Voluntary Waiting Period Management Practices in Dairy Herds Participating in a Progeny Test Program

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ABSTRACT

A survey was mailed to approximately 4,000 herds participating in a young sire progeny test program to estimate the percentage of herds that selectively alter the voluntary waiting period (VWP) for individual cows or groups of cows. Responses were received from 673 herds (17%; 583 Holsteins, 55 Jerseys, 35 other dairy breeds). The mean VWP cited by respondents was 56 ± 0.6 d (range = 30 to 90 d) and did not differ by breed. Among responding herds, 64% (432/673) indicated the VWP was selectively altered for one or more reasons. The most frequently cited reasons for altering the VWP were postpartum health (50%), season (18%), milk yield (18%), parity (14%), and other reasons (14%). In Holstein herds that altered the VWP based on milk yield, the highest production group averaged 14 more days to first service than the lowest production group (≥ 40 vs. < 20 kg of energy-corrected milk, respectively). In contrast, days to first service were nearly identical for all production groups in Holstein herds that did not vary the VWP based on milk yield. In conclusion, management decisions to selectively alter the VWP led to differences in days to first service and may have a confounding effect on genetic estimates of daughter fertility. Opportunities to improve the accuracy of daughter pregnancy rate estimates may reside in models that adjust for VWP management decisions on a within-herd basis.

Key words: voluntary waiting period, daughter pregnancy rate, progeny test program

INTRODUCTION

The reproductive efficiency of dairy cattle in the United States has declined significantly during the last 20 to 25 yr (Lucy, 2001; Washburn et al., 2002). This decline in fertility has been associated with changes in the management and environment of commercial dairy herds and with genetic selection for increased milk pro-

duction. Although the heritability of fertility is low (Nadarajah et al., 1988; Stålhammar et al., 1994; VanRaden et al., 2004), the economic importance and phenotypic variation is extremely high. The first genetic evaluations for daughter pregnancy rate (DPR) in the United States were released in February 2003 (VanRaden and Tooker, 2003; VanRaden et al., 2004), and provide dairy producers with a valuable tool to thwart further declines in female reproductive efficiency. These procedures estimate the genetic component of the variance in days to conception following a voluntary waiting period (VWP) that is assumed to be 60 d in length and homogeneous within and across herds. However, numerous studies suggest that the accuracy of female fertility estimates are highly subject to management biases, such as selective alteration of the VWP within herds (Janson and Andreasson, 1981; Oseni et al., 2003; Oseni et al., 2004). Goodling et al. (2005) concluded that use of estrus synchronization to manage insemination substantially reduces residual variances and moderately reduces sire variances for days to first breeding, days open, and pregnancy rate by 120 DIM, an encouraging result which implies that the accuracy of DPR estimates may be improved as management biases are identified and accounted for within evaluation models.

Although DPR evaluations indicate that possibilities exist to select for both production and reproduction, the relationship between milk yield and DPR is largely antagonistic (VanRaden et al., 2002). However, a number of studies have reported significant economic returns for high-producing dairy cows assigned to an extended VWP (Bar-Anan and Soller, 1979; Arbel et al., 2001; Tenhagen et al., 2003). Herds that alter the VWP based on milk production would tend to confound and exaggerate the negative relationship between milk yield and DPR. Other studies indicate advantages afforded by altering the VWP for individual cows, groups of cows, or both based on lactation (Tenhagen et al., 2003) or season of calving (Oseni et al., 2003). Although it is well recognized that many herds selectively alter the VWP for various reasons, the impact of these management decisions on the accuracy of DPR estimates is unknown because there are presently no estimates of

Received March 18, 2006.

Accepted August 24, 2006.

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the percentage of herds that selectively alter the VWP. The objectives of this study were to estimate the incidence and basis for management decisions to selectively alter the VWP for individual cows or groups of cows in herds that participate in a young sire progeny test program and to determine the impact of these decisions on days to first service.

MATERIALS AND METHODS

A VWP questionnaire was printed on self-addressed, postage-paid postcards (Appendix 1) and mailed to approximately 4,000 dairy herds that were participating in a large-scale progeny testing program (Select Sires, Inc., Plain City, OH). Herds were classified by the predominant breed of cattle in the herd. Holsteins and Jerseys were considered separately, but the remaining breeds (Ayrshires, Brown Swiss, and Guernseys) were combined into an "other breeds" group. The percentage of herds that selectively altered the VWP for various reasons was compared across breeds using logistic regression and chi-squared procedures. The actual VWP reported and the average herd sizes were compared across breeds using ANOVA. In a GLM, average herd size was also compared within each respective category for altering the VWP, including the effects of breed, altered VWP ("yes" or "no"), and breed $\times$ altered VWP interaction.

Survey results were matched with insemination and production records obtained from Dairy Records Management Systems (DRMS, Raleigh, NC) to determine the effects of reported alterations of the VWP on the mean days to first service after calving. Days to first service were determined from insemination records routinely retrieved for all progeny test herds processed by DRMS. However, only a subset of respondents report to DRMS, and insemination records were not available for all respondents. Inseminations were restricted to the most recently available data at the conclusion of the survey, which encompassed first services occurring from July 1, 2004, to September 30, 2005. Cows with calving dates prior to June 1, 2004, were excluded to enhance accuracy in the definition of first-service insemination. Cows >250 DIM at first insemination were also excluded. Seven herds with <10 first services were excluded. The final edited data set included 54,452 first-service inseminations from 347 Holstein and 30 Jersey herds. Because of the limited sample size, other dairy breeds were excluded from the analysis of the effects of VWP management on days to first service. The effects of the reason cited for altering the VWP on least square mean days to first service were analyzed independently using general linear regression models. Each model included the effects of breed, altered VWP ("yes" or "no"),

and the interaction of breed $\times$ altered VWP, with herd included as a nested variable within breed and the categorical VWP grouping.

Because of the highly confounded nature of these data, extensive nesting of effects within models was required for more detailed analysis of some variables, as described in the models below. All statistical analyses were performed using SAS JMP Statistical Discovery Software (SAS Inst. Inc., Cary, NC).

The effects of an altered VWP by lactation number on days to first service were evaluated in the following model:

$$\begin{aligned} \text{DFS} = & \text{Breed} + \text{LACT} + \text{Breed} \times \text{LACT} \\ & + \text{SPAR}(\text{LACT}, \text{Breed}) + \text{Parity}(\text{SPAR}, \text{LACT}, \text{Breed}) \\ & + \text{Herd}(\text{SPAR}, \text{LACT}, \text{Breed}) + \text{residual error}, \end{aligned}$$

where DFS is days to first service after last calving; Breed is breed of the herd cited by the respondent, categorized as Holsteins, Jerseys, or other dairy breed; LACT is the survey response to an inquiry of altered VWP by lactation number ("yes" or "no"); SPAR is the survey response to identify the parity that had the longer VWP among herds that altered the VWP by lactation number; and Parity is the parity of the individual cow as defined in DRMS insemination records, grouped as primiparous or multiparous. Responses to SPAR were categorized into 4 levels: 1) the VWP not altered by LACT, 2) primiparous cows having a longer VWP, 3) multiparous cows having a longer VWP, or 4) unknown because the respondent suggested the VWP was altered by lactation number but did not indicate which group had the longer VWP.

The effects of an altered VWP by season were evaluated in the following model:

$$\begin{aligned} \text{DFS} = & \text{Season} + \text{Season avoided}(\text{Season}) \\ & + \text{CALVMY}(\text{Season avoided}, \text{Season}) \\ & + \text{Herd}(\text{Season avoided}, \text{Season}) + \text{residual error}, \end{aligned}$$

where DFS is days to first service after last calving; Season is the survey response to an inquiry of an altered VWP by season ("yes" or "no"); Season avoided is a survey response indicating that the season VWP 1) was altered to avoid summer breeding and freshening, 2) was altered to avoid winter freshening, or 3) was not altered by season; and CALVMY is a categorical classification of month and year of calving.

The effects of altered VWP by milk yield were evaluated separately for each breed using the following model:

Table 1. Summary of survey responses for herd size, voluntary waiting period (VWP), and reason for altering VWP within and across dairy breeds

Breed	No. of herds	Herd size, mean $\pm$ SEM	Cited VWP, mean $\pm$ SEM	VWP altered for ≥ 1 reason	Reason cited for selective altering VWP				
					Postpartum health	Lactation no.	Season	Milk yield	Other reasons
					(% of herds)				
Holsteins	583	242 $\pm$ 17 ^a	56 $\pm$ 0.53	64	50	14	17	18	16
Jerseys	55	292 $\pm$ 54 ^a	56 $\pm$ 1.65	60	40	9	29	15	7
Other breeds	35	67 $\pm$ 67 ^b	57 $\pm$ 2.30	71	66	23	17	14	3
Total	673	237 $\pm$ 15	56 $\pm$ 0.50	64	50	14	18	18	14

^{a,b}Column means lacking common superscripts differ ($P < 0.05$).

$$\text{DFS} = \text{Milk} + \text{ECMGRP} + \text{Milk} \times \text{ECMGRP} \\ + \text{Herd}(\text{Milk}) + \text{Parity}(\text{Herd}, \text{Milk}) + \text{residual error},$$

where DFS is days to first service after last calving; Milk is the survey response to an inquiry of an altered VWP by milk yield ("yes" or "no"); ECMGRP is the ECM grouping (Clay and McDaniel, 2001) for each individual cow, as identified in DRMS insemination and production records: <20, 20 to 24, 25 to 29, 30 to 34, 35 to 39, or ≥ 40 kg; and Parity is the parity of the individual cow as defined in DRMS insemination records, grouped as primiparous or multiparous.

RESULTS AND DISCUSSION

The survey was mailed to approximately 4,000 herds, and 673 herds responded (17% response rate). The results presented in Table 1 indicate that the mean VWP cited by respondents was 56 ± 0.6 d (range = 30 to 90 d) and did not differ by breed. Sixty-four percent of the herds reported selectively altering the VWP for individual cows for one or more reasons, and the incidence was similar across breeds. The number of cows per herd was greater ($P < 0.05$) for Holstein and Jersey herds than for other dairy breeds. Herds that selectively altered the VWP were of similar size ($P = 0.12$) compared with herds that did not alter the VWP. Across all reasons, Holstein herds that altered the VWP averaged 3 more days to first service ($P < 0.05$) than Holstein herds that did not alter the VWP, whereas days to first service in Jerseys and other dairy breeds were not affected ($P > 0.05$; Table 2). Among herds that did not alter the VWP for any reason, there was no correlation between the cited VWP for the herd and the actual mean number of days to first service ($r = 0.13$, $P = 0.16$).

The most frequently cited reason for altering the VWP was postpartum health, whereby cows experiencing difficult births or early postpartum metabolic diseases were assigned to an extended VWP. A similar percentage of Holstein and Jersey herds altered the VWP because of postpartum health (50 and 40%, re-

spectively), whereas other dairy breeds tended ($P = 0.06$) to have a higher percentage of herds that altered the VWP because of postpartum health (66%). Holstein herds that altered the VWP based on postpartum health averaged 2 more days to first service ($P > 0.05$; Table 2) than did Holstein herds that did not alter the VWP for health reasons. Days to first service in Jerseys and other dairy breeds were not affected by an altered VWP based on postpartum health. Cow health is an integral component of daughter fertility, and the current DPR methodology would justifiably penalize cows with postpartum health issues. However, the subjective management decision regarding how long the VWP should be extended before attempting to breed unhealthy cows may be a confounding issue nonetheless, because individual cows may recover and possess the capacity to conceive much sooner than they are given an opportunity to conceive.

Fourteen percent of respondents varied the VWP by lactation number, and this percentage did not differ ($P > 0.05$) by breed. Altering the VWP by lactation number is of no consequence to DPR estimates because parity within the herd is included in the model effects. Of the 95 herds across breeds that reported altering the VWP by lactation, 17 did not report the actual VWP for each lactation group. Sixty-five percent of herds that varied the VWP by lactation number (51/78) indicated that a longer VWP was assigned to first-lactation cows (74 ± 1.7 d), compared with multiparous cows (57 ± 1.3 d). In contrast, 35% of herds (27/78) indicated that a shorter VWP was used for first-lactation cows (55 ± 1.9 d) than for multiparous cows (70 ± 2.6 d). Among Holstein herds with available insemination data that indicated the VWP was extended for first-lactation cows ($n = 26$ herds), the first-lactation cows ($n = 2184$) averaged 9 more ($P < 0.05$) days to first service (95 ± 0.77 d) than did cows in second lactation and greater (86 ± 0.66 d, $n = 3766$). Among Holstein herds ($n = 8$) that indicated a longer VWP for cows in second lactation and greater, those cows ($n = 372$) averaged 7 more ($P < 0.05$) days to first service (92 ± 1.4 d) than did first-lactation cows

Table 2. Effect of an altered voluntary waiting period (VWP) on least square mean (LSM) days to first insemination

Breed	Altered VWP	Total	Reason cited for altered VWP				
			Postpartum health	Lactation no.	Season	Milk production	Other reasons
			[LSM ± SEM (no. of herds; no. of first services)]				
Holsteins	No	85 ± 0.31 ^a (112; 18,783)	86 ± 0.25 ^a (173; 30,486)	86 ± 0.25 ^a (301; 43,896)	86 ± 0.20 ^a (270; 42,392)	86 ± 0.19 ^a (284; 44,083)	86 ± 0.19 ^a (291; 44,531)
	Yes	88 ± 0.21 ^b (235; 32,575)	88 ± 0.25 ^b (174; 20,872)	91 ± 0.82 ^b (46; 7,462)	91 ± 0.39 ^b (77; 8,966)	89 ± 0.42 ^b (63; 7,275)	89 ± 0.42 ^b (56; 6,827)
Jerseys	No	85 ± 1.00 (11; 1,029)	86 ± 0.88 (18; 1,825)	87 ± 1.05 (27; 2,529)	84 ± 0.75 (19; 2,014)	86 ± 0.73 ^a (27; 2,204)	85 ± 0.68 ^a (28; 3,013)
	Yes	86 ± 0.88 (19; 2,065)	83 ± 1.03 (12; 1,269)	79 ± 3.75 (3; 565)	87 ± 1.30 (11; 1,080)	80 ± 1.59 ^b (3; 890)	95 ± 2.97 ^b (2; 81)
Total	No	85 ± 0.52 ^a (123; 19,812)	86 ± 0.46 (191; 32,311)	86 ± 0.54 (328; 46,425)	90 ± 0.66 (298; 44,691)	90 ± 0.63 (322; 46,561)	85 ± 0.36 ^a (319; 47,891)
	Yes	87 ± 0.45 ^b (254; 34,640)	86 ± 0.53 (186; 22,141)	85 ± 1.92 (49; 8,027)	91 ± 1.24 (91; 10,108)	92 ± 1.18 (67; 8,238)	92 ± 1.50 ^b (58; 6,908)

^{a,b}Column means within breed or total lacking common superscripts differ ($P < 0.05$).

(85 $\pm$ 1.73, $n = 251$). These results imply that Holstein herds tended to be compliant with the survey response regarding the assignment of cows to a VWP by lactation. Among Jerseys and other dairy breeds, an insufficient number of herds (inseminations) were available to provide meaningful statistics on the effects of an altered VWP by lactation on days to first service. The observation of contradictory guidelines among herds for assigning cows to a VWP by parity illustrates the importance of adjusting for these effects on a within-herd basis, as is presently performed in DPR estimates.

The percentage of herds that altered the VWP because of season tended ($P = 0.09$) to be greater in Jerseys (29%) than in Holsteins (17%) or other dairy breeds (17%; Table 1). Among the herds that altered the VWP by season, 78% (94/1208) did so to avoid insemination, calving, or both during the summer months. Surprisingly, 22% (26/120) of respondents indicated that the VWP was altered to avoid calving cows during the winter months. The effects of management decisions to seasonally alter the VWP on days to first service by month of calving for 77 Holstein and 11 Jersey herds with available insemination records were combined and are presented in Figure 1. Herds that altered the VWP to avoid summer breeding ($n = 75$) had greater ($P < 0.05$) days to first service for cows that calved during the months of July, August, and September 2004 compared with the same months for herds that did not alter the VWP by season ($n = 289$). Herds that altered the VWP to avoid calving cows during the winter months ($n = 13$) had greater ($P < 0.05$) days to first service for cows that calved in September and November through February when compared with the same months for herds that did not alter the VWP by season ($n = 289$). Seasonal alteration of the VWP likely has a minimal impact on DPR estimates because the current methodology ad-

justs for season of calving on a within-herd basis. However, these observations imply that there may be opportunities to improve the accuracy of DPR estimates incrementally by reducing the number of months (days) in the seasonal contemporary definition within those herds that seasonally alter the VWP or by adjusting for differing variances across seasons.

The VWP period was altered based on milk yield in 18% of reporting herds and did not differ ($P > 0.05$) by breed. Many of the write-in comments from these herds indicated that cows were assigned to a VWP at a 1:1 ratio (in days) with pounds of milk at peak lactation. Among the Holstein herds with available insemination data, herds that reported altering the VWP based on milk production exhibited a linear increase in days to first service with increasing levels of milk production (Table 3). In Holstein herds that altered the VWP based on milk production, all production groupings ≥ 30 kg of milk had greater ($P < 0.05$) days to first service than did all milk production groups in herds that did not alter the VWP based on milk production. Insemination data were available for only 3 Jersey herds that indicated the VWP was altered based on milk production, which was insufficient to provide meaningful statistics regarding days to first service. The confounding effect of management decisions to selectively alter the VWP based on milk production may inflate the observed negative correlations between milk yield and DPR. The argument can be made that only 6.5% of the Holstein cows with available insemination records were significantly affected (i.e., ≥ 30 kg of ECM, 3,359/51,358), which may not be sufficient incidence to bias estimates. However, on a within-herd basis, differential treatment of any animal may also influence the evaluation of contemporaries. In this respect, 14% of the cows (7,275 out of 51,358) resided in herds in which such an opportunity

Figure 1. Effect of month of calving and seasonal voluntary waiting period (VWP) management practices on days to first service in Holstein and Jersey herds. Asterisks (*) indicate data points that are significantly different ($P < 0.05$) from herds that do not alter the VWP within the same month of calving.

for DPR bias existed because of an altered VWP based on milk yield. These observations imply that opportunities may exist to improve the accuracy of DPR estimates through statistical models that adjust for a varied VWP based on milk production.

Miller et al. (2005) recently investigated statistical models designed to identify herds that use estrus synchronization and fixed-time AI to control days to first service. The objective of that study was to determine the influence of these time management tools on the accuracy of DPR estimates. These procedures appear equally amenable for use in identifying herds that selectively alter the VWP based on milk yield and season for an identical purpose.

Table 3. Effect of an altered voluntary waiting period (VWP) based on milk yield on least square mean (LSM) days to first insemination in Holstein herds

Item	Altered VWP by milk yield	
	No	Yes
No. of herds	284	63
	— [LSM $\pm$ SEM (no. of first services)] —	
ECM per cow, kg		
<20	86 $\pm$ 0.61 ^{ef} (2,496)	85 $\pm$ 1.48 ^{def} (428)
20 to 24	85 $\pm$ 0.41 ^f (7,913)	89 $\pm$ 0.92 ^{cde} (1,519)
25 to 29	86 $\pm$ 0.41 ^{ef} (12,220)	90 $\pm$ 0.93 ^{cd} (1,969)
30 to 34	86 $\pm$ 0.48 ^{ef} (10,565)	92 $\pm$ 1.13 ^{bc} (1,895)
35 to 39	86 $\pm$ 0.55 ^{ef} (6,978)	95 $\pm$ 1.38 ^{ab} (973)
≥ 40	86 $\pm$ 0.65 ^{def} (3,911)	99 $\pm$ 1.75 ^a (491)

^{a-f}Column and row means lacking common superscripts differ ($P < 0.05$).

Among the other reasons cited for altering the VWP, BCS (7%, 47/673) and embryo transfer donorship (3%, 19/673) were the primary write-in responses. Additional reasons included in the other category were the timely production of show calves and previous breeding history. Because these reasons were unsolicited write-ins that were not included on the questionnaire, the actual incidence may be slightly higher than that reported.

By nature and definition, population data are highly confounded and entrenched with management biases that may influence the accuracy of genetic estimates. The issues discussed here are not necessarily unique to DPR estimates. Milk production estimates may be biased for individual (or groups of) cows because of selective management decisions related to feeding, cow comfort, milking frequency, and bST use, to mention but a few. Although milk production and days open are both quantitative traits, there is an important difference that make days open more susceptible to management biases. Cows have an opportunity to produce milk each day of lactation. However, cows do not have an equal opportunity to conceive each day they are open, but rather only once every 21 d. Thus, days open is a quantitative trait that is toggled by a binomial variable once every 21 d. Converting insemination records into a series of sequential binomial interrogations certainly has merit to illustrate fertility for the producer in a functional manner (VanRaden et al., 2004). However, selective VWP management decisions (or management oversights) that forego insemination at a fertile estrus

may have a relatively large impact on the observed outcome, resulting in a confounding effect that may be largely responsible for the extremely low heritability of DPR.

Few production variables are economically more important than reproductive capacity. Declining conception rates in dairy breeds over the last 20 yr have heightened awareness, sensitivity, and emotions among dairy producers regarding female fertility. The negative relationship between milk yield and reproduction is irrefutable, and current estimates of DPR provide the dairy industry with a valuable tool to enhance the reproductive capacity of replacement females and thwart the current decline in conception rates in the national herd. Furthermore, the importance of including accurate estimates of daughter fertility in future sire selection decisions cannot be overemphasized. It is imperative that DPR provide accurate genetic rankings so that they can be used with confidence to guide breeding programs in the desired genetic direction. These data imply that opportunities may exist to further improve the accuracy of DPR estimates to accelerate genetic progress in this critically important trait.

CONCLUSIONS

Survey results indicated that 64% of respondents selectively altered the VWP for individual cows or groups of cows. Herds that altered the VWP for management purposes tended to have significantly different profiles for average days to first service than herds that did not. In turn, selective VWP management may have a confounding effect on DPR estimates, especially within herds that altered the VWP based on milk yield. The subjective basis for implementing VWP management decisions makes statistical adjustment for these effects quite complex and problematic. However, the results imply that opportunities may exist to improve the accuracy of DPR estimates through within-herd adjustments for selective VWP management decisions. The procedures of Miller et al. (2005), developed to identify herds that use synchronized breeding for first service,

appear amendable for identification of herds with altered mean days to first service (VWP) as a function of milk yield or other reasons cited in this survey.

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APPENDIX

Voluntary Waiting Period Survey

The voluntary waiting period (VWP) is the postpartum recovery period during which producers will typically refrain from breeding cows even if they are detected in estrus. The VWP across most herds typically ranges between 40 and 90 days after calving.

USDA conducts genetic evaluations of how quickly cows become pregnant after calving as an indication of cow fertility. These genetic evaluations are published as Daughter Pregnancy Rate (DPR) PTAs. The USDA DPR evaluation makes assumptions about the VWP and how it is managed in dairy herds. This survey is intended to gather information about the VWP in Select Sires PGATM herds to see if these assumptions are valid. Your response to this survey will help us provide more accurate estimates of cow fertility.

Please take a moment to fill out the attached questionnaire on a self-addressed postcard and return to Select Sires. In appreciation of your input, you will be entered into a random drawing to receive a credit of \$500 to be applied to your member coop account for use against future purchases.

Thank you in advance for your assistance.

Mel DeJarnette and Chuck Sattler
Select Sires, Inc.

Voluntary Waiting Period (VWP) Survey

DHIA Herd Number: _____ Breed (circle) HO JE AY GU Other _____

Herd Name: _____ Total number of cows in milking herd: _____

Does management in this herd ever selectively alter the VWP to delay breeding for individual cows or groups of cows? ____ YES ____ NO

If NO, please indicate the VWP used for all cows in this herd: _____ days

If YES, please check all reasons that apply.

____ Postpartum health problems (dystocia, RP, metritis, etc.)

____ The VWP in this herd varies by lactation group. 1st Lactation = _____ $\geq$ 2nd Lactation = _____

____ The VWP in this herd is seasonally altered to avoid breeding and/or calving during the summer months.

____ The VWP in this herd varies by cow based on milk production. Guidelines used to assign cows to their respective VWP are: _____

____ The VWP in this herd is selectively altered for the following reasons not listed above: _____