Development of a New Evaluation for Sire and Cow Fertility

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Abstract

Genetic evaluation of Holstein dairy cows, heifers and bulls for Non-Return-90 (NR90) is carried out in Germany since the mid-eighties. NR reflects only one aspect of fertility. Additional time traits are necessary. There are indications that NR in heifers and in cows are genetically different traits. Therefore a multitrait model for genetic evaluation of fertility is described. The four traits included in the model are NR and age at 1st service in heifers and NR and interval from calving to 1st service in cows. The necessity of a permanent environmental effect of the service sire that varies over time is identified. Advantages of this effect are that firstly there is a more accurate correction for service sire in the model and secondly it is possible to estimate a current ability of the service sire to fertilise a cow. The latter may be of interest for AI-stations. First results of data analyses are shown and possible additional checks based on herd-year averages and linkage of fertility data with calving data are discussed.

1. Introduction

Genetic evaluation for non-return 90 days after 1st service (NR90) of Holstein dairy cows, heifers and bulls is carried out in Germany since the mid-eighties. But, what is fertility of dairy cows? The best measurable trait that describes the whole complex is the calving interval. Condition for a short calving interval is a timely start of the first cycle, with an accurate observation of heat and subsequently a high conception rate after insemination. Both the start of the first cycle and the insemination success are influenced by many different factors, e.g., health or energy balance. Data for some traits that are closely related to these influence factors is available: urea, fat and protein concentrates in the milk, and BCS (De Jong, 2005). Though calving interval is available it appears to be more sensible to choose its components as evaluation traits. Heifers do not have a calving interval and the calving interval of culled cows is not observed. Thus correct consideration of these animals in an evaluation model for calving interval is not guaranteed.

Calving interval is put together by interval from calving to 1st service, NR, and gestation length. The traits calving to 1st service and NR offer up-to-date data for genetic evaluation. Thus animals without a completed calving interval or even without a NR observation at data cut-off can be considered in the evaluation model.

Regarding an international harmonisation, the German evaluation is developed to include a time trait additionally to NR. There are several indications of fertility in growing, non-lactating animals (heifers) genetically to be at least partially different to fertility of cows. The time trait will be age at 1st service (earliness of maturity) for heifers and interval from calving to 1st service for cows.

2. Material and Methods

2.1. Data

Data originates from the central VIT data base with all reported inseminations and natural services on cows and heifers in herds with milk recording (VIT, 2005). The services are reported either by the AI-stations themselves or by milk recording or herd book organisations on behalf of the AI-stations. The records in the VIT database contain cow ID, insemination or service date, ID of service sire, and inseminator. Embryo transfer is also recognized. Additional information about recent inseminations is available such as semen supplier, batch number, whether semen was frozen before use. The availability of the additional information differs among regions. Therefore, the additional information cannot yet be considered in an evaluation model.

For genetic evaluation these data are completed with pedigree information, calving dates and lactation number. Fertility data of all females of the breeds Holstein, Red-Holstein, Angler and Jersey and of crosses among these breeds are used for genetic evaluation. There is no constraint on the breed of the service sire. Artificial inseminations and natural services are included in the genetic evaluation.

Additional data checks are tested, especially related to the completeness of the reported services. Gestation length can be computed when there is a calving following on a NR event. Data changes must be made when the gestation length is not in the interval accepted in milk recording. Too short gestation lengths lead to an exclusion of the record from the evaluation. Gestation lengths above the upper limit, but below the upper limit + 56 or 90 lead to NR56 / NR90 being changed from 1 to 0. See also figure 1.

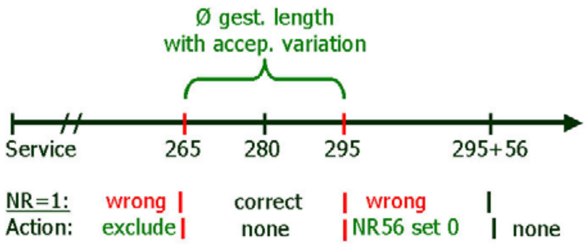

Figure 1. Changes on NR56=1 when subsequent calving date is known depending on estimated gestation length.

A check on completeness of insemination reports by the herds is to be carried out before parameter estimation. This check is a single side t-test of NR in a particular herd year being equal to population NR. The acceptable upper limit of NR for herd year i is defined as:

$$\text{Limit} = p + t_{\infty,prob} * \sqrt{(p*q / n_i)}$$

with:

p:	proportion NR in the population
q:	1-p
prob:	probability of a larger value
n_i:	no. observations in herd-year i

Application of this simple test for genetic evaluation may lead to a too-high amount of data losses in some regions. Different average NRR (p) of subgroups may be necessary. Sub-populations may be regions, AI by farmers, or herds with natural services.

2.2. Model

The genetic evaluation will be set up as a multitrait repeatability animal model for heifers and cows. Time traits in the model are age at 1st service for heifers and no. days from calving to 1st service. NR of cows and heifers will be separate traits, for which paternal and maternal breeding values will be estimated. Fixed environmental effects will remain to be the same as in the current model (VIT, 2006).

The relevance of the paternal breeding value for NR is disputable. Firstly, paternal genetic effects are not considered in the genetic evaluation of cow NR in some countries because the influence of these on the maternal effects was considered to be negligible. Secondly the current fertilisation potential of the semen is much more important to the AI-stations than a paternal breeding value of the service sire, because a paternal breeding value only gives information about the inheritance of paternal NR to the sons of a sire.

The authors think that the effect of the fertility of the semen used to service the cow is important. This effect is a combination of the following two effects:

1. the genetic effect of the service sire,
2. a permanent environmental effect of the service sire that may vary over time periods.

The ideal way to consider the second effect would be through the interaction of batch number or semen production date with insemination date. Semen production date is not reported and batch number is only available in recent data. This means that batch number first can be considered on a longer term.

Until then, a time dependent permanent environmental sire effect will be considered in the estimation model for NR by including an additional effect service sire * time period in the model for NR. All inseminations for first crop progeny will classified into one (the first) time period of a bull. Inseminations for second crop progeny will be divided over years. Correlations among environmental effects will make it possible to consider inseminations in past periods for the estimation of later time periods.

The sum of the time dependent environmental effect and the paternal proof describes the fertilising potential of the bull at the time of service. This combined estimate may be of special interest for AI-stations and breeders as well.

Estimation of variance components, genetic and non-genetic parameters will be necessary because additional traits will be evaluated and additional genetic and environmental effects (permanent and non-permanent) will be considered.

The non-return trait may be NR56 instead of NR90 to get an internationally more harmonised trait (Jorjani, 2005). But all our investigations indicate that NR90 gives more reliable information for real conception rate.

2.3. Inclusion of auxiliary traits ?

The heritability of fertility traits is generally low, therefore it will be tested which additional prediction traits can be used to increase the reliability of the proofs. Prediction traits may be milk urea concentration and body condition score to describe health and energy balance of the cow at insemination time. Body condition score is scored together with type traits throughout Germany since July 2004. Urea concentration data are collected routinely by milk recording and used for feeding recommendations. First analyses on German data into the relationship of fertility with protein and urea concentration were carried out by Rensing *et al.* (2005). They found urea concentration to be a moderate heritable trait (h2=0.10 to 0.12 on test-day basis). Protein and urea concentration also had significant effects on NR56.

3. Results of data analyses

The data from 1995 onwards for the analysis consisted of ca. 51 million services of which ca. 27 million were first services. Nearly 5 million services are added to the data base per year. Averages for the relevant traits in the raw data are shown in table 1; table 2 shows the averages per lactation.

Table 1. Means and standard deviations in the raw data.

Trait	unit	N	Mean	SD
Age at 1st service	months	7,647,747	19.5	4.4
Interval calving-1st service	days	19,024,158	91.3	60.8
Non-return 56	%	26,871,123	66.0	21.8
Non-return 90	%	26,871,123	59.0	24.2

Table 2. Means in raw data for heifers and cows in 1st, 2nd, and 3rd lactation.

Trait	unit	Heifers	1st lactation	2nd lactation	3rd lactation
N		7,647,747	6,603,980	4,908,525	3,294,087
Age at 1st service / Int. calv. – 1st serv.	months /days	19.5	93.9	89.5	89.7
NR56	%	75.5	63.3	62.3	61.7
NR90	%	70.6	55.3	54.4	53.9

The services divide themselves up in 75.3% AI with proven bulls, 19,5% AI with test bulls, and 5.2% natural services. Traditionally German AI-stations allowed 1st lactation cows only to be inseminated with test bull semen. The percentage of test bull inseminations on 1st lactation cows over Germany is still approx.. 80%, but with large differences among regions. In a crude analysis, Non-return rates of inseminations with test bulls in the raw data were equal from those of inseminations with proven bulls except in lactation one, where non-return rate for test-bulls were 3.7% lower with a 14 days shorter interval calving to 1st service (94 vs. 108 days). In lactations 2 and 3 the interval calving to 1st service was 6 and 10 days longer respectively when the 1st insemination was carried out with a test bull. The observed difference in NR56 is in contrary to expectations that proven bull semen may be less fertile due to maximum dilution.

4. Publication of proofs and use in indices

The current reproduction index composed of proofs for calving traits (calving ease / stillbirth rate) and fertility (NR90) will be replaced by a calving index and a fertility index. The separate fertility index with calving interval as a breeding goal may be constituted by the proofs for NR and age at 1st service in heifers and NR and interval calving to 1st service in cows. Weights for the single breeding values will be derived later.

It is disputed, whether the resulting paternal EBV for NR will be published. The AI-stations demand a comparable value for the current ability of a bull to fertilise a cow. It will be attempted to derive such a value from the paternal EBV and the yearly environmental effects of the bull. This is an internationally new development. So far only paternal EBV or phenotypic non-return rates were available.

5. Outlook

After completion of parameter estimation a first parallel test run of the new national evaluation method is scheduled for August 2006. The earliest possible start of routine evaluation is for publication in February 2007. The frequency of evaluation will be increased after introduction of the new evaluation. This is also necessary because of the expected higher future weights of reproduction traits in the total merit index.

The further development of the fertility evaluation is a large project that reflects the increasing importance of fertility. The evaluation will also deliver management information for herds and AI-stations beside the proofs. The amount and quality of the data allows the use of detailed models from which maximum benefit for practice can be obtained.

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