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Days to calving in artificially inseminated cattle: Alternative models and analyses

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Abstract

Investigations by Robinson [Robinson, D.L., 2007. Days to calving in artificially inseminated cattle: comparison of potential traits. Livestock Science 110, 174–180] concluded that the most useful trait for assessing fertility of artificially inseminated (AI) beef cows is AI days to calving (AIDC), a trait that mimics days to calving for naturally mated cows. Various fixed and random effects were fitted to AIDC to determine the best way of modelling lactation status of the cow, the effect of service sire, using smaller contemporary groups and lowering the penalty value for non-calvers. Fitting the time interval between calving and the start of mating either as a 10-level factor or a cubic spline function explained considerably more variation than fitting the standard 2-level factor (wet or dry). Estimated permanent environmental effects of the cow were considerably reduced. This suggests that, if a cow calves late in the season (less than 60 days before she is inseminated), her fertility is reduced. Models should therefore account for this effect. If fitted, service sire explained 1.6% of phenotypic variation, compared to a much larger sire × contemporary group interaction (3% of phenotypic variation). It is therefore important to account for sire × contemporary group interactions. When the fertility of service sires is not being evaluated, service sires could be incorporated into the definition of contemporary groups. Ideally, breeders should be encouraged to formally record contemporary (or mating) groups. Reducing the size of contemporary groups (inferred from the data) by limiting the time interval between first and last inseminations from 120 to 60 days had only a marginal effect as did reducing the penalty for non-calvers from 21 to 10 days.

Keywords: Beef cattle; Female fertility; Artificial insemination; Days to calving; Calving interval; AIDC

1. Introduction

Fertility of beef cows is an important aspect of profitable beef production (Ponzoni, 1992; Phocas et al., 1998). In Australia, days to calving (**DC**) became the standard trait for genetic evaluation of naturally mated cows, following investigations by Meyer et al. (1990, 1991) and Johnston and Bunter (1996). Many breeders are now using artificial insemination (**AI**) to access the best available genetics, so a female fertility trait is also required for cows mated by AI. Investigations by Robinson (2007) concluded that the most useful trait was AI days to calving (**AIDC**). AIDC is calculated in an almost identical way to naturally mated days to calving, by defining the 'start date' as the day when the first insemination of the mating

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group (also referred to as the contemporary or management group) took place, mimicking the date of joining for naturally mated cows. For cows that calved, AIDC is defined as the number of days from the 'start date' to calving. For non-calvers, AIDC is the maximum of all cows in the contemporary group that calved, plus a penalty of 21 days.

Robinson (2007) showed that AIDC had a similar frequency distribution and heritability to days to calving in naturally mated cows. Unlike naturally mated days to calving, where all cows in the mating group necessarily have the same service sire(s), different service sires can be used within a group of cows mated by AI. The aim of this study was to investigate whether AIDC can be improved by fitting service sire as a random, cross-classified factor, by reducing contemporary group size, reducing the penalty value for non-calvers, or by more sophisticated modelling of fixed effects such as lactation status.

A recent study reported a relatively high heritability (10.6%) of calving interval (**CI**) and a high estimated genetic correlation (1.0) of CI with days open (**DO**; estimated h^2 of DO = 13.5%, Goyache et al., 2005). A secondary aim was therefore to investigate the potential of these traits in Australian AI data.

2. Materials and methods

2.1. Data

As described by Robinson (2007), mating records were obtained from seedstock herds participating in the Australian Angus BREEDPLAN genetic evaluation system (Graser et al., 2005). Entries in the total female inventory system were merged into one record per cow per season, comprising AI sire identifier, date of initial AI, age of the cow at AI, number of days from the birth of any previous calf to the date of initial AI and, if the cow calved (either from the initial or subsequent AIs that season, or to a backup bull) number of days from initial AI to calving, sex and sire of the calf, and whether a single or multiple birth. There were 88,185 records from inseminations in 1983–2001 in 643 herds and 4338 AI sires. To create a consistent, convenient dataset for analysis, 1543 twin/multiple birth records were deleted, as were records for cows artificially inseminated within 14 days of giving birth (104 records), cows over 10 years old at AI (3453), cows aged over 3.5 years at AI but no record of a previous calf (1343), mature cows with no record of a calf in the 1000 days before their AI (97), cows from herds with pregnancy rates of more than 90% to the AI sire (263 herds with 27,073 records, where the inventory system may have failed to include the entire breeding population) and cows from herds with less than 200 AI records (15,559 records from 303 herds). This left a total of 39,013 records from 21,546 cows mated to 717 AI service sires and with 34,126 animals in the cows' pedigree file. Over the same time period, the same herds had a total of 50,709 naturally mated days to calving (**NMDC**) records, which were used in bivariate analyses of AI and naturally mated data.

2.2. Contemporary groups

As described by Robinson (2007), contemporary groups were inferred from the pattern of inseminations for each AI-sire and maturity class (maiden heifer < 1.9 years at AI, or older cow) within each herd. Mating is usually seasonal (most often annually, but sometimes twice yearly), so records were split into seasons whenever gaps of more than 50 days with no inseminations were encountered. Long seasons, whose 'season_span' (the interval between the first and last insemination) exceeded a pre-defined maximum (max_span = 120 days) were further split ('sliced') into contemporary groups. The number of slices, Nslice, was calculated as (1 + int(season_span/max_span)), then the season split into Nslice contemporary groups, each covering season_span/Nslice days. Cows in groups of size 1 ($N = 1758$) are uninformative, so were excluded from the analysis, leaving a total of 4316 contemporary groups (**cgp120**).

To determine the effect of using smaller contemporary groups, a second set of contemporary groups (**cpg60**) was defined as above, but with max_span of 60 days. This produced a total of 4504 contemporary groups with more than 1 record, and 1899 uninformative groups containing only a single record.

To determine whether there was any benefit from fitting service sire and contemporary groups as cross-classified random effects, the process of defining contemporary groups was also carried out within each herd, year and heifer/cow classification, but ignoring service sire. This resulted in a third set of contemporary groups (**cgpxs**). After excluding 195 records corresponding to groups of size 1, cgpxs had 1335 levels (for max_span = 120; 286 uninformative records and 1549 levels for max_span = 60).

2.3. Definition of traits

The 'start date' for a contemporary group was defined as the date the first cow in the group was inseminated. For cows that calved, AIDC was the number of days from the 'start date' to the day of calving. For non-calvers, it was the maximum for all cows in the group that calved plus a penalty of 21 days. A reduced penalty of 10 days was also considered. AIDC mimics days to calving in a naturally mated herd, assuming contemporary groups are the basic management unit and that, after detecting heat and inseminating the first cow in the group, other cows will be monitored and inseminated when ready. For the 145 cows still pregnant from the previous season, the 'start date' was taken as the date of calving (Johnston and Bunter, 1996).

To explore how individual terms in the models relate to different components of the trait, a second trait, **AIDIC**, the number of days from *first insemination* to calving (or, for non-calvers, the maximum of the contemporary group plus a penalty) was also analysed.

Finally calving interval (CI) was investigated a possible alternative trait. Many herds used backup bulls, so the related