Is It Possible to Define a European Total Merit Index?
(Presentation for the PROTEJE group)

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Abstract

Developing a common European bull list is an objective of the PROTEJE (PROduction Traits European Joint Evaluation) workgroup started in 2001 as an initiative of the European Holstein herdbooks. Six Total Merit Indexes were compared to define a common breeding goal across Europe. A principal component analysis was used to observe the direction of the largest common variation among the studied Total Merit Indexes. Results showed that the considered indexes had a lot in common. The first principal component explained 86% of the total variation. Based on previous researches establishing combined proofs on a European phantom scale for most traits and trait groups and using a multiple regression for this European Total Merit Index, relative emphases on production and functionality of 37% and on conformation of 26% could be established.

Introduction

The PROTEJE (PROduction Traits European Joint Evaluation) workgroup started in 2001 as an initiative of the European Holstein Herdbooks. The goal of this workgroup was mainly to investigate the possibility of having one common list of bulls potentially useful for Europe. The advantage of one European list is a common European direction of selection and easiest comparisons of bulls on the international market.

Based on selection index theory, the workgroup developed a method allowing the combination of the current Interbull MACE results from several country scales into one list of bull proofs on one common European scale assuming equal correlations of the different countries with this phantom scale. More details of this method are available in Täubert et al. (2008).

In a second step, an analysis was carried out to study how much the Total Merit Indexes (**TMI**) of several European countries have in common in order to develop a global European TMI. This analysis will be reported in this paper. This common index could be the starting point for further studies to define a precise European TMI expressing a common breeding goal across Europe. A side effect would be that this European TMI would help to promote high ranking bulls from European countries inside and outside Europe on a common scale.

Materials and Methods

Data

Six European countries or regions, France (**ISU**), Germany (**RZG**), Walloon Region of Belgium (**V€G**), Italy (**PFT**), The Netherlands (**NVI**), and the Nordic countries (**NTM**) provided their national TMI for bulls published in their countries. The descriptive statistics of these global indexes are displayed in Table 1. The minimum number of published bulls was 7,490 in the Nordic countries and the maximum was 120,717 in Netherlands.

Table 1: Descriptive statistics of national global index for the bulls provided by the six countries

	Min	Mean	SD	Max
ISU	-44.00	86.71	27.33	195.00
RZG	40.57	91.89	13.43	148.69
V€G	-936.00	-17.63	140.52	502.00
PFT	-2273.00	0.64	787.30	2795.00
NVI	-510.00	-94.71	83.45	297.00
NTM	-59.00	-13.25	11.81	35.00

Principal Component Analysis

A principal component analysis (**PCA**), which is a way to observe common directions of variability from a multi-dimensional record space of several individuals, was carried out on the published TMIs for bulls common to these six European countries. This pool of bulls will be named "shared pool" of bulls hereafter. It was created linking proofs for the same bulls across countries based on their cross-reference identifications provided by Interbull. PCA provides eigenvalues of each principal component estimated from the correlation matrix among variables, their related eigenvectors, and a graphical representation of individuals in the principal component space. Based on the PCA results, a draft for the European TMI was defined.

Multiple regressions of combined proofs

The draft for the European TMI was regressed on the currently available combined proofs, the MACE proofs on a phantom country scale, in order to obtain index coefficients.

Combined proofs were available for all traits that had all six national genetic evaluations, had an official Interbull evaluation and had reasonable correlations between European countries. Therefore, combined proofs for longevity, global conformation score and calving traits were not available. For the first two traits, this was due to lack of harmonized traits definitions between countries leading to low correlations among them. For calving traits, this was due to the lack of a national genetic evaluation system of calving traits or the non-participation in Interbull evaluations for the Walloon Region and Germany.

A detailed description of the computations of these combined proofs is given in Täubert et al. (2008). Used combined proofs were obtained after rescaling on mean of 0 and standard deviation of 1, for bulls within birth year 2002.

The procedure to predict the draft for the European TMI consisted in two steps. First, three separate trait groups were defined: production (with milk, fat and protein yields), functionality (limited to udder health based only on somatic cell score because of the availability of data, and female fertility, i.e. cow’s ability to conceive) and conformation (with 17 conformation traits, locomotion and Body Condition Score (**BCS**)). By using a selection process based on significance, group specific multiple regressions allowed identifying the traits to retain for the second step. In the second step, the three predicted trait group indexes were regressed on the draft for the European TMI expressing the common breeding goal across Europe

Results & Discussion

Principal Component Analysis

A shared pool of 458 bulls producing a published national global index and shared by all the six countries was found. Table 2 shows the descriptive statistics of the shared pool of bulls. Bulls of the shared pool apparently belong to a theoretically highly selected group and might therefore produce a bias in the results. Despite the effect of selection, the differences between original and selected population were rather small, especially the standard deviations (**SD**) of selected population remained in the same range of values than the original population indicating that a sufficient variability were retained.

Table 2: Data description of the shared pool for each national TMI

	Min	Mean	SD	Max
ISU	31.00	106.82	22.38	189.00
RZG	61.09	102.56	12.74	148.69
V€G	-335.00	112.26	120.59	452.00
PFT	-1630.00	467.08	690.16	2760.00
NVI	-282.00	-24.60	75.94	297.00
NTM	-50.00	-8.28	11.66	32.00

A first view of the common variability among the six European countries could be represented by the correlations between their national TMIs as displayed in Table 3. Correlation estimates ranged from .75 (between NTM and PFT indexes) to .90 (between RZG and NVI indexes).

Table 3: Correlation between six European national TMIs for the shared pool of bulls

	ISU	RZG	V€G	PFT	NVI
RZG	.89				
V€G	.82	.87			
PFT	.83	.83	.79		
NVI	.82	.90	.87	.78	
NTM	.79	.87	.79	.75	.85

This strong relationship among national TMIs explained the large variability described by the first principal component (**Prin1**), close to 86%.

This fact could be explained by the increasingly similar selection goals across countries. The second principal component (**Prin2**) described another 5% of the common variability. The remaining 9% were split between the other four principal components. Figure 1 shows the correlation circle defined by Prin1 and Prin2. All the national TMIs were clearly in the same direction for Prin1. This was not the case for Prin2. The national TMIs of Italy (PFT) and of France (ISU) differ from the four other indexes. Correlations of Prin1 with the six national TMIs were close to .90 with the highest correlation observed for RZG (.97). Correlations of Prin2 with the six national TMIs were always lower (in absolute figures) than those for Prin1 or even equal to zero for two of them (V€G and RZG). Moreover, a similar magnitude for eigenvectors of Prin1 appeared while this was not the case for eigenvectors of other components.

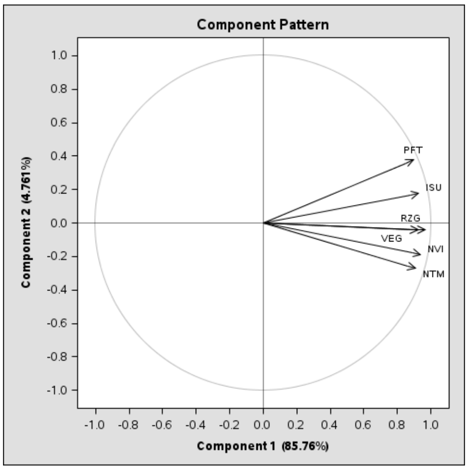

Figure 1: Correlation circle for national TMIs

Estimates of correlations between the two first components (Prin1 and Prin2) and all available combined proofs on phantom scale are displayed in Table 4.

The highest positive correlation is observed for Prin1 with protein (.68) and the highest negative one is with rear leg set (-.26). Prin1 is moderately correlated with production traits, udder health, locomotion and some conformation traits. Prin2 presents moderate correlations only with conformation traits. Hence, the part of common variability between the six national TMIs explained by Prin2 is mainly affected by morphological aspects. According to these results, Prin1 could be considered as being a good compromise between the different countries to express a common breeding goal across these six European countries. Therefore, the rest of this study will be focused only on Prin1 that will be considered as the draft European TMI, and by extension, the predicted value will be hereafter called European TMI.

Multiple regressions of combined proofs

The estimated regression coefficients were used to define three groups of traits.

For production, regression coefficient of milk was negative in opposition to fat and protein regression coefficients, which seemed consistent with the payment system of milk in the majority of European countries.

On the nineteen morphological traits regressed on Prin1, only nine of them showed a significant effect (below .05) and thus defined conformation group: BCS, body depth, fore teat placement, locomotion, overall feet & legs, rear leg rear view, rear teat placement, rear udder height and udder support.

Then, the multiple regression method was used to find regression coefficients allowing the combination of these 3 values in order to estimate a European TMI expressing the common breeding goal across Europe (represented by Prin1).

Table 5 shows relative emphases on traits in European TMI and Table 6 shows relative emphases on traits in the six national TMIs. These relative emphases, in both tables, were expressed as a percentage and were calculated as the economic weight divided by SD of the breeding value. In European TMI, production and functionality had a relative emphasis of 37% while conformation had a relative emphasis of 26%. Relative emphasis on production and functionality in European TMI were in the same range of values than relative emphasis in the six national TMIs (see Table 6). Concerning conformation, relative emphasis was slightly greater than relative emphasis in the six national TMIs.

Correlations between European TMI and combined proofs for available traits were estimated (see Table 4). Results were slightly different than those observed for Prin1 since the European TMI is the predicted value based on currently available traits. As observed before between Prin1 and combined proofs, the highest positive correlation is observed with protein. Some conformation traits presented negative correlations with the European TMI (e.g. body depth, rear leg set). All correlations with the six national TMIs were in the range of .83 to .93, the lowest for the Nordic countries, and the highest for France respectively. The lower result for the Nordic countries can be linked to their large emphasis on other functional traits.

Table 4: Estimates of correlations of all combined proofs available with Prin1 and Prin2 and correlations with the European TMI

	Prin1	Prin2	Europe TMI		Prin1	Prin2	Europe TMI
Milk	.44	.00 ^{NS}	.52	Locomotion	.37	.12	.32
Fat	.55	.06 ^{NS}	.62	Overall Feet & Legs	.42	.12	.32
Protein	.68	-.12	.73	Overall Udder Score	.40	.41	.33
Udder Health (SCC)	.38	.22	.49	Rump Angle	.08 ^{NS}	-.07 ^{NS}	.06
Female Fertility (C2)	.20	-.25	.08	Rear Leg Rear view	.28	.08 ^{NS}	.17
Angularity	.02 ^{NS}	.41	.11	Rear Leg Set	-.26	-.03 ^{NS}	-.19
BCS	.14	.46	.16	Rear Teat placement	.12	.30	.08
Body Depth	-.20	.42	-.13	Rear Udder Height	.35	.42	.34
Chest Width	-.09 ^{NS}	.32	-.08	Rump Width	.04 ^{NS}	.33	.02
Foot Angle	.23	.29	.24	Stature	.10	.49	.09
Fore Teat Length	.02 ^{NS}	.06 ^{NS}	-.03	Udder Depth	.32	.37	.19
Fore Teat Placement	.28	.24	.26	Udder Support	.28	.34	.21
Fore Udder Attachment	.15	.28	.16				

^{NS}: Not significant

Table 5: Relative emphases (%) on traits in European TMI

Production	*37*		*Conformation*	*26*	
Milk		-8	BCS		1
Fat		7	Body Depth		-4
Protein		23	Fore Teat placement		2
Functionality	*37*		Locomotion		3
Udder Health (only SCC)		30	Overall Feet & Legs		3
Female Fertility		7	Rear Leg Rear view		-4
			Rear Teat placement		-4
			Rear Udder height		2
			Udder support		3

Table 6: Relative emphases (%) in the six national TMIs in June 2011

Index	ISU	RZG	V€G	PFT	NVI	NTM
Prod.	50	45	48	49	33	31
Funct.	37.5	40	28	28	45	54
Conf.	12.5	15	24	23	22	15

Conclusions

PCA seems to be a straightforward method to assess common variation for the six studied European national TMIs, a large part of their selection goals being considered very similar. A proposal for a European TMI was derived using Prin1 and was based on currently available combined proofs on phantom scale. Some important traits as longevity could not yet be considered. Therefore, even if the described strategy is straight forward, many other issues have to be considered (e.g., participation of other European countries, availability of combined proofs for all traits including longevity and other health related traits). Still the obtained results for this strategy showed its potential usefulness to help establish, if desired, a European bull list to represent the dairy selection in Europe on the international market. Results also showed that such a European TMI cannot completely replace country specific TMIs representing local differences.

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