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Extended lactation in high-yielding Holstein cows: Characterization of milk yield and risk factors for lactations > 450 days

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ABSTRACT

Two data files consisting of 3278 (one herd) and 4393 lactations (three herds) were used to characterize milk production of high-yielding Holstein cows milked three times per day and experiencing extended lactations (up to 1399 days) in a hot environment. Additional objectives were to identify risk factors for the occurrence of extended lactations, to assess the association between lactation length and milk yield and to determine the conception rates of cows with extended lactations and with multiple services. Thirty percent of lactations were between 450 and 1399 days. Lactation yield of cows with lactations > 900 days was over 30,000 kg. Average daily milk yield from 305 to > 450 days in milk was 29.9 and 31.9 kg for primiparous and multiparous cows, respectively. The epidemiological analysis of risk factors for extended lactations using a multiple variable logistic regression indicated that ketosis (OR = 1.4), peak milk yield (< 50 vs > 50 kg d^{-1}, OR = 1.4), temperature-humidity index at 60 days postpartum (< 82 vs > 82 units, OR = 1.4), retained placenta (odds ratio (OR) = 1.5), 305-d milk yield (< 11,000 vs > 11,000 kg, OR = 1.6) and the occurrence of metritis (OR = 1.8), significantly increased the risk for lactations > 450 days. Primiparous cows had less than half the risk of extended lactations (OR = 0.3) compared to multiparous cows. Conception rate in cows with extended lactations decreased as number of services increased (conception rate = 50.5% for 4 services and 13% for ≥ 14 services). The data showed that well-managed Holstein cows milked three times daily were capable of lactating for over 1200 days with remarkably high persistency and with high milk yield at drying-off. Reproductive and metabolic disorders associated with calving were important risk factors for extended lactations.

1. Introduction

In intensive dairy operations, a general practice is to get cows pregnant before 120 days in milk, with the aim of having a calving interval of 12–13 months, which is considered optimum in terms of profitability (De Vries, 2006). This calving interval is very hard to attain with high-yielding Holstein cows in hot environments because heat stress severely depresses fertility (García-Ispierto et al., 2007). Pregnancy rates for Holstein cows in hot zones of northern Mexico are around 33% (Mellado et al., 2012a, 2014). Heat stress in cows in this environment is exacerbated by three times milking, intense solar radiation input, elevated ambient temperature, poor night cooling and minor air movement.

The low reproductive rate caused by the intense heat load leads to a high culling rates (García-Ispierto et al., 2007) and premature replacement of cows (Hadley et al., 2006). This increased risk of culling imposes a hidden cost, which is not always obvious to the farmer because involuntary cullings are associated with replacement costs, and hence include costs of rearing or acquiring a heifer (Fetrow et al., 2006). If replacement heifers are not available at the time a group of cows is culled, capacity utilization is reduced as part of the facilities will be empty while the fixed costs remain unchanged. One alternative for dairy producers in zones of high ambient temperatures, low herd fertility and consequently a low number of replacement heifers, is to extend lactations far beyond the traditional 10-month cycles. Extended lactations (up to 18 months) do not necessarily mean a lower productivity (Osterman and Bertilsson, 2003). In fact, it has been shown that by combining longer calving intervals with increased milking frequency, the milk production per day from one calving to the next might even be higher. The practice of extended lactations has also shown to be beneficial for fertility (Larsson and Berglund, 2008) and animal welfare (Osterman and Redbo, 2001).

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Additionally to the prolonged lactations due to failure of cows to become pregnant, a common practice of dairy producers in hot areas of northern Mexico is the continued use of artificial inseminations beyond five services. This practice is questionable, because cows requiring three or more consecutive services before conception, with no clinical signs of disease, are designated as repeat breeders (subfertile/unfertile; Pothmann et al., 2015). *Furthermore, numerous services* result in prolonged calving intervals, which is considered undesirable for dairy farmers since the annual revenue per cow decreases (Van Arendonk and Liinamo, 2003).

This latter view has been recently challenged and some researchers consider extended lactation economically competitive, provided lactation persistency is maximized (Knight, 2005). Among the advantages of extended lactation would be a more even spread of labor requirements, input costs and income across the year. Additionally, some cows regarded as infertile can get pregnant after the fifth service; thus, acquisition of replacement heifers may be reduced. Extended lactations could, therefore, be a suitable option for dairy enterprises in zones of intense heat where a *high level* of *reproductive efficiency* cannot be maintained.

The overall aim of this study was to quantify the milk production capacity of infertile or subfertile high-yielding Holstein cows with extended lactations (15–40 months) and to identify risk factors associated with the occurrence of extended lactations in these cows. An additional objective was to determine the influence of the number of previous services on the conception rate of cows inseminated at an advanced stage of lactation.

2. Material and methods

2.1. Study herds, housing and feeding conditions

Data for this retrospective field study were obtained from four neighboring large commercial dairy herds located in northeastern Mexico (26°N, elevation 1140 m, mean annual temperature 27 °C, mean annual rainfall 230 mm). This zone is characterized by high daytime temperatures in spring, summer and fall (around 40 °C) and intense solar radiation associated with low relative humidity while nights are warm.

All experimental procedures complied with The Guide for Care and Use of Agricultural Animals of the Agrarian Autonomous University Antonio Narro. The herd sizes ranged from 2900 to 3400 lactating Holstein cows housed in open-lot, dirt floor pens with ample shade structures in each pen and with a feed alley. Most animals used in the study were born and raised in the herds studied. Cows were fed total mixed rations formulated to provide recommended nutrients (1.62 Mcal/kg NE_L, 18% crude protein) for 670-kg dairy cows producing >35 kg of milk d^{-1} (NRC, 2001). Cows were fed *ad libitum* for a daily *feed* refusal of approximately 10% of that offered.

Cows were milked three times per day (04:00, 12:00, and 20:00 h) in milking parlors and were fed following each milking. Lactation number of cows included in the study varied from one to eight; with body condition score of lactating cows at calving ranging from 2.75 to 3.5 (scale 1–5). The actual 305-day rolling herd average for these dairy herds was about 10,900 kg and the herd-turnover rate (# of animals culled per year/average # in herd +# culled; excluding deaths) varied from 25% to 32%. Average calving-to-culling intervals for cows in these herds ranged from 267 to 299 days. Average days to first calving ranged from 761 to 783 days and average days in milk (DIM) at first service ranged from 61 to 78.

2.2. Data sets

Two data files were used. Data file 1 (n=3278 lactations; one complete lactation per cow) was from a single herd. The herd consisted of 3400 cows total with approximately 84% of cows in milk (2898 milking +502 dry). Data comprised a 4-yr period from lactations starting in 2011 and finishing in 2014. This information was used to assess the risk factors involved in the occurrence of extended lactations and non-accumulative conception rates in Holstein cows. Data file 2 (n=4393 lactations starting in 2011 and finishing in 2014) consisted of lactation ranging from 15 to 46 months, from cows from three adjacent dairy farms (mean of 2341 cows per operation; only one lactation per cow) with similar management and facilities. This information was used to assess the association between lactation length and milk yield in cows with lactations >450 days, as well as the survival analysis for pregnant and non-pregnant cows. Lactation records included in the study were either from cows that were not culled for failure to conceive (these animals were culled at the end of lactation), or cows not culled for poor health or low milk yield before 300 DIM. Data file 2 could not be merged with data file 1, because several variables, particularly those related to occurrence of periparturient disorders were not available in data set 2.

2.3. Reproductive management

All cows were routinely vaccinated against diseases that impair reproduction functions, such as bovine viral diarrhea, infectious bovine rhinotracheitis, bovine respiratory syncytial virus, parainfluenza and leptospirosis (5-varieties; CattleMaster Gold FP5®, Zoetis, Mexico D.F., Mexico). The reproductive tract of each cow was routinely examined by rectal palpation around 30 d postpartum to check for normal ovarian structures and uterine involution. Additionally, a veterinarian examined fresh cows to identify and treat cows with postpartum reproductive disorders, such as retained placenta, clinical metritis and *endo*metritis, as well as ketosis (urine ketone evaluation with Ketostix; Bayer Corp. Diagnostics Division, Elkhart, IN). Routine brucellosis tests were undertaken in these dairy operations using the card test.

The voluntary waiting period was 50 d postpartum, after which cows were submitted for AI when detected in estrus. Detection of estrus based on pedometer technology integrated with the milking system, and artificial insemination (AI) was conducted after visual observation of estrous behavior, following the standard a.m./p.m. rule. Timed breeding protocols, e.g. Ovsynch and timed AI were performed in repeat breeder cows. Due to low conception rates in these dairy herds, the majority of cows continued to be inseminated beyond 250 days in milk; the range for number of services was 1–24.

Commercial frozen-thawed semen from multiple sires from USA was used across all months of the year. Pregnancy was detected by rectal palpation of the uterus and its contents about 45 days post-AI. Conception rate was defined as the number of cows that conceived out of the ones that were detected in estrus at each estrous cycle.

2.4. Milk data collection

Milk yield per milking (three times per day) was recorded daily electronically on each cow using the Alfa-Laval milking equipment installed in the barn and linked to a computer recording data for each cow separately. The milk meters were checked regularly and calibrated by the suppliers of the milking equipment. The data were used to calculate 305-d milk yield and total lactation yield for each cow. Cows with milk yield of ≤ 20 kg were dried off. Pregnant cows that maintained production above this level for the entire lactation were dried off 60 days before their expected parturition date.

Lactation records were deleted if initiated by abortion or by