Investigation of interval first to last insemination for dairy cattle in The Netherlands

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Abstract

Interval between first and last insemination (IFL) was investigated as a new fertility trait in The Netherlands. Three IFL traits were defined: IFL with a valid next calving (IFL1), IFL without check for next calving (IFL2) and IFL with extra days added if no valid calving date was present (IFL3). The maximum interval length between first and last insemination was determined as 220 days and number of penalty days for IFL3 was 57 days. Heritabilities were low and ranged from 0.02 to 0.04, with highest heritabilities for IFL3. Genetic correlations between the three IFL traits were very high (> 0.97). Genetic correlations were moderate to high with calving interval (0.7 to 0.9), low to moderate (0.3 to 0.4) with interval calving to first insemination and negative and moderate (-0.5 to –0.6) with Non-Return. IFL3 was the best interval trait as it had the highest heritabilities and strongest genetic correlations with other fertility traits. Including IFL3 in a selection index resulted in higher reliabilities than using IFL2 or IFL1. Records without valid next calving contain valuable information about fertility and should be included in breeding value estimation.

1. Introduction

Currently Interbull analyses five fertility traits for her members. One of the fertility traits is an interval trait, which describes the ability of lactating cows to become pregnant. Interval first to last insemination (IFL) is considered as a trait, which could be used. In the current Dutch/Flemish genetic evaluation fertility traits Non-Return at 56 days (NR), interval calving to first insemination (ICF) and calving interval (CI) are evaluated. The trait IFL could also explain variation in the trait CI, as ICI and NR are doing. Definition of IFL is open to discussion, for example should it only include animals with a next calving or not.

The objective of this study is to select the best IFL trait to be used in the genetic evaluation. Three alternative interval traits are compared based on genetic parameters and selection index results.

2. Material and Methods

2.1 Trait definition

Three IFL traits were analysed:

- IFL1: interval length between first and last insemination, with a valid next calving.
- IFL2: interval length between first and last insemination, with or without valid next calving.
- IFL3: interval length between first and last insemination, with check for a valid next calving. If not present, data are not eliminated, but a number of penalty days is added to the interval length.

The maximum interval length for IFL1 and IFL2 was determined as the interval from first to last insemination that was needed by 99% of the heifers and cows with confirmed calving. The number of penalty days was determined as the interval where 50% of the reinseminations was successful.

The maximum interval length for IFL3 was the maximum interval length for IFL1 and IFL2, increased with penalty days.

2.2 Parameter estimation of fertility traits

For IFL1, IFL2, IFL3 and currently analysed fertility traits NR, ICF, and CI, genetic parameters were estimated using ASReml (Gilmour *et al*., 2006). Parameters were estimated bivariately using the following models:

$$Y1_{ijklm} = HIY_i + IYP_j + S_k + MGS_l + e_{ijklm}$$

$$Y2_{ijklm} = HCY_i + CYP_j + S_k + MGS_l + e_{ijklm}$$

where:

$Y1_{ijklm}$ = Observation for NR
$Y2_{ijklm}$ = Observation for ICF, CI, IFL1, IFL2, IFL3
HIY_i = Herd x insemination year *i*
IYP_j = Insemination year x period *j*. For each year 36 insemination periods were defined of 10 days
HCYi = Herd x calving year *i*
CYPj = Calving year x period *j*
S_k = Sire effect *k*
MGS_l = Maternal grandsire effect *l*
E_{ijklm} = Error term

Sire, maternal grandsire (mgs) and residual are random effects, the other effects are fixed. For the sire and mgs effects pedigree data were included.

2.3 Selection of a new interval trait

There were two criteria to select the interval trait of interest. The first criterion was moment of availability of a trait. The second was reliability of selection, estimated for young and proven bulls for the breeding goals IFL1 and CI.

Breeding values of young bulls were estimated assuming 150 records (offspring) on milk production, with 135 (90%) valid records for IFL2, IFL3, NR and ICF and 120 (80%) for IFL1 and CI. For the proven bulls 1000 records were assumed available, with 800 valid records for IFL1 and CI and 900 for other fertility traits. To estimate reliability of selection, the Selection Index Program (Wageningen Agricultural University, 1995) was used, with genetic parameters per trait as estimated in this report.

2.4 Data

One data set was created to determine the number of penalty days and maximum interval length for IFL traits. In this data set, IFL1 and IFL2 were calculated. Data ranged from September 2001 to August 2008, including insemination records of heifers and cows of at least 7/8 parts Holstein Friesian. Sire and herd had to be known and the animal had to be registered in the herdbook.

Maximum number of lactations was 5. Minimum age at first calving was 640 days. Only artificial insemination data were included. Maximum interval length between calving and first insemination was 250 days. IFL1 and IFL2 were 0 if there was only one insemination, or if reinsemination occurred within four days. IFL1 was missing if next calving date was missing or if number of days between last insemination and next calving was less than 210 or more than 400 days, or if number of days between two inseminations was more than 150.

A second data set with additional restrictions was created to estimate genetic parameters. Records were selected with lactations starting in 2002 and 2003.

Only lactations 1, 2 and 3 were included. First inseminations had to occur within 30 to 250 days after calving, otherwise ICF, NR, IFL1, IFL2 and IFL3 were set to missing. If next calving date was missing or CI was more than 800 days, IFL1 and CI were missing and IFL3 received penalty days.

If CI was between 550 and 800 days, CI was set to 550 days. Gestation length had to range from 265 to 295 days, otherwise IFL1 was missing and IFL3 received penalty days. Only records of sires with at least 25 first lactation (grand)daughters in the data set were included. Minimum number of first lactation records per herd x year class was 20.

3. Results and Discussion

3.1 New interval traits

From the frequency distribution of IFL1 the maximum interval length was determined as 220 days. This value is comparable to international values: 206 days in Canada (Kistemaker, 2009), 230 in Denmark (Sun *et al*., 2009) and smaller than used in Germany: 315 days (Liu *et al*., 2008). The number of penalty days

was 57 days and therefore, for IFL3 the maximum interval length was 277.

3.2 Parameter estimation

Records on 213,329 heifers and cows were selected, with 2,214 sires and maternal grandsires.

Heritabilities for IFL traits were low (0.02-0.04), but they increased in later lactations (Table 1). In general, heritabilities were highest for IFL3 and weakest for IFL1. Heritabilities were comparable to international results. In Canada heritabilities used for IFL1 are 0.03 for first the lactation and 0.07 for later lactations (Kistemaker, 2009). In Denmark a heritability of 0.03 for IFL3 was found (Sun *et al*., 2009). In Germany estimated heritabilities for IFL1 were 0.014 for the first lactation and 0.010 for later lactations (Liu *et al*., 2008).

Genetic correlations between IFL traits within lactations were very high (0.98 to 1.0). Across lactations, genetic correlations were still high.

Genetic correlations with IFL traits were strong for CI (0.73 to 0.87) (Table 2), with strongest correlations with IFL3 and the weakest with IFL1. The correlations with CI increased slightly in later lactations.

Genetic correlations of NR with IFL traits were moderate and negative (-0.52 to -0.63), with strongest correlations with IFL1 and the weakest with IFL3.

Table 2. Genetic correlations within lactations of IFL traits with ICF, CI and NR estimated with bivariate analysis.

Par.	Trait	ICF	CI	NR
1	IFL1	0.322	0.726	-0.600
	IFL2	0.359	0.783	-0.524
	IFL3	0.358	0.795	-0.518
2	IFL1	0.302	0.741	-0.630
	IFL2	0.343	0.798	-0.577
	IFL3	0.396	0.841	-0.519
3	IFL1	0.434	0.790	-0.575
	IFL2	0.414	0.826	-0.532
	IFL3	0.440	0.870	-0.517

Genetic correlations of ICF with IFL traits were low to moderate (0.30 to 0.44), with strongest correlations with IFL3 and weakest with IFL1. There was a slight increase in later lactations.

3.3 Selection of a new interval trait

Due to the higher heritability and higher number of valid records, reliabilities for breeding goals IFL1 and CI were higher if IFL3 was included compared to including IFL2 or IFL1 (Table 3). Compared to the current selection index with CI and NR, the combination of IFL3 with ICF resulted in higher reliabilities. For breeding goal IFL1 these reliabilities were slightly increased by adding NR to the index. In conclusion, of the three interval traits IFL3 was the best index trait. Compared to IFL1, IFL3 also has the advantage that data are available sooner.

Table 1. Genetic correlations (off-diagonal) and heritabilities (diagonal) of IFL traits, estimated with bivariate analysis. Standard errors varied between 0.003 (h^2) and 0.05 (correlations lactation 1 and 3).

Lact.		1			2			3		
	Trait	IFL1	IFL2	IFL3	IFL1	IFL2	IFL3	IFL1	IFL2	IFL3
1	IFL1	0.024	0.999	0.999	0.959			0.823		
	IFL2		0.028	0.985		0.952			0.848	
	IFL3			0.031			0.963			0.880
2	IFL1				0.029	0.999	0.999	0.989		
	IFL2					0.035	0.981		0.972	
	IFL3						0.039			0.978
3	IFL1							0.034	0.999	0.999
	IFL2								0.040	0.980
	IFL3									0.045

Table 3. Reliability estimates from index calculations for young and proven bulls for breeding goals IFL1 and CI.

Breeding goal: IFL1		
Index Trait	R^2 Young bulls	R^2 proven bulls
IFL1	0.420	0.828
IFL2	0.481	0.828
IFL3	0.521	0.843
IFL1+ICF	0.444	0.831
IFL2+ICF	0.485	0.828
IFL3+ICF	0.525	0.843
IFL1+ICF+NR	0.515	0.856
IFL2+ICF+NR	0.549	0.859
IFL3+ICF+NR	0.579	0.865
ICF+NR	0.249	0.529
CI+NR	0.478	0.739
Breeding goal: CI		
IFL1	0.223	0.438
IFL2	0.299	0.525
IFL3	0.335	0.552
IFL1+ICF	0.669	0.902
IFL2+ICF	0.702	0.924
IFL3+ICF	0.725	0.940
IFL1+ICF+NR	0.678	0.908
IFL2+ICF+NR	0.708	0.929
IFL3+ICF+NR	0.729	0.942
ICF+NR	0.580	0.815
CI+NR	0.678	0.933

4. Conclusions

- Genetic correlations within and across lactations between IFL traits were very strong.
- Heritabilities for IFL3 were higher than for IFL2 and IFL1.
- Genetic correlations with CI or ICF were strongest with IFL3.
- Genetic correlations with NR were strongest for IFL1.
- IFL3 was a better index trait than IFL2 or IFL1.
- Compared to IFL1, data on IFL3 are available sooner.
- IFL3 is the best trait to use for interval first to last insemination. This means that records without valid next calving contain valuable information about fertility and should be included in breeding value estimation.

5. References

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