Deriving Final Score from Linear Traits in the Italian Holstein Population

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Introduction

Current type classification in Italian Holstein comprises 20 linear traits plus final score. Each linear trait is evaluated on a 1-50 objective scale and then grouped into 4 sub-sections: Stature, Dairy Strength, Mammary System and Feet & Legs. Sub-sections are used to assign Final Score, according to the following relative weights: Structure 25%, Dairy Strength 15 %, Feet &Legs 20 % and Mammary System 40 %. The highest score a first lactation cow can be assigned is 89 points (minimum 70). At the beginning of 2007 the relative weights have been updated as follows: Structure 20%, Dairy strength 20%, Feet &Legs 20 % and Mammary System 40 %.

In order to increase the accuracy of type classification it could be useful to estimate final score directly from the linear traits. Comparing the estimated final score to the official final score, the classifier might detect possible mistakes or verify whether the assigned score reflects the linear traits of the cow. The main challenge is to cope with traits that have an intermediate optimum or nonlinear relationships with final score (e.g, rear legs, rump angle). (Dekkers and Gibson, 1998)

Sub-sections relative weights change across time and consequently Final Score definition is not the same. This could have an impact on breeding value at national level (Pelt *et al.*, 2006). Estimating final score using the same formula for all the animals could represent a possible solution.

The aim of this study is to set up an equation to estimate final score from linear traits.

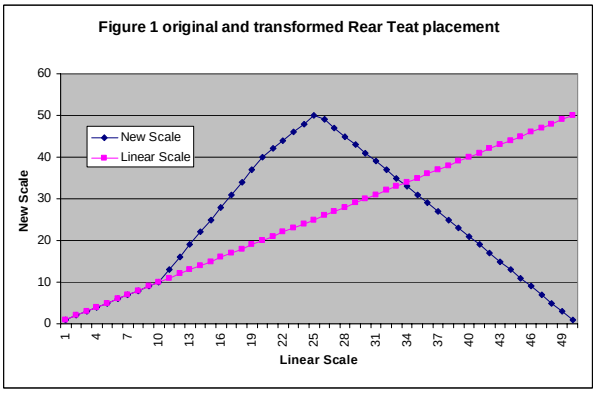
Material and methods

Based on the new sub-section weights (Structure 20%, Dairy Strength 20 %, Feet &Legs 20 % and Mammary System 40 %), 15 linear traits were selected and used to estimate final score according to the following equation:

es_FS = Stature *x* 0,04 + Chest Width *x* 0,10 + Body Depth *x* 0,06 + Angularity *x* 0,10 + Rump Angle *x* 0,07 + Rump Width *x* 0,03 + Rear Leg Set *x* 0,02 + Rear Leg Rear View *x* 0,03 + Foot Angle *x* 0,05 + Overall Feet & Leg *x* 0,10 + Fore Udder *x* 0,08 + Rear Udder Height *x* 0,06 + Udder Support *x* 0,08 + Udder Depth *x* 0,10 + Front Teat Placement *x* 0,08

The formula was used to estimate final score from 2 data set. The first dataset (sample 1) consisted of the type classification of 60 cows, scored by the same classifier. The latter included all the primiparous cows classified in 2006.

In order to cope with non-linear traits, original linear scores for Rump Angle, Rear Leg Rear View , Front Teat Placement and Udder Depth were transformed according to the values presented in table 1. The transformation was mainly based on “empirical” observations and considerations coming out during the discussion with the classifiers. In figure 1 the original and the transformed linear score are presented for Front Teat Placement.



The estimated final score was then scaled to the same mean and standard deviation of the original final score according to the following formula:

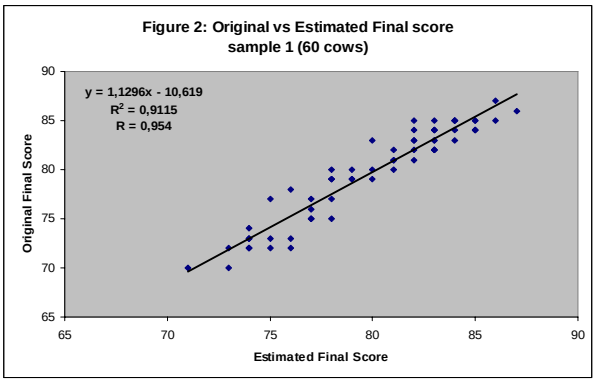
$S^* = (S - mES) * (SD\_O / SD\_E) + mOR$

In which:

S* = scaled score
mES = mean for estimated final score
S = estimated final score
SD_O = standard deviation of original final score
SD_E = standard deviation of the estimated final score
mOR = mean for original final score

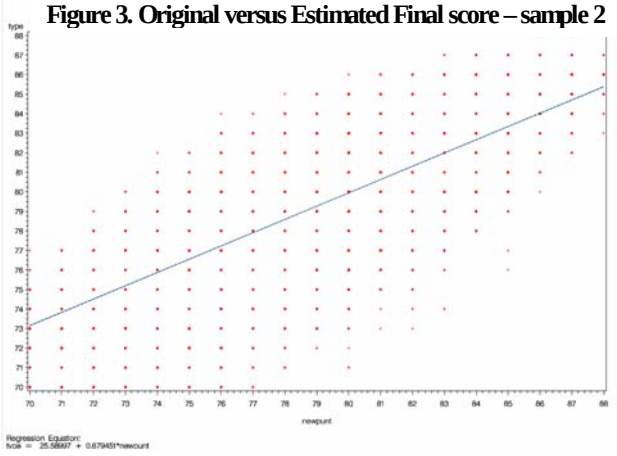
Results and discussion

Means and standard deviations of estimated and original final score were 79.8 ± 4.77 and 80.0 ± 4.03 for sample 1 and 79.7 ± 2.35 and 79.6 ± 2.75 for sample 2. Figure 2 shows the regression of Estimated Final Score on original final score for sample 1. The estimated final score agreed well with the original final score and model R-square was 0.9115, corresponding to a correlation of 0.954. The largest difference between estimated and original final score was, in absolute value, 3.



The regression of estimated on original final score for sample 2 is on figure 3. The R-square of the model was 0.63, corresponding to a correlation of 0.793.

Figure 3. Original versus Estimated Final score – sample 2



Correlations between estimated and original final score was computed for each classifier and ranged from a minimum of 0.72 to a maximum of 0.94.

Results from sample 1 suggest that linear traits used to estimate the final score, the relative weight assigned to each of them and the "empirical" transformation of the linear score worked in the right direction. Moreover, using only one classifier and 60 cows might have biased the result.

In sample 2 the estimation was not totally consistent with the observed in sample 1 even if there was a good variation among classifiers and correlation approached 0,80. It must be recalled that in 2006 classifiers were still classifying cows weighting 25 % for structure and 15 % for dairy characters and this could have had a negative impact on the correlation.

Analysing the cows which showed the largest absolute difference between estimated and original final score we found that in some cases the original final score was not consistent with the linear traits. These could be due to several reasons, among the others mistyping at the moment of classification, *e.g* the score is 30 but the classifier digitised 3.

Conclusion and future developments

Developing a formula to estimate final score from linear traits seems to be feasible but traits which have an intermediate optimum or nonlinear relationships with final score must be previously transformed. In the current study the linear scores for Rump Angle, Rear Leg Rear View, Front Teat Placement and Udder Depth were transformed according to empirical evidences. Transformation based on mathematical formulas could be investigated.

If a formula is available, it will help the classifier to perceive immediately possible mistakes or inconsistencies in the classification. The estimated final score will not substitute the official final score but it is expected to increase the accuracy of evaluation.

In terms of genetic evaluation the estimated final score could be used to develop an aggregate index for type. By means of the selection index theory, the estimated final score could represent the breeding objective, while linear traits would be the selection criterions. Calculation of the genetic and phenotypic correlations between and among the estimated final score (breeding objective) and all the linear traits (selection criterions), would allow to compute the index weights necessary to set up the aggregate index. Alternatively sub-indexes, reflecting the 4 sub-sections used to assign the final score, could be developed.

The priority is to develop a consistent and applicable formula to estimate final score.

Reference

Dekkers, J.C.M. & Gibson, J.P. 1998. Applying Breeding Objectives to Dairy Cattle Improvement. *J. Dairy Sci. 81(2)*, 10-35.

van Pelt, M.L., van der Linde, C., Harbers, A.G.F. & de Jong, G. 2006. Consistency of conformation trait definitions across time. Proceedings of the 2006 Interbull Meeting Kuopio, Finland, June 4-6, 2006. *Interbull Bulletin 35*, 159-163.

Table 1. Original and transformed Linear Score

	Transformed Linear Score			
Linear Score	**Rump Angle**	**Rear Leg Rear View**	**Front Teat Placement**	**Udder Depth**
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	13	13	13	11
12	16	16	16	12
13	19	19	19	13
14	22	22	22	14
15	25	25	25	15
16	28	28	28	16
17	31	31	31	17
18	34	34	34	18
19	37	37	37	19
20	40	40	40	20
21	42	42	42	21
22	44	44	44	22
23	46	46	46	23
24	48	48	48	24
25	50	50	50	25
26	49	49	49	26
27	47	47	47	27
28	45	45	45	28
29	43	43	43	29
30	41	41	41	30
31	38	38	39	31
32	35	35	37	32
33	32	32	35	33
34	29	29	33	34
35	26	26	31	35
36	23	23	29	36
37	20	20	27	37
38	17	17	25	38
39	14	14	23	39
40	11	11	21	40
41	10	10	19	41
42	9	9	17	42
43	8	8	15	43
44	7	7	13	44
45	6	6	11	15
46	5	5	9	14
47	4	4	7	13
48	3	3	5	12
49	2	2	3	11
50	**1**	**1**	**1**	**10**