J. Dairy Sci. 98:1–12
http://dx.doi.org/10.3168/jds.2014-8924

Genetic parameters of ovarian and uterine reproductive traits in dairy cows

T. R. Carthy,*† D. P. Ryan,‡ A. M. Fitzgerald,* R. D. Evans,§ and D. P. Berry*[1]
*Animal & Grassland Research and Innovation Centre, Teagasc, Moorepark, Co. Cork, Ireland
†School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
‡Reprodoc Ltd., Fermoy, Co. Cork, Ireland
§Irish Cattle Breeding Federation, Bandon, Co. Cork, Ireland

ABSTRACT

The objective of the study was to estimate genetic parameters of detailed reproductive traits derived from ultrasound examination of the reproductive tract as well as their genetic correlations with traditional reproductive traits. A total of 226,141 calving and insemination records as well as 74,134 ultrasound records from Irish dairy cows were used. Traditional reproductive traits included postpartum interval to first service, conception, and next calving, as well as the interval from first to last service; number of inseminations, pregnancy rate to first service, pregnant within 42 d of the herd breeding season, and submission in the first 21 d of the herd breeding season were also available. Detailed reproductive traits included resumed cyclicity at the time of ultrasound examination, incidence of multiple ovulations, incidence of early postpartum ovulation, heat detection, ovarian cystic structures, embryo loss, and uterine score; the latter was a subjectively assessed on a scale of 1 (little fluid with normal uterine tone) to 4 (large quantity of fluid with a flaccid uterine tone). Variance (and covariance) components were estimated using repeatability animal linear mixed models. Heritability for all reproductive traits were generally low (0.001–0.05), with the exception of traits related to cyclicity postpartum, regardless if defined traditionally (0.07; calving to first service) or from ultrasound examination [resumed cyclicity at the time of examination (0.07) or early postpartum ovulation (0.10)]. The genetic correlations among the detailed reproductive traits were generally favorable. The exception was the genetic correlation (0.29) between resumed cyclicity and uterine score; superior genetic merit for cyclicity postpartum was associated with inferior uterine score. Superior genetic merit for most traditional reproductive traits was associated with superior genetic merit for resumed cyclicity (genetic correlations ranged from −0.59 to −0.36 and from 0.56 to 0.70) and uterine score (genetic correlations ranged from −0.47 to 0.32 and from 0.25 to 0.52). Genetic predisposition to an increased incidence of embryo loss was associated with both an inferior uterine score (0.24) and inferior genetic merit for traditional reproductive traits (genetic correlations ranged from −0.52 to −0.42 and from 0.33 to 0.80). The results from the present study indicate that selection based on traditional reproductive traits, such as calving interval or days open, resulted in improved genetic merit of all the detailed reproductive traits evaluated in this study. Additionally, greater accuracy of selection for calving interval is expected for a relatively small progeny group size when detailed reproductive traits are included in a multitrait genetic evaluation.

Key words: fertility, genetic correlation, ultrasound, detailed reproductive trait

INTRODUCTION

Traditional measures of reproductive performance recorded by producers are routinely available and are now included in many national dairy breeding goals (Miglior et al., 2005). Traditional reproductive traits such as calving interval (**CI**), days open (**DO**), and pregnancy rate to first service (**PRFS**) are, however, generally not very heritable (<0.05; Berry et al., 2014). The observed low heritability delays the achievement of high accuracy of selection and, thus, genetic gain for reproductive traits (Berry et al., 2014).

Decomposing aggregate reproductive phenotypes into their detailed components, which are potentially less influenced by management, could prove to be more heritable and, assuming sufficient genetic variation exists, genetic gain for reproductive performance could be accelerated. For example, CI is composed of several detailed reproductive components, such as the postpartum interval to commencement of estrus cyclicity, expression of estrus, conception, maintenance of pregnancy, and gestation length. Therefore, a cow with a long calving to first service interval (**CFS**) but a good pregnancy rate may have a similar phenotypic value for CI to a cow with a short CFS but poor pregnancy rate.

Received October 1, 2014.
Accepted February 23, 2015.
[1]Corresponding author: Donagh.Berry@teagasc.ie

These are profoundly distinct cows, yet have the same phenotypic value, and potentially the same estimated breeding value for CI if estimated in a univariate genetic evaluation model.

Detailed reproductive traits, such as postpartum commencement of luteal activity measured by progesterone levels, are both phenotypically and genetically correlated with traditional reproductive traits (Darwash et al., 1997; Royal et al., 2002b; Berry et al., 2012). Furthermore, postpartum interval to the commencement of luteal activity is generally more heritable than traditional reproductive traits (Berry et al., 2014). This indicates that detailed reproductive traits may be less exposed to unrecorded management decisions (e.g., voluntary waiting periods), and thus a more pertinent assessment of the underlying reproductive performance of the cow.

The objective of the present study was to estimate genetic parameters for detailed reproductive traits derived from ultrasound examination of the reproductive tract in a large population of commercial dairy cows and to estimate the genetic correlations between these detailed reproductive traits and traditional reproductive traits. Results from our study will be useful in quantifying the genetic variation present in these detailed reproductive traits, but also their usefulness as part of a strategy to improve the accuracy and relevance of genetic evaluations for reproductive performance. Moreover, the results will be useful in elucidating the effect of current breeding strategies for traditional reproductive traits on the underlying detailed components of reproductive success.

MATERIALS AND METHODS

Data

Data from the Irish Cattle Breeding Federation database (http://www.icbf.com) were available on 5,872,465 calving events from 2,218,544 dairy cows from 19,637 herds, as well as 4,299,285 insemination records from 1,255,632 dairy cows from 13,502 herds, between the years 2008 and 2013. Data were also available on 194,880 ultrasound records from 114,306 lactations on 72,120 dairy cows in 894 herds over the same period. Supplementary data on animal pedigree, breed composition, and cow parity were also available. Dairy breeds included Holstein-Friesian, Jersey, Montbeliarde, and Norwegian Red.

Traditional Reproductive Traits. Eight traditional reproductive traits were generated: (1) CI, (2) CFS, (3) DO, (4) number of inseminations (**NI**), (5) PRFS, (6) interval from first service to conception (**IFC**), (7) pregnant within 42 d of the herd breeding season (**PR42**), and (8) submission in the first 21 d of the herd breeding season (**SR21**). Calving interval was defined as the number of days between 2 consecutive calving events. Calving interval records were limited to be between 300 and 600 d; if an insemination occurred within 150 d postpartum, CI was then restricted to between 300 and 800 d. Calving to first service interval was defined as the number of days between calving and first insemination; only CFS records between 10 and 250 d were retained.

The approximate date of conception was determined as 283 d (i.e., average gestation length of different dairy breeds; Norman et al., 2009) before the subsequent calving date; where no subsequent calving date was available, date of conception was based on the reported gestational age of embryo or fetus at pregnancy diagnosis during ultrasound examination. The actual date of conception used in the present study was the last service date for that lactation, which was within ±15 d of the estimated conception date previously described. If no corresponding insemination date was found within these margins, then conception date was set to missing. Days open was defined as the number of days between calving and conception; DO was limited to between 10 and 350 d. Similarly, IFC was defined as the number of days between first service and the estimated date of conception, as described above.

Ireland operates a seasonal calving (and breeding) production system (Berry et al., 2013). The start of a herd's calving season in the present study was defined as the date when at least 5 cows within a herd calved within the subsequent 14-d period (Berry et al., 2013). A herd calving season was terminated on the date the last cow calved with no calving occurring in the subsequent 21 d. Similarly, a herd's breeding season was initiated by the date when at least 5 cows were served within the subsequent 14-d period and terminated by the last date a service occurred with no subsequent service occurring in the following 21 d. Only data from calving seasons and breeding seasons between 35 and 100 d in length were retained.

The binary trait, SR21, was defined as whether a cow was inseminated in the first 21 d of the breeding season (SR21 = 1) or not (SR21 = 0); if a cow was submitted for insemination before the start of the breeding season, SR21 was set to missing. Number of services was defined as the number of inseminations within a lactation; number of services >10 were set to 10. The binary trait, PR42, was defined as whether conception occurred (PR42 = 1) or not (PR42 = 0) in the first 42 d of the herd's breeding season; date of conception (previously described) was used in the calculation of PR42. If an insemination occurred or a cow was diagnosed as not pregnant after d 42 of the breeding season, failure