which the Hereford breed in Uruguay reaches their MW has not yet been established, results from analysis of CW will help determine how to best obtain estimates for MW.

Materials and Methods

Data. Cow weights from Hereford females used for this analysis were from INIA national performance database. Cows were routinely weighted at weaning time since 2007 at which time BCS is registered. A BCS scale were assessed subjectively using a scale from 1 to 8 points (Vizcarra et al. (1986)) was recorded by each breeder. For this analysis, all cows with own weaning weight and at least one CW with BCS was used. Final data set contained 17,192 cows that came from 180 breeders, with a total of 1800 sires, 877 of these with 5 or more daughters, cows born from 1995 to 2010. See Table 1 for a description of data.

Table 1. Descriptive statistics for weaning weight (WW), and cow weights taken at 3, 4, 5, 6 and 7 or more years of age (CW1,CW2,CW3,CW4,CW5) *.

Trait	No	Mean	Std.Dev.	Age**	BCS
WW	17875	198.9	35.6		
CW1	7235	463.1	35.7	35.7	4.0
CW2	6483	492.5	65.3	48.5	4.1
CW3	4805	508.2	72.0	60.1	4.1
CW4	3133	515.6	73.4	72.3	4.0
CW5	4038	523.1	73.6	94.9	4.1

*WW- weaning weight adjusted to 205 days by age of dam.
** Age in months.

Cow weights where defined as CW1 to CW5 (24-42, 43-54, 55-66, 67-78, 79 to 120 months respectively) depending on the age at calving of each weight available. CW where taken whenever they weaned a calf at the moment of weaning. Thus, dataset contained only cow weights of those that weaned a living calf.

Contemporary groups used for CW1 to CW5 where those assigned to the calf at weaning, using the national genetic evaluation criteria (same herd, season, sex and management group, while the cows own contemporary group at weaning was used for WW. Pedigree information was provided by ARU (Asociación Rural del Uruguay). Several quality controls on performance records were carried out in order to exclude logical inconsistencies and biological incompatibilities.

Statistical analysis. The following multiple trait model was used for the analysis of the dataset.

$$y_{tijk} = CG_{tj} + AOA + BCS_k + a_{ti} + e_{tijk}$$

where: y_{tijk}= record for weight trait t, of the i^{th} animal in the j^{th} contemporary group and the k^{th} BCS, CG_{tj}= contemporary group j for trait t (1 to 1225, 1256, 1158,909 and 935 respectively), AOA= age in months as a linear covariable, BCS_{tk}= BCS k of the animal for trait t (1 to 8 for each trait), a_{ti}= random additive genetic effect and e_{tijk} is the random residual effect.

For WW, maternal and permanent maternal effect was included in the model while for all other traits, these were fixed to 0.

Analysis where made with GIBBS2F90 (Misztal et al. (2002)) via the Bayesian approach using Gibbs sampling. A single chain of 200,000 samples was run, with the first 50,000 samples discarded as burn-in. Posterior mean and standard deviation, high posterior density interval (HPD) and effective sample size were calculate for each parameter. Convergence was determined by graphical inspection of the chain.

Results and Discussion

Estimates of variance components for direct additive genetic effects for CW1 to CW5 and for direct and maternal additive genetic and permanent maternal genetic effects for WW are shown in Table 2. Estimates are in increasing order for WW, CW1, CW2 to CW3, CW3 is similar to CW4, and CW5 decreases slightly. Magnitudes found are smaller than those reported by Costa et al. (2011) for younger cows, with an apparent plateau at 5 years (CW3) compared to at 3 or 4 years, magnitudes are similar at the plateau. Obtained estimates for WW are smaller from those obtained when no restriction to CW is applied on the dataset.

Table 2. Estimated statistics of marginal posterior distributions of additive genetic effect (σ_a^2), residual (σ_e^2) and heritability (h^2).

Trait	Param.	Mean	PSD	95% HPD_L	95% HPD_U
WW	σ_a^2	74.2	21.1	55.2	98.6
	σ_m^2	117.7	60.5	28.8	235.7
	$\sigma_{a,m}$	-4.2	9.6	-26.0	9.7
	σ_{mpe}^2	21.4	15.7	0.5	44.7
	σ_e^2	374.4	163.3	319.5	410.5
CW1	σ_a^2	593.9	111.9	417.5	738.6
	σ_e^2	939.7	274.9	789.7	1215.0
CW2	σ_a^2	930.1	107.1	770.0	1135.0
	σ_e^2	1002.5	133.5	844.5	1138.0
CW3	σ_a^2	1523.1	178.4	1211.0	1798.0
	σ_e^2	702.9	159.8	480.5	905.4
CW4	σ_a^2	1464.7	213.3	1155.0	1844.0
	σ_e^2	972.9	224.4	726.6	670.1
CW5	σ_a^2	1143.6	311.9	891.2	1029.0
	σ_e^2	1282.4	408.6	1029.0	1684.0

PSD: posterior standard deviation; 95%HPD: 95% highest posterior density interval Lower (L) -Upper (U) bound.
WW- weaning weight adjusted to 205 days by age of dam.
CW1-CW5 - cow weight taken at 3, 4, 5, 6 and 7 and more 8 years.

Heritability estimates shows a similar trend (Table 3), increasing until CW3 and CW4 and decreases for CW5. The trend is similar to that of Williams et al., (2009), with values of 0,66 and 0,62 at 5 and 6 years of age that agrees with present results, were maternal and permanent maternal effects for CW were not included. Estimates are higher than those found in Costa et al. (2011) where maternal and permanent maternal effects were included for all traits analyzed. A full model with all maternal was tried but did not converge (results not shown), maybe due to data structure.

Estimates of genetic correlations between WW and CW1 to CW5 ranged from 0.78 to 0.63, the lowest for CW5 (Table 3). Correlations between CW1 to CW5 were between 0.8 and 0.90, somewhat lower than those from Costa et al. (2011) and Williams et al. (2009).

Table 3. Heritability and correlations (± standard deviation*.

Trait	WW	CW1	CW2	CW3	CW4	CW5
WW	0.13	0.77	0.77	0.75	0.78	0.63
	±0.03	±0.11	±0.21	±0.16	±0.22	±0.22
CW1	0.33	0.39	0.93	0.86	0.80	0.80
	±0.03	±0.07	±0.06	±0.04	±0.08	±0.06
CW2	0.29	0.52	0.48	0.69	0.65	0.85
	±0.03	±0.06	±0.04	±0.09	±0.11	±0.08
CW3	0.29	0.50	0.54	0.68	0.90	0.86
	±0.03	±0.08	±0.07	±0.05	±0.04	±0.07
CW4	0.26	0.44	0.50	0.58	0.60	0.90
	±0.03	±0.10	±0.07	±0.09	±0.06	±0.05
CW5	0.25	0.63	0.34	0.56	0.61	0.47
	±0.03	±0.20	±0.14	± 0.07	±0.08	±0.08

*Heritability on diagonal and additive correlation on upper diagonal, phenotypic correlations on lower diagonal.
WW- weaning weight adjusted to 205 days by age of dam.
CW1-CW5 - cow weight taken at 3, 4, 5, 6 and 7-8 years.

Conclusion

Results from the present study indicates that more studies need to be conducted including weights at least to 5 years of age, since parameters seem to change around that age. Reproductive success imposes selection, so, including WW will avoid bias. Genetic correlations between different CW were high, thus allowing for use of repeated records for genetic evaluations of MW, increasing accuracies of predicted breeding values. However, given that variances were different across ages a repeated measurement model that accounts for heterogeneous variances should be considered for genetic evaluation of mature cow weight.

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