ESTIMATION OF GENETIC PARAMETERS FOR CARCASS TRAITS FOR SIMMENTAL CATTLE IN CROATIA

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SUMMARY

The objective of this paper was an estimation of genetic parameters for carcass weight, conformation, fatness class and net gain for Simmental cattle in Croatia. Data of young bulls slaughtered in years 2005 and 2006 with 12 to 24 months of age was taken from the central database of the Croatian Livestock Centre. Three data sets were constructed as follows: 1) data set 1 (DS1) included 80462 records of bulls with known and unknown parents; 2) data set 2 (DS2) had 26245 records of bulls with at least one known parents; 3) data set 3 (DS3) with 6272 records of bulls slaughtered between 12 and 14 months of age.
Pedigree for DS1 included a total of 118595 animals, 70415 animals and 19319 animals in pedigree for DS2 and DS3, respectively. Variance components were estimated by REML method as implemented in the VCE-5 program package. Statistical model included region, calving season, abattoir-supervisor interaction as fixed class effects and slaughter age as quadratic regression. Direct additive genetic effect was included in the model as random effect. For carcass weight heritability estimates were 0.10 ± 0.006, 0.13 ± 0.02 and 0.11 ± 0.03 for DS1, DS2 and DS3, respectively. Heritability estimates for net gain were 0.09 ± 0.006, 0.16 ± 0.03 and 0.13 ± 0.03, and for carcass conformation were 0.05 ± 0.006, 0.03 ± 0.01 and 0.05 ± 0.006 for DS1, DS2 and DS3, respectively. Results attained indicate that DS2 can be used for genetic evaluation of the Simmental carcass traits in Croatia. However, in the future more improvement should be done, concerning the constitution of contemporary groups, and special attention should be given to data collection.

Key-words: cattle, carcass traits, genetic parameters

INTRODUCTION

Only 77% of beef requirement in Croatia is supplied by own production (Ivanković et al., 2005), and Simmental dual purpose cattle is a dominant breed, representing around 75% of overall cattle, being the base for beef production in the country. Systematic breeding work lasts for more than 80 years, but it became well organised after 1991 when the current National cattle breeding program was prepared by Caput et al. (1991). According to this program, and based on Livestock Breeding Act (OG, n°: 70/97) all bulls used by artificial insemination (AI) have progeny tested. Until now, breeding values were calculated by using contemporary comparison (CC) method for average daily gain, killing-out percentage and lean meat content in ribs segment. However, last years some changes were introduced in breeding, and the performance station test were replaced by an field test. So, in the future estimation of breeding values of Simmental bulls will be based on carcass traits measured on their sons slaughtered at commercial abattoirs. Genetic evaluation for carcass traits (weight, conformation, fatness class and net gain) will be based on animal model applying mixed model methodology known as Best Linear Unbiased Prediction (BLUP, Henderson, 1973). The objective of this work was to develop an animal model for estimation of genetic parameters and prediction of breeding value for carcass traits in Simmental cattle in Croatia.

MATERIAL AND METHODS

Data of young bulls, slaughtered in 2005 and 2006 were taken from the central database of the Croatian Livestock Center. Data were edited and records were deleted if: 1) carcass weight was lower than 150 or higher than 550 kg, 2) carcass conformation was labeled as M and N, 3) unknown birth

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date, 4) unknown slaughter age, and 5) regions and abattoirs with small number of records were also removed from analysis. Three data sets were constructed for this analysis. Data set 1 (DS1) with 80462 records included young bulls with age between 12 and 24 months with known and unknown parents. From DS1 only animals with at least one known parent were taken to construct data set 2 (DS2) with 26245 records of young bulls. Data set 3 (DS3) was constructed with records of young bulls age between 12 and 14 months, and contains 6272. This data set includes of bulls the same age as progeny station tests animals. DS3 has small age variability, however young bulls are often slaughtered at older age. Descriptive statistics for carcass traits and age at slaughter are presented in Table 1.

Table 1. Descriptive statistics for carcass traits and age at slaughter

DS	Trait	N	Mean	SD	MIN	MAX
1	Net gain (kg/day)	80462	0.600	0.127	0.224	1.539
	Carcass Weight (kg)		301.8	47.9	150.0	550.0
	Conformation		2.3	0.8	1	5
	Fatness Class		2.6	0.7	1	5
	Age at slaughter (days)		516	87	351	747
2	Net gain (kg/day)	26245	0.601	0.136	0.225	1.099
	Carcass Weight (kg)		289.7	52.5	150.0	550.0
	Conformation		2.4	0.8	1	5
	Fatness Class		2.5	0.7	1	5
	Age at slaughter (days)		494	83	351	747
3	Net gain (kg/day)	6272	0.696	0.110	0.347	1.094
	Carcass Weight (kg)		283.1	42.7	150.0	437.0
	Conformation		2.4	0.8	1	5
	Fatness Class		2.4	0.7	1	5
	Age at slaughter (days)		408	23	351	442

Mean net gain was highest in DS3, but presented the lowest standard deviation. However mean net gain was similar to that presented by Engellandt et al. (1999). DS1 presented the highest values range. In the three data sets mean carcass weight was lower than that presented by Crews et al. (2003). All data sets presented similar values for carcass conformation and fatness class.

Table 2. Number of animals with records, non-base and base animals and total number of animals

Pedigree structure	Number of data		
	DS1	DS2	DS3
Animals with records	80462	26245	6272
Non-base animals:	40304	46900	12386
Both parents known	39490	45905	12288
Only Sire known	770	950	94
Only Dam known	44	45	4
Base animals	78291	23515	6933
Total number of animals	118595	70415	19319

Pedigree file was constructed to provide genetic ties among animals as shown in Table 2. For DS1, genetic ties are not strong, and the number of base animals is practically twice larger than number of non-base animals. DS2 and DS3 presented better pedigree structure, with better genetic ties among animals, and the number of non-base animals is higher than the number of base animals.

GLM procedure (SAS Inst. Inc., 2001) based on Least Square Method was used for the statistical analysis of fixed part of the model. Models were compared using the coefficient of determination (R^2), degrees of freedom (d.f.) as well as significance and proportion of variation explained by effects. The model [1] that best fit carcass weight and net gain was determined with fixed effects as follows: region (R_i) and calving season (C_j) as fixed class effects and slaughter age (x_{ijk}) as quadratic regression. Model [2] for conformation and fatness class has abattoir-supervisor interaction (AS_i) instead of region as fixed class effect. Direct additive genetic effect was included in both models as random effect. Owner (o_{ijk}) was not included in fixed part of the models because of small number of animals per owner. However, it was included as random effect when variance components were estimated on

VCE, and models without and with owner were constructed, respectively. In the results, model without owner is presented as Model A and model with owner as random effect is presented as Model B.

$$y_{ijkl} = \mu + R_i + C_j + b_I(x_{ijkl} - \bar{x}) + b_{II}(x_{ijkl} - \bar{x})^2 + (o_{ijk}) + a_{ijkl} + e_{ijkl} \qquad [1]$$

$$y_{ijkl} = \mu + AS_i + C_j + b_I(x_{ijkl} - \bar{x}) + b_{II}(x_{ijkl} - \bar{x})^2 + (o_{ijk}) + a_{ijkl} + e_{ijkl} \qquad [2]$$

Variance components were estimated by Residual Maximum Likelihood (REML) method as implemented in the VCE-5 program package (Kovač et al., 2002). PEST program package (Groeneveld et al., 1990) was used for breeding value prediction.

RESULTS AND DISCUSION

In the three data sets, the proportion of variation accounted for fixed part of the model for carcass traits ranged from 9 till 48% (Table 3). In DS1 and DS2, the model for net gain presented the highest coefficient of determination when compared to other traits. In DS3, the model for conformation and fatness class explained higher proportion of variation than in other two data sets. The lowest coefficient of determination was attained for carcass weight in all data sets.

Table 3. Coefficient of determination (R^2) and degrees of freedom (d.f.) for models

DS	Model	Trait	R^2 (%)	d.f.
1	1	Net gain (kg/day)	47.85	40
	1	Carcass Weight (kg)	7.58	40
	2	Conformation	26.55	380
	2	Fatness Class	32.50	380
2	1	Net gain (kg/day)	45.78	40
	1	Carcass Weight (kg)	8.90	40
	2	Conformation	32.90	351
	2	Fatness Class	29.05	351
3	1	Net gain (kg/day)	18.76	39
	1	Carcass Weight (kg)	8.62	39
	2	Conformation	38.10	286
	2	Fatness Class	32.70	286

The estimated heritabilities for net gain, carcass weight, conformation and fatness class are shown in Table 4 and presented as Model A and Model B containing also owner as a random effect.

Table 4. Estimated heritabilities for carcass traits

DS		Model A		Model B		
		h^2	error	H^2	owner	error
1	Net gain (kg/day)	0.09±0.006	0.91±0.006	0.01±0.004	0.51±0.004	0.48±0.0006
	Carcass Weight (kg)	0.10±0.006	0.90±0.006	0.02±0.006	0.51±0.004	0.47±0.007
	Conformation	0.05±0.01	0.95±0.01	0.41±0.003	0.17±0.004	0.42±0.003
	Fatness Class	0.01±0.004	0.99±0.004	0.01±0.004	0.12±0.004	0.87±0.006
2	Net gain (kg/day)	0.16±0.03	0.84±0.03	0.01±0.005	0.53±0.002	0.46±0.005
	Carcass Weight (kg)	0.13±0.02	0.87±0.02	0.01±0.005	0.55±0.002	0.44±0.005
	Conformation	0.03±0.006	0.97±0.006	0.02±0.005	0.20±0.007	0.78±0.005
	Fatness Class	0.02±0.005	0.98±0.005	0.01±0.005	0.12±0.005	0.87±0.007
3	Net gain (kg/day)	0.13±0.03	0.87±0.03	0.01±0.008	0.60±0.004	0.39±0.009
	Carcass Weight (kg)	0.11±0.03	0.89±0.03	0.01±0.008	0.60±0.004	0.39±0.009
	Conformation	0.05±0.01	0.95±0.01	0.03±0.01	0.21±0.02	0.77±0.01
	Fatness Class	0.05±0.01	0.95±0.01	0.05±0.01	0.10±0.01	0.85±0.02

For all traits estimated heritabilities were lower in Model B, except for conformation. As observed before, all data sets do not have desirable data structure per owner, being in accordance with the expected because in Croatia the majority of beef production is based on small and medium-sized

family farms. In fact, more than 60% of owners raise only one animal per farm (Figure 1), and owners with more than 10 animals per farm represents approx. 10% of all data.
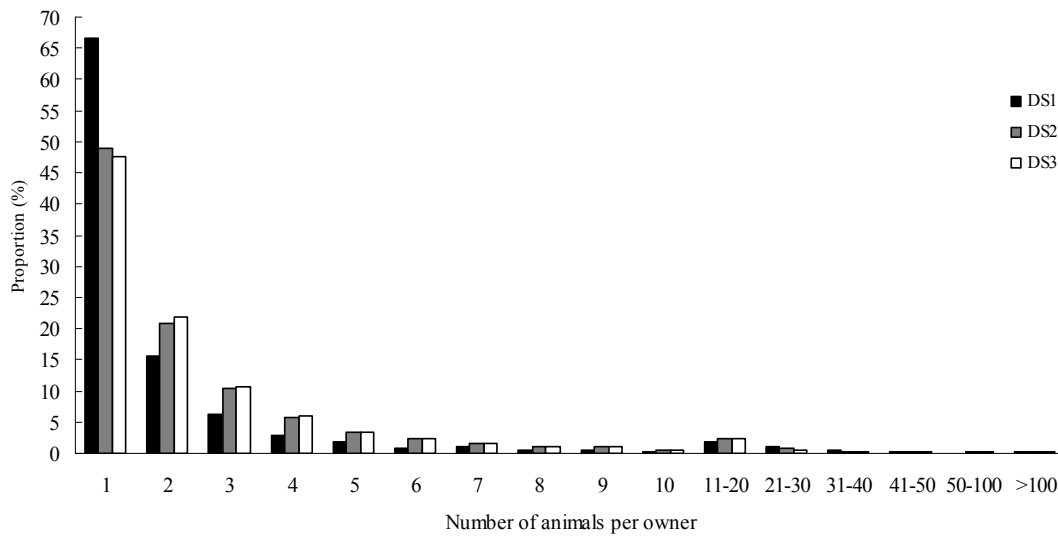

Figure 1. Number of animals per owner

Estimated heritabilities, for net gain, carcass weight, conformation, and fatness class are higher in Model A (Table 4), although these results were lower than results for Simmental cattle attained in Germany, Austria, and in Ireland. However, model used was different from the one we present in this paper. In Germany and Austria, using join evaluation with data from in commercial abattoirs, the estimated heritability was 0.24 for net gain and 0.27 for conformation (Schild et al., 2003). In Ireland, Hickey et al. (2007) found heritability estimates for carcass weight, conformation, and fatness class of 0.54, 0.10 and 0.40, respectively. In general, low heritabilities in our paper expected since we used field data. Similar problems were pointed out by Dijkstra et al. (1990) cited by Engellandt et al. (1999).
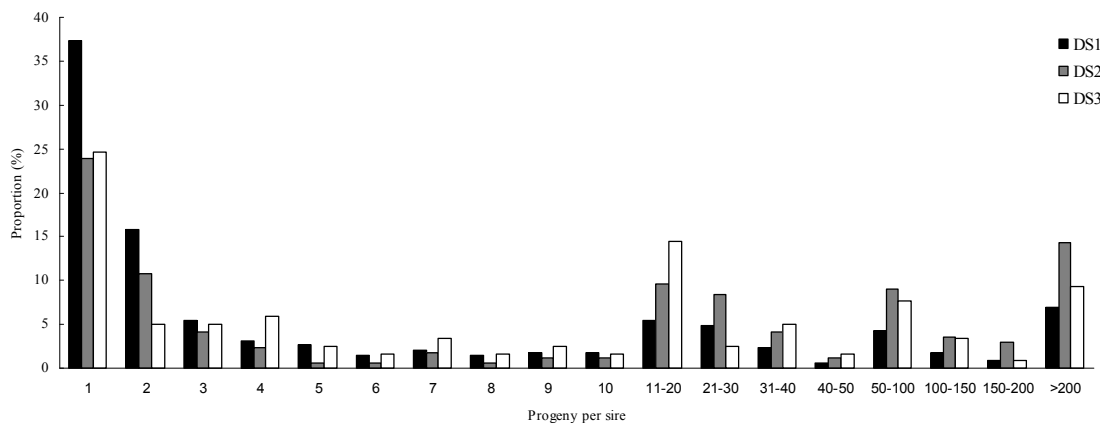

Figure 2. Number of progeny per sire

The low heritabilities found in this paper can be explained by the low genetic connections among animals. In fact, most of the sires have small number of sons (Figure 2), around 40% of sires have only one son, and only 25% of the sires have more than 10 sons. Comparing data sets among themselves, DS1 has the worst structure, and in DS2 and DS3 the structure was similar However, DS2 had a higher number of sires with more than 10 sons.

CONCLUSION

Based on the results of this study and under the conditions it was developed we can conclude that variance components and breeding values for carcass traits in Simmental cattle can be estimated with DS2, since presented the best pedigree structure. The best fitting quality was presented by Model A, and will be used to calculate breeding values for Croatian Simmental cattle population. This paper was based on data from two years, so in the future with more data results can be confirmed and improved since it is expected an improvement in data structure, namely in the one concerning the owner.

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