

## Survey of Management Practices on Reproductive Performance of Dairy Cattle on Large US Commercial Farms

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### ABSTRACT

A survey regarding general management, sire selection, reproductive management, inseminator training and technique, heat abatement, body condition scoring, facility design and grouping, nutrition, employee training and management, and animal health and biosecurity was carried out from March to September of 2004 in 153 herds in the Alta Genetics (Watertown, WI) Advantage Progeny Testing Program. A total of 103 herds (67.3%) completed the survey. Herd size was  $613 \pm 46$  cows, with herds located in Wisconsin (26), California (12), New York (11), Minnesota (10), Michigan (7), Washington (6), Pennsylvania (6), Iowa (5), Idaho (5), Texas (4), Ohio (4), and other states (7). These farms sold  $34.5 \pm 0.3$  kg of milk/d per cow, with an annual culling rate of  $34 \pm 1\%$  and a calving interval of  $13.8 \pm 0.1$  mo. Cows were observed for estrus  $2.8 \pm 0.3$  times/d, for a duration of  $27 \pm 4$  min, but 78% of the respondents admitted that detection of estrus was not the employee's sole responsibility at that time. Managers tried to achieve pregnancy until  $8.8 \pm 0.9$  failed inseminations,  $300 \pm 26$  d postpartum, or milk yield  $<17.7 \pm 0.5$  kg/d. Nonpregnant cows were culled at  $326 \pm 36$  d postpartum or milk yield  $<16.4 \pm 0.3$  kg/d. Mean durations of the voluntary waiting period were  $52 \pm 1.3$  and  $53 \pm 1.4$  d for primiparous and multiparous cows, respectively. Hormonal synchronization or timed artificial insemination programs were used in 87% of the herds, with 86% synchronizing first services, 77% resynchronizing repeat services, and 59% treating cystic, anestrus, or anovular cows. Finding good employees was identified as the greatest labor challenge, followed by training and supervising employees. Mastitis and hairy heel warts were noted as the greatest animal health concerns, followed by lameness, abortions, and death losses, whereas the greatest reproductive challenges were artificial insemination service rate, con-

ception rate, twinning, and retained placenta or metritis. Results of this study can provide a useful benchmark or reference with regard to commonly used management practices on large commercial US dairy farms at the present time.

**Key words:** reproduction, fertility, herd management, survey

### INTRODUCTION

The reproductive performance of high-producing dairy cows on modern commercial farms is influenced by a multitude of factors (Westwood et al., 2002; Caraviello et al., 2006). Numerous variables related to energy balance (Veerkamp et al., 2000), BCS (Moreira et al., 2000), milk yield (Veerkamp et al., 2000), disease (Windig et al., 2005), hormonal synchronization (Pursley et al., 1995), and reproductive management (Santos et al., 2004; Moore and Thatcher, 2006) have been associated with differences in reproductive performance in previous studies.

In a series of papers, Bewley et al. (2001a,b,c) and Weigel et al. (2003) presented results of a detailed management survey involving 302 Wisconsin farms that expanded their milking herds significantly between 1994 and 1998. All aspects of these operations, including biosecurity, employee management, housing, bedding, feed delivery, manure removal, stocking density, animal restraint, heat abatement, and fresh cow management, were evaluated as predictors of animal health, milk production, reproductive efficiency, culling rate, labor efficiency, and overall owner satisfaction. Although these studies provided a wealth of information, the survey was limited to herds in Wisconsin, and details regarding specific aspects of reproductive management were not considered.

Therefore, the objective of the present study was to examine current management practices on large commercial dairy farms, paying particular attention to factors that could influence reproductive performance, via an extensive survey of managers of herds that par-

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ticipated in the Alta Genetics (Watertown, WI) Advantage Progeny Testing Program.

## MATERIALS AND METHODS

A comprehensive survey was developed that included questions regarding 10 aspects of each dairy operation, including general management issues, sire selection, reproductive management, inseminator training and techniques, heat abatement devices, body condition scoring, facility design and pen movement, nutrition, employee training and management, and animal health and biosecurity. Between March and September 2004, this survey was delivered to each of 153 large commercial dairy farms that participated in the Alta Genetics Advantage Program, a program for concentrated progeny testing of elite young Holstein sires in large herds, by an Advantage Program consultant, who assisted the herd manager in completing the survey. These herds were located in Wisconsin (26), California (12), New York (11), Minnesota (10), Michigan (7), Washington (6), Pennsylvania (6), Iowa (5), Idaho (5), Texas (4), Ohio (4), and other states (7). Means and corresponding standard errors were computed for continuous and ordinal variables, whereas frequencies were tabulated for binary and categorical variables.

## RESULTS AND DISCUSSION

A total of 103 of the 153 herds receiving a survey responded, resulting in a 67.3% response rate. The response rate was relatively high, because most of these herds have a long-standing relationship with Alta Genetics and, more important, because Advantage Program consultants assisted herd managers in completing the survey. Mean herd size of respondents was  $613 \pm 46$  lactating cows.

Table 1 provides a summary of information regarding labor, herd size, milk production, calving interval, culling, management of nonpregnant cows, and use of Posilac (recombinant bST, **rBST**) on these farms. Managers anticipated continued expansion, because the mean 5-yr goal for herd size of  $942 \pm 94$  cows (ranging from 150 to 7,000 cows) represented a 54% increase from the current mean of  $613 \pm 46$  cows. Approximately 73% of labor was provided by nonfamily employees, with most of these employees working full-time. Based on a 50-h work week, the average number of cows per full-time equivalent employee in the dairy operation was 84, which was greater than that reported for recently expanded Wisconsin herds surveyed by Bewley et al. (2001c). The most frequent employee benefits were paid vacation time and housing, which were of-

fered on a greater percentage of farms than reported by Bewley et al. (2001b). Roughly one-half of the farms provided health insurance, but few offered profit sharing. Managers identified finding good employees as the greatest labor management challenge, followed by training and supervising employees, whereas employee absences and employee retention were not considered problematic. Respondents to the survey of Bewley et al. (2001b) also identified finding good employees as the top labor management challenge, followed by training employees, although employee retention was considered more problematic than in the present study.

Mean daily milk yield, expressed as the amount of milk sold per cow per day, was  $34.5 \pm 0.3$  kg (with SD of 3.0 kg), whereas means for annual culling rate and calving interval were  $34 \pm 1\%$  (with SD of 7.4%) and  $13.8 \pm 0.1$  mo (with SD of 0.6 mo), respectively. Mean culling rate and calving interval in 1998 in recently expanded Wisconsin herds surveyed by Bewley et al. (2001b) were similar, at  $33.2 \pm 0.7\%$  and  $13.8 \pm 0.1$  mo, respectively. All of these herds used predominantly AI sires, which was expected given that heavy usage of young sire semen was a key requirement of the Advantage Progeny Testing Program. A total of 44 herds used a clean-up bull, and nonpregnant cows were moved to the clean-up pen after  $6.6 \pm 0.6$  failed inseminations or  $232 \text{ d} \pm 9 \text{ d}$  postpartum. Interestingly, these managers kept trying to achieve pregnancy until cows reached  $8.8 \pm 0.9$  failed inseminations,  $300 \pm 26 \text{ d}$  postpartum, or when milk yield dropped below  $17.7 \pm 0.5$  kg/d. Culling of nonpregnant cows occurred shortly thereafter, at  $326 \pm 36 \text{ d}$  postpartum, or when milk yield was less than  $16.4 \pm 0.3$  kg/d. By comparison, de Vries and Risco (2005) reported a mean of 415 d until culling of nonpregnant cows in Florida and Georgia, with a corresponding minimum milk yield of nonpregnant cows of 12.3 kg/d. Posilac (rBST) was used in 71 herds, with 41% of cows in these herds receiving Posilac every other week from  $97 \pm 6 \text{ d}$  postpartum through the end of lactation, regardless of pregnancy status. However, usage may have been reduced because of limited availability of Posilac at the time of this survey. Managers indicated that a slightly lower proportion of herds and cows would use Posilac in the future, but that Posilac treatment would begin earlier in lactation than at present.

Table 2 provides a summary of responses regarding detection of estrus, hormonal synchronization, and use of a voluntary waiting period (**VWP**) to determine the minimum number of days to first insemination. Most herds used on-farm labor for detection of estrus, and cows were observed  $2.8 \pm 0.3$  times on weekdays and  $2.5 \pm 0.2$  times on weekends, for an average duration of

**Table 1.** Summary of responses by herd managers (n = 103) to questions related to labor, herd size, milk production, calving interval, culling, management of nonpregnant cows, and use of Posilac (rBST), along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables)

Question	Response (number)	
How many people are involved in the management and work of your operation?		
Full-time family	1.9 $\pm$ 0.1 (89 $\pm$ 9 h/wk)	
Part-time family	9.0 $\pm$ 0.1 (9 $\pm$ 1 h/wk)	
Full-time nonfamily	6.7 $\pm$ 0.6 (244 $\pm$ 31 h/wk)	
Part-time nonfamily	1.5 $\pm$ 0.2 (23 $\pm$ 4 h/wk)	
What benefits do you offer full-time employees?	Paid vacation time (77)	
	Housing (60)	
	Health insurance (49)	
	Milk or meat (42)	
	Employee-owned cows (8)	
	Profit-sharing (4)	
	Share of calves born (1)	
	Other (17)	
Please describe the following aspects of employee management on your operation (1 = not a problem to 5 = major problem)		
Finding good employees	2.94 $\pm$ 0.12	
Training employees	2.69 $\pm$ 0.09	
Supervising employees	2.69 $\pm$ 0.10	
Keeping good employees	2.39 $\pm$ 0.10	
Employee absences	1.74 $\pm$ 0.09	
What is your 5-yr goal for herd size?	942 $\pm$ 94 cows	
Do you have any breeds other than Holstein in your herd?	Yes (52)	
	No (51)	
How much milk do you ship per cow per day?	34.5 $\pm$ 0.3 kg/d	
What is the average calving interval in your herd?	13.8 $\pm$ 0.1 mo	
What percentage of your cows left the herd last year?	34 $\pm$ 1%	
When do you decide to cull nonpregnant cows?		
Failed inseminations	8.8 $\pm$ 0.9	
Days postpartum	300 $\pm$ 26 d	
Milk production	<17.7 $\pm$ 0.5 kg/d	
When do you cull nonpregnant cows?		
Days postpartum	326 $\pm$ 36 d	
Milk production	<16.4 $\pm$ 0.3 kg/d	
What is the extent of AI use in your herd?	AI only (58)	
	AI with clean-up bull (44)	
When do you move cows to the clean-up bull pen?		
Failed inseminations	6.6 $\pm$ 0.6	
Days postpartum	232 $\pm$ 9 d	
Do you use male fertility data when selecting AI sires?	Yes (37)	
	No (54)	
Do you use female fertility data when selecting AI sires?	Yes (14)	
	No (78)	
	Current	Future
	Response (number)	Response (number)
Do you use Posilac (rBST)?	Yes (71)	Yes (67)
	No (30)	No (33)
What percentage of cows receive Posilac?	41 $\pm$ 3%	36 $\pm$ 3%
When do you start giving Posilac?	97 $\pm$ 6 d postpartum	78 $\pm$ 4 d postpartum
What injection interval do you use?	13.9 $\pm$ 0.1 d	13.5 $\pm$ 0.2 d
Do nonpregnant cows receive Posilac?	Yes (66)	Yes (66)
	No (4)	No (4)

observation of  $27 \pm 4$  min and  $25 \pm 4$  min, respectively. Interestingly, 78 herds admitted that detection of estrus was not the employee's sole responsibility during this period, so "multitasking" appears to be a widespread and limiting factor with respect to estrus detection efficiency. Among estrus detection aids, tail chalk was most commonly used, with few herds using pedom-

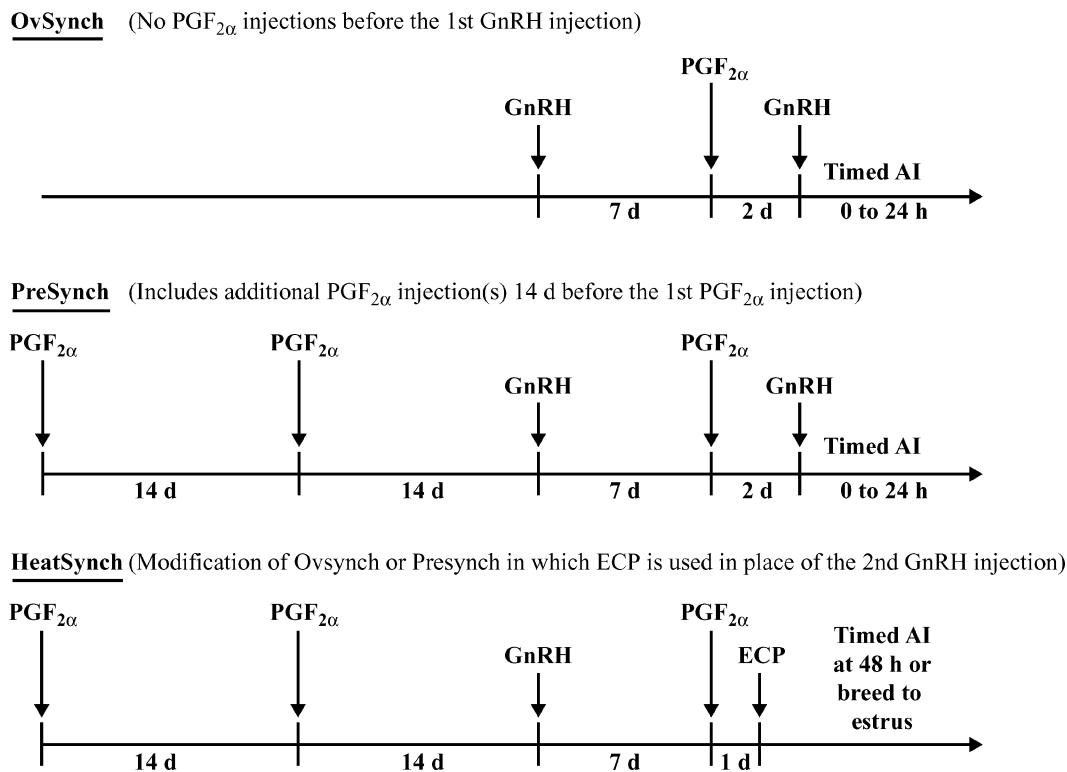
eters or pressure-activated rump-mounted patches. Nearly all herds used a VWP, with a mean duration of  $52 \pm 1.3$  d for primiparous cows and  $53 \pm 1.4$  d for multiparous cows. About one-quarter of herds indicated that the duration of the VWP for an individual cow depended on milk yield, BCS, or other factors. In a recent study, Stevenson and Phatak (2005) noted

**Table 2.** Summary of responses by herd managers (n = 103) to questions related to detection of estrus, hormonal synchronization, and voluntary waiting period, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables)

Question	Response (number)
Who is responsible for estrus detection on your farm? (check all that apply)	Hired employee (78) Family member (50) AI stud employee (15) Other (15)
How many times per day do they watch cows for estrus?	
Weekdays	2.8 $\pm$ 0.3
Weekends	2.5 $\pm$ 0.2
How much time is spent on detection of estrus each time?	
Weekdays	27 $\pm$ 4 min
Weekends	25 $\pm$ 4 min
Is detection of estrus their sole responsibility at this time?	Yes (22) No (78)
Where are cows observed for estrus? (check all that apply)	Barn (82) To or from parlor (59) Parlor (37) Other (24)
What estrus-detection aids are used? (check all that apply)	Tail chalk (60) Pedometers (8) Pressure patches (3) Other (9)
How were staff responsible for estrous detection trained?	On-farm (75) Off-farm (7)
Do you use a voluntary waiting period?	Yes (97) Primiparous: 52 $\pm$ 1.3 d Multiparous: 53 $\pm$ 1.4 d No (5)
Does your voluntary waiting period vary by these factors? (check all that apply)	Milk production (28) Body condition score (25) Other (23)
Do you use estrous synchronization and/or timed AI?	Yes (90) No (13)
For what do you use estrous synchronization or timed AI? (check all that apply)	Setting up cows for first service (77) Resynchronizing second and later services (69) Breeding cows with ovarian cysts (53) Breeding anestrous or anovular cows (53) Synchronizing embryo transfer recipients (10) Other (7)
Which commercial PGF <sub>2<math>\alpha</math></sub> products do you use? (check all that apply)	Lutalyse (76) Prostamate (42) Estrumate (9)
Which commercial GnRH products do you use? (check all that apply)	Cystorelin (66) Factrel (37) Fertagyl (21) Other (24)
Which protocol is most often used to resynchronize cows for second and later services (refer to Figure 1)	OvSynch (50) HeatSynch (5) PreSynch (4) Other (13)
Which protocol is most often used to breed cows with ovarian cysts (refer to Figure 1)	OvSynch (50) HeatSynch (4) PreSynch (2) Other (8)
Which protocol is most often used to breed anestrous or anovular cows (refer to Figure 1)	OvSynch (43) HeatSynch (3) PreSynch (3) Other (7)

that delaying first AI resulted in an increase in conception rate. The majority of herds used hormonal synchronization or timed AI programs. A description of the OvSynch, Presynch + Ovsynch, and HeatSynch protocols (Pursley et al., 1995; Navanukraw et al., 2004;

Moore and Thatcher, 2006), as shown in Figure 1, was provided to each farm as an appendix to the management survey. The most common strategies for use of synchronization protocols included setting up cows for first postpartum service (77 herds), resynchronizing



**Figure 1.** Diagrams of 3 common synchronization protocols for milking cows. ECP = estradiol cypionate.

cows for second and greater services (69 herds), and treatment of cystic, anestrus, or anovular cows (53 herds). The majority of herds indicated use of OvSynch, with the exception of setting up cows for first service, in which Presynch + OvSynch was most commonly used. Several studies have reported that presynchronization can improve the pregnancy rate to first postpartum timed AI, relative to OvSynch alone (El-Zarkouny et al., 2004; Navanukraw et al., 2004).

Table 3 provides a summary of information regarding breeding procedures, pregnancy examinations, and managers' perceived reproductive challenges. The majority of herds used rectal palpation for pregnancy diagnosis, with a mean interval between examinations of  $20.8 \pm 1.7$  d and a mean time to reexamination of pregnant cows of  $118 \pm 6$  d after insemination. Interestingly, nearly 30% of these herds used ultrasound for conducting pregnancy diagnoses, indicating that ultrasound is beginning to displace rectal palpation as the method of choice for pregnancy diagnosis in some herds. Fricke (2002) noted the importance of early and accurate detection of nonpregnant cows, although recent reports have questioned the efficacy of conducting pregnancy diagnosis using ultrasound earlier than 30 to 40 d after timed AI (Sterry et al., 2006). Among the reproductive challenges identified by herd managers,

AI service rate, conception rate, twinning, and retained placenta or metritis were noted most frequently. Detection of estrus and early embryonic loss were of intermediate concern, whereas ovarian cysts and (especially) reproductive record keeping were not considered problematic. As noted in Table 3, a total of 68 herds had self-locking manger head gates, whereas the remainder inseminated cows in the free stalls (24 herds) or used a palpation rail (21 herds). Bewley et al. (2001a) found no significant difference between self-locking head gates and palpation rails in terms of labor efficiency, ease of use, or worker safety. Most breeding technicians were trained on farm, and the vast majority used water thawing of semen at approximately 35°C for 35 to 40 s. The technicians surveyed indicated that they typically thawed no more than 3 straws of semen at a time. Dalton et al. (2004) found no association between conception rate and insemination sequence in lactating Holstein cows when up to 4 straws of AI semen were thawed simultaneously.

Table 4 summarizes housing, heat stress, and manure removal strategies on farms. Nearly all herds provided shade throughout the day, and most also shaded parlor walkways and holding pens. Only 15 herds used wind tunnel ventilation, whereas 83 used recirculation fans, and 69 used soakers (sprinklers).

**Table 3.** Summary of responses by herd managers (n = 103) to questions related to breeding procedures, pregnancy diagnosis, and reproductive challenges, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables).

Question	Response (number)	
How frequently are pregnancies diagnosed?	20.8 $\pm$ 1.7 d	
Who diagnoses the milking herd?	Veterinarian (93) On-farm employee (4)	
What method is used for diagnosis?	Palpation (80) Ultrasound (33)	
Are pregnant cows reexamined?	Yes (85) 118 $\pm$ 6 d after AI No (15)	
Indicate the importance of these reproductive issues among lactating cows in your herd: (1 = not a problem to 5 = major problem)		
AI service rate	2.69 $\pm$ 0.10	
Conception rate	2.68 $\pm$ 0.10	
Twinning	2.65 $\pm$ 0.10	
Retained placenta or metritis	2.62 $\pm$ 0.10	
Estrous detection	2.45 $\pm$ 0.10	
Early embryonic loss	2.45 $\pm$ 0.11	
Ovarian cysts	2.24 $\pm$ 0.10	
Reproductive record keeping	1.40 $\pm$ 0.08	
What restraint system is used to breed cows? (check all that apply)	Self-locking manger (68) Free stall (24) Palpation rail (21) Animal-handling chute (11) Parlor return lane (6) Stanchion or tie-stall (6) Milking parlor (3) Other (4)	
When did you last train the AI technicians?	2.4 $\pm$ 0.2 yr ago	
	Primary technician	Secondary technician(s)
Who is the technician employed by?	Farm (82) AI stud (18)	Farm (62) AI stud (12)
How was the technician trained?	Off-farm (49) On-farm (41)	Off-farm (42) On-farm (30)
How does the technician thaw the semen?	Water (80) 34.8 $\pm$ 0.3°C, 38 $\pm$ 1.4 s Pocket (3)	Water (62) 35.1 $\pm$ 0.2°C, 37 $\pm$ 2.4 s Pocket (6)
Maximum number of straws thawed at once?	2.8 $\pm$ 0.1	
How does the technician dry the straw?	Paper towel (86) Cloth towel (5) Tissue (4) Don't dry (1)	Paper towel (66) Cloth towel (1) Tissue (3) Don't dry (2)
How does the technician cut the straw?	Scissors (53) Cutter (41) Knife (2)	Scissors (41) Cutter (32) Knife (0)
Do the straws get exposed to direct sunlight?	Yes (2) No (93)	Yes (0) No (73)

These herds are located throughout the United States, so the absence of heat abatement devices generally applies to herds in the northern states, although Fricke et al. (2002) noted that conception rates are reduced during the summer in northern Wisconsin as well. As noted in Table 4, fresh bedding is applied every 2.4  $\pm$  0.3 d. However, fewer than half of respondents indicated that maternity pens were cleaned after every calving, and many indicated that  $\geq 4$  calvings occur between successive cleanings. This is in contrast to the recommendation of Elbers et al. (1998), who noted the importance of disinfecting the maternity pen after calving with respect to management of clinical masti-

tis. The vast majority of cows were housed on concrete, which increases the risk of lameness (Cook et al., 2004) and decreases expression of estrus behavior (Vailes and Britt, 1990). A total of 44 herds reported that cows had feet trimmed >3 times per year, whereas 21 herds performed maintenance trimming only once a year or less, suggesting a wide variation in hoof care management on these farms. However, almost all herds used a foot bath to control infectious causes of lameness.

Table 5 summarizes data regarding nutrition and BCS. Drive-through feeding was the most common means of feed delivery, presumably because of high producer satisfaction with this practice, as noted in the

**Table 4.** Summary of responses by herd managers (n = 103) to questions related to housing, heat stress, and manure removal, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables).

Question	Response (number)
How many pens hold your nonpregnant cows?	4.1 $\pm$ 0.2
Do nonpregnant cows have easy access to shade all day?	Yes (102) No (1)
Do cows have shade in parlor walkways and holding pens?	Yes (86) No (16)
How far is the parlor from the nonpregnant cow pen(s)?	63 $\pm$ 6 m
How high are the sidewalls in the nonpregnant cow pen(s)?	2.9 $\pm$ 0.2 m
Distance between the barns and nonpregnant cow pen(s)	27 $\pm$ 3 m
Do you use wind tunnel ventilation?	Yes (15) No (85)
Do you have recirculation fans?	Yes (83) No (15)
Location of fans	Holding area (76) Stalls (53) Feed bunk (48) Other (12)
Do you use soakers (sprinklers) to cool your cows?	Yes (69) No (33)
Location of soakers (sprinklers)	Feed bunk (45) Other (18) Stalls (1)
At what frequency is fresh bedding applied?	2.4 $\pm$ 0.3 d
If individual maternity pens are used, how often do you clean and disinfect them?	Every calving (17) $\geq$ 4 calvings (22) 2 to 3 calvings (8)
Do you use electronic sorting gates?	Yes (14) No (87)
How many times per day is manure removed from alleyways?	4.5 $\pm$ 0.5 times/d
How do you usually remove manure?	Tractor scraper (58) Alley scrapers (20) Flush (20) Slats (3)
What is the predominant floor type in the pen?	Concrete (91) Rubber (6) Other (4)
Please describe your hoof care program	Maintenance trimming of whole herd (90) Treat animals with sore feet only (24)
If maintenance trimming is used, which animals are trimmed?	Dry cows (68) Late lactation (58) Mid-lactation (57) Fresh cows (34) Calves or heifers (9)
How frequently does maintenance trimming take place in your herd?	$\geq$ 3 times/yr (44) 2 times/yr (27) 1 time/yr (15) <1 time/yr (6)
Do you use a foot bath?	Yes (92) No (9)

survey of Bewley et al. (2001a). The mean frequency of feed delivery was  $1.8 \pm 0.1$  times/d, and feed was pushed up an average of  $6.8 \pm 0.4$  times/d. DeVries et al. (2005) noted that increasing the frequency of feed delivery from once to twice daily reduced the amount of feed sorting and improved access to fresh feed for all cows during peak feeding periods. Stone (2004) recommended that feed should be pushed up 8 to 10 times daily to encourage adequate intake and to minimize sorting. The mean targeted feed refusal rate was  $3.5 \pm 0.2\%$  of feed delivered, whereas the mean amount of bunk space per cow was  $52.6 \pm 1.5$  cm in the main

breeding pen and  $56.4 \pm 2.5$  cm in other pens that contained nonpregnant cows. Cook et al. (2004) noted the importance of adequate bunk space with respect to avoidance of metabolic disorders and reported means of 46 and 74 cm/cow in fully stocked 3-row and 2-row free-stall barns, respectively. Diets were reformulated and feeds were tested approximately once per month ( $28 \pm 5$  and  $24 \pm 2$ -d intervals, respectively), and responsibilities for diet formulation were shared primarily between feed company nutritionists (48 herds) and private nutrition consultants (42 herds). The mean percentage of CP in the nonpregnant cow

**Table 5.** Summary of responses by herd managers (n = 103) to questions related to nutrition and body condition scoring, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables)

Question	Response (number)
How are your cows typically fed?	Drive-through (67) Drive-by (19) Outside feeding (9)
At what frequency is fresh feed delivered?	1.8 $\pm$ 0.1 times/d
How many times is feed pushed up each day?	6.8 $\pm$ 0.4 times/d
How much bunk space per cow in the main breeding pen?	52.6 $\pm$ 1.5 cm/cow
How much bunk space per cow in other breeding pens?	56.4 $\pm$ 2.5 cm/cow
What is the targeted feed refusal rate?	3.5 $\pm$ 0.2% of feed delivered
How often are your feeds tested?	24 $\pm$ 2 d
How often are the diets reformulated?	28 $\pm$ 5 d
Who is the main person responsible for formulating diets?	Feed company nutritionist (48) Private consultant (42) Veterinarian (5) On-farm employee (1) Other (4)
What is the percentage of CP in the nonpregnant cow diet?	17.8 $\pm$ 0.1% (DM basis)
What proportion is RDP?	51.7 $\pm$ 2.1% (of CP)
Is urea fed to nonpregnant cows?	Yes (43) 53 $\pm$ 6 mL/cow No (44)
Percentage of NDF in nonpregnant cow rations	30.8 $\pm$ 0.6%
Percentage of nonfermentable carbohydrates in these rations	38.9 $\pm$ 0.7%
Percentage of fat in nonpregnant cow rations	5.0 $\pm$ 0.1%
Percentage of phosphorous in nonpregnant cow rations	0.44 $\pm$ 0.03%
How often do you BCS your cows?	Never (53) Evaluate at pen level every 30 $\pm$ 6 d (31) Evaluate cows individually every 59 $\pm$ 23 d (12)
When were cows in the breeding pen(s) scored most recently?	70 $\pm$ 36 d prior to the survey
When had cows in the breeding pen(s) been scored previously?	123 $\pm$ 56 d prior to the survey
Which pens are routinely scored?	Yearling heifers (81) Nonpregnant cows (75) Cows calved $\leq$ 10 d (72) Nonlactating cows (71) All pens (70)
Who does the BCS?	Nutritionist (26) Farm employee (12) Other (9)
Does the nutritionist use these scores when balancing rations?	Yes (35) No (10)

diet was 17.8  $\pm$  0.1%, on a DM basis, and the mean percentage of RDP (of total CP) was 51.7  $\pm$  2.1%. The mean percentage of CP was in close agreement (17.5%) with Godden et al. (2001) in Ontario herds, although the mean percentage of RDP was 65.5% in the Ontario study. Roughly half of the herds (43 of 87 herds that responded to the question) fed urea, at 53  $\pm$  6 mL/d per cow. Mean percentages of NDF and nonfermentable carbohydrates were 30.8  $\pm$  0.6 and 38.9  $\pm$  0.7%, respectively, which were very similar to the 31.3 and 39.4%, respectively, in the study of Godden et al. (2001). Mean percentages of fat and phosphorous in the diet were 5.0  $\pm$  0.1 and 0.44  $\pm$  0.03%, respectively. Responses regarding evaluation of BCS were somewhat inconsistent, although nearly all herds evaluated heifers, cows recently calving, nonpregnant cows, and nonlactating cows periodically, with pens of nonpregnant cows evaluated at roughly 2-mo intervals. The importance of BCS with respect to postpartum health and fertility

is well documented (e.g., Veerkamp et al., 2000). Furthermore, BCS near the time of timed AI after Presynch + Ovsynch is inversely related to fertility (Moreira et al., 2000).

Table 6 documents the type of housing, group size, and pen movement strategy on farms. Mean entry and exit dates for the pregnant, nonlactating cows ("far-off dry cow pen") were 52.5  $\pm$  1.2 and 20.7  $\pm$  0.7 d prepartum, respectively. Mean group size was 60  $\pm$  4 cows, with free stall (47 herds) and bedded pack (15 herds) as the most common housing types, and with sand (30 herds), mattresses (14 herds), and sawdust (13 herds) as the most common bedding types. Mean entry and exit dates for the "close-up dry cow pen" were 20.3  $\pm$  1.3 and 3.1  $\pm$  0.8 d prepartum, respectively, whereas mean group size was 41  $\pm$  4 cows. Bedded packs (29 herds) were used more commonly, relative to free-stall housing (38 herds), than in the far-off dry cow pens. Sand (26 herds) was again the preferred type of bed-

**Table 6.** Summary of information provided by herd managers (n = 103) relative to grouping strategies and pen movements, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables)

Pen characteristic	Response (number)
Pen for pregnant, nonlactating cows ("far-off dry cow pen")	
Entry time	52.5 $\pm$ 1.2 d prepartum
Exit time	20.7 $\pm$ 0.7 d prepartum
Group size	60 $\pm$ 4 cows
Barn type	2-row head to head (9) 2-row tail to tail (17) 3-row (21) Bedded pack (15) Other (18)
Bedding type	Sand (30) Mattress (14) Sawdust (13) Other (19)
Stall dimensions	210 $\pm$ 11 $\times$ 116 $\pm$ 4 cm
Pen for pregnant, nonlactating cows shortly before calving ("close-up dry cow pen")	
Entry time	20.3 $\pm$ 1.3 d prepartum
Exit time	3.1 $\pm$ 0.8 d prepartum
Group size	41 $\pm$ 4 cows
Barn type	2-row tail to tail (9) 3-row (17) Other (10)
Bedding type	Sand (26) Mattress (12) Sawdust (12) Other (21)
Stall dimensions	207 $\pm$ 13 $\times$ 110 $\pm$ 7 cm
Pen for cows at calving ("maternity cow pen")	
Entry time	2.4 $\pm$ 1.1 d prepartum
Exit time	0.8 $\pm$ 0.3 d postpartum
Group size	8.9 $\pm$ 1.3 cows
Barn type	2-row head to head (1) Bedded pack (55) Other (5)
Bedding type	Sand (9) Mattress (1) Sawdust (11) Other (30)
Stall dimensions	N/A
Pen for cows immediately after calving ("post-fresh milk withhold pen")	
Entry time	1.1 $\pm$ 0.1 d postpartum
Exit time	8.4 $\pm$ 1.4 d postpartum
Group size	22 $\pm$ 3 cows
Barn type	2-row head to head (14) 2-row tail to tail (10) 3-row (20) Bedded pack (16) Other (11)
Bedding type	Sand (24) Mattress (21) Sawdust (4) Other (16)
Stall dimensions	212 $\pm$ 12 $\times$ 115 $\pm$ 5 cm
Pen for cows that calved recently ("post-fresh saleable milk pen")	
Entry time	10 $\pm$ 3 d postpartum
Exit time	51 $\pm$ 7 d postpartum
Group size	73 $\pm$ 6 cows
Barn type	2-row head to head (22) 2-row tail to tail (13) 3-row (27) Bedded pack (4) Other (5)
Bedding type	Sand (33) Mattress (23) Sawdust (4) Other (11)
Stall dimensions	215 $\pm$ 8 $\times$ 113 $\pm$ 5 cm

ding, followed by mattresses and sawdust (12 herds each). Contreras et al. (2004) documented the effects of dry cow grouping strategy on health, body condition, and fertility and recommended a 2-group nutritional strategy for dry cows. Mean entry and exit dates for the "maternity cow pen" were  $2.4 \pm 1.1$  d prepartum and  $0.8 \pm 0.3$  d postpartum, respectively. Average group size was  $8.9 \pm 1.3$  cows, with a bedded pack (55 herds) as the most common type of housing. Weigel et al. (2003) reported a significantly lower risk of involuntary culling in herds with individual maternity pens. In the immediately after calving pen ("postfresh milk withhold pen"), mean group size was  $22 \pm 3$  cows, with mean entry and exit dates of  $1.1 \pm 0.1$  d and  $8.4 \pm 1.4$  d postpartum, respectively. Free-stall housing (44 herds) was most common, with sand (24 herds) and mattresses (21 herds) used for bedding. Weigel et al. (2003) and Bewley et al. (2001a) reported a reduced risk of involuntary culling and increased cow comfort in herds that used sand bedding, rather than mattresses. Last, the after-calving pen ("postfresh saleable milk pen") contained  $73 \pm 6$  cows, with mean entry and exit dates of  $10 \pm 3$  d and  $51 \pm 7$  d postpartum, respectively. Once again, free-stall housing (62 herds) was most common, with sand (33 herds) or mattresses (23 herds) as the preferred bedding choice. Average stall dimensions were largest in the postfresh saleable milk pen, at  $215 \pm 8$  by  $113 \pm 5$  cm, whereas average dimensions were smallest in the close-up dry cow pen, at  $207 \pm 13$  by  $110 \pm 7$  cm, most likely indicating the use of older barns to house dry cows. Tucker et al. (2004) reported higher average lying time in wide (126 or 132 cm) vs. narrow (106 or 112 cm) stalls, although stall width did not influence the number of lying events or milk yield.

Table 7 summarizes responses regarding animal health and biosecurity on farms that responded to the management survey. As expected, these herds were in a continuous state of expansion, with annual purchases ranging from  $63 \pm 16$  cows (in 2000) to  $109 \pm 25$  cows (in 2002). Pregnant heifers with increasing mammary gland development ("springing heifers") were purchased most frequently (63 herds), whereas in roughly equal numbers of herds (37 and 35, respectively) fresh primiparous cows and multiparous cows were purchased. Bewley et al. (2001b) noted that in 66% of expanding herds surveyed in Wisconsin, respondents purchased springing heifers, whereas 63% bought multiparous animals, and 21% purchased recently calved primiparous cows. Respondents to this survey indicated that only  $37 \pm 4\%$  of purchased animals were sire-identified. Lack of sire identification among purchased animals is a common problem in expanding herds, because it causes records from these

animals to be discarded from the national genetic evaluation system and precludes the use of computerized mating programs to control inbreeding. Strategies to minimize health problems when purchasing animals varied widely, with visual inspection prior to purchase (66 herds), vaccination of new cattle before (41 herds) or after purchase (51 herds), increased vaccination of the existing herd (24 herds), and quarantine of purchased animals (23 herds) as the most commonly used precautions. Bewley et al. (2001b) reported similar trends in expanding Wisconsin herds, with visual inspection before purchase used in 91% of herds, increasing the vaccination level of the existing herd used in 67%, and vaccination of new cattle before or after purchase used in 49 and 51%, respectively. Disease exposure can occur when heifers are sent to a multiple-source custom raiser, although this occurred in only 15 herds, as 68 raised their own heifers and 12 used a single-source custom calf raiser. In the survey of expanded Wisconsin herds (Weigel et al., 2003), 26% of farms sent heifers to a custom raiser.

Respondents were asked to indicate vaccines or injections that were typically used, as well as to rank the significance of various diseases as problems in their herds (1 = no problem, 2 = slight problem, 3 = major problem). Nearly all herds vaccinated animals for bovine viral diarrhea, infectious bovine rhinotracheitis, and leptospirosis (including 38 herds that used Spirovac specifically for *Lepto Hardjo-bovis*), although the use of Endovac (73 herds) and J-5 or J-Vac (45 herds) was also very common. In addition, 45 herds used supplemental vitamin E and selenium, in addition to that which was available in the diet. Among the health problems listed in Table 7, mastitis ( $2.17 \pm 0.05$  on a 3-point scale) and hairy heel warts ( $2.15 \pm 0.05$ ) were of greatest concern, followed by lameness ( $2.01 \pm 0.06$ ), abortions ( $1.94 \pm 0.04$ ), cow death losses ( $1.88 \pm 0.06$ ), John's disease ( $1.76 \pm 0.07$ ), and ketosis ( $1.64 \pm 0.05$ ). Although Bewley et al. (2001b) did not consider specific diseases or disorders, mastitis was the most commonly reported animal health problem in recently expanded Wisconsin herds.

## CONCLUSIONS

The present study provides a comprehensive summary of management practices, particularly those related to reproductive performance, on large, well-managed commercial dairy farms located throughout the United States. As such, it can serve as a useful reference regarding current practices in various aspects of modern dairy operations, including general management issues, sire selection, reproductive management, inseminator training and techniques, heat abatement

**Table 7.** Summary of responses by herd managers (n = 103) to questions related to animal health and biosecurity, along with corresponding means  $\pm$  SE (continuous variables) or counts (binary or categorical variables)

Question	Response (number)
Approximately how many animals did you purchase in the last 4 yr?	
2000	63 $\pm$ 16
2001	87 $\pm$ 18
2002	109 $\pm$ 25
2003	84 $\pm$ 21
What type of animals did you buy?	Pregnant heifers (63) Recently calved heifers (37) Mature cows (35) Calves or nonpregnant heifers (16)
Where did you buy these animals?	Cattle dealers (53) Private sale (48) Auctions (27) Sale barns (15) 37 $\pm$ 4%
What proportion of animals had sire identification?	
Which of the following practices did you use to minimize health problems when purchased animals?	Visually inspected animals before purchase (66) Vaccinated new cattle after moving them (51) Increased vaccinations of existing herd (24) Quarantined new animals for 15 $\pm$ 3 d (23) Vaccinated new cattle before moving them (41) Examined individual cow SCC records (19) Did bulk tank cultures before purchasing (18) Blood-tested animals before purchase (13) Examined individual cow health records (11)
What do you do with your heifer calves?	Raise them yourself (68) Multisource raiser (15) Single-source raiser (12) Sell them (2)
At what age are they at the custom raiser?	4.0 $\pm$ 0.7 mo until 20.3 $\pm$ 1.1 mo
How satisfied are you with your heifer program? (1 = very dissatisfied to 5 = very satisfied)	
Size and condition	4.01 $\pm$ 0.10
Health	4.18 $\pm$ 0.09
Please indicate the vaccines or injections that are used on your farm	Bovine viral diarrhea (90) Infectious bovine rhinotracheitis (87) <i>Lepto</i> (87) Endovac (73) J-5 or J-Vac (45) Vitamin E and selenium (45) Spirovac (38)
Which diseases are problems in your herd? (1 = no problem to 3 = major problem)	
Mastitis	2.17 $\pm$ 0.05
Hairy heel warts	2.15 $\pm$ 0.05
Lameness	2.01 $\pm$ 0.06
Abortions	1.94 $\pm$ 0.04
Death losses	1.88 $\pm$ 0.06
Johne's	1.76 $\pm$ 0.07
Ketosis	1.64 $\pm$ 0.05
Milk fever	1.38 $\pm$ 0.05
<i>Salmonella</i>	1.38 $\pm$ 0.06
<i>Lepto</i>	1.30 $\pm$ 0.05
Bovine viral diarrhea	1.11 $\pm$ 0.03
Infectious bovine rhinotracheitis	1.08 $\pm$ 0.03
Parainfluenza-3	1.08 $\pm$ 0.03

devices, BCS, facility design and pen movement, nutrition, employee training and management, and animal health and biosecurity.

Several key challenges and opportunities were identified in the present survey. Managers identified finding good employees as their greatest labor management challenge, although training and supervision of employees were also considered as challenging on

many farms. Mastitis, hairy heel warts, lameness, abortions, death losses, Johne's disease, and ketosis were identified as the most critical animal health concerns on these dairy farms. These herds were in a continuous state of expansion, with plans to increase the milking herd by more than 50% in the next 5 yr. However, fewer than 40% of animals purchased over the past 5 yr were sire-identified. As such, it is likely

that many purchased animals have poor genetic merit, and effective control of inbreeding in their progeny will be impossible. Additional opportunities may exist with regard to cleanliness of maternity pens, hoof trimming, and stall size. Fewer than half of respondents cleaned maternity pens after every calving, whereas many allowed  $\geq 4$  calvings between successive cleanings. In addition, many herds reported that maintenance hoof trimming took place at a frequency of once a year or less. Stall dimensions were adequate in the postcalving saleable milk pens, but other groups of animals, particularly nonlactating pregnant cows, were housed in older facilities with smaller stalls.

With regard to reproductive management, several key challenges were identified, including AI service rate, conception rate, twinning, and retained placenta or metritis. Among aids for detection of estrus, use of tail chalk was common, but few herds used pedometers or pressure-release patches. Nonpregnant cows were observed for estrus 3 times a day, for approximately 30 min per period, but it is of concern that nearly 80% of farms admitted to "multitasking" of other management activities during detection of estrus. These herds kept trying to achieve pregnancy in problem breeders well beyond peak lactation, with repeat inseminations continuing through nearly 9 failed inseminations, 300 d postpartum, or milk yield  $< 18$  kg/d, although one might question the value of achieving pregnancy at such a late stage in lactation. Nearly all farms used a VWP, although the average length of the VWP was just over 50 d in both primiparous and multiparous cows, and extending the time until first insemination might enhance the first-service conception rate. As expected, the vast majority of herds used hormonal synchronization or timed AI programs, and as such, the dedication of vast research resources to development and optimization of such programs in recent years appears justified. In summary, this study can provide a useful benchmark or reference with regard to commonly used management practices on large commercial US dairy farms at the present time.

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