Prediction of UK Fertility Proofs for Foreign Bulls

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Introduction

Poor fertility has become a major reason for involuntary culling of dairy cows in the UK. Research in the UK has recently developed a Fertility Index for dairy cattle. After examining national data it was decided that fertility proofs in the UK would be based on calving interval (CI) and non-return rate after 56 days (NR56) weighted by their relative economic weights (independent of culling). Sire PTAs for these traits were produced from a hexavariate BLUP run of fertility traits (CI, NR56; days to first service (DFS) and number of inseminations per conception (INS)) and correlated traits (milk yield in kgs at test nearest day 110 (MILK); body condition score on a scale of 1-9 (BCS)). There was an unfavourable genetic correlation between the fertility traits and milk yield and BCS. PTAs produced were similar in size and range to those produced in other studies and genetic trends were as expected. Results are encouraging and have lead to a fertility index that will help to improve national dairy cow fertility (Wall *et al.*, 2003).

However, just under half of the available bulls have no milking daughters in the UK. It would take about 4 years from the time of first use in the UK, for a foreign bull to have sufficient daughters for a reliable fertility proof. Waiting this long before having fertility information on which to base selection decisions will slow down genetic progress and is undesirable as many of these bulls could have fertility proofs in their country of first test. As there are currently no INTERBULL procedures in place for the conversion of foreign fertility proofs, direct conversion of the fertility proofs from other countries to UK equivalents is deemed necessary. The aim of this study was to examine the nature of other countries fertility proofs and decide which traits can accurately predict some or all of the UK fertility traits. Conversion equations were then derived and foreign proofs converted to UK equivalents.

Materials and Methods

Files were received from countries publishing fertility proofs; Ireland, The Netherlands, France, Germany, Denmark, New Zealand and The United States. UK and Australia are currently in the process of developing a fertility proof. After IDs were reformatted to INTERBULL standards, files were matched across countries, in pairs. UK matches were then extracted from this table and a number of restrictions were used on each pair-wise match to ensure that the data from the common bulls was suitable for the derivation of conversion equations. First and second crop daughters of AI bulls were extracted. In the majority of cases minimum birth year was set at 1990. This rule was however relaxed when numbers of common bulls were low. The edit on sire birth year was never reduced below 1988 in accordance with INTERBULL guidelines (1990) that bulls should be born in a ten year period ending with the most recent birth year. In this case the most recent bull date of birth was never after 1998. Reliability of the fertility proof from each country was at least 50% in all cases. This lower limit was raised where there were sufficient number of bulls.

Conversion methodologies were based on INTERBULL guidelines (Philipsson *et al.*, 1986) following methods described by Goddard (1985). First proofs in the importing country (UK) were "deregressed" using the following equation.

$$P_B' = \frac{P_B - g}{R_B} + g \qquad \text{(Goddard, 1986)}$$

where
- P_B' = Deregressed proof
- P_B = Proof in country B, importing
- R_B = Reliability in Country B
- g = The average group effect of the genetic group to which the bull belongs.

Next the regression of $P_B{}'$ on the proof in country A (P_A), the exporting country, was calculated giving the following type of equation

$$P_B{}' = a + bP_A$$

Results

Solutions for *a* (intercept) and *b* (slope) values of the conversion regression equations, correlations between countries and counts of common bulls after edits are given in Table 1.

Ireland

In Ireland, breeding values for CI over the first three lactations were predicted using a multivariate sire model. Other traits evaluated included survival and 305-day milk yield in the first 3 lactations, foot angle, angularity, udder depth and BCS (Pool *et al.*, 2002). Breeding values for CI were averaged across lactations. The minimum year of birth for common sires was 1988, the minimum reliability of UK CI was 70% and the minimum reliability of Irish CI was 65%. The correlation of actual and predicted CI PTA was 0.69. The plot of these animals and the fitted regression line is shown in Figure 1.

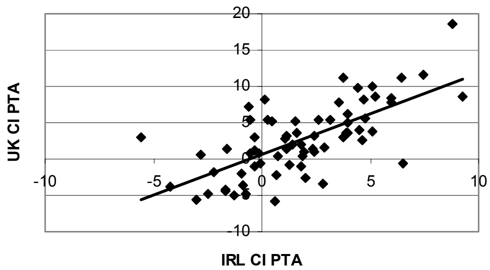

Figure 1. Plot of UK CI PTA (deregressed) and IRL CI PTA with linear regression line.

The Netherlands

The Dutch female fertility index is derived from breeding values for non return rate at day 56 (NR56) and Calving to first service interval (CFI) Their fertility index is described in terms of CI and is derived from CFI*0.4*NR56. Sire year of birth was set to at least 1990 with a reliability of 60% in both countries. Conversion equations were based on linear regression of UK deregressed proofs on Dutch PTAs. The correlations between actual and redicted UK CI DFS NR56 PTAs were 0.71, 0.85 and 0.65 respectively, based on conversions from NLD CI index (FI), CFI and NR56.

New Zealand

Fertility evaluation in NZL is based on analysis of 2 binomial traits, ability to be presented for mating in the first 21 days (DFM) and ability to bear a calf from Artificial Insemination (CAI) in the first 3 lactations. Breeding values are estimated by BLUP with a multiple (6) trait animal model. These proofs are then combined in an index. The component traits of the fertility index were not received from NZL and therefore work on conversions for NZL was based on the fertility index. The limit on sire year of birth was set at 1990. Reliability limits were set at 50% in the UK (CI reliability) and 60% in NZL with a correlation of actual and predicted UK CI PTAs was 0.51, as predicted from NZL FI. There was a low correlation and non-significant regression coefficients between NZL FI and UK NR56 or NZL FI and the UK FI. Correlations between traits in each country might be higher and therefore conversion equations possible if component traits of the NZL index were available.

Denmark

The female fertility index is derived from weighted breeding values for NR56 for heifers and cows, first to last insemination interval for heifers and cows, and calving to first insemination interval for cows. Heifer and cow traits are considered different and breeding values are obtained by multitrait BLUP evaluation using a sire model. These are weighted in an index and again this was the only index information received from Denmark on fertility traits. Sire year of birth was set to be at least 1990 with reliability of DNK FI being 70% and 60% reliability in the UK. The correlation between actual and predicted UK CI PTAs was 0.51. The correlation between the UK FI and DNK FI was low (0.26) and regression components non-significant therefore direct conversions were not attempted. However, the availability of the component trait information would allow for individual trait conversions of heifer CI and NR56 to UK equivalents.

United States of America

Preliminary PTAs were introduced for daughter pregnancy rate (DPR) February, 2003. DPR measures the percentage of non-pregnant cows that become pregnant during each 21-day opportunity period. PTA DPR is provided for both bulls and cows, but reliabilities average only 60% for recently progeny tested bulls and 30% for recent cows. All common bulls were born after 1990 and the minimum reliability in the US and UK was 70% and 65% respectively with a correlation of 0.76 between UK CI PTA and predicted CI PTA. There was a correlation of 0.25 between USA DPR PTA and UK NR56 PTA and regression coefficient were non-significant.

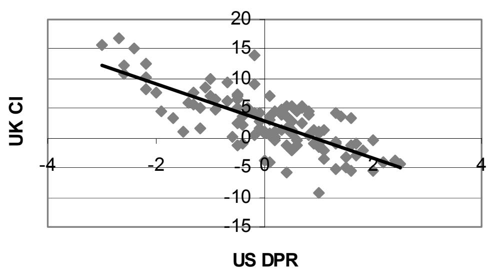

Figure 2. Plot of UK CI PTA (deregressed) and USA DPR PTA with linear regression line.

There was a correlation of 0.48 between USA DPR PTA and UK fertility index. This is lower than the correlation DPR with CI PTA, however the regression of US DPR on UK FI was significant. The conversion equation was derived from USA DPR PTA to UK fertility index (Figure 3) and was;

UK FI = 0.44 + 0.15(US DPR).

Having this conversion equation would mean there would be no missing information on US imported bulls in the UK available bull lists.

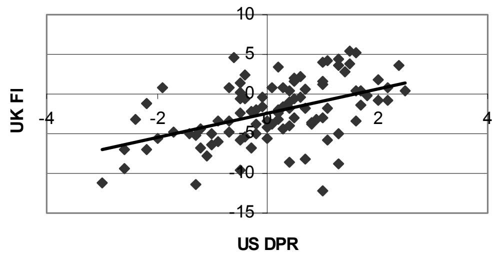

Figure 3. Plot of UK FI (deregressed) and USA DPR PTA with linear regression line.

France

The analysed trait is defined as the result (success/failure) of each artificial insemination using a sire and maternal grand sire model including the random effect of the service bull. There were a total of 47 common bulls that had a year of birth later than 1990 a reliability of 70% in France and 50% in the UK. The correlation of the actual and predicted UK NR56 PTA was 0.58.

Germany

The reproduction (fertility) index comprises direct paternal and maternal effects estimated simultaneously by BLUP with an animal model. Component traits include calving difficulties, stillbirth and non-return rate at day 90 (NR90). The year of birth of sire was at least 1988 and the reliability of German and British proofs was 70% and 60% respectively. There was a correlation of 0.39 between actual and predicted UK NR56 PTA, as predicted from DEU NR90 (mat) EBV. A potential reason for this poor correlation could be the model that is used in Germany, as this model includes a correction for the genetic effect of the mate. Correlations between DEU NR90 and NLD NR56 were also low.

Australia

Australia is currently developing a fertility proof and are at the industry consultation stage of development (similar situation to the UK). The preliminary breeding values were made available only for research purposes and individual proofs are therefore confidential. At this stage breeding values are based on calving interval but they hope to extend the traits to include mating information. Minimum sire year of birth was 1990 and reliability in UK and Australia was 50% and 70% respectively. This resulted in 65 common bulls with a correlation of 0.73 between actual and predicted UK CI.

Discussion

Conversion equations have been successfully developed for the UK for a number of foreign countries' fertility proofs. Data could not be obtained from all countries that currently publish a fertility index but data was available from the main countries trading semen with the UK (*e.g.*, USA, NLD, DEU *etc.*). Not all countries have finished developing their fertility proofs so the conversion equations for these countries are either not final or not available. *e.g.*, Australia is developing an index and sent preliminary proofs, Canada does not have a fertility proof). The differences in the fertility traits evaluated and the model used in each country limited the accuracy of conversions. An example would be the inclusion of mate information in the German model for NR90 or the choice of fertility traits in New Zealand. Some countries have combined fertility index values in preference to individual component proofs. If individual trait proofs were available conversions could be more precise. Conversions for all traits was not possible, for example, French bulls only have converted NR56 PTA. Conversions of foreign proofs were applied where possible and over 85% of the available UK bulls had either domestic or partially converted fertility proofs. Correlations between fertility proofs in the UK and other countries were moderate to high.

Another option to the conversion of individual country proofs would be the development of an international evaluation service for fertility traits similar to the multiple across country evaluation (MACE) evaluation service of the INTERBULL. Experience from this and similar studies suggest that a multiple trait MACE may be more suitable for fertility traits and this approach will be strongly recommended. A pairwise matching of countries based on fertility information was attempted in this study and 40-60% of USA, UK, AUS and NLD bull fertility and longevity proofs could be matched to at least one other country. The remaining countries had between 12-32% match rate with other countries. The number of common bulls between each pairwise comparison of countries is shown in Table 2. Some of the pairwise comparisons are low or zero. This tended to occur when the file received used national IDs to identify bulls and could prove difficult to match, even after reformatting.

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Table 1. Regression coefficients (*a* and *b*), correlations (r) and count of common bulls (No.) of the conversion equations for fertility proofs from foreign countries to UK equaivalents.

	UK CI				**UK NR56**				**UK DFS**			
	a	***b***	**r**	**No.**	***a***	***b***	**r**	**No.**	***a***	***b***	**r**	**No.**
IRL CI	0.68	1.11	0.69	68								
US DPR	2.96	-3.12	0.76	108								
NLD FI	0.96	-2.18	0.71	46								
NZL FI	-2.07	-0.34	0.51	42								
DNK FI	3.24	-0.48	0.51	103								
AUS CI	n/a	n/a	0.73	65								
NLD NR56					-0.017	0.010	0.65	46				
FRA FI					-0.036	0.013	0.58	47				
DEU NR					-0.028	0.003	0.39	64				
NLD CFI									1.05	-1.11	0.85	46

Table 2. Numbers of common bulls with fertility and/or longevity proofs (pre-edits) between countries. Countries in italics have not yet officially publish fertility proofs and are based on preliminary fertility runs.

	USA	**UK**	**NLD**	**IRL**	**NZL**	**AUS**	**DNK**	**FRA**	**DEU**
USA									
UK	*900*								
NLD	10,198	*3,252*							
IRL	457	*2,441*	2,785						
NZL	546	*723*	833	548					
AUS	*415*	*428*	*482*	*327*	*660*				
DNK	0	*261*	2,488	627	7	*0*			
FRA	239	*351*	3,615	280	49	*24*	0		
DEU	405	*611*	1,155	783	313	*234*	11	128	