

There and Back Again: A Tale of Choosing Female Fertility Traits

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Introduction

Choice of female fertility traits to be included in the international genetic evaluation conducted at the Interbull Centre was (and is) very much affected by the biological complexity of these traits. Thus, from the beginning a partitioning of the fertility complex into the following components has been the guiding principle:

- a) Traits that measure the animal's ability to become pregnant, i.e. high probability of conception. Two examples of traits for this ability are Non-Return Rate (NR) and Number of Inseminations (NI);
- b) Traits that measure the animal's ability to re-cycle after calving. An example of a trait for this ability is the interval between Calving and First insemination (CF);
- c) Traits that measure a combination of the above two abilities. Combination of the above two abilities might be through single measurements (e.g. Days Open (DO), Calving Interval (CI)), through index traits (e.g. Fertility Index (FI)), or through correlated composite traits (e.g. body Condition Score (CS)).

Consequently, four trait groups could be envisaged in an international genetic evaluation:

- Group 1: Maiden heifer's ability to conceive;
- Group 2: Lactating cow's ability to recycle after calving;
- Group 3: Lactating cow's ability to conceive; and
- Group 4: Lactating cow's measurements of interval traits calving-conception.

The above trait group classification corresponds to the current Interbull trait groupings of trait groups 1, 2, 3 and 5, respectively.

However, two lines of arguments have had modifying effects on the choice of traits to be included in the five trait groups considered for evaluation. According to the first argument some traits are not very suitable for an international genetic evaluation, because either they are very management dependent and also prone to recording mistakes or they have non-optimal distributional properties. According to the second argument because a large number of countries have evaluation only for one trait, strict adherence to the biological definitions prevents bull comparisons from many 2-country combinations. Therefore, discussions at all Interbull levels/organs during Interbull Open meeting in Kuopio, Finland, in June 2006, lead to the conclusion that there is a need for a mixed trait group containing all sorts of traits. In this mixed trait group (currently known as trait group 4) every country is entitled to submit any trait they wish.

Results of two Interbull test evaluations, in which genetic correlations are estimated, however, show that estimated genetic correlations among the traits included in trait group 4, are very variable and very low for many country combinations. Further, despite the fact that all countries (populations) are represented in the evaluation for this trait group, the comparisons among different bull populations are far from satisfactory. Therefore, it is prudent to re-evaluate the suitability of different submitted traits for inclusion in different trait groups analyzed at the Interbull Centre.

Material and Methods

Data submitted for March 2007 test evaluation from 14 countries/populations were used to estimate genetic correlations for the five trait groups currently evaluated at the Interbull Centre. These countries were: BEL, CHE, CHR, DFS, ESP, FRA, GBR, IRL, ISR, ITA, NLD, NZL and USA. Traits submitted by these countries are the same as described in Interbull Centre report for August 2007 routine evaluation (accessible through http://www-interbull.slu.se/Female_fert/framesida-fert.htm).

Methods for estimation of genetic correlations are also the same as the methods described in the above mentioned document.

Traits added/changed

Suggestion for a new way of trait grouping had been submitted from Canadian Dairy Network (CDN, March 2007) to the Interbull Technical Committee and Interbull Steering Committee. This suggestion was modified so that trait additions/changes can be compared with the current practice (Table 1).

Trait group	Current traits ¹	Traits added / changed
T1: Maiden heifer's ability to conceive	CZE CR, DFS NR, FRA CR	--
T2: Lactating cow's ability to recycle after calving	CHE CF, CHR CF, DFS CF, ITA CF, NLD CF, NZL PM21	ESP DO, GBR CI, IRL CI, USA DP
T3: Lactating cow's ability to conceive (1)	CZE CR, DFS FL, FRA CR, ISR CR	CHE NR, CHR NR, DFS FL, GBR NR, ITA NR, NLD NR, NZL CR42
T4: Lactating cow's ability to conceive (2)	BEL PR, CHE NR, CHR NR, CZE CR, DFS NR, ESP DO, FRA CR, GBR NR, IRL CI, ISR CR, ITA NR, NLD NR, NZL CR42, USA DP	CHE CF, CHR CF, DFS CF, DFS FL, DFS DO, GBR CI, ITA CF, NLD CF
T5: Lactating cow's measurements of interval traits calving-conception	BEL DP, DFS DO, ESP DO, GBR CI, IRL CI, ITA CI, NLD CI, NZL CR42, USA DP	CHE CF, CHR CF

¹ Trait abbreviations: CF=Interval calving to first insemination, CI=Calving interval, CR=Conception rate, CR42=re-calving in the first 42 days of the herd's calving period, DO=Days open, DP=Daughter Pregnancy Rate, FL=Interval from first to last insemination, NR=Non Return Rate, PM=Present for mating in the first 21 days of the herd's mating period, PR=Pregnancy Rate

Results & Discussion

Due to limitation on the number pages only a brief description of the results will follow. Complete results in form of an Excel file are available for interested parties. The following four tables show the estimated correlation matrices for trait groups 2-5. Columns and rows in bold indicate the new traits added/changed.

Trait group 1: All available heifer traits are already included in the evaluation of trait group 1. Therefore, there was no re-evaluation of traits to be included in this trait group.

Trait group 2: This trait group 2 includes cow's ability to recycle after calving. The best measure would be the interval calving to the first insemination (CF). However, both calving interval (CI) and days open (DO) circumscribe CF. Therefore, CI/DO from ESP, GBR, IRL and USA were added to this trait group. These new traits had reasonably high correlations with each other and the old traits. Changes in the correlations among the old traits were negligible. Another participating country/trait that can be added to this trait group is DP from BEL. Addition of these new country/traits would increase the number of traits from 6 to 11.

Trait group 3: This trait group includes cow's ability to conceive. The ideal measure would be confirmed conception. Previously non-return rate (NR) was excluded from this trait group on the grounds that NR is too management dependent and prone to recording mistakes. Addition of NR from CHE, CHR, GBR, ITA and NLD together with CR42 from NZL was tested. The trait CR42 had very low average correlation with the rest of traits (0.26) and was discarded from further analysis. These new traits had reasonably high correlations with each other and the old traits. However, they caused the correlations among the old traits to change dramatically. Changing DFS trait FL to NR alleviated the problem to some extent and among other things improved the DFS average correlation by 7%.

Trait group 4: This trait group is meant to be a mixed group of traits to provide comparison links. Because of the presence of all

populations in this trait group, only change of the country traits was possible. Considering the inclusion of NR in the trait group 3, it seems logical to test traits other than NR in this trait group. Therefore, NR from CHE, CHR, DFS, GBR, ITA and NLD were replaced with an interval trait from these countries. Introduction of new traits had no directional effect on average correlation, even though many country correlations changed. However, use of the new traits lead to the reduction of extremely small correlations (< 0.25) to decrease from 25 to 9.

Trait group 5: This trait includes measurements of interval caving-conception and up to now has been reserved for CI/DO. However, CF (from CHE and CHR) being a component of CI/DO can be added to this trait group. These new traits had reasonably high correlations with each other and the old traits. Changes in the correlations among the old traits were negligible.

Trait group 2

		CHE	CHR	DFS	ESP	GBR	IRL	ITA	NLD	NZL	USA
		CF	CF	CF	DO	CI	CI	CF	CF	PM	DP
CHE	CF	1.00	0.97	0.94	0.74	0.77	0.65	0.88	0.89	0.55	0.70
CHR	CF	0.97	1.00	0.91	0.66	0.74	0.57	0.79	0.87	0.45	0.61
DFS	CF	0.94	0.91	1.00	0.70	0.79	0.68	0.89	0.90	0.56	0.72
ESP	DO	0.74	0.66	0.70	1.00	0.88	0.80	0.81	0.73	0.58	0.93
GBR	CI	0.77	0.74	0.79	0.88	1.00	0.82	0.83	0.78	0.62	0.85
IRL	CI	0.65	0.57	0.68	0.80	0.82	1.00	0.71	0.63	0.65	0.76
ITA	CF	0.88	0.79	0.89	0.81	0.83	0.71	1.00	0.86	0.69	0.78
NLD	CF	0.89	0.87	0.90	0.73	0.78	0.63	0.86	1.00	0.56	0.71
NZL	PM	0.55	0.45	0.56	0.58	0.62	0.65	0.69	0.56	1.00	0.49
USA	DP	0.70	0.61	0.72	0.93	0.85	0.76	0.78	0.71	0.49	1.00
<i>AVERAGE</i>		<i>0.79</i>	<i>0.73</i>	<i>0.79</i>	<i>0.76</i>	<i>0.79</i>	<i>0.70</i>	<i>0.80</i>	<i>0.77</i>	<i>0.57</i>	<i>0.73</i>

Trait group 3

		CHE	CHR	CZE	DFS	FRA	GBR	ISR	ITA	NLD
		NR	NR	CR NR/FL	CR	CR	NR	CR	NR	NR
CHE	NR	1.00	0.94	0.56	0.83	0.73	0.65	0.84	0.88	0.84
CHR	NR	0.94	1.00	0.54	0.88	0.55	0.54	0.87	0.84	0.83
CZE	CR	0.56	0.54	1.00	0.65	0.77	0.36	0.55	0.48	0.40
DFS	NR/FL	0.83	0.88	0.65	1.00	0.61	0.71	0.92	0.82	0.82
FRA	CR	0.73	0.55	0.77	0.61	1.00	0.63	0.65	0.55	0.62
GBR	NR	0.65	0.54	0.36	0.71	0.63	1.00	0.76	0.66	0.73
ISR	CR	0.84	0.87	0.55	0.92	0.65	0.76	1.00	0.72	0.88
ITA	NR	0.88	0.84	0.48	0.82	0.55	0.66	0.72	1.00	0.75
NLD	NR	0.84	0.83	0.40	0.82	0.62	0.73	0.88	0.75	1.00
<i>AVERAGE</i>		<i>0.78</i>	<i>0.75</i>	<i>0.54</i>	<i>0.78</i>	<i>0.64</i>	<i>0.63</i>	<i>0.77</i>	<i>0.71</i>	<i>0.74</i>

Trait group 4

		BEL	CHE	CHR	CZE	DFS	ESP	FRA	GBR	IRL	ISR	ITA	NLD	NZL	USA
		PR	CF	CF	CR	DO	DO	CR	CI	CI	CR	CF	CF	CR	DP
BEL	PR	1.00	0.75	0.73	0.68	0.84	0.93	0.62	0.87	0.82	0.23	0.78	0.76	0.74	0.84
CHE	CF	0.75	1.00	0.96	0.26	0.83	0.72	0.17	0.77	0.64	-0.08	0.88	0.90	0.47	0.66
CHR	CF	0.73	0.96	1.00	0.15	0.83	0.65	0.15	0.74	0.62	-0.15	0.81	0.88	0.37	0.59
CZE	CR	0.68	0.26	0.15	1.00	0.53	0.71	0.76	0.54	0.40	0.74	0.39	0.33	0.60	0.78
DFS	DO	0.84	0.83	0.83	0.53	1.00	0.85	0.55	0.88	0.76	0.32	0.84	0.82	0.53	0.89
ESP	DO	0.93	0.72	0.65	0.71	0.85	1.00	0.67	0.88	0.79	0.31	0.81	0.72	0.66	0.93
FRA	CR	0.62	0.17	0.15	0.76	0.55	0.67	1.00	0.58	0.55	0.64	0.30	0.22	0.39	0.76
GBR	CI	0.87	0.77	0.74	0.54	0.88	0.88	0.58	1.00	0.82	0.28	0.84	0.77	0.66	0.84
IRL	CI	0.82	0.64	0.62	0.40	0.76	0.79	0.55	0.82	1.00	0.16	0.72	0.62	0.72	0.73
ISR	CR	0.23	-0.08	-0.15	0.74	0.32	0.31	0.64	0.28	0.16	1.00	0.15	0.08	0.38	0.57
ITA	CF	0.78	0.88	0.81	0.39	0.84	0.81	0.30	0.84	0.72	0.15	1.00	0.86	0.64	0.76
NLD	CF	0.76	0.90	0.88	0.33	0.82	0.72	0.22	0.77	0.62	0.08	0.86	1.00	0.53	0.70
NZL	CR	0.74	0.47	0.37	0.60	0.53	0.66	0.39	0.66	0.72	0.38	0.64	0.53	1.00	0.61
USA	DP	0.84	0.66	0.59	0.78	0.89	0.93	0.76	0.84	0.73	0.57	0.76	0.70	0.61	1.00
<i>AVERAGE</i>		<i>0.74</i>	<i>0.61</i>	<i>0.56</i>	<i>0.53</i>	<i>0.73</i>	<i>0.74</i>	<i>0.49</i>	<i>0.73</i>	<i>0.64</i>	<i>0.28</i>	<i>0.68</i>	<i>0.63</i>	<i>0.56</i>	<i>0.74</i>

Trait group 5

		BEL	CHE	CHR	DFS	ESP	GBR	IRL	ITA	NLD	NZL	USA
		PR	CF	CF	DO	DO	CI	CI	CI	CI	CR	DP
BEL	PR	1.00	0.78	0.76	0.86	0.92	0.88	0.81	0.79	0.89	0.68	0.84
CHE	CF	0.78	1.00	0.94	0.85	0.77	0.79	0.61	0.69	0.78	0.49	0.73
CHR	CF	0.76	0.94	1.00	0.86	0.69	0.76	0.56	0.65	0.81	0.40	0.65
DFS	DO	0.86	0.85	0.86	1.00	0.85	0.88	0.75	0.87	0.91	0.52	0.89
ESP	DO	0.92	0.77	0.69	0.85	1.00	0.87	0.77	0.88	0.87	0.64	0.92
GBR	CI	0.88	0.79	0.76	0.88	0.87	1.00	0.81	0.85	0.88	0.62	0.83
IRL	CI	0.81	0.61	0.56	0.75	0.77	0.81	1.00	0.75	0.78	0.72	0.73
ITA	CI	0.79	0.69	0.65	0.87	0.88	0.85	0.75	1.00	0.87	0.64	0.90
NLD	CI	0.89	0.78	0.81	0.91	0.87	0.88	0.78	0.87	1.00	0.62	0.86
NZL	CR	0.68	0.49	0.40	0.52	0.64	0.62	0.72	0.64	0.62	1.00	0.58
USA	DP	0.84	0.73	0.65	0.89	0.92	0.83	0.73	0.90	0.86	0.58	1.00
<i>AVERAGE</i>		<i>0.82</i>	<i>0.74</i>	<i>0.71</i>	<i>0.82</i>	<i>0.82</i>	<i>0.82</i>	<i>0.73</i>	<i>0.79</i>	<i>0.83</i>	<i>0.59</i>	<i>0.79</i>

Conclusions & Recommendations

Trait Group 1: No suggestion for any change.

Trait Group 2: Add other interval traits to this traits group (CI/DO/DP/PR)

Trait Group 3: Add other rate traits to this trait group (NR)

Trait Group 4: Use any interval trait in this trait group (preferably not the ones used in trait group 5)

Trait Group 5: Add other interval traits to this traits group (CF)