

Comparison of Different Test-Day Models for Genetic Evaluation of Italian Brown Dairy Cattle

Riccardo Dal Zotto

Associazione Nazionale Allevatori Razza Bruna –Università di Padova

Introduction

Genetic evaluation of dairy cattle is based on comparison of animal performance accounting for different environmental conditions. With traditional evaluations based on lactation yield, records are usually grouped in herd-year-season classes and prediction of breeding values is performed accounting for such effects. Use of test-day models offers the opportunity of accounting for more refined effects such as those due to the herd-test day and makes fitting of random regressions feasible.

For populations with very small average herd size, like the Italian Brown breed, accounting for herd-test day effects might be difficult due to the reduced size of the contemporary groups. (1,2) Use of test-day models provides a number of advantages over models based on lactation records (3). However, loss of herds and animals enrolled in the genetic evaluation system due to changes in procedures for prediction of breeding values should be limited. The aim of the present study was to compare a number of test-day models considering the loss of herds and animals involved in the genetic evaluation system which would occur when applying these models to the Italian Brown population.

Material and Methods

Data were 3,232,922 test-day records of 188,022 Italian Brown cows which calved in 10,271 herds from 1988 to 1995. For each cow test-day yield of milk, fat and protein were available. Contemporary groups were created according to the current definition used in the genetic evaluation procedure of the Italian Brown Cattle association (ANARB). The definition of a contemporary group under the current procedure is flexible in order to reduce loss of animals and observations. In

consequence of this application, 74,378 herd-year-season contemporary groups have been formed. A number of test-day models, ranging from repeatability models to random regressions models (4,5,6) was compared to the traditional procedure, named *TRAD*, in terms of loss of observations, animals, lactation records and herds involved in the genetic evaluation system..

Description of models and data constraints:

- TRAD*: current ANARB genetic evaluation procedure.
- TD2_A2*: repeatability model with at least 2 obs per HTD and 2 obs. per animal (perm. env. effect);
- TD2_L2*: repeatability model with at least 2 obs per HTD and 2 obs. per lactation (perm. env. effect);
- TD3_A2*: repeatability model with at least 3 obs per HTD and 2 obs. per animal (perm. env. effect);
- TD3_L2*: repeatability model with at least 3 obs per HTD and 2 obs. per lactation (perm. env. effect);
- RR2_A4*: random regression model with at least 2 obs per HTD and 4 obs per animal (perm. env. effect);
- RR2_A5*: random regression model with at least 2 obs per HTD and 5 obs per animal (perm. env. effect);
- RR2_A6*: random regression model with at least 2 obs per HTD and 6 obs per animal (perm. env. effect);
- RR2_L4*: random regression model with at least 2 obs per HTD and 4 obs per lactation (perm. env. effect);
- RR2_L5*: random regression model with at least 2 obs per HTD and 5 obs per lactation (perm. env. effect);
- RR2_L6*: random regression model with at least 2 obs per HTD and 6 obs per lactation (perm. env. effect);

- RR3_A4*: random regression model with at least 3 obs per HTD and 4 obs per animal (perm. env. effect);
- RR3_A5*: random regression model with at least 3 obs per HTD and 5 obs per animal (perm. env. effect);
- RR3_A6*: random regression model with at least 3 obs per HTD and 6 obs per animal (perm. env. effect);
- RR3_L4*: random regression model with at least 3 obs per HTD and 4 obs per lactation (perm. env. effect);
- RR3_L5*: random regression model with at least 3 obs per HTD and 5 obs per lactation (perm. env. effect);
- RR3_L6*: random regression model with at least 3 obs per HTD and 6 obs per lactation (perm. env. effect).

In random regression models, the minimum number of observations which must be ensured for each level of the permanent environment effect depends upon the number of regression coefficients fitted, i.e. the time-dependent function used. As a general condition for each level, the number of observations must be equal to the number of curve parameters plus 1.

Using a random regression models and taking into account Wilmink, Wood, or Schaeffer functions, 4, 5 or 6 observations per permanent environment level are needed, respectively.

In this study, description of the shape of the lactation curve (within animal or lactation) has been hypothesized to be carried out using 3 different types of function:

1. Wilmink:

$$a + b_1 \dim + b_2 \exp^{(-0.05 \cdot \dim)}.$$
2. Wood:

$$a + b_1 \ln(\dim) + b_2 \dim + b_3 \dim^{0.5}.$$
3. Shaeffer:

$$a + b_1 (\dim/360) + b_2 (\dim/360)^2 + b_3 \ln(360/\dim) + b_4 \ln(360/\dim)^2.$$

The general form of repeatability models for analysis of test-day records was hypothesized to be :

$$y_{ijkl} = \text{HTD}_i + \text{AGE}_{p_n} + \sum b_{mj} X_m + a_k + pe_k + e_{ijkl};$$

where:

- | | |
|--------------------|---|
| y_{ijkl} | = test-day record; |
| HTD_i | = fixed effect of the herd-test-day; |
| AGE_{p_n} | = fixed effect of age of calving nested within parity; |
| b_{mj} | = regression coefficients on the various functions of DIM; |
| X_m | = covariates; |
| a_k | = cow effect (random); |
| pe_k | = effect of permanent environment associated with each cow or lactation (random); |
| e_{ijkl} | = random residual. |

Results

Due to the small average size of herds, average number of observations and animals per HTD level was low. Figure 1, 2, and 3 show that the percentage of HTD levels with only 1 observation was 18 % (86,095 HTD levels), the percentage of HTD levels with at least 2 observations per HTD level was 13.1% (51,297 HTD levels), and the percentage of HTD levels with at least 3 observations per HTD was 17 % (58,028 HTD levels), respectively. Moreover, 50% of HTD levels had less than 5 animals.

Table 1 and Figures 4 and 5 report the loss (%) of animals and herds by repeatability or random regression models compared to the traditional procedure.

Repeatability models (*TD2_A2*, *TD2_L2*, *TD3_A2*, *TD3_L2*) did not loose more than 2% of animals and 3% of herds.

Random regression models (*RR2* and *RR3*) showed greater changes than repeatability models.

The loss of animals for random regressions models with at least 2 observations per HTD (*RR2*) ranged from 1 to 5 % and from 2 to 6 % when considering the animal (*A4*, *A5*, *A6*) or the lactation (*L4*, *L5*, *L6*) as permanent environment effect, respectively. Under a more restrictive constraint on data used (3 observation per HTD), the loss of animals was more evident ranging between 3.0 to 8.5 and 3.5 to 13 when considering the animal (*A4*, *A5*, *A6*) or the lactation (*L4*, *L5*, *L6*) as permanent environment effect, respectively.

The loss of lactation records or herds enrolled in the genetic evaluation system followed the same trend of animals as well.

Conclusion

This study provided useful figures and informations about the application of test-day models to the genetic evaluation of a cattle population of small size with animals distributed in small herds. Repeatability models (*TD2_A2*, *TD2_L2*, *TD3_A2*, *TD3_L2*) were more conservative than random regression models in relation to the number of animals and herds enrolled in the genetic evaluation system. Use of random regression models caused, due to an increase in the minimum number of observations per animal or per lactation, greater losses of cows and of herds. With random regression models, the use of functions with a limited number of parameters, as proposed by Wilmink, a

minimum of 3 observations per HTD level and considering the lactation as permanent environment effect ensured, albeit the specific structure of the Italian Brown population and characteristics of herds, limited losses both in terms of animals and herds.

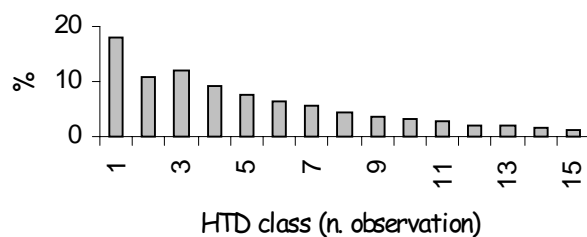
References

1. Strabel, T. 1997. Herd-test-date clustering. *Proc. of the 1998 Interbull Meet. Rotorua*, New Zeland. Agosto 1997.
2. Grünhagen, E. & Swalve, H. 1997. Effect of cell size in test day models. *Proc. of the 1998 Interbull Meet. Rotorua*, New Zeland. Agosto 1997.
2. Swalve, H. 1995. Test day models in the analysis of dairy production data - a review. *Arch. Tierz.* 38, 591-612.
3. Jamrozik, J. & Schaeffer, L.R. 1997. Estimates of genetic parameters for a test day model with random regressions for yield traits of first lactation holsteins. *J. Dairy Sci.* 80, 762-770.
4. Reents, R. 1995. The use of test day models in genetic evaluation. Proceedings of international workshop on genetic improvment of functional traits in cattle.
5. Swalve, H. 1995. The effect of test day models on the estimation of genetic parameters and breeding values for dairy yield traits. *J. Dairy Sci.* 78, 929-938.

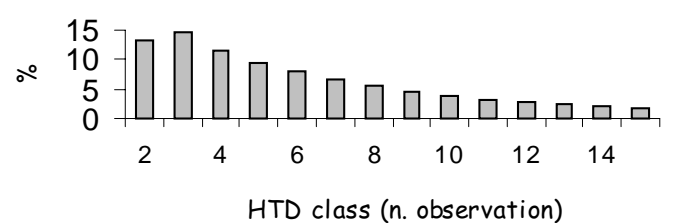
Table 1. Comparison between the traditional genetic evaluation procedure and test-day models in terms of loss of observations, lactation records, animals, and herds enrolled in the genetic evaluation system

	n. obs	n. animal	n. lactation	n. perm. env.	n. herd.	n. htd	n. hmg
TRAD	3232922	188022	422868	422868	10271	-	74378
TD2_A2	3146263	186654	417802	186654	10260	392401	-
TD2_L2	3144463	186561	416405	416405	10259	391853	-
TD3_A2	3042568	184888	413244	184888	9975	340811	-
TD3_L2	3039158	184801	411190	411190	9973	339953	-
RR2_A4	3143341	185805	416763	185805	10241	391552	-
RR2_L4	3135790	185686	413768	413768	10238	389377	-
RR2_A5	3136990	184431	415278	184431	10200	390418	-
RR2_L5	3110124	184084	408032	408032	10195	385310	-
RR2_A6	3105965	178657	409302	178657	9992	386760	-
RR2_L6	2960088	176224	379577	379577	9940	368860	-
RR3_A4	3032748	182404	409958	182404	9675	338093	-
RR3_L4	3002198	181419	401367	401367	9593	330251	-
RR3_A5	3016095	179427	406184	179427	9422	334293	-
RR3_L5	2933194	176637	387379	387379	9207	316478	-
RR3_A6	2969304	171802	397293	171802	8965	328824	-
RR3_L6	2711160	163695	347641	347641	8475	286289	-

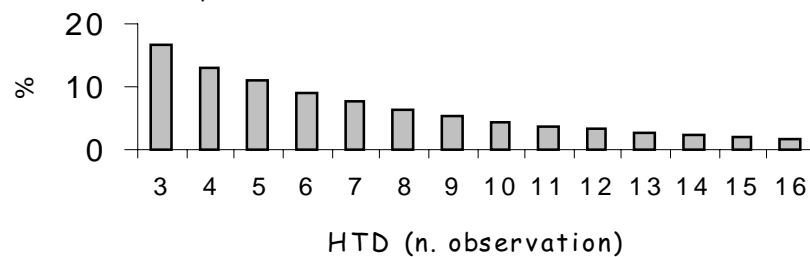
Graph 1. Distribution of HTD class size



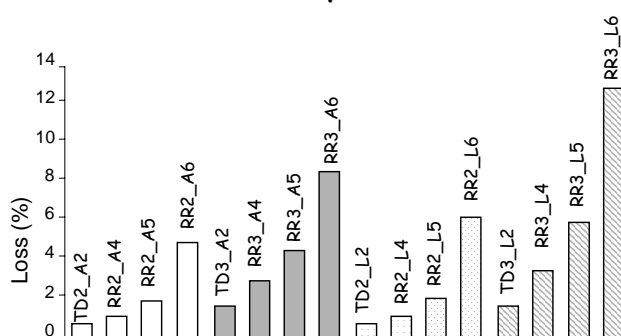
Graph 2. Distribution of HTD class size



Graph 3. Distribution of HTD class size



Graph 4. Loss of animals (%) compared to traditional procedure



Graph 5. Loss of herds (%) compared to traditional procedure

