Genetic Evaluation for Milkability Using Subjective and Measured Observations in Italian Dual Purpose Simmental Cows

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Abstract

In italian Simmental milking speed is a very important trait. Nowadays milking speed is taken into account in italian Simmental selection index (IDA) with an economic weight of 7.5%. Since early '90s this trait is recorded as farmer's score collected by type classifiers. Recently, in order to get more reliable bulls proofs, italian Simmental breed organization(ANAPRI) started to collect also measured data on progeny-test bulls daughters and on bull's mothers. Therefore, milk recording agencies have been asked to collect also Total Milking Time (TMT) during official milk recording test-days. Milk flow (kg/m) i.e. ratio between milk yield by TMT, was analyzed. A bi-trait Blup Animal Model analysis has been developed estimating genetic parameters. Heritabilities were .15 and .20 respectively for farmer's score and milk flow. Genetic correlation between these two traits was high (.83). Breeding values have been also estimated for entire population observing a slightly favourable genetic trend. Pretty good correlations have been also observed between proofs of bulls evaluated also in other countries (Germany-Austria-France).

Introduction

Milking speed (MS) can be considered an important functional trait in dairy cattle, that affects profitability of herds. Milkability is related to udder health, cost of labour, and is an important reason of involuntary culling. Increased milking speed is associated with decreased milking labour time, and labour is one of the most significant costs in milk production. Moreover, lowering milking time per cow reduces costs for electrical power and weariness of milking equipment (Boettcher *et al.,* 1996). The Italian Simmental (IS) is a dual purpose cattle population of about 45,000 cows reared in very small herds (average size: 11 cows) located mostly in the north-east of Italy. Milkability is included in the breeding goal for IS and the economic weight attributed to the trait in the current selection index (IDA) is 7.5%. So far, genetic evaluation for milkability was performed by analysing scores attributed by the farmer. In 2004 it has been decided to start the recording of milking time by using two collection methods:

1. manual "stop-watch"
2. milking flow or milking time measured by automatic meters installed on milking parlours.

The most frequently used method was manual "stop-watch".

Because of recording costs, data are not collected on all cows under official milk recording. Cows on which data collection is focussed are the bulls dams and daughters of bulls involved in the progeny testing program. Moreover, since several years milking speed data were available from cows which are sold at auctions in the South Tirol region. About 35 cows are sold at auction monthly, i.e. 400 records on milking speed are available per year. Collection method of milking speed at auctions was simply by "stop-watch".

Aim of this study was to develop a multi-trait BLUP-AM that considers all available measures of milking speed, i.e., subjective farmer's scores, manual "stop-watch" measures and milk flow data.

Material and Methods

Data

Size of initial data set was 57,670 observations of subjective farmer's scores collected using a 1-3 scale (1 = slow, 2 = normal, 3 = fast) and 6,680 records of milk flow (kg/min). Two kinds of milk flow records were available respectively, 2,350 were collected during milk recording schemes and 4,330 on sold cows at auction markets in South Tirol. Data editing was performed in order to get more reliable estimates. Data out from a given range of age at calving within parity, stage of lactation (from 5 to 350 d), contemporary group size (at least 2 observations) were eliminated.

Four data sets have been extracted from milk flow data in order to apply four different models which differed by the contemporary group definition (table 1).

Data sets Data1 and Data2 included observations on auctions sold cows only. Data sets Data3 and Data4 included observations collected during official milk recording schemes. The contemporary group (CG) for Data1 and Data3 was defined as herd-test date (HTD). For Data2 and Data4, CG was defined as herd-year of calving (HYC).

Table 1. Structure of different data sets used in this study.

		Data1	Data2	Data3	Data4
Source		Auction cattle		Milk recording schemes	
Data	Farmers' Scores	Milk Flow			
# Records	57,670	3,017	1,092	1,852	1,999
Period of recording		1990-2004	1990-2004	2003-2004	2003-2004
Definition of CG	HYE	HTD	HYC	HTD	HYC
# CG levels	13,526	127	395	321	451
Average CG size (# obs.)	4.3	25	2.8	3.7	4.4

For the farmers' scores dataset, CG was defined as herd-year-classifier (HYE).

Features of 4 different models are reported in table 2.

Table 2. Features of four different models used.

	Data1	Data2	Data3	Data4
Model	Model 1	Model 2	Model 3	Model 4
C.G. effect	HTD; i=1,…,127	HYC; i=1,…,395	HYC; i=1,…,321	HYC; i=1,…,451
Parity effect	j=1,2; first parities vs other parities			
DIM effect	k=1,..3; 5-30, 30-60 dim >60 dim		k=1,..7; 5-45 , 45-90 , 90-135 , 135-180 , 180-225 , 225-270, >270 dim	
Season effect	m=1,…4;			

Parity (2 levels) and season (4 levels) fixed effects had the same definition for each 4 models. Only three days in milk classes have been defined for Data1 and Data2 because these cows are sold at auction mostly during the initial 100 d of lactation. Observations in Data3 and Data4 showed a more uniform distribution across lactation stages, allowing definition of 7 days in milk classes.

Statistical analysis

A preliminary analysis using the GLM procedure (SAS, 1990) was carried out with the aim of investigating the sources of variations and differences due to the definition of CG. The analysis was performed using the following linear model:

$$Y_{ijklmn} = CG_i + P_j + DIM_k + P*DIM_{jk} + b_{lj} x_l + S_m + e_{ijklmn}$$

where:

Y_{ijklmn} is a record on milk flow
CG_i is the fixed effect of CG
P_j is the fixed effect of parity
DIM_k is the fixed effect of the stage of lactation class
P_j*DIM_k is the interaction between P and DIM
b_{lj} is the linear regression coefficient of age at calving within parity
x_{ijklmn} is age at calving within P (days)
S_m the fixed effect of the season of calving
e_{ijklmn} is a random residual

Genetic parameters were estimated by REML using a multi-trait BLUP Animal Model using model 4 and Data4. The statistical model for analysis of farmers' scores was:

$$Y_{ijklmn} = HYE_i + OPEP_j + SP_k + \sum_{l=1}^{2} b_l X_{ijklmn} + A_m + e_{ijklmn}$$

where:

Y_{ijklmn} record of farmer score
HYE_i fixed effect of CG (i=1,…,13,526)
AP_j fixed effect of age at calving within parity (j=1,…,44)
S_k fixed effect of season of calving (k=1,…6)
B_l linear regression coefficient polinomial II° order (l=1,…2)
X_{ijklmn} Dim (d)
A_m additive genetic effect (m=1,…, 151.533)
e_{ijklmn} random effect of error

As in the Italian Simmental population a large number of foreign bulls is used, mostly coming from Germany, Austria and France (Montbeliarde), simple correlations between national ebvs computed as previously stated and those from countries of origin were estimated. Milking speed in the German-Austrian Simmental population is recorded with different methods. In Austria the most frequent collection method is "stop watch" while in Germany (Bavaria) is the Lactocorder (Sprengel *et al.,*2001).

For the French Montbeliarde, a farmer's score collected during conformation assessmente is the unique available information.

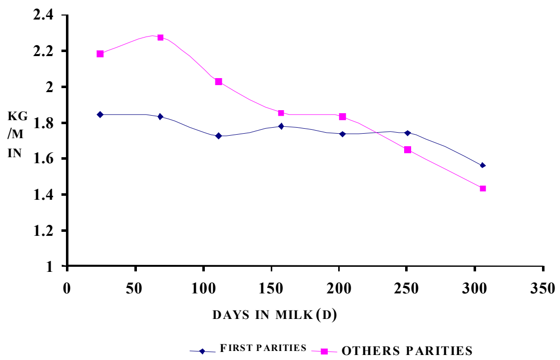
Results and Discussion

Descriptive statistics for the datasets are reported in table 3. The four datasets are quite comparable, with the exception of Data2 where average milk flow is slightly higher than that for the other datasets. Furthermore, it seems that first parity cows are slower to milk than later parities. Lower milk yield in first parity may be the main reason of this pattern.

Table 3. Descriptive statistic of data set used in this study.

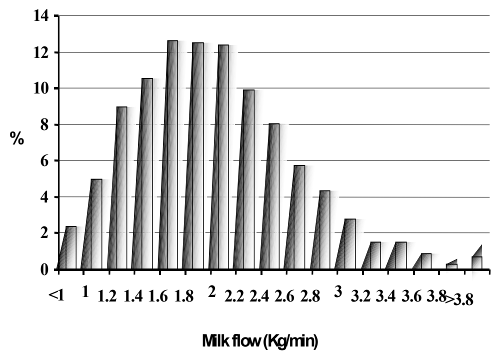
		Data1	Data2	Data3	Data4
Overall	Mean std	1,851 ±0,528	1,935 ±0,518	1,870 ±0,642	1,840 ±0,640
First parities	Mean std	1,835 ±0,567	1,929 ±0,505	1,784 ±0,582	1,756 ±0,589
Other Parities	Mean std	1,912 ±0,567	1,960 ±0,578	1,983 ±0,670	1,959 ±0,689

Figure 1. DIM effect across parities (Least Squares Means).



As shown in figure 2, data distribution is close to normality although a little bit higher frequency in the upper side.

Figure 2. Distribution of milk flow records.



Regarding to farmer's score records, data distribution was quite unbalanced being about 11% of cows classified by farmers as slow, 48% as normal and 40% as fast. Mean size of CG was around 4,3±3,4 observations and about 89% of CG levels ranged between 2 and 5 observations. As above reported, records with CG levels with one observation have been discarded. Results of ANOVA are presented in table 4. Generally, all fixed effects considered in the models were significant. The effect of contemporary group was highly meaningful and it explained the most percentage of total variation.

Table 4. ANOVA (Type I) of milk flow data (kg/m).

	Model 1		Model 2		Model 3		Model 4	
C.G.	83	***	129	***	397	***	397	***
Parity	2.8	***	0.6	ns	8.5	***	9.0	***
DIM	12.3	***	1.3	ns	32.5	***	22.0	***
Parity * DIM	1.8	*	1.9	**	9.2	***	12.5	***
Age at calving	6.6	***	1.2	ns	0.9	ns	0.1	ns
Season of calving	1.0	ns	0.2	ns	0.3	ns	2.3	**
R^2	12%		46%		59%		56%	

1) P<0,0001=***; P<0,01=**; P<0,05=*; ns=no significant

Differences among models in terms of R^2 were due mainly to the definition of CG. With Model 1 where CG was defined as HTD, it has been found a low values of R^2 around 12%. With others models R^2 values ranged from 46% and 59%.

Model 1 seems to be not feasible because CG defined as HTD isn't able to take into account of all management and enviromental conditions, although the highest CG size (25 obs./HTD). Actually, in this case cows share same conditions just in the “auction date”, i.e. in recording day, but absolutly not in the previous days because they come from different herds.

Defining CG as HYC, i.e. herd-year of calving, model seems more suitable to explain management and enviromental differencies, actually in this case R^2-value increased to 46%. Nevertheless, in this case lost of data due to editing on CG size is much bigger. In fact, farmers that sell only one cow per year are quite a lot, so that dataset size decreased from 3,017 to 1,092 records.

Between models 3 and 4 this difference is much smaller because herd effect is the same in both cases and moving from a single recording day to a period of one year time effect changes only. Therefore, considering that number of collection days per year are never more than 2, differencies between two models can be very poor.

In Table 5 are reported estimates of genetic parameters of milk flow and farmer's score using model 4; heritability and genetic variance were respectively 15,3±1% and 0,061 points^2 for farmer's score and 19,7±4% and 0,049 kg^2/min^2 for milk flow. Since heritability of milk flow present a standard error of 4%, genetic parameters can be subjected to meaningful variations by adding new informations, i.e. new data.

Table 5. Genetic parameters of milk flow and farmer's score.

	Farmers' score	**Milk Flow**
Error Variance	0.341	0.201
Genetic Variance	0.061	0.049
Genetic Co(Va)riance	0.045	
Heritability(%)	15.1±1%	19.7±4%
Genetic correlation	82.7±8%	

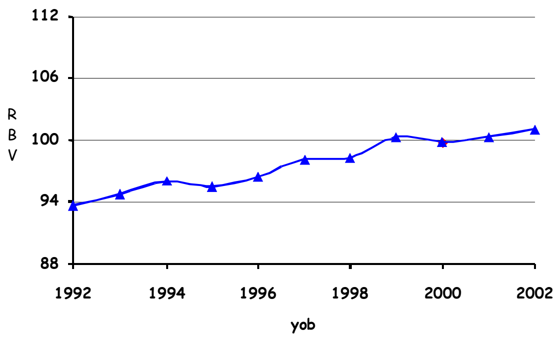
Genetic correlation between the two different measures of milkability was very high (82.7±8%) and very comparable to similar previous studies. (Rensing and Ruten, 2005).

Moreover, breeding values for bulls and cows have been also estimated simultaneosly applying the same model used for genetic parameters estimation. Original ebvs of both traits were not published but combined in one single relative index with equal weights for one genetic standard deviation. This index is expressed as 100 mean and 12 standard deviation.

Genetic trend for cows has been also computed showing a favourable pattern. In figure

3 observed genetic improvement is reported. It amounts to around ½ standard deviation in 10 years.

Figure 3. Cow Genetic trend of Milking ability in IS.



Correlation on 88 bulls evaluated either in Italy as in Germany-Austria with at least 80% reliability was .82. Considering the 40 french bulls (Montbeliarde) having both proofs with at least 50% reliability, correlation was .70. Increasing reliability requirement correlation increased as well up to .89 while number of common bulls went down to 27.

Conclusions

By this research it has been possible to develop a routine genetic evaluation system for MS including all sources of data with a multitrait model.

Estimated genetic parameters were reliable and comparable with those found in other similar studies. Nevertheless, further estimations are needed on larger dataset in order to confirm these results.

With more data it will be also needed to investigate if inclusion of data from auctions can be feasible.

Further studies will be also addressed to include also data coming from electronic meters installed in the milking parlors. In this case, all data collected in a given test-day shall to be considered with a reapetability model.

Official breeding values have been also estimated routinely. Correlations between national and foreign proofs on bulls evaluated in more than one country were promising in order to develop an international evaluation at INTERBULL level.

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