

FACTORS ASSOCIATED WITH FIRST SERVICE CONCEPTION IN AI BRED NULLIPAROUS HOLSTEIN HEIFERS IN FLORIDA, USA

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Abstract

A study was conducted to determine factors associated with first service conception in nulliparous dairy heifers in Florida. Six hundred and one 12 to 16 month old Holstein heifers from one farm were used for the study. Data collected on each animal included body weight, height at the withers and tail head, body condition score at 6 months and 5 to 30 days prior to first AI breeding and pelvimetry measurements including pelvic height, width and diagonal taken 5 to 30 days before first AI breeding. Management data collected included date of first artificial insemination, inseminator, service sire, method of estrous detection [standing vs secondary signs], whether the estrus of first insemination was induced using prostaglandin F_{2γ} [PGF] and whether the heifer received a multivalent modified live virus respiratory disease vaccine within 21 days of first insemination. Data were analyzed using least squares means analysis of variance.

The final statistical model showed that heifers bred in the summer had significantly lower conception to first service than heifers bred in the winter months. Heifers bred on secondary signs of estrus (heat detection aids, chin resting, etc) and heifers bred on a PGF induced estrus had reduced fertility at first breeding compared to those bred on observed standing heat and naturally occurring estrus, respectively (P<0.05). Also, larger framed heifers, as measured by internal pelvic measurement, had significantly higher conception rates to first service than smaller framed heifers (P<0.05). Body weight and height, body condition, rate of body weight gain prior to breeding and vaccination with multivalent, modified live viral respiratory vaccine within 21 days of first insemination were not significantly associated with pregnancy outcome at first service. No statistically significant two-way interactions were found.

Introduction

The main objectives of a dairy replacement program are to produce heifers with minimal health problems that will calve at 22-24 months of age with a post-calving weight and withers height of 545 to 565 kg and 137 to 142 cm, respectively (6, 9). Many factors will influence these outcomes not the least of which is reproductive efficiency. Reproductive performance is dependent upon estrus detection efficiency and conception rate. Estrous detection can be a limiting factor in replacement heifer reproduction (7). Numerous estrous detection schemes have been devised and implemented on dairy farms, however little published efficacy data is available (5, 11, 12).

Chiang et al. (4) reported that heifers vaccinated with a replicating IBR-mlv will have decreased conception on the service immediately following vaccination. In an Israeli study of the effects of suckling on heifer performance, no statistical difference in conception rates was seen between the fast growing suckle calves and slower growing control calves (3). Environmental heat stress should not have a significant negative impact on conception in Holstein heifers (2, 7, 18).

The objective of this study was to identify factors associated with conception to first artificial insemination in Holstein dairy heifers.

Materials And Methods

Study Animals and Reproductive Management

Six hundred and one nulliparous Holstein heifers from a dairy farm in north central Florida were used for the study. The criteria for entry into the heifer breeding herd were body weight greater than 327 kg (720 lb) and over 13 months of age. Heifers visually appraised as over 273 kg (600 lb) were weighed monthly.

Once target weight and age were attained, animals were 'processed' by deworming and vaccinating with a multivalent a modified live virus vaccine containing replicating IBR, BVD, PI3 and BRSV virus. Breeding was generally initiated 21-28 days after 'processing'.

All heifers were bred by artificial insemination by five experienced inseminators using 22 AI sires. Date of breeding, inseminator, service sire and observed sign of estrus were recorded for each breeding. Estrus was primarily detected by visual observation, but some animals were bred using secondary signs such as triggered heat mount detection patch, secondary behavioral signs or veterinary palpation findings. Heifers not seen in estrus within 5 days of entry into the breeding herd were treated with prostaglandin $F_{2\alpha}$ (PGF). Heifers that continued to show no signs of estrus within 10 days of PGF treatment were presented for veterinary examination. If a palpable corpus luteum were found on veterinary examination the heifer was again treated with PGF and a heat mount detection patch was applied to the tail head area. If no palpable corpus luteum was found, the animal was observed for estrus and presented for veterinary examination again in 14 days if no estrus was observed. Pregnancy diagnosis was performed by herd veterinarians 40 to 46 days post-insemination.

Heifer Data Collection

Growth data including body weight, height at withers, height at pelvis and body condition score (19) were collected on all heifers at approximately 6 months of age and again at pre-breeding processing. Growth in height (mm/d) and weight (kg/d) from 6 months to pre-breeding was calculated from these data. Pelvimetry measurements (height, width and diagonal) were collected at pre-breeding processing. The pelvic diagonal was the largest internal pelvic measurement and was measured approximately 30° off vertical. Pelvic area was calculated as the product of pelvic height and pelvic width.

Environmental Data

Breeding season was dichotomized into summer and winter using data from the University of Florida Weather Center in Gainesville, Florida. Summer was defined as the time period when the mean weekly temperature was >25C, which is the upper thermoneutral temperature, or comfort temperature, for dairy cattle (16). During this study, this corresponded to May 7 to Sept 23. Winter was thus determined to be from Sept 24 to May 6.

Statistical Analysis

Data were analyzed by least squares means linear regression using commercial computerized statistical software (Statistix[®], Tallahassee, Florida). Because of the number of sires used, 9 bulls contributing more than 25 inseminations were assigned a unique design variable; the remaining 14 bulls that represented 27% of inseminations were grouped together as one design variable. A backward stepwise linear regression model was developed that included all biologically feasible interaction terms.

Results

Overall first service conception for the 601 heifers was 47.1%. The proportion of heifers bred in the summer, on observed standing estrus and as a result of PGF induced estrus were 54.2%, 96.2% and 48.8%, respectively.

The final least squares regression model is presented in Table 1. The only animal factor associated with first breeding pregnancy status was pelvic size. All measures of pelvic size were significant when included in the model signally, however inclusion of the diagonal measurement provided the highest R^2 value. Body weight and body condition score at breeding, ADG from 6 mo to breeding and age at first breeding were not significantly associated with pregnancy status at first service.

Management factors that were negatively associated ($P < 0.05$) with pregnancy status to first service were summer season of breeding, using secondary signs for estrus detection and use of PGF to induce estrus. Heifers bred between May 15 and September 15 had significantly lower conception rates to first service

Table 1 Least squares mean analysis of variance for factors associated with conception to first AI breeding in Holstein heifers

Variable	Coefficient	Std Error	T-test	P-value
Intercept	-1.03960	0.38427	-2.71	<0.01
Summer ¹	-0.26896	0.03963	-6.79	<0.01
Pelvic diagonal ²	0.08415	0.02174	3.87	<0.01
PGF Heat ³	-0.09176	0.03821	2.40	0.02
Secondary Heat ⁴	0.21787	0.09950	2.19	0.03

¹ Summer = May 15 to Sept. 15; winter = Sept. 16 to May 14

² Measurement of diagonal (longest measurement) of pelvic canal using pelvimetry

³ Naturally occurring estrus or estrus induced with prostaglandin F_{2v}

⁴ Secondary signs of estrus including triggered estrus detection aids and secondary behavioral signs of estrus

than than those bred in the winter (Figure 1). There was considerable variability in conception rates for the AI sires used to breed the study heifers. There was also significant correlation (P<0.10) between sire and season of breeding, that is, some bulls were used almost exclusively in the summer and others were used to a higher degree in the winter.

Discussion

The magnitude of effect of environmental temperature on fertility in heifers is greater than that which has been reported previously (2, 10). Using data from a farm in northern Florida, Badinga et al. (2) found that the effect of environmental heat stress on reproduction was profound in lactating cows but minimal in replacement heifers. Their findings indicated that heifer fertility should not be negatively impacted until maximum daily temperature exceeds 35C (93F). Analysis of data collected from the Gainesville, Florida weather station indicates that the weekly average maximum temperature for all 17 weeks included in the 'summer' season exceeded 30C and 4 weeks exceeded 35C. Unpublished data from the study farm shows a 50% reduction in overall conception rate in the replacement herd during the last four summers when compared to breedings that occurred in the winter.

Heifers that had received PGF to induce estrus had a 10% reduction in conception rate compared to heifers that were bred to a naturally occurring heat. The majority of studies in lactating dairy cows found no detrimental effect of PGF use on conception on subsequent estrous (8, 14, 18). In a summary of 17 studies in which cloprostenol was used as a tool for estrus detection in adult cows, PGF treated cows had a non-significant reduction in conception rates in 4 studies and in 13 studies the conception rate was higher in PGF treated cows; statistically significant in 5 of these studies (14). Overall, a 4% improvement in conception rates was found in cows treated with cloprostenol. A second study Zu, et al. (17) showed that in dairy cows treated with two doses of PGF 13 days apart and bred on subsequent observed estrus, conception to first AI was significantly reduced (61.1% vs. 70.5%).

The method of estrus detection was also associated with pregnancy outcome to first service. Heifers bred using secondary signs had a 50% reduction in conception rates compared to heifers bred after observation of standing heat. The number of heifers bred in this manner was low. In the authors' opinion, many of the heifers bred in such a manner were those that were not observed in heat and management was more likely to depend on secondary signs of estrus. Many of the secondary behavioral signs of estrus are demonstrated in the hours preceding and subsequent to standing estrus (1).

There was a strong effect of pelvic size on conception to first insemination (Figure 1). Pelvic size is likely a surrogate for skeletal size. Puberty in dairy heifers is interdependent on body weight and age (15). Animals with large skeletal size reach puberty at younger ages and therefore have had more post-pubertal estrus cycles than smaller framed animals. Heifers with more post-pubertal estrus cycles have been showed to have higher fertility.

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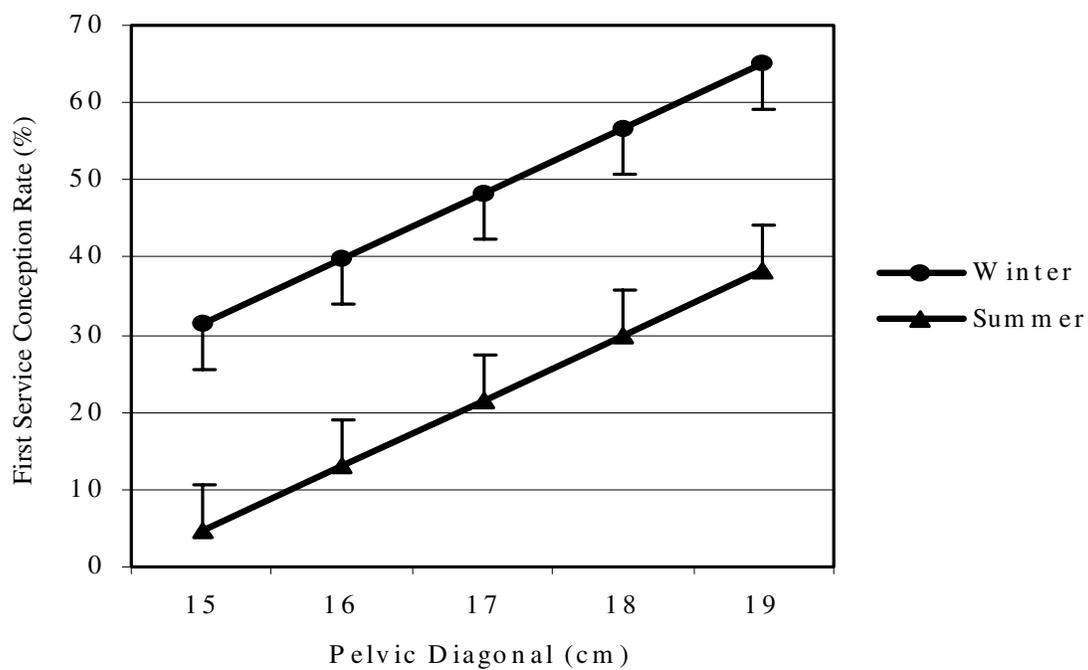


Figure 1 Effect of pelvic diagonal measurement and season of first breeding on first service conception rate in nulliparous Holstein heifers (from LS Mean ANOVA; $P < 0.05$)