Joint Nordic Genetic Evaluation of Growth and Carcass traits in Dairy Breeds

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Abstract

A growth index was developed and will be included in the Nordic Total Merit Index (NTM). It combines EBVs for daily carcass gain (CG) and carcass conformation score (CS). The evaluation is a multiple trait animal model using information from fattening bulls. The carcass gain is divided in carcass gain for a short intensive fattening period (CGS, up to 550 days at slaughter) and a long extensive (CGL, more than 550 days). Fat score (FS) is used as an indicator trait. Heritabilities, estimated in the data, were 0.36,, 0.29, 0.29 and 0.23 for RDC and 0.28, 0.32, 0.29 and 0.18 for Holstein for CGS, CGL, CS and FS respectively. Genetic correlations between CGS and CGL were close to unity, 0.97 for RDC and 0.98 for Holstein.

Introduction

Most of the male progeny of dairy cows are raised for beef production in the Nordic countries. The growth and carcass traits are included in the breeding goal and also in the NTM, (Pedersen 2008), with weight 0.06 for Holstein. For RDC growth index is presented but not included in NTM. Healthy and fast growing heifers are important in modern dairy production (Almér 2000). Pedersen (2008) points out that fast growth is important for fertility of the young heifer. Thus not only the beef production units but also dairy production itself has an economic benefit from selection on growth and carcass traits in bulls from dairy herds. Moreover the impact on climate is of increasing importance today. Beef production from dairy cows compared to suckler cows is efficient in terms of climate impact and would be rather straightforward and not so costly to improve genetically.

Currently there are national evaluation schemes for growth and carcass traits in Denmark and Sweden. There is a need for better and easier comparison between bulls in the Nordic countries for these traits. This study will report the development of a joint Nordic evaluation of growth and carcass traits in Denmark, Finland and Sweden.

Material and Methods

Beef production systems are quite similar in Sweden and Finland. Bulls used in this study are slaughtered between 100 and 500 kg carcass weight and age at slaughter varies from 200 to 900 days. Average carcass weight and age are 320 kg, and 600 days, but the latter is decreasing due to changes towards a more intense feeding system. The majority of bull calves are raised in specialized herds (Pedersen 2008). Danish bulls are slaughtered between 100 and 320 kg carcass weight and age at slaughter varies between 200 and 540 days. Mean slaughter weight and age are 220 kg, and 360 days.

Means and standard deviations for the studied traits are given in table 1. Daily carcass gain was calculated, assuming a constant birth carcass weight of 15, 23 and 25 kg for Jersey, RDC and HOL respectively.
Since there were large differences in production systems (short intensive versus long extensive fattening periods) within Sweden and Finland, daily carcass gain was divided on herd basis into 2 traits, one with short (less than 550 days) fattening period (CGS), and one with long (more than 550 days) fattening period (CGL). The definition was based on yearly herd means for age at slaughter. RDC-means for carcass gain were 537 and 458 g/day and 533 and 500 g/day for CGS and CGL in Sweden and Finland respectively.

Carcass conformation score (CS) was recorded following the EUROP system in 15 ordered classes. All three countries used the same scale. Carcass fat score (FS) was classified in 15 classes in Sweden and Finland but five classes in Denmark. The Swedish and Finnish fat scores were in this paper divided by three to make them comparable to the Danish data.

All Danish bulls are slaughtered before 550 days so there were just CGS records from Denmark. For the Jerseys there were few records in Sweden and consequently the number of CGL records is very low. Further, from Finland there was no data on Jersey bulls. Therefore the Jersey evaluation contained information from Denmark and Sweden and only the CGS, CS and FS traits.

Estimation of genetic parameters
Genetic parameters were estimated using restricted maximum likelihood (Madsen and Jensen, 2000) for all three breeds on a subset of data. The model used was a sire model but with all other effects as in the evaluation model described below. For Holstein, somewhat more than 420 000 and for RDC 240 000 bulls from the recent years were used in the analyses.

Genetic evaluation model
The evaluation model was a multiple trait animal model for fattening bulls containing CGS, CGL, CS and FS. Fat score was used as an indicator trait.

All traits were pre-corrected for heterogeneous variance due to year of birth and country. The model included herd*year and animal as random effects and herd*period, dam-age*country, and year*month of birth*country as fixed class effects. The periods were 5 years. For RDC, effects of Original Red Danes, Danish Friesian, Finnish Ayrshire, Norwegian Red, American Brown Swiss, American Holstein, Swedish Red Cattle, Canadian Ayrshire and Finncattle were accounted for by regressions on population proportions. For the Nordic Holstein population, the effect of Holstein versus Friesian was accounted for by regression on the population proportion. Heterosis is accounted for using the regression on expected total heterosis.

The data used in the evaluation start in years 1990, 2005 and 1996 for Denmark, Finland and Sweden respectively. The genetic parameters used in the model were all estimated from the data.

Table 1. Means and standard deviations of Carcass Gain (CG), Carcass Conformation Score (CS) and Fat Score (FS)

	Denmark		Finland		Sweden	
	Mean	S.D	Mean	S.D	Mean	S.D
Holstein						
No of bulls	1846495		31744		356507	
CG	565	74	526	82.0	494	83
CS	4.2	0,97	4.1	0.92	4.2	0.9
FS	2.4	0.53	2.3	0.64	2.2	0.5
RDC						
No of bulls	281279		65991		374288	
CG	574	82	503	85	486	83
CS	4.9	1.0	4.6	1.0	4.9	1.0
FS	2.5	0.5	2.4	0.6	2.2	0.5
Jersey						
No of bulls	93737				958	
CG	396	58			358	79
CS	3.2	0.8			3.6	0.9
FS	2.3	0.53			2.0	0.6

Results and discussion

Genetic parameters

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Genetic parameters are given in table 2. Heritabilities are rather similar for Holstein and RDC but lower for Jersey. They are higher than estimates from Hickey et. al., 2007 on Holstein. The genetic correlation between CGS and CGL is high which means that all observations, even those that are gathered in environments with low feeding intensity, are valuable in the analysis. In the evaluation the across country correlations are assumed to be 1.0. Preliminary analyses showed that the between country correlations were high, for both CS (0.96) and CGS (0.93). This suggests that the genotype by environment interactions are rather small implying that the unity assumption of the between country correlation will work rather well. Genetic correlations between CG and CS and FS are medium to low. The residual correlations are somewhat higher than the genetic.

Table 2. Genetic parameters, genetic correlations below, residual correlations above, and heritabilities on diagonal

	CGS	CGL	CS	FS
Holstein[1]				
CGS	**0,28**	-	0,44	0,27
CGL	0,98	**0,32**	0,42	0,31
CS	0,41	0,36	**0,29**	0,26
FS	0,17	0,17	0,35	**0,18**
RDC[2]				
CGS	**0,36**	-	0,42	0,16
CGL	0,97	**0,29**	0,41	0,21
CS	0,34	0,32	**0,29**	0,21
FS	- 0,14	-0,12	0,15	**0,23**
Jersey[3]				
CGS	**0,22**		0,47	0,23
CS	0,43		**0,16**	0,21
FS	0,09		0,34	**0,11**

Genetic correlations: [1]Standard error <0,033. [2]Standard error <0,041, [3]Standard error <0,068

Genetic evaluation

The growth information is combined in an index with economic weights in euros using the following formulas:
Growth index for Holstein= 100.65*CGS+100.65*CGL+13.8*CS

Growth index for RDC　　= 111.4*CGS+111.4*CGL+13.6*CS

The value of using two daily carcass gain traits, one for a short intensive fattening period and the other for a long extensive, is that the overall variances are somewhat different, and the heritabilities differ between CGS and CGL. The presented model is well suited to account for this. In figure 1 the standard deviations of EBVs for bulls are given. There is a clear difference in standard deviations between carcass gain in short and long fattening period. The somewhat lower standard deviations for Finnish bulls arise from the few years with data (from 2005 to 2008) from Finland.
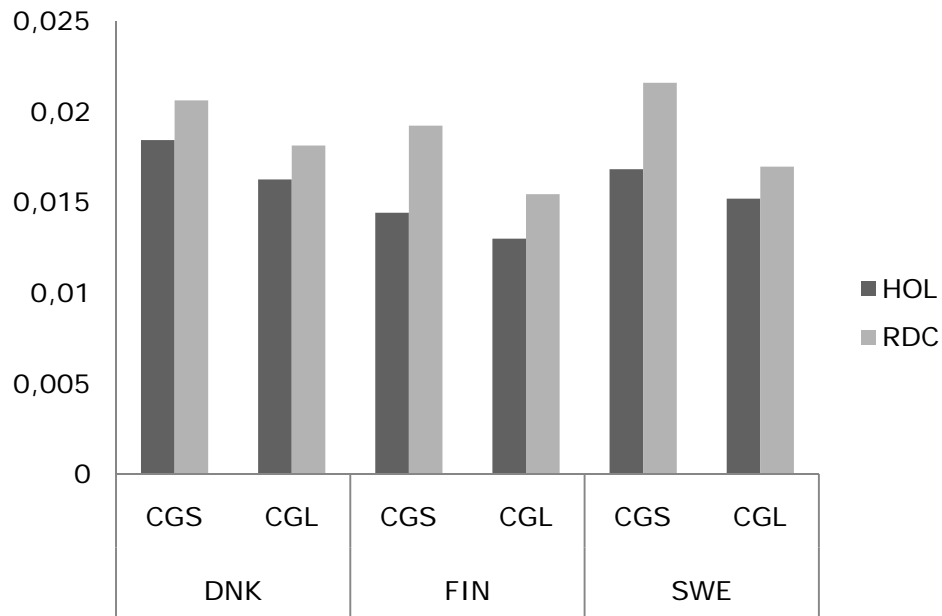

Figure 1. Standard deviations of EBVs for bulls on carcass gain in Holstein and RDC.

 Holstein has a distinct negative genetic trend in carcass conformation (see figure 2). There is also a negative trend in carcass conformation in RDC from year 2002 and onwards. In both breeds the carcass gain has increased genetically.
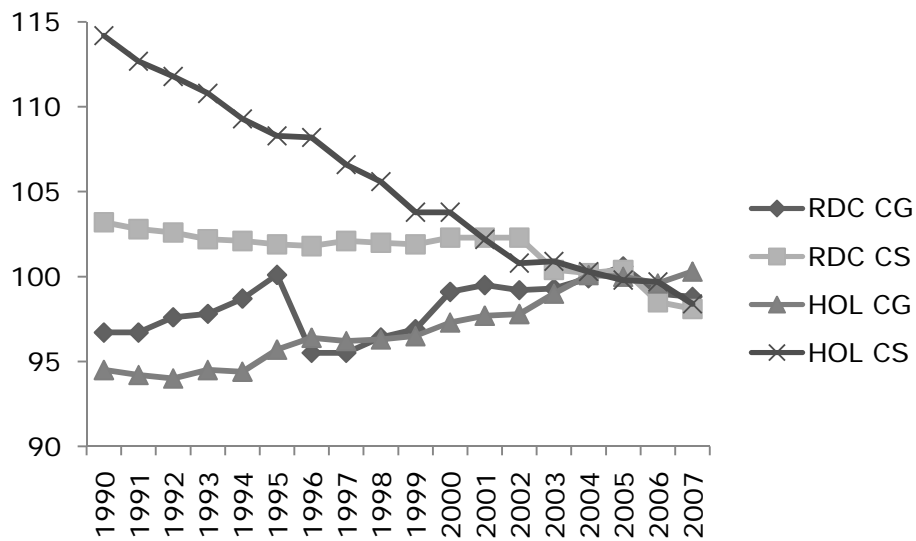
Figure 2. Genetic trends for bulls

The genetic development for growth index is given in figure 3. It should be noted that in both breeds the negative developments in CS will lead to negative trends in growth index.
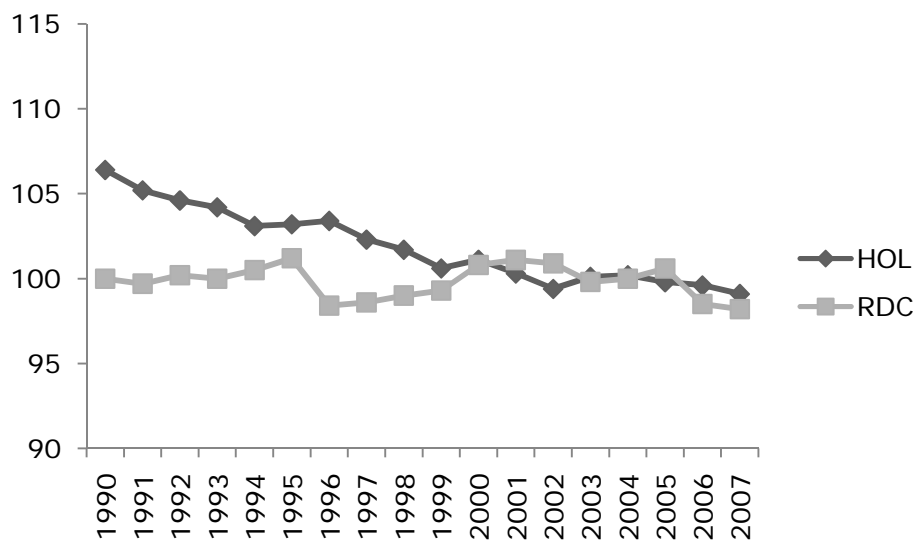

Figure 3. Development of growth index for bulls

The model has been validated with Interbull method 3 (Boichard, et. al. 1995). The growth index has passed the validation for both Holstein and RDC while there is a validation problem for Danish carcass gain in RDC.

Further work may reveal reasons behind this, but indications are that the outbred status of the red cattle breeds is a reason.

Selection made on the growth index will hinder the ongoing deterioration in carcass conformation and speed the progress made in carcass gain. The traits are heritable and selection should thus be effective. There will also be benefits for the dairy farmer since faster growing heifers will mature earlier and have lower first calving age.

Conclusions

A joint evaluation between Denmark, Finland and Sweden makes it possible to utilize carcass gain information across countries.

A growth index containing daily carcass gain and conformation score will be included in Nordic Total Merit index.

A selection on carcass gain in dairy populations is efficient, and will result in economic benefits for beef production using dairy bulls, and in faster growing heifers.

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