Genetic Parameters for Body Weight, Body Condition Score and Lameness in Austrian Dairy Cows

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Abstract

This study is part of a larger project whose overall objective is to evaluate the possibilities for genetic improvement of efficiency in Austrian dairy cattle. Efficiency is understood as a combination of already existing traits of milk, beef and functional traits and traits aiming at feed efficiency and health. In the year 2014 a one-year data collection was carried out. Data of approximately 5,400 cows, i.e. 3,100 Fleckvieh (dual purpose Simmental), 1,300 Brown Swiss, 1,000 Holstein kept on 167 farms were recorded. In addition to routine performance recording, data on new traits like body weight, body measures, lameness, claw health, subclinical ketosis and data about feed quality and feed intake was collected. The specific objective of this study was to estimate genetic parameters for body weight, body condition score and lameness in Austrian Fleckvieh, Brown Swiss and Holstein cows. Heritabilities of body weight and body condition score were moderate and ranged from 0.35 to 0.44 and 0.18 to 0.34, respectively. For lameness lower heritabilities were found (0.03 to 0.07). Body weight and body condition score were moderately correlated, with estimates ranging from 0.39 to 0.58. Moderate genetic correlations were also found between body weight and lameness (0.57 to 0.63), indicating that animals that are heavier have more lameness. Genetic correlation estimates between body condition score and lameness were not significant.

Key words: genetic parameters, body weight, body condition score, lameness

Introduction

Breeding and management need to find answers for new questions in milk and beef production. Increasing consumer concerns for healthy products from healthy cows as well as environmental awareness is being observed. Breeding values for udder health and fertility based on veterinarian diagnoses are available for Fleckvieh (Simmental) since 2010 and for Brown Swiss since 2012 (Fuerst *et al.,* 2011).

A survey based on Austrian farmers expressed their need for including further trait complexes like efficiency, metabolism and claw health in Austrian dairy breeds (Steininger *et al.,* 2012). To achieve genetic improvement phenotypes describing these traits need to be available. To get insight into these new trait complexes, the project "Efficient Cow" was started in Austria in 2012. Due to lack of possibilities to record sufficient data on station for estimation of heritabilities and genetic correlations between these traits and those in the total merit index, novel phenotypes have been recorded on 167 farms and around 5,400 cows in Austria covering the breeds Fleckvieh (Simmental), Brown Swiss and Holstein Friesian. The interest of the participating farmers was to get answers about efficiency and carbon footprint of milk production, and to get knowledge about new possible management tools like lameness score or BCS. In addition the impact of body weight on production efficiency as well as leg and claw health was of interest.

The specific objective of this study was to estimate genetic parameters for body weight, BCS and lameness in Austrian Fleckvieh, Brown Swiss and Holstein cows.

Materials and Methods

Data

Body weight. In Austria standard housing systems for dairy cows are without equipment for weighing routinely. During the observation

period of the project "Efficient Cow", all cows were weighed at each time of milk recording.

Body condition score. At the same time as body weight, BCS was recorded by trained staff at each milk recording with 1 = severe underconditioning to 5 = severe overconditioniong.

Lameness. Lameness was recorded by trained staff from the milk recording organizations using the scoring system (Sprecher *et al.*, 1997) with 1 = not lame to 5 = severe lame.

For each trait repeated records per cow and lactation were available. For genetic analyses only records between 5 and 365 days in milk were considered. For Fleckvieh 21,650 records from 3,421 cows were available. For Brown Swiss 9,826 records from 1,488 cows were available and for Holstein 7,319 records from 1,192 cows were considered for the genetic analyses. A summary statistic of the analyzed traits with means and standard deviations for all breeds is given in Table 1.

Table 1. Summary statistics of the analyzed traits with means and standard deviations in parentheses.

	Body weight (kg)	BCS	Lameness
Fleckvieh	731.3 (85.2)	3.29 (0.55)	1.29 (0.66)
Brown Swiss	651.9 (75.4)	3.06 (0.51)	1.24 (0.62)
Holstein	682.8 (77.4)	2.86 (0.62)	1.44 (0.75)

The animal pedigree files were generated by tracing back the pedigrees as far as possible.

Model

Bivariate linear animal models were fitted using the AI-REML procedure in the DMU package (Madsen and Jensen, 2008). The model used was as follows:

$$y = H + YS + AP + LS + C + a + pe + res$$

where:

y = observation of the animal
H = fixed effect of herd
YS = fixed effect of year season of calving
AP = fixed effect of calving age-parity
LS = fixed effect of lactation stage
C = fixed effect of classifier (only for BCS and lameness)
a = random additive genetic effect
pe = random permanent environmental effect
res = random residual effect

Results and Discussion

Genetic parameters for Fleckvieh (Simmental), Brown Swiss and Holstein cows are shown in Table 2, 3 and 4, respectively.

For Fleckvieh, heritabilities of body weight and BCS were moderate with estimates of 0.44 and 0.22, respectively. For lameness a lower heritability of 0.07 was found. High repeatabilities of 0.83, 0.56 and 0.35 were found for body weight, BCS and lameness, respectively. Body weight was moderately correlated with BCS, with an estimate of 0.39. A moderate genetic correlation of 0.57 was also found between body weight and lameness, indicating that animals that are heavier are more prone to lameness. The genetic correlation estimate between BCS and lameness was close to zero.

For Brown Swiss and Holstein cows similar results were found, except the genetic correlation between BCS and lameness. However as less records were available for Brown Swiss and Holstein, these estimates should be taken with caution.

Table 2. Heritabilities (in bold on the diagonal, SE in parentheses) and genetic correlations (above the diagonal, SE in parentheses) in Fleckvieh cows.

	Body weight	BCS	Lameness
Body weight	**0.44 (0.05)**	0.39 (0.08)	0.57 (0.13)
BCS		**0.22 (0.03)**	0.05 (0.15)
Lameness			**0.07 (0.02)**

Repeatabilities were 0.83, 0.56 and 0.35 for body weight, BCS and lameness, respectively.

Table 3. Heritabilities (in bold on the diagonal, SE in parentheses) and genetic correlations (above the diagonal, SE in parentheses) in Brown Swiss cows.

	Body weight	BCS	Lameness
Body weight	**0.36 (0.07)**	0.58 (0.10)	0.69 (0.27)
BCS		**0.18 (0.05)**	0.71 (0.41)
Lameness			**0.03 (0.02)**

Repeatabilities were 0.80, 0.60 and 0.35 for body weight, BCS and lameness, respectively.

Table 4. Heritabilities (in bold on the diagonal, SE in parentheses) and genetic correlations (above the diagonal, SE in parentheses) in Holstein cows.

	Body weight	BCS	Lameness
Body weight	**0.35 (0.07)**	0.56 (0.10)	0.63 (0.34)
BCS		**0.34 (0.07)**	-0.10 (0.26)
Lameness			**0.04 (0.03)**

Repeatabilities were 0.80, 0.68 and 0.35 for body weight, BCS and lameness, respectively.

Conclusions

The results based on the data from the Austrian project "Efficient Cow" show that it is possible to record various novel traits on farm and to achieve sufficient variation to use them for genetic evaluation.

Recording of body weight at each milk recording was easier to handle than taking different body measures.

There was a positive feedback for management tools like body condition scoring and lameness scoring from farmers.

The genetic analysis showed that animals that are heavier have more lameness.

Overall there is potential to use these management data for breeding as there are possibilities for automation.

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