J. Dairy Sci. 96:5954–5964
http://dx.doi.org/10.3168/jds.2012-6236

Estimation of genetic parameters for novel functional traits in Brown Swiss cattle

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ABSTRACT

The aim of this study was to estimate genetic parameters and accuracies of breeding values for a set of functional, behavior, and conformation traits in Brown Swiss cattle. These traits were milking speed, udder depth, position of labia, rank order in herd, general temperament, aggressiveness, milking temperament, and days to first heat. Data of 1,799 phenotyped Brown Swiss cows from 40 Swiss dairy herds were analyzed taking the complete pedigree into account. Estimated heritabilities were within the ranges reported in literature, with results at the high end of the reported values for some traits (e.g., milking speed: 0.42 ± 0.06, udder depth: 0.42 ± 0.06), whereas other traits were of low heritability and heritability estimates were of low accuracy (e.g., milking temperament: 0.04 ± 0.04, days to first heat: 0.02 ± 0.04). For most behavior traits, we found relatively high heritabilities (general temperament: 0.38 ± 0.07, aggressiveness: 0.12 ± 0.08, and rank order in herd: 0.16 ± 0.06). Position of labia, arguably an indicator trait for pathological urovagina, was genetically analyzed in this study for the first time, and a moderate heritability (0.28 ± 0.06) was estimated.
Key words: genetic parameter, accuracy of breeding value, behavior, conformation

INTRODUCTION

Although dairy cattle breeding in the past largely focused on production traits, functional aspects such as udder health, milking speed, or behavioral traits are becoming increasingly important, both from an economic and an animal welfare point of view. In the conventional breeding scheme it is often costly and time consuming to collect sufficient numbers of daughter records for a wide range of functional traits to obtain daughter-based sire predictions with sufficient accuracy. Many functional traits have a low heritability, are difficult or expensive to measure, or are expressed late in life only. Because of the currently high relevance of functional traits, it might be appropriate to consider the possibility of integrating new phenotypic traits related to behavior, health, conformation, and fertility into modern dairy cattle breeding programs. For implementing these new traits into a routine breeding value estimation, it is important to make phenotyping as cost effective as possible and ensure that recording does not disturb the working routine on a dairy farm. Therefore, we considered it important to cover a wide range of traits that were described in different ways (scoring by farmers, scoring by experts, exact measurement of conformation) and to use simple scales that could be applied by the farmer or simple, less expensive tools for measurement.

Heritability of Behavioral Traits

Behavior traits represent an important functional trait complex. As shown by Sewalem et al. (2010), behavioral traits and docility of a cow significantly influence her productivity and longevity. The authors found that Holstein cows described as very nervous were 18% more likely to be culled than Holstein cows of average temperament, whereas cows classified as very calm had a 7% lower risk of being culled than the average. Despite this high importance of behavioral traits in dairy cattle, most behavior studies in cattle deal with beef cattle (e.g., Le Neindre et al., 1995; Hoppe et al., 2010). Schutz and Pajor (2001) noted that work on temperament and behavior in dairy cattle is limited. In the last decades, different studies have estimated heritabilities for traits that describe behavior and temperament traits of dairy cows. Heritability estimates together with the characteristics of these studies are summarized in Table 1. In general, many different traits have been used to describe behavior and docility of cattle. Heritability estimates of these traits were in a wide range (0.07– 0.53) but were mostly moderate to low.

Received October 5, 2012.
Accepted June 7, 2013.
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Table 1. Overview of estimated heritabilities for behavioral traits in dairy and beef cattle from literature

Trait	Reference	Breed	No. of observations	Scale	Measurement done by	Heritability
Dairy cattle behavior						
Milking temperament	Dickson et al. (1970)	Holstein	1,017	1–4	Farmer	0.53
Dominance value		Holstein	921	Continuous	Independent person	0.07
Milking behavior	Sullivan and Burnside (1988)	Holstein	18,178	1–9	Farmer	0.16
Aggressiveness at feeding		Holstein	18,178	1–9	Farmer	0.11
Milking temperament	Rensing and Ruten (2005)	Holstein	382,500	1–9	Farmer	0.07
Milking temperament (univariate)	Sewalem et al. (2011)	Holstein	20,000	1–5	Independent person	0.13
Milking temperament (bivariate)		Holstein	20,000	1–5	Independent person	0.20
Beef cattle behavior						
Docility	Le Neindre et al. (1995)	Limousin	904	6.5–17	Independent person	0.22
Flight speed	Nkrumah et al. (2007)	Different cross breeds	302	m/s	Independent person	0.49
Flight speed score	Hoppe et al. (2010)	German Angus	706	1–4	Independent person	0.20
Flight speed score		Charolais	556	1–4	Independent person	0.25
Flight speed score		Hereford	697	1–4	Independent person	0.36
Flight speed score		Limousin	424	1–4	Independent person	0.11
Flight speed score		Simmental	667	1–4	Independent person	0.28

Heritability of Milking Speed

Another important functional trait is milking speed. Sewalem et al. (2010) described the importance of milking speed in 2 different ways. On the one hand, very slow milking cows disturb the flow of cows through the milking parlor and thus increase production costs due to increased labor costs. On the other hand, Rupp and Boichard (1999) found that very fast milking cows tend to have a high SCS and so have a higher risk of being affected by mastitis or ultimately being culled. Hence milking speed is considered as a trait with an intermediate optimum in the range of about 2 kg/min (Winter, 2009). In principle, milking speed of a cow can be measured by using 2 different methods. The first method is a subjective scoring, mostly done by farmers on a scale from 1 to 5 or 1 to 9. Subjectively scored milking speed is a trait with low to moderate heritability (e.g., Rupp and Boichard, 1999; Rensing and Ruten, 2005; Table 2). The other method is an objective measurement in kilograms per minute (during the complete milking event or only in the main milking phase). When objectively assessed, milking speed is a trait with moderate to high heritability (e.g., Lassen and Mark, 2008; Table 2).

Heritability of Conformation Traits

One conformation trait that influences udder health is udder depth. This trait is defined as the distance between the base of udder and the hock or ground. Seykora and McDaniel (1985) found a significantly ($P < 0.01$) higher SCC in cows with low udder depth, and the older the cow, the stronger the effect. Most studies that estimated genetic parameters for conformation traits used a scale of 1 to 9 to score udder depth and found moderate heritabilities (e.g., Neuenschwander et al., 2005; Table 2). Heritability of udder depth was found to be higher when objective measurements (in centimeters) were used (Seykora and McDaniel, 1985; Table 2).

A novel trait that is linked to fertility is position of labia (Bühler and Maurer, 2004). As explained by F. Schmitz-Hsu (Swissgenetics, Zollikofen, Switzerland; personal communication), the position of the labia is highly correlated with urovagina, which in turn has a significant influence on fertility. Gautam and Nakao (2009) found that 15.4% of cows from 7 herds had clinically relevant urovagina. These cows required more inseminations to get pregnant (5 vs. 2; $P < 0.001$), had more days open (370 vs. 136; $P < 0.001$), and were at higher risk of endometritis (36.4 vs. 9.2%; $P < 0.001$) than cows without urovagina. Bühler and Maurer (2004) noted that more dairy cattle than beef