Inclusion of direct health traits in the total merit index of Fleckvieh and Brown Swiss cattle in Austria and Germany

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Abstract

In Austria a health monitoring system for cattle started in 2006 and has become part of the routine performance recording in the meantime. Similar health monitoring systems in Baden-Wurttemberg and Bavaria were established later on. So far the focus is on veterinarian diagnoses, but diagnostic observations of farmers are also recorded and will be included in the routine evaluation in the near future. Routine genetic evaluations for the direct health traits mastitis, early reproductive disorders, ovarian cysts and milk fever were introduced in 2010 for Fleckvieh and 2013 for Brown Swiss. So far no genomic EBVs are available for the direct health traits, therefore conventional EBVs and pedigree indices are used instead. In 2013, two new indices were introduced to include direct health traits in the total merit indices (TMI). The first one is a female fertility index consisting of non-return-rate, time from first to last insemination, early reproductive disorders and ovarian cysts. Early reproductive disorders have an economic weight of 33 and 34% for Fleckvieh and Brown Swiss, for ovarian cysts these weights are 14 and 15%, respectively. Within the TMI the weight of the fertility index is 6.8% in Fleckvieh and 8.6% in Brown Swiss. The second new index is an udder health index calculated from somatic cell score (weight of 70%) and mastitis (30%). To increase reliability, the conformation traits fore udder attachment, udder depth and teat placement are used as auxiliary traits. The weight of the udder health index in the TMI is 9.7% and 10.0% in Fleckvieh and Brown Swiss, respectively. Changes in TMI due to the inclusion of the health traits were small, correlations were above 0.99 because of rather low reliabilities of health EBVs so far. Currently, a research project is in process to re-estimate the economic weights, optimize the index calculation and revise the composition of traits in the TMI in order to improve the genetic gain particularly for fitness and health traits.

Keywords: total merit index, genetic evaluation, health traits, fitness, Fleckvieh, Brown Swiss, dairy cattle

Introduction

A nation-wide health monitoring system for cattle was started in Austria in 2006 (Egger-Danner *et al*., 2012) and has become part of the routine performance recording in the meantime. Similar health monitoring systems in Baden-Wurttemberg and Bavaria were established later on. So far the focus is on veterinarian diagnoses, but diagnostic observations of farmers are also recorded and will be included in the routine evaluation in the near future. In 2010, routine genetic evaluations for mastitis, early reproductive disorders, cystic ovaries and milk fever started as part of the joint Austrian-German genetic evaluation for Fleckvieh cattle (dual purpose Simmental; Fuerst *et al*., 2011). The genetic evaluation for Brown Swiss followed in August 2013. So far no genomic EBVs are available for the direct health traits. The EBVs for health traits of bulls were published as relative EBVs but were not included in the total merit index initially.

In the Scandinavian countries, EBVs for direct health traits have been included in the total merit indexes for years (e.g. Philipsson & Linde, 2003; Heringstad *et al.*, 2007). In the non-Scandinavian countries, experience with direct health data is still limited. France and Canada have started publication of EBVs for health traits mainly based on observations of farmers in 2012 and 2013, respectively.

The objectives of this paper are (1) to present the construction of a fertility and an udder health index and (2) their implementation into the official total merit index in Austria and Germany.

Genetic evaluation for direct health traits

Data from veterinary diagnoses are used for routine genetic evaluation for direct health traits. Up to last year, only Austrian data from Fleckvieh cattle were used in the joint Austrian-German evaluation. In August 2013, the genetic evaluation was extended to Brown Swiss cattle and to veterinary diagnoses from Baden-Wurttemberg. Data from Bavaria will follow soon.

At present, the four traits or trait groups mastitis (MAS), early reproductive disorders (EREP), cystic ovaries (CYST) and milk fever (MF) are used in the routine genetic evaluation (Fuerst *et al*., 2011). Data characteristics from the latest evaluation are given in Table 1. The frequencies of cows having at least one veterinary diagnosis in the respective time spans vary between 2.4 (milk fever Fleckvieh) and 10.5% (mastitis Brown Swiss).

Table 1. Characteristics of data for routine genetic evaluation in April 2014.

	Fleckvieh		Brown Swiss	
Trait	N	Frequency (%)	N	Frequency (%)
Mastitis	670,772	9.5	75,325	10.5
Early repr. disorders	741,911	4.5	83,812	6.4
Cystic ovaries	658,355	4.7	74.036	2.9
Milk fever	756,774	2.4	85,421	2.8

Routine genetic evaluation is performed using the program MiX99 (Lidauer *et al*., 2008) based on a univariate linear AM. As already described by Fuerst *et al*. (2011), the following model is used:

$$y_{ijklmnopq} = lact_i*age_j + y_k*m_l + rec_m*y_k + h_n*y_k + pe_o + a_p + e_{ijklmnopq} \quad (1)$$

where $y_{ijklmnopq}$ is the observation for MAS, EREP, CYST and MF (0 = healthy, 1 = diseased); $lact_i*age_j$ is the fixed effect of parity (1, 2,…,5+) by calving age (6 classes for 1st and 2nd parity); y_k*m_l is the fixed effect of calving year and month; rec_m*y_k is the fixed effect of type of recording of diagnoses (electronic by veterinarian/milk recording) by year; h_n*y_k is the random herd-year effect; pe_o is the random permanent environmental effect; a_p is the random genetic effect of the animal and $e_{ijklmnopq}$ is the random residual effect.

Heritabilities for Brown Swiss were calculated by means of the software package VCE6 (Groeneveld *et al*., 2008) using model (1). Genetic parameters for Fleckvieh are adopted from Fuerst *et al*. (2011). Results for both breeds are given in Table 2.

Table 2. Heritabilities (h^2) and standard errors (SE) for health traits of Fleckvieh and Brown Swiss.

	Fleckvieh (Fuerst *et al.*, 2011)			Brown Swiss		
Trait	N	h^2	SE	N	h^2	SE
Mastitis	41,149	0.020	0.005	36,801	0.030	0.006
Early repr. disorders	45,869	0.023	0.005	40,669	0.022	0.005
Cystic ovaries	40,468	0.046	0.006	36,268	0.011	0.004
Milk fever	46,824	0.036	0.006	41,389	0.017	0.004

As part of the joint genetic evaluation of Austria and Germany, genetic evaluations for direct health traits are carried out by ZuchtData three times a year. Breeding values for health traits are published as relative EBVs on a rolling base with a mean of 100 and 12 points for one genetic SD, where higher values are desirable. Between 3,161 and 4,128 Fleckvieh bulls and between 323 and 677 Brown Swiss bulls have official EBVs for the different health traits with a reliability of at least 30%. Figure 1 shows the average frequency of daughters with at least one diagnosis for the 10 worst and best bulls according to the respective EBV. Although the heritabilities are rather low, the variation is quite high, indicating the selection potential for direct health traits.

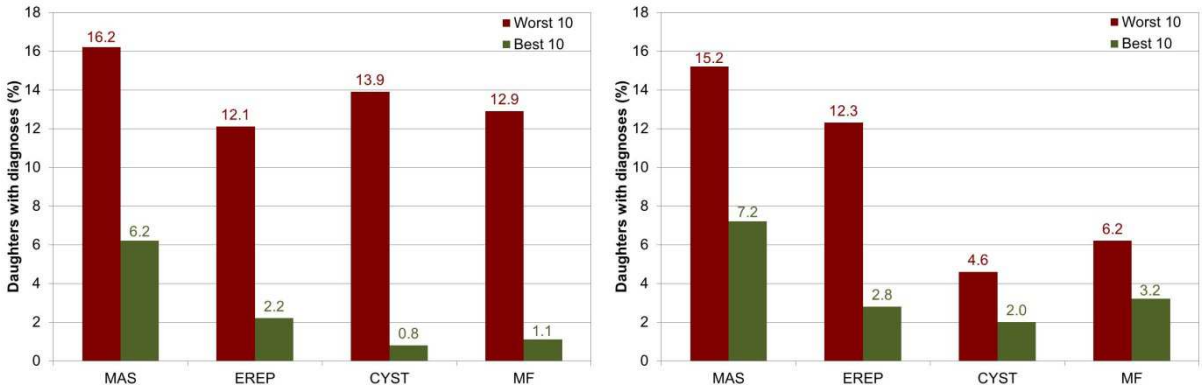

Figure 1. Average frequency of daughters with at least one diagnosis for the 10 worst and best Fleckvieh (left) and Brown Swiss bulls (right) according to respective EBV (reliability >50%).

Fertility index

A female fertility index was introduced in Austria and Germany in 2008. The old fertility index (FRUm) consisted of the traits non-return rate and interval from first to last insemination for heifers and cows, respectively (Fuerst & Gredler, 2009). In August 2013, this index was extended by the two direct health traits EREP and CYST. The relative economic weights per genetic standard deviation are 53, 33 and 14% for Fleckvieh and 51, 34 and 15% for Brown Swiss for FRUm, EREP and CYST, respectively. These weights were calculated based on the frequencies of diagnoses using the Austrian Health Monitoring data and extra costs of medicine and labor (Fuerst-Waltl *et al.*, 2010).

The traits were combined by an approach of Miesenberger (1997) based on selection index theory resulting in the new fertility index FRW replacing FRUm. The genetic correlations in the index for both breeds are given in Table 3.

Table 3. Genetic correlations in the new fertility index FRW.

	FRUm	EREP	CYST
FRUm	1.00	0.52	0.44
EREP		1.00	0.22
CYST			1.00

Udder health index

Besides the new fertility index a new udder health index was introduced in August 2013. So far, only EBVs for somatic cell count were used in selection. EBVs for MAS were published for Fleckvieh bulls since 2010, but were not included in any selection index. The new udder health index (EGW) consists of the EBVs for SCS and MAS with economic weights of 70 and 30%, respectively. These weights were chosen based on analyses to optimize the selection response for udder health. The higher weight on SCS is due to the fact that recording of mastitis is not as comprehensive as of SCC at the moment. As reliability for MAS will permanently increase, economic weights will have to be adapted in the near future. Additionally three udder conformation traits were included as indicator traits. These are fore udder attachment, udder depth and front (Fleckvieh) and rear (Brown Swiss) teat placement. The five traits were combined by using the approach of Miesenberger (1997) taking the genetic correlations into account (Tables 4 and 5). EGW is published additionally to the EBVs for SCS and MAS.

Table 4: Genetic correlations in the new udder health index EGW for Fleckvieh.

	SCS	MAS	Fore udder attachment	Udder depth	Front teat placement
SCS	1.00	0.71	0.28	0.40	0.18
MAS		1.00	0.38	0.64	0.28
Fore udder attachment			1.00	0.62	0.41
Udder depth				1.00	0.34
Front teat placement					1.00

Table 5: Genetic correlations in the new udder health index EGW for Brown Swiss.

	SCS	MAS	Fore udder attachment	Udder depth	Rear teat placement
SCS	1.00	0.60	0.24	0.30	0.15
MAS		1.00	0.60	0.51	0.16
Fore udder attachment			1.00	0.65	0.39
Udder depth				1.00	0.33
Rear teat placement					1.00

Inclusion of health traits in total merit index

The two new indices FRW and EGW have been included in the official total merit index (GZW) since August 2013 by replacing FRUm and the EBV for SCS. No changes in economic weights were made so far. Therefore, the relative economic weights per genetic standard deviation are 6.8 and 8.6% for FRW and 9.7 and 10.0% for EGW in Fleckvieh and Brown Swiss, respectively. For animals without own health EBVs parent averages are used.

As no genomic evaluation is available for direct health traits so far, this is particularly the case for young genomic candidates and also for cows. Changes in GZW due to the inclusion of the health traits were small, correlations were 0.997 for young and proven bulls in both breeds because of rather low reliabilities of health EBVs so far.

In Austria and Germany emphasis is put on further expansion of recording of direct health traits. Different projects and initiatives were initiated to promote recording of veterinarian diagnoses as well as the use of health related observations by farmers especially around calving. Currently, a research project is in process to re-estimate the economic weights, optimize the index calculation and revise the composition of traits in the TMI in order to improve the genetic gain particularly for fitness and health traits.

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