

Genetic Evaluations of Milkability in Norwegian Red Based on Data from Automatic Milking Systems

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ABSTRACT: Automatic milking systems (AMS) provides objective, frequent and accurate measures of many traits. The aim of this first genetic analysis of Norwegian AMS data was to estimate heritability and predict breeding values for milkability in Norwegian Red. The data came from 46 herds with DeLaval milking robots and included 4835 cows, and 1.5 million daily records. Milkability was defined as average milk yield per total time spent in the milking robot (kg milk per minute box time). Estimated heritability was 0.11 for daily milkability, 0.30 for mean of day 30-60, and 0.29 for lactation mean milkability. The genetic difference between the cow with the highest and lowest EBV for milkability, was equivalent to 0.87 kg more milk per minute box time. Data routinely recorded in AMS provide information on new traits that can supplement or replace current traits in genetic evaluation.

Key words: Automatic milking systems; Milkability; Dairy cow

Introduction

Norwegian dairy farming is changing towards larger herds with automatic milking systems (AMS). Today about 1/3 of the dairy cows are in AMS herds, and within a few years will AMS be the dominating dairy production system in Norway. Vast amounts of data are recorded routinely in AMS, and research is needed to find how we best can make use of these data for genetic evaluation. AMS provides objective, frequent and accurate measurements of several important traits. The main aim of this first genetic analysis of Norwegian AMS data was to estimate heritability and predict breeding values for milkability in Norwegian Red.

Material and methods

AMS data. The analyzed data came from 46 herds with DeLaval milking robots. From each herd data from at least 2 years were extracted, and the dataset had information from about 6000 cows, and included more than 2 million daily records. Details regarding data collection and editing are given by Bugten (2013). Records from 6 to 305 days after calving, from lactation 1-7, from daughters of Norwegian Red A.I. sires were kept for analyses. The final data set had 1.6 million daily records, from 8134 lactations of 4,835 Norwegian Red cows. A pedigree file with 44,403 animals was built by tracing pedigree of cows with records back as far as possible.

Milkability. Milkability was defined as average milk yield per total time spent in the milking robot; kg milk per minute “box time”. In addition to the actual milking time box time includes the time used for preparation and attachment of teat cups as well as the time the cow uses before she decide to leave the robot. This is a combined measure of milk flow/milking speed and how efficient the cow is when visiting the milking unit, thus directly associated with the capacity of the milking robot. Figure 1 shows the variation in daily average milk yield per minute box time. The overall mean was 1.5 kg milk per minute spent in the robot, and 95 % were within the interval 0.7 – 3.3.

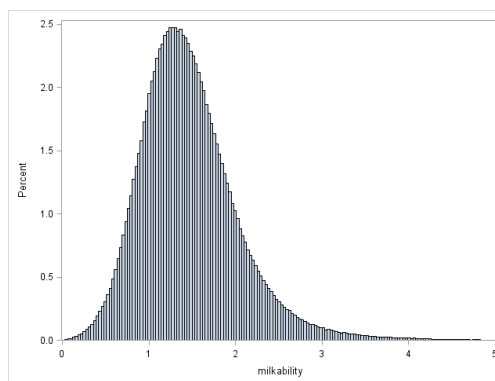


Figure 1: Distribution of average milk yield per minute spent in the milking robot

Trait definition. Three trait definitions were compared; daily milkability (one observation per cow per day), mean milkability from day 30 to 60, and lactation mean milkability from day 6 to 305. Summary statistics of the analyzed traits are given in Table 1. A minimum of 5 daily records were required to be included in the mean milkability traits.

Table 1. Summary statistics of milkability traits (kg milk per minute box time)

	Daily	Mean d 30-60	Lactation mean
No of observations	1,597,156	6,808	8,046
No of cows	4,835	4,264	4,787
Milkability, mean kg/min	1.47	1.48	1.44

Factors affecting milkability. Milkability varied with DIM; were low in early lactation, increased towards top lactation, and decreased thereafter somewhat as the milk yield decreased towards the end of lactation (Figure 2). Figure 2 also illustrates that first lactation cows on average were slower than older cows, especially in early lactation. Other factors affecting milkability (results not shown) were herd, year and season, milking frequency, and milk yield. Higher milk yield is associated with faster milking speed (kg/min). Box time will also be affected of the cows behavior, e.g. if she stands still while being milked, kick off the milking unit, and how fast she will leave the robot after milking.

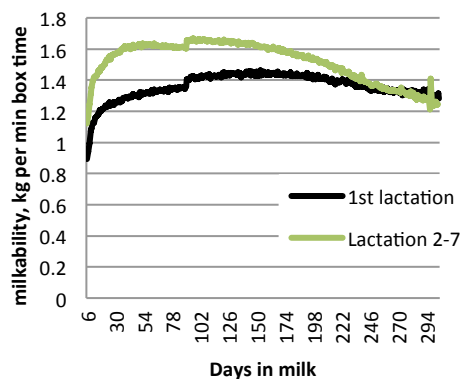


Figure 2: Milkability (kg milk per minute box time) by days in milk for first- and later lactation cows

Model. Milkability traits were, for this study, assumed to be the same trait across lactations and analyzed with repeatability models. The univariate linear animal models included fixed effects of herd-year, month-year of calving, age at calving by lactation number, and random effects of animal and permanent environment. The model for daily milkability had in addition an effect of days in milk (DIM). Variance components were estimated using DMUAI in the DMU software (Madsen and Jensen, 2006)

Results and discussion

Heritability. Estimated variance components for the 3 traits are given in Table 2. The heritability of milkability (average kg milk per minute box time) was 0.11 for daily-, 0.30 for mean of day 30-60, and 0.29 for lactation mean milkability. These estimates were lower than found in some previous studies of related traits based on AMS data. Carlström et al. (2013) reported heritabilities of 0.37-0.48 for average flow rate and 0.38-0.44 for box time for Swedish Red. Byskov et al (2012) estimated a heritability of 0.63 for milk flow in Danish Holsteins. The heritability of the two traits based on mean values (0.29 and 0.30) were higher than the heritability currently used in the routine genetic evaluation of milking speed for Norwegian Red (0.19), which is based on milking speed scored by the

farmer in 3 categories (slow, medium, fast) (Geno, 2014). More precise phenotypes give higher heritability and more accurate breeding values.

Table 2. Estimated variance components, with their standard error (SE) and the corresponding heritability of daily-, mean day 30-60 -, and lactation mean milkability.

Variance component	Milkability trait (kg milk per minute box time)		
	Daily	Mean day 30-60	Lactation mean
Animal	0.033 (0.004)	0.037 (0.005)	0.033 (0.004)
Permanent environment	0.073 (0.004)	0.050 (0.004)	0.046 (0.004)
Residual	0.198 (0.0002)	0.038 (0.001)	0.035 (0.001)
Heritability	0.11	0.30	0.29

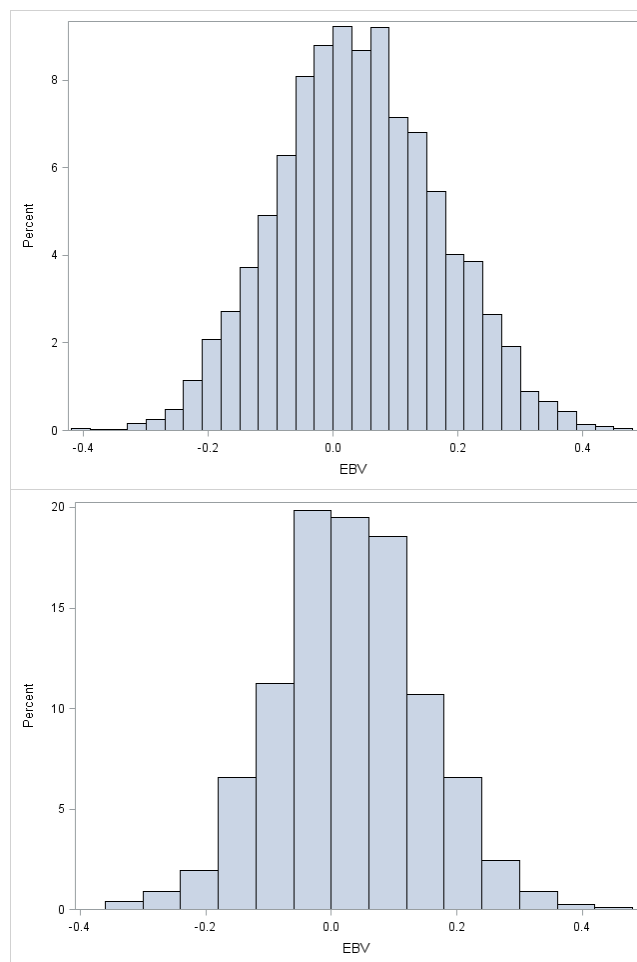


Figure 3: Distribution of estimated breeding values (EBV) for milkability (day 30-60), kg milk per minute box time, for cows with data (top panel) and AI sires with daughters in the dataset

Breeding values. Figure 3 shows the distribution of estimated breeding values (EBV) for milkability (day 30-60) for cows with data (4264 cows) and AI sires with daughters in the dataset (775 bulls). EBV, expressed in kg milk per minute box time, varied from -0.40 to 0.47. The genetic difference between the cow with the highest and lowest EBV is equivalent to 0.84 kg more milk per min box time. The rank correlation between EBV for daily milkability and EBV for lactation mean milkability was 0.98, while the rank correlation to EBV for mean milkability from 30-60 day were 0.87 (daily) and 0.88 (lactation mean).

Trait. Milkability defined as average milk yield per total time spent in the milking robot is directly associated with the capacity of the milking robot, and may be an interesting trait if the objective is to breed more efficient cows for AMS. Genetic improvement of milkability would be beneficial also in other production systems.

Conclusion

Results show that data from AMS can be used for genetic evaluations. Data routinely recorded in AMS provide information on new traits that can supplement or replace current traits in genetic evaluation.

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References

- Bugten, H. K. (2013). Master thesis Norwegian University of Life Sciences, Department of Animal and Aquacultural Sciences, Ås, Norway.
- Byskov, K., Buch, L. H., and Aamand, G. P. (2012). Interbull Bulletin, 46: 28-32.
- Carlström, C., Petterson, G., Johansson, K. et al. (2013). J. Dairy Sci., 96: 5324-5332
- Geno (2014). <http://www.geno.no>
- Madsen, P. and Jensen, J. (2006). DMU. Version 6, release 4.6.

