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Original Research Paper

Associations between management practices and major reproductive parameters of Holstein-Friesian replacement heifers

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ABSTRACT

The aim of this study was to assess the relationship between the reproductive management practices and the performance of replacement heifers on large commercial dairy farms. The individual data of 14,763 heifers, first inseminated in 2014, were analysed from 33 Holstein-Friesian dairy herds in Hungary. The relationships between management practices and major reproductive parameters (age at first service, AFS; age at first calving, AFC; conception risk to first insemination, CR1; and pregnancy status at 20 months of age) were examined by mixed-effects models, with the herd as the random effect. The results showed that farms using oestrus detection aids experienced reduced AFS ($p < 0.001$) and AFC ($p = 0.001$). Observation of oestrus for shorter periods instead of continuously showed a tendency towards lower AFC ($p = 0.057$) and was associated with higher odds of pregnancy at 20 months of age ($p = 0.020$). Heifers on farms using sexed semen had younger AFS, but poorer CR1, compared to those using conventional semen exclusively ($p < 0.05$). In addition, the odds of heifers being pregnant by 20 months of age was higher on farms with more experience using sexed semen ($p = 0.020$). Frequent pregnancy diagnosis (i.e. more than once per week) was associated with younger AFC ($p = 0.023$). Our results suggest the use of certain advanced reproductive management practices for heifer reproductive management in large dairy herds (e.g. oestrus detection aids), which can improve reproductive efficiency considerably, but are currently used only to a limited extent.

1. Introduction

Raising replacement heifers is the second largest expense for a dairy farm, representing 20% of the total operational costs (Heinrichs, 1993). Each day older at first calving increases the total cost of rearing a heifer by £2.87 (Boulton et al., 2017). Consequently, improvements in the reproductive performance of replacement heifers can potentially yield remarkable economic benefits. Many studies related to heifer reproduction have focused on the relationship between growth rate (expressed as average daily gain), body weight at insemination and reproductive performance (Chebel et al., 2007; Cooke et al., 2013). Age at first service (AFS) is a function of management decision; however, nutrition and growth rate during rearing have a large influence as well. Poorly growing heifers need more services to conceive, and they will subsequently have higher age at first calving (AFC); moreover, their performance as cows will be inferior than their better-growing counterparts (Wathes et al., 2008). Heinrichs (1993) suggested that the economically optimal AFC is 23–24 months.

As average herd size increases, more widespread adoption of oestrus detection aids is expected (Diskin and Sreenan, 2000). In a

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survey of Canadian dairy herds, 27% of farmers who used activity monitoring devices applied this technique in heifers, and the most common reason for adopting an activity monitoring system was the desire to improve reproductive performance (Neves and LeBlanc, 2015). Reproductive ultrasonography allows for earlier nonpregnancy diagnosis compared to rectal palpation; therefore, both breeding intervals and the time to conception can be shortened (Romano et al., 2006). In a study of 1079 cows and 321 heifers, sensitivity and negative predictive value peaked 3 days earlier (26 vs. 29 days post-AI) in heifers than in cows, which suggests that this technique may be effective in improving reproductive results in heifers as well (Romano et al., 2006).

The aim of our study was to assess the associations between management practices and the major reproductive indices (AFS; AFC; first-service conception risk, CR1; and pregnancy status at 20 months of age) in dairy heifers on large commercial dairy farms.

2. Materials and methods

2.1. Data collection

A survey was conducted between May and November 2015 in 34 large Holstein-Friesian dairy herds in Hungary. The following inclusion criteria were set up for the herds: (1) use of computerized on-farm records, (2) continuous participation in milk recording dated from at least January 1, 2011, (3) herd size above 250 cows and (4) willingness to provide data to the authors. At least two dairy herds were surveyed from each of the seven regions of Hungary. Farm managers and veterinarians of each herd were personally interviewed about the management practices applied to heifers in 2014. The interviews were conducted by the same person (one of the authors) and took approximately 1 h. Thirteen general and reproductive management practices were analysed; these were assumed to be the most significant from a reproductive perspective based on the expertise of the authors. Individual heifer data from the participating farms were gathered from Livestock Performance Testing Ltd. (Gödöllő, Hungary). Herd, animal ID, date of birth, date of inseminations, number of inseminations, results of pregnancy diagnoses, date of first calving and culling date were collected. Data of heifers first inseminated between January 1, 2014, and December 31, 2014, were analysed retrospectively. The original dataset consisted of inseminated heifers only. One farm had only 12 complete heifer records, and therefore was excluded from the study. Heifers with a gestation length outside of the 265-290-day range were excluded from the analyses. After data editing, a total of 14,763 heifers from 33 farms remained in the dataset. Data were edited in MS Excel (Microsoft Corporation, Redmond, WA, USA).

2.2. The analysed management practices and reproductive parameters

Dairy heifers are inseminated all year round in Hungary, usually through artificial insemination. The decision to breed is usually based on a combination of body weight, withers height and age. Heifers are generally inseminated either at the observed oestrus, at the signals of oestrus detection aids or when tail chalk is rubbed off; hormonal synchronization is not typical in heifers. The management practices involved in the analyses are shown in Table 1.

The following reproductive indices were evaluated: age at first service, age at first calving, conception risk to first insemination and pregnancy status at 20 months of age. When calculating the probability of pregnancy at 20 months of age, heifers already culled by this age were excluded.

2.3. Statistical analysis

The relationships between the continuous variables (i.e. AFS, AFC) and the management practices were examined by linear mixed effects models using the lme4 package in R software (Bates et al., 2015). The continuous dependent variables were Box-Cox transformed to eliminate skewness of the data (Box and Cox, 1964). The relationships between dichotomous dependent variables (i.e. CR1, pregnancy status at 20 months of age) and reproductive management practices were analysed by logistic regression, including mixed effects using the lme4 package in R software (Bates et al., 2015). Univariate analyses were performed, and in each mixed model a management practice was included as a fixed effect, whereas herd was chosen as a random effect. When three options were examined within a given management practice, pairwise comparisons of the options were performed by Tukey's post-hoc test using the glht procedure from the multcomp package in R (Hothorn et al., 2008). The statistical analyses were performed in R version 3. 3. 2. (R Core Team, 2016). The level of significance was set to 0.05.

3. Results

Mean (± SD) herd size of the participating farms was 702 ± 359 cows, with a 305-day milk yield of 9993 ± 972 kg on average. The mean (± SD) number of heifers first inseminated in 2014 was 447 ± 293. Altogether, 14,763 heifers were inseminated during the study period, and these were included in the analyses of AFS and CR1. First calving was achieved by 13,818 heifers, and these were included in the analysis of AFC. These heifers represented replacement animals that conceived and did not have any problems during pregnancy that would lead to death or culling prior to first calving. Few inseminated heifers were culled or died before 20 months of age; therefore, pregnancy status at 20 months of age was assessed in 14,608 heifers. Each farm raised its own replacement heifers.

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