Management factors associated with veterinary usage by organic and conventional dairy farms

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RUMINANTS

Objective—To identify management factors associated with veterinary usage by organic and conventional dairy farms.

Design—Prospective case-control study.

Sample—292 farms.

Procedures—Organic farms in New York, Oregon, and Wisconsin were matched to conventional farms on the basis of location and herd size. During a single herd visit, a questionnaire was administered, information about animal disease incidence and number of veterinarian visits in the preceding 60 days was collected, and forms to record similar information during the 60 days after the visit were left for the herd manager to complete. For analysis, conventional herds were classified as either grazing or nongrazing. Multiple correspondence analysis was used to assess relationships among management factors and selected outcomes for frequency of veterinary usage.

Results—Intensive management practices were closely associated with frequent veterinary usage. Generally, organic management practices were associated with less frequent veterinary usage than were conventional management practices. Conventional grazing practices were associated with intermediate veterinary usage (more than organic practices but less than intensive practices), whereas conventional nongrazing practices were associated with frequent veterinary usage. Cost of routinely scheduled veterinarian visits/45 kg (100 lb) of milk produced/y was greater for small farms than that for large farms.

Conclusions and Clinical Relevance—Results suggested that management intensiveness was more closely associated with frequency of veterinary usage than was organic status; therefore, veterinarians should characterize farms by factors other than organic status when investigating which farms are most likely to use their services. Economic factors substantially affected routine veterinary usage on small farms. (*J Am Vet Med Assoc* 2013;242:1732–1743)

Relationships between veterinarians and dairy herd managers vary greatly, and results of several studies[1–4] suggest that that relationship might be influenced by adoption of organic management practices. Canadian researchers reported that veterinarians visited organic dairy farms only 3 to 4 times/y to treat sick cows.[1] Several European researchers have reported that veterinarians treated fewer sick cows on organic farms, compared with number of sick cows treated by veterinarians on conventional farms.[2–4] In Europe, information regarding the frequency of treatments performed by veterinarians is often obtained from national disease recording databases; however, reporting bias can occur and may be influenced by disease diagnosis and severity as well as compliance with reporting requirements.[5] Reporting bias also occurs when herd managers fail to record treatments administered to cows.[6] Also, organic herd managers are more likely to initiate treatment of diseased cattle without veterinary input than are conventional herd managers such that there is a greater potential for reporting bias in data obtained from organic farms than in data obtained from conventional farms.[4] Consequently, information obtained from national databases may underestimate the true frequency of treatments performed by veterinarians on dairy farms and may not provide an accurate comparison between organic and conventional management systems.

Herd managers use a variety of criteria to decide when to call a veterinarian. For example, the definition

Abbreviations

AI	Artificial insemination
DHIA	Dairy Herd Improvement Association
MCA	Multiple correspondence analysis
RHA	Rolling herd average
SCC	Somatic cell count

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of mastitis may be a key determinant for initiation of clinical mastitis treatment.[7–9] Prior to calling a veterinarian, many herd managers also consider the individual characteristics (eg, parity and stage of lactation) of the affected cow, herd factors (eg, predominant breed or presence of another sick animal on the farm),[10] and their previous experience with alternatives to traditional treatment (eg, drying off the affected quarter or segregating mastitic milk from the bulk tank).[8] Lack of standardization of criteria for having a veterinarian examine and treat a sick animal may result in variations in the frequency of treatments administered by veterinarians among national databases.[11] The United States does not have a unified database of treatments performed on dairy farms, and the US National Organic Program strictly limits the medications allowed for use on certified organic farms. Thus, veterinarians practice under a different set of guidelines on organic farms than they do on conventional farms.[12]

Results of multiple studies[13–16] suggest that veterinarians are less involved in animal health care on organic farms than they are on conventional farms. In 1 study,[13] only 112 of 288 (39%) organic farms used routine veterinary services, compared with 836 of 1,194 (70%) conventional farms that used routine veterinary services.[13] In Denmark, organic herd managers reported that veterinarians were more involved in the treatment of individual sick cattle rather than in the advisement of disease prevention programs.[14,15] In the United States, organic herd managers are more likely to rely on other producers for advice regarding individual cow treatments, whereas conventional herd managers are more likely to rely on veterinarians for advice regarding individual cow treatments.[16] The frequency of treatments administered by veterinarians represents only 1 aspect of the relationship between veterinarians and dairy herd managers. The role of a veterinarian on a dairy farm may also include the performance of routine practices (ie, pregnancy diagnosis), creation of standard operating protocols for the treatment of various diseases, input into the assessment and establishment of herd performance goals, and training of farm personnel. Information regarding the role of veterinarians on US dairy farms is lacking. The objectives of the study reported here were to characterize the role of veterinarians on organic and similarly sized conventional dairy farms and to identify farm characteristics that were associated with the frequency of veterinary usage.

Materials and Methods

Farm selection—Between April 2009 and April 2011, dairy farms located in New York, Oregon, and Wisconsin were recruited for the study. To be included in the study, each farm had to have a minimum of 20 cows and must have produced and sold milk commercially for at least the 2 years prior to study enrollment. To be classified as an organic farm, a farm must have been certified as organic for at least the 2 years prior to study enrollment. Letters that described the study were mailed to all organic dairy farms as well as randomly selected conventional dairy farms that were located in the same counties as the organic farms. Letters were mailed to nonresponding farms multiple times in an effort to increase study participation. Conventional farms were matched to each organic farm that was enrolled in the study on the basis of herd size (total lactating and dry cows), which was classified into 1 of 4 categories: < 100 cows, 100 to 199 cows, 200 to 299 cows, or ≥ 300 cows). Because of variations in farm demographics within each state, the ratio of organic farms to conventional farms varied by state (3:1 for New York, 1:1 for Oregon, and 2:1 for Wisconsin).

Questionnaire—The questionnaire[17] used was adapted from published survey instruments,[16,18] with input from veterinarians familiar with the organic dairy industry. The questionnaire consisted of 208 questions regarding herd inventory and expansion (n = 8), production and health (7), reproduction (14), housing (4), feed and water (18), milking procedures (21), cow routine and screening procedures (8), cow disease definitions and treatment (42), mastitis definitions and treatment (20), paratuberculosis (13), selected disease scenarios (3), veterinarian involvement (8), routine management of calves (14), calf disease definitions and treatment (12), routine management of heifers (8), and heifer disease definition and treatment (8). For each farm, responses were recorded on the basis of the herd manager's recall and review of farm records. The definition for each disease that was evaluated via the questionnaire varied among farms and represented the herd manager's perception of that disease.

The likelihood of a veterinarian being called to examine a cow was evaluated with a 5-point Likert scale (ie, not at all likely, slightly likely, somewhat likely, very likely, or extremely likely) for each of 3 scenarios: a newly identified anorexic cow, an anorexic cow that had been treated for 2 days and its condition remained the same, and an anorexic cow that had been treated for 2 days and its condition had deteriorated. Despite frequent communication among study personnel and contemporaneous scheduling of farm visits, this question was inadvertently asked in different manners in the 3 states. In New York and Oregon, herd managers were asked to rank the likelihood of their calling a veterinarian on a scale from 1 to 5, whereas in Wisconsin, herd managers were asked to choose from the list of choices provided in the questionnaire. The answers to the 3 likelihood scenarios were combined into a Likert summative scale to measure the underlying latent outcome variable for likelihood of calling a veterinarian.[19] Because of differences in administration of the questionnaire, the data for the combined latent outcome variable for farms in Wisconsin were analyzed separately and compared with that data for farms in New York and Oregon.

For most questions, the recall period was either 60 days or 1 year, but for a few questions, the recall period could have been up to 3 years before the visit. The same questionnaire was used for both conventional and organic farms. Study approval was obtained from the Institutional Review Board and Animal Care and Use Committee of Oregon State University.

Data collection—Within each state, herd managers were interviewed by the same investigator. All study investigators met and were trained on administra-

tion of the questionnaire before the herd visits began. Throughout the data collection period, investigators held monthly conference calls to discuss questions and help ensure standardization of data collection among farms in the 3 states.

For most farms, the person directly responsible for animal care was interviewed. Information regarding frequencies of farm visits by a veterinarian, disease, and treatments was collected for both retrospective and prospective periods. Retrospective data were collected for the 60 days immediately prior to the farm visit on the basis of manager recall and review of farm records. Prospective data were collected for the 60-day period immediately after the farm visit via completion of standardized forms by the herd manager. Herd managers were instructed to recall or record information about all sick cattle, regardless of administration of treatment.

Statistical analysis—Each farm was classified as organic, conventional grazing, or conventional nongrazing. For the present study, the definition of a grazing farm was the same as that established by the US National Organic Program[20]; thus, conventional grazing farms were farms that were not certified organic and on which ≥ 30% of dry matter intake by lactating cows during the growing season was obtained from pasture. Other farm variables evaluated included state where the farm was located (New York, Oregon, or Wisconsin), number of years the herd manager had been involved in dairy farming (< 15 years, 15 to 32 years, or > 32 years), herd size (20 to 99 cows, 100 to 199 cows, or ≥ 200 cows), predominant breed of cows in herd (Holstein, Jersey, or other), proportion of cows in their third or later lactation (0% to 34%, > 34% to 50%, or > 50%), RHA (≤ 5,674 kg/cow/y [≤ 12,483 lb/cow/y], > 5,674 to 8,960 kg/cow/y [>12,483 to 19,712 lb/cow/y], or > 8,960 kg/cow/y), bulk tank SCC (≤ 130,000 cells/mL, > 130,000 to 280,000 cells/mL, or > 280,000 cells/mL), amount of grain fed (none, ≤ 3.6 kg/cow/d [≤ 7.9 lb/cow/d], > 3.6 to 8.2 kg/cow/d [> 7.9 to 18.0 lb/cow/d], or > 8.2 kg/cow/d), whether pregnancy checks were performed (yes or no), use of a nutritionist (yes or no), use of DHIA testing (yes or no), use of vaccines or homeopathic nosodes (ie, vaccines; yes or no), cows bred by AI exclusively (yes or no), use of written herd records (yes or no), and whether new cattle were added to the herd during the observation period (yes or no). The unit of analysis was farm. Descriptive statistics were generated to verify accuracy of data, detect missing data, and observe frequency distributions. Because the outcomes for all the variables were categorized, comparisons among the 3 farm classifications were performed via χ^2 analyses except when the expected value in at least 1 cell was < 5 and a Fisher exact test was performed. All analyses were performed with statistical software,[a] and values of $P \leq 0.05$ were considered significant.

Completion of the prospective data forms by the herd manager was considered a potential source of selection bias and was evaluated via multiple methods. A Wilcoxon rank sum test was used to determine whether herd size or RHA was associated with completion of the prospective data form by the herd manager. A χ^2 analysis was used to determine whether the state where the farm was located or farm classification was associated with completion of the prospective data form. Finally, a Cochran-Mantel-Haenszel analysis was used to determine whether completion of the prospective data form was associated with farm classification after an adjustment was made for variation in farm recruitment by state.

Multiple correspondence analysis was performed to assess relationships between categorical outcome and explanatory variables.[21] Continuous variables were categorized; typically, the cutoffs used to define the categories were none (when appropriate) and the 25th and 75th percentiles. When possible, outcome variables were categorized into ≥ 3 levels to more clearly demonstrate associations.[22] The outcome variable for each MCA was projected as a supplementary variable onto the MCA axes.[21,22]

For each farm in New York and Wisconsin, the number of all veterinary visits during the 60 days before (ie, retrospective data collection period) and after (ie, prospective data collection period) the farm visit by the study investigators was adjusted for herd size to create a standardized outcome variable (ie, the number of veterinary visits/100 cows/30 d) and then categorized (none, few [> 0 to ≤ 0.85 veterinary visits/100 cows/30 d], some [> 0.85 to 2.3 veterinary visits/100 cows/30 d], or many [> 2.3 veterinary visits/100 cows/30 d]). The number of routinely scheduled veterinary visits was similarly standardized (ie, the number of routinely scheduled veterinary visits/100 cows/y) and categorized (none, few [> 0 to ≤ 0.75 routinely scheduled veterinary visits/100 cows/y], some [> 0.75 to 19 routinely scheduled veterinary visits/100 cows/y], or many [> 19 routinely scheduled veterinary visits/100 cows/y]). χ^2 analyses were used to determine the respective associations between the number of veterinary visits (all and routinely scheduled visits) and each farm variable evaluated. For each χ^2 analysis, the categories for the number of veterinary visits formed the columns and the categories for each farm variable formed the rows. All farm variables that were unconditionally associated with the number of veterinary visits were included in an MCA.

The respective associations between farm classification and type of veterinary visit (routine, scheduled in advance, or not scheduled in advance) and type of work performed during the veterinary visit (reproductive, examination and treatment of sick cows, routine [vaccination or dehorning], consulting, or emergency) were evaluated with χ^2 analyses. For the subset routinely scheduled veterinary visits, the association between farm classification and type of work performed during the veterinary visit was evaluated with χ^2 analysis. χ^2 analysis was also used to evaluate the association between herd size and the number of routinely scheduled veterinary visits. The extent of agreement between the number of routinely scheduled veterinary visits reported by the herd manager during the interview with study investigators and the number of routinely scheduled veterinary results obtained via records review for the retrospective and prospective data collection periods was assessed with a κ statistic.[22] The cost of a routinely scheduled veterinary visit/45 kg (100 lb) milk produced/y was calculated for each farm on the basis of the following assumptions:

call fee per veterinary visit, $40; hourly veterinary fee, $160/h; only pregnancy examinations were performed during each visit; each pregnancy examination took 1 minute to perform; and each cow calved and was examined for pregnancy once/y.

The respective associations between the likelihood that a herd manager would call a veterinarian to examine a sick cow and the various farm variables were evaluated with χ^2 analyses. For Wisconsin farms, all farm variables that were unconditionally associated with the likelihood that a herd manager would call a veterinarian to examine a sick cow were included in an MCA.

χ^2 analyses were performed to evaluate the respective associations between veterinary examination of at least 1 sick cow during the retrospective and prospective data collection periods and the various farm variables as well as the association between farm classification and the other types of work performed by veterinarians during farm visits (ie, training of farm personnel, development of treatment protocols, or necropsies). For each selected disease (clinical mastitis, foot problems, ketosis, metritis, hypocalcemia, pneumonia, or other disease), the association between farm classification and the probability that an affected cow would be examined by a veterinarian was evaluated by the use of generalized estimating equations with farm included as a random effect in the model to account for clustering of disease-affected cows within farm.

Results

Study farms—Approximately 30% of the eligible organic dairy farms in New York and Wisconsin and 60% of the eligible organic dairy farms in Oregon were enrolled in the study. The enrollment criteria used resulted in a study population of farms that approximated the general population of dairy farms in the 3 participating states.[23] Descriptive data for the 292 dairy farms that were enrolled in the study were summarized (**Table 1**). The majority (209/292 [72%]) of study farms had < 100 cows, whereas the remaining farms were equally split between the medium (100 to 199 cows) and large (≥ 200 cows) herd size categories. The proportion of conventional nongrazing farms that were classified as medium- and large-sized herds was greater, compared with the proportion of organic or conventional grazing herds that were classified as medium- and large-sized herds. Organic and conventional grazing farms had a greater proportion of cows in their third or later lactation than did conventional nongrazing farms. For the farms for which RHA data were available, the majority (174/189 [92%]) of organic farms were classified in the low and medium RHA categories, whereas the majority (44/64 [69%]) of conventional nongrazing farms were classified in the high RHA category. Of the 192 organic farms, 24 (13%) did not feed any grain to their cows and 60 (31%) fed only low amounts (≤ 3.6 kg/cow/d) of grain to their cows, whereas the majority (40/64 [63%]) of conventional nongrazing farms fed high amounts (> 8.2 kg/cow/d) of grain to their cows. Farm classification (organic, conventional grazing, or conventional nongrazing) was significantly associated with having cows examined for pregnancy ($P < 0.001$), use of a nutritionist ($P < 0.001$), use of DHIA testing ($P = 0.021$), use of vaccines ($P < 0.001$), predominant breed of cows in herd ($P < 0.001$), and number of sick cows examined by a veterinarian during the study observation period ($P < 0.001$).

Completion of data collection—Completion of the prospective data forms by the herd manager was not associated with herd size or RHA. After adjusting for state, farm classification was also not associated with completion of the prospective data forms by the herd manager. Information regarding veterinary visits during the retrospective data collection period was obtained for 87 farms in New York and 112 farms in Wisconsin, of which 28 (32%) farms in New York and 83 (74%) farms in Wisconsin also provided information regarding veterinary visits during the prospective data collection period; thus, complete information regarding veterinary visits was available for 111 farms. Information regarding sick cows during the retrospective data collection period was obtained for 95, 40, and 147 farms in New York, Oregon, and Wisconsin, respectively, of which 29 (31%), 31 (78%), and 118 (80%) farms in New York, Oregon, and Wisconsin, respectively, also provided information regarding sick cows during the prospective data collection period. Thus, complete information regarding sick cows was available for 178 farms.

All veterinary visits—For the 199 study farms from which data were obtained, 50 (25%) reported no veterinary visits during the observation period (**Table 2**). For the remaining 149 farms, 682 veterinary visits were recorded during the retrospective and prospective data collection periods (**Table 3**). Of those 682 visits, 321 (47%) were routinely scheduled, 119 (17%) were scheduled in advance, and 242 (35%) were not scheduled in advance. For all veterinary visits, reproductive work (398/682 [58%]) was most frequently performed followed by examination and treatment of sick cows (286/682 [42%]), whereas emergency work (68/682 [10%]) and consulting (15/682 [2%]) were performed infrequently. Routine work (ie, vaccination or dehorning) was the only category of veterinary work that was significantly ($P < 0.001$) associated with farm classification and was more frequently performed on conventional grazing farms than on organic or conventional nongrazing farms.

The frequency of veterinary visits ranged from 0.11 to 7.1 veterinary visits/100 cows/30 d. Farm classification was significantly ($P < 0.001$) associated with the frequency of veterinary visits. Approximately equal proportions of organic farms were classified as having no (48/135 [36%]) or some (ie, > 0.85 to ≤ 2.3 veterinary visits/100 cows/30 d; 47/135 [35%]) veterinary visits. Most conventional grazing farms (11/19) were classified as having some veterinary visits, whereas most conventional nongrazing farms were classified as having some (17/45 [38%]) or many (ie, > 2.3 veterinary visits/100 cows/30 d; 20/45 [44%]) veterinary visits. Other farm variables unconditionally associated with frequency of veterinary visits included state, RHA, bulk tank SCC, amount of grain fed to cows, having cows examined for pregnancy, use of a nutritionist, use of DHIA testing, use of vaccines, predominant breed of cows in the herd, and method used to breed cows.

Results of MCA revealed that the frequency of veterinary visits was associated with multiple factors

Table 1—Frequency distribution (No. [%]) of organic (n = 192), conventional grazing (36), and conventional nongrazing (64) dairy farms in New York (97), Oregon (48), and Wisconsin (147) that were enrolled in a prospective case-control study to identify management factors associated with the frequency of veterinary usage for various explanatory variables.

	Farm classification				
Variable	Organic	Conventional grazing	Conventional nongrazing	All farms	*P* value
State located					0.002
New York	72 (38)	11 (31)	14 (22)	97 (33)	
Oregon	24 (13)	13 (36)	11 (17)	48 (16)	
Wisconsin	96 (50)	12 (33)	39 (61)	147 (50)	
Time involved in dairy farming					0.200
Few (< 15 y)	55 (29)	9 (25)	11 (17)	75 (26)	
Medium (15–32 y)	93 (48)	19 (53)	30 (47)	142 (49)	
Many (> 32 y)	44 (23)	8 (22)	23 (36)	75 (26)	
Herd size					< 0.001
Small (20–99 cows)	146 (76)	27 (75)	36 (56)	209 (72)	
Medium (100–199 cows)	25 (13)	4 (11)	13 (20)	42 (14)	
Large (≥ 200 cows)	21 (11)	5 (14)	15 (23)	41 (14)	
Predominant breed					< 0.001
Holstein	103 (54)	26 (72)	55 (86)	184 (63)	
Jersey	21 (11)	6 (17)	3 (5)	30 (10)	
Other breed or crossbred	68 (35)	4 (11)	6 (9)	78 (27)	
Proportion of cows in third or later lactation					< 0.001
Few (0%–34%)	45 (23)	12 (33)	24 (38)	81 (28)	
Medium (> 34%–50%)	85 (44)	16 (44)	34 (53)	135 (46)	
Many (> 50%)	62 (32)	8 (22)	6 (9)	76 (26)	
RHA*					< 0.001
Low (≤ 5,674 kg/cow/y)	64 (34)	4 (11)	2 (3)	70 (24)	
Medium (> 5,674–8,960 kg/cow/y)	111 (59)	18 (50)	18 (28)	147 (51)	
High (> 8,960 kg/cow/y)	14 (7)	14 (39)	44 (69)	72 (25)	
Bulk tank SCC					0.443
Low (≤ 130,000 cells/mL)	42 (22)	13 (36)	15 (23)	70 (24)	
Medium (> 130,000–280,000 cells/mL)	95 (49)	14 (39)	33 (52)	142 (49)	
High (> 280,000 cells/mL)	55 (29)	9 (25)	16 (25)	80 (27)	
Amount of grain fed					< 0.001
None	24 (13)	0 (0)	0 (0)	24 (8)	
Low (≤ 3.6 kg/cow/d)	60 (31)	2 (6)	6 (9)	68 (23)	
Medium (> 3.6–8.2 kg/cow/d)	88 (46)	13 (36)	18 (28)	119 (41)	
High (> 8.2 kg/cow/d)	20 (10)	21 (58)	40 (63)	81 (28)	
Have pregnancy checks performed	115 (60)	28 (78)	60 (94)	203 (70)	< 0.001
Use a nutritionist	88 (46)	32 (89)	62 (97)	182 (62)	< 0.001
Use DHIA testing	102 (53)	25 (69)	45 (70)	172 (59)	0.021
Use vaccines†	139 (72)	36 (100)	63 (98)	238 (82)	< 0.001
Cows bred by AI exclusively	93 (48)	25 (69)	50 (78)	168 (58)	< 0.001
Use written herd health records‡	183 (95)	33 (92)	60 (94)	276 (95)	0.647
New cattle added to herd	72 (38)	20 (56)	27 (42)	119 (41)	0.125

Organic farms were matched to each conventional farm on the basis of herd size and location, and the ratio of organic farms to conventional farms varied by state (3:1 for New York, 1:1 for Oregon, and 2:1 for Wisconsin) because of variations in farm demographics among the 3 states. For variables with > 1 category, rounding may result in percentages that do not sum to 100 within a farm classification.

*Data available for only 189, 36, and 64 organic, conventional grazing, and conventional nongrazing farms, respectively. †Vaccines included commercially prepared vaccines, autogenous vaccines, and homeopathic nosodes. ‡Herd health records included information related to reproduction such as breeding or calving records.

(**Figure 1**). The category many veterinary visits was closely associated with conventional grazing. The category some veterinary visits was closely associated with a cluster of variables that included Holstein as the predominant breed of cows in the herd, a low bulk tank SCC, use of vaccines, having cows examined for pregnancy, use of a nutritionist, exclusive use of AI for breeding purposes, and farms located in Wisconsin and New York. The category few veterinary visits was loosely associated with a cluster of variables that included feeding a medium amount of grain to cows, having a medium RHA, and Jersey as the predominant breed of cows in the herd. The category no veterinary visits was closely associated with a cluster of variables that included no use of vaccines, no use of a nutritionist, not having cows examined for pregnancy, feeding a low amount of grain to cows, use of bulls for breeding purposes, and crossbred as the predominant breed of cows in the herd.

Routinely scheduled veterinary visits—For the 199 study farms from which data were obtained, 80 (40%) recorded 321 routinely scheduled veterinary visits during the retrospective and prospective data collection periods (Table 3). During routinely scheduled veterinary visits, reproductive work (307/321 [96%]) was most frequently performed followed by routine work (ie, vaccination or dehorning; 119/321 [37%]), examination and treatment of sick cows (53/321 [17%]), and consulting (11/321 [3%]); emergency work was not performed during any routinely scheduled veterinary visit. Reproductive work ($P = 0.001$) and routine work ($P < 0.001$) were significantly associated with farm classification. Reproductive work was more commonly performed during routine veterinary visits on conventional nongrazing farms than during routinely scheduled veterinary visits on organic or conventional grazing farms. Routine work was more commonly performed during routinely scheduled veterinary visits on conventional

grazing farms than during routine veterinary visits on organic or conventional nongrazing farms.

Of the 292 study farms, 154 (53%) reported having no routinely scheduled veterinary visits (Table 2). The frequency of routinely scheduled veterinary visits ranged from 0.51 to 67 visits/100 cows/y and was significantly associated with herd size ($P < 0.001$) and farm classification ($P < 0.001$). Of the 209 small-sized herds (ie, 20 to 99 cows), 130 (62%), 6 (3%), 41 (20%), and 32 (15%) had no, few, some, and many routinely scheduled veterinary visits, respectively. Of the 42 medium-sized herds (ie, 100 to 199 cows), 14 (33%), 8 (19%), 18 (43%), and 2 (5%) had no, few, some, and many routinely scheduled veterinary visits, respectively. Of the 41 large-sized herds, 10 (24%), 21 (51%), 9 (22%), and 1 (2%) had no, few, some, and many routinely scheduled veterinary visits. The majority (123/192 [64%]) of organic farms reported no routinely scheduled veterinary visits, compared with 16 of 36 (44%) conventional grazing and 15 of 64 (23%) conventional nongrazing farms that had no routinely scheduled veterinary visits. The proportion of conventional grazing farms with some routinely scheduled veterinary visits was approximately twice that of organic farms with some routinely scheduled veterinary

Table 2—Frequency distribution (No. [%]) of farms from Table 1 for various outcome variables.

Variable	Farm classification			All farms	*P* value
	Organic	Conventional grazing	Conventional nongrazing		
All veterinary visits (for farms in New York and Wisconsin)*					< 0.001
None	48 (36)	1 (5)	1 (2)	50 (25)	
Few (> 0 to ≤ 0.85/100 cows/30 d)	26 (19)	3 (16)	7 (16)	36 (18)	
Some (> 0.85 to ≤ 2.3/100 cows/30 d)	47 (35)	11 (58)	17 (38)	75 (38)	
Many (> 2.3/100 cows/30 d)	14 (10)	4 (21)	20 (44)	38 (19)	
Routinely scheduled veterinary visits					< 0.001
None	123 (64)	16 (44)	15 (23)	154 (53)	
Few (> 0 to ≤ 7.5/100 cows/y)	23 (12)	4 (11)	8 (13)	35 (12)	
Some (> 7.5 to ≤ 19/100 cows/y)	33 (17)	14 (39)	21 (33)	68 (23)	
Many (> 19/100 cows/y)	13 (7)	2 (6)	20 (31)	35 (12)	
Likelihood of calling a veterinarian for a sick cow (for farms in New York and Oregon)					0.738
Low (likelihood value, ≤ 6)	26 (27)	7 (29)	5 (20)	38 (26)	
Medium (likelihood value, > 6 to ≤ 11)	44 (46)	8 (33)	12 (48)	64 (44)	
High (likelihood value, > 11)	26 (27)	9 (38)	8 (32)	43 (30)	
Likelihood of calling a veterinarian for a sick cow (for farms in Wisconsin)					< 0.001
Low (likelihood value, ≤ 6)	11 (11)	0 (0)	0 (0)	11 (7)	
Medium (likelihood value, > 6 to ≤ 11)	59 (61)	7 (58)	13 (33)	79 (54)	
High (likelihood value, > 11)	26 (27)	5 (42)	26 (67)	57 (39)	
Veterinary examination of at least 1 sick cow during retrospective and prospective data collection periods†	49 (47)	18 (75)	36 (78)	103 (59)	< 0.001

*Data available for only 135, 19, and 45 organic, conventional grazing, and conventional nongrazing farms, respectively. †Data available for only 105, 24, and 46 organic, conventional grazing, and conventional nongrazing herds, respectively. The 60 days before and after the farm visit by study investigators were defined as the retrospective and prospective data collection periods, respectively.

See Table 1 for remainder of key.

Table 3—Number (%) of various types of veterinary visits and types of work performed during veterinary visits for either the 60 days before or the 120-day observation period extending from 60 days before to 60 days after a farm visit by study investigators for 135 organic, 19 conventional grazing, and 45 conventional nongrazing farms described in Table 1.

Variable	Farm classification			All farms	*P* value
	Organic	Conventional grazing	Conventional nongrazing		
Type of veterinary visit					
Routine	117 (43)	27 (40)	177 (51)	321 (47)	0.044
Scheduled in advance	70 (26)	20 (30)	29 (8)	119 (17)	< 0.001
Not scheduled in advance	84 (31)	20 (30)	138 (40)	242 (35)	0.038
Type of work performed during all veterinary visits					
Reproductive	160 (59)	36 (54)	202 (59)	398 (58)	0.682
Examination and treatment of sick cows	105 (39)	27 (40)	154 (45)	286 (42)	0.310
Routine (vaccinations or dehorning)	70 (26)	26 (39)	62 (18)	158 (23)	< 0.001
Teaching, training, or consulting	5 (2)	0 (0)	10 (3)	15 (2)	0.398
Emergency	28 (10)	9 (13)	31 (9)	68 (10)	0.526
Type of work performed during routinely scheduled veterinary visits*					
Reproductive	107 (91)	24 (89)	176 (99)	307 (96)	0.001
Examination and treatment of sick cows	19 (16)	4 (15)	30 (17)	53 (17)	0.957
Routine (vaccinations or dehorning)	47 (40)	19 (70)	53 (30)	119 (37)	< 0.001
Teaching, training, or consulting	3 (3)	0 (0)	8 (5)	11 (3)	0.562

*Data for 117, 27, and 177 routinely scheduled veterinary visits on 39 organic, 9 conventional grazing, and 32 conventional nongrazing farms, respectively.

See Table 1 for remainder of key.

visits, and the proportion of conventional nongrazing farms with many routinely scheduled veterinary visits was approximately 5 times that of organic or conventional grazing farms with many routinely scheduled veterinary visits. Other farm variables associated with the frequency of routinely scheduled veterinary visits were state, RHA, proportion of cows in the herd in their third or later lactation, amount of grain fed to cows, having cows examined for pregnancy, use of a nutritionist, use of vaccines, use of written herd health records, and predominant breed of cows in the herd.

Results of MCA revealed that the frequency of routinely scheduled veterinary visits was associated with multiple factors (**Figure 2**). The category no routinely scheduled veterinary visits was closely associated with the use of a bull for breeding purposes and organic farms. The category some routinely scheduled veterinary visits was closely associated with the use of a nutritionist. The categories few and many routinely scheduled veterinary visits were not closely associated with any farm variables.

The estimated cost of a routinely scheduled veterinary visit/45 kg of milk produced/y decreased as the number of cows in the herd increased, the mean milk production per cow increased, and the number of routinely scheduled veterinary visits per year decreased (**Figure 3**). The extent of agreement for the use of routinely scheduled veterinary visits reported by herd managers during the interview conducted by study investigators and information obtained from records review for the retrospective and prospective data collection periods was 98% with a κ of 0.87, which indicated good agreement between the 2 reporting methods.

Examination of sick cows by veterinarians—The use of veterinarians to diagnose various diseases

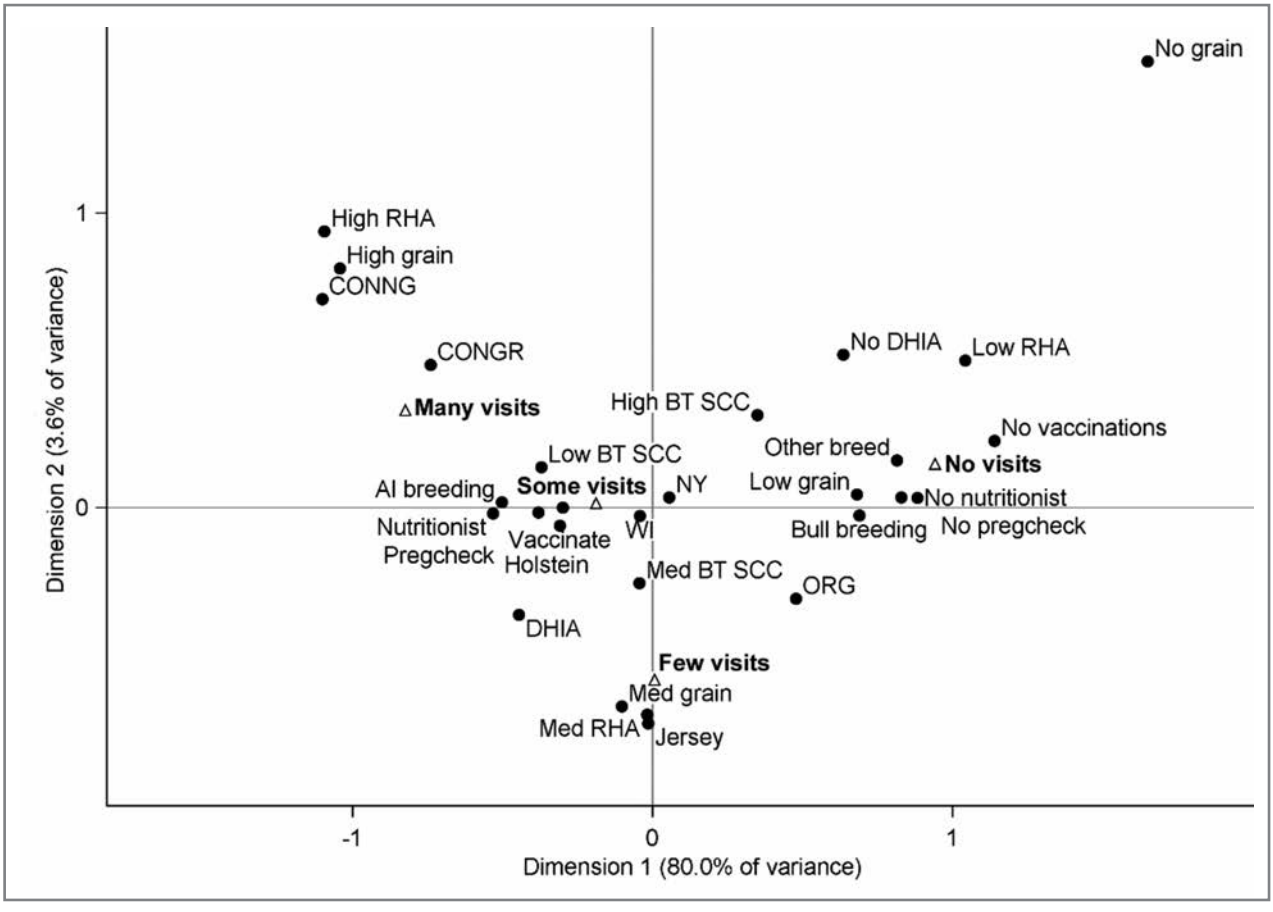

Figure 1—Results of MCA of frequency of all veterinary visits (no visits, few visits [> 0 to ≤ 0.85 visits/100 cows/30 d], some visits [> 0.85 to ≤ 2.3 visits/100 cows/30 d], or many visits [> 2.3 visits/100 cows/30 d]; open triangles) with various farm variables (black circles) for organic (n = 192), conventional grazing (36), and conventional nongrazing (64) dairy farms in New York (97), Oregon (48), and Wisconsin (147). Farm variables that were unconditionally associated with frequency of all veterinary visits via χ^2 analysis and evaluated with MCA included farm classification (organic [ORG], conventional grazing [CONGR], or conventional nongrazing [CONNGR]), state (New York [NY] or Wisconsin [WI]), RHA (low RHA [≤ 5,674 kg/cow/y {≤ 12,483 lb/cow/y}], med RHA [> 5,674 to 8,960 kg/cow/y {> 12,483 to 19,712 lb/cow/y}], or high RHA [> 8,960 kg/cow/y]), bulk tank SCC (low BT SCC [≤ 130,000 cells/mL], med BT SCC [> 130,000 to 280,000 cells/mL], or high BT SCC [> 280,000 cells/mL]), amount of grain fed (no grain, low grain [> 0 to 3.6 kg/cow/d {> 0 to 7.9 lb/cow/d}], med grain [> 3.6 to 8.2 kg/cow/d {> 7.9 to 18.0 lb/cow/d}], or high grain [> 8.2 kg/cow/d]), predominant breed of cows in herd (Holstein, Jersey, or other breed), having cows examined for pregnancy (pregcheck = yes; no pregcheck = no), use of a nutritionist (nutritionist = yes; no nutritionist = no), use of vaccines or homeopathic nosodes (vaccinate = yes; no vaccinations = no), use of DHIA testing (DHIA = yes; no DHIA = no), and method used to breed cows (AI breeding or bull breeding). Data on the frequency of all veterinary visits were not available for Oregon herds. Less intensive farm management practices are plotted on the positive side of the dimension 1 axis (ie, x-axis), and more intensive farm management practices are plotted on the negative side of the dimension 1 axis. Variables that are clustered more closely together are more strongly associated, compared with variables that are not clustered together, and variables that are plotted farther from the origin (0, 0) account for a larger percentage of the variability in that direction, compared with variables that are plotted closer to the origin.

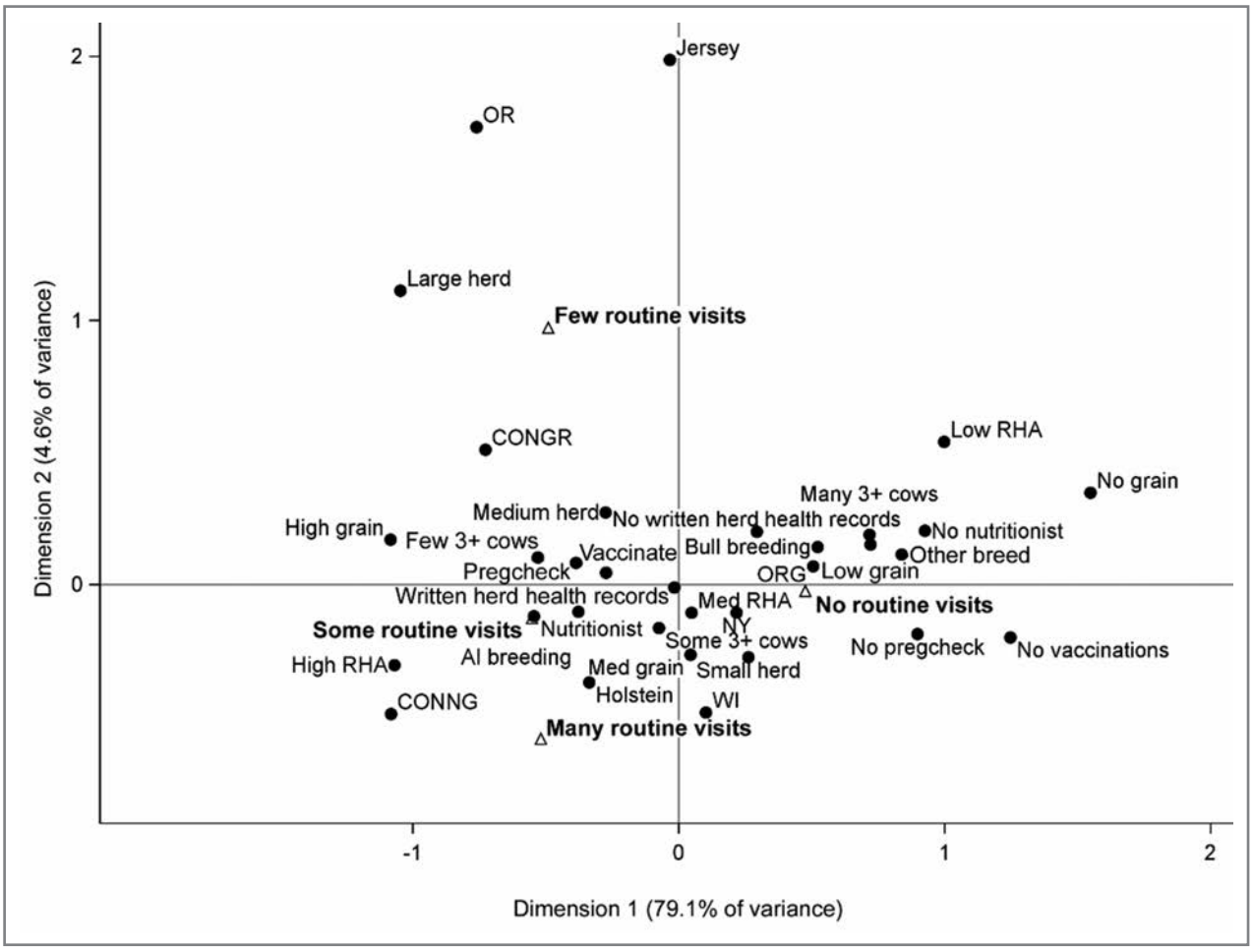

Figure 2—Results of MCA of frequency of routinely scheduled veterinary visits (no routine visits, few routine visits [> 0 to ≤ 7.5 visits/100 cows/y], some routine visits [> 7.5 to ≤ 19 visits/100 cows/y], or many routine visits [> 19 visits/100 cows/y]; open triangles) with various farm variables (black circles) for the dairy farms in Figure 1. Farm variables that were unconditionally associated with frequency of routinely scheduled veterinary visits via χ^2 analysis and evaluated with MCA included farm classification, state (New York [NY], Oregon [OR], or Wisconsin [WI]), herd size (small herd [20 to 99 cows], medium herd [100 to 199 cows], or large herd [> 200 cows]), RHA, amount of grain fed, proportion of cows in their third or later lactation (few 3+ cows [0% to 34%], some 3+ cows [> 34% to 50%], or many 3+ cows [> 50%]), predominant breed of cows in herd, having cows examined for pregnancy, use of a nutritionist, use of vaccines or homeopathic nosodes, use of written herd health records (written herd health records = yes; no written herd health records = no), and method used to breed cows. *See* Figure 1 for remainder of key.

was infrequent and did not vary among the farm classifications (**Table 4**). Veterinarians were most frequently used to diagnose metritis, followed by ketosis and pneumonia in adult cows. None of the farms relied on veterinarians to diagnose clinical mastitis. Farm classification was significantly associated with the use of a veterinarian to administer initial treatment for clinical mastitis ($P < 0.001$), ketosis ($P = 0.017$), and pneumonia in adult cows ($P = 0.004$). Regardless of the disease considered, the proportion of conventional nongrazing farms that used veterinarians to initiate treatment was greater than the proportion of organic or conventional grazing farms that used veterinarians to initiate treatment.

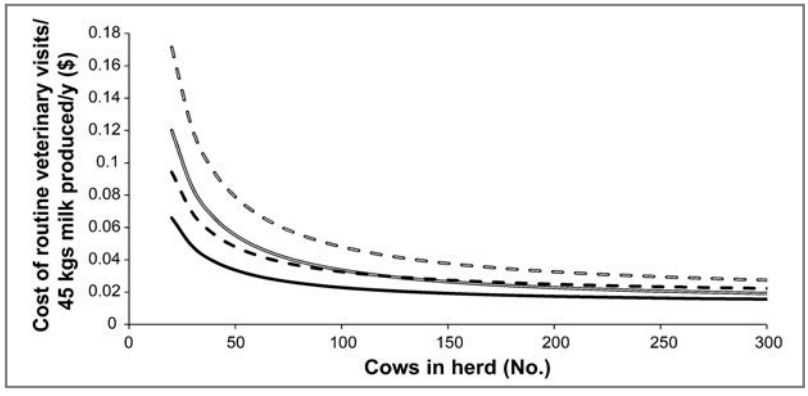

Figure 3—Estimated cost of routinely scheduled veterinary visits/45 kg (100 lb) of milk produced/y by number of cows in herd for dairy farms with 6 routinely scheduled veterinary visits/y and a mean milk production of 10,000 kg/cow/y (22,000 lb/cow/y; solid black line) or 7,000 kg/cow/y (15,400 lb/cow/y; dashed black line) or 12 routinely scheduled veterinary visits/y and a mean milk production of 10,000 kg/cow/y (solid open line) or 7,000 kg/cow/y (dashed open line).

For farms in New York and Oregon, the only variable that was unconditionally associated with the likelihood of calling a veterinarian to examine a sick cow was the use of written herd health records. For farms in Wisconsin, the likelihood of calling a veterinarian to examine a sick cow was unconditionally associated

Table 4—Number (%) of farms by classification type (organic, n = 192; conventional grazing, 36; or conventional nongrazing, 64) on which various diseases were diagnosed and veterinarians were responsible for diagnosing or providing the initial treatment for that disease.

	Farms on which disease was diagnosed			Farms on which veterinarian diagnoses the disease				Farms on which veterinarian may administer initial treatment for the disease			
Disease	Organic	Conventional grazing	Conventional nongrazing	Organic	Conventional grazing	Conventional nongrazing	*P* value*	Organic	Conventional grazing	Conventional nongrazing	*P* value*
Calf pneumonia	142 (74)	30 (83)	62 (97)	2 (1)	0 (0)	2 (3)	0.762	25 (18)	3 (10)	13 (21)	0.430
Calf diarrhea	170 (89)	33 (92)	62 (97)	—	—	—	—	3 (2)	0 (0)	3 (5)	0.300
Clinical mastitis	189 (98)	36 (100)	64 (100)	0 (0)	0 (0)	0 (0)	—	10 (5)	3 (8)	16 (25)	< 0.001
Ketosis	111 (58)	26 (72)	59 (92)	9 (8)	2 (8)	11 (19)	0.121	49 (44)	7 (27)	35 (59)	0.017
Metritis†	102 (70)	24 (80)	47 (90)	19 (19)	1 (4)	12 (26)	0.080	27 (26)	6 (25)	19 (40)	0.220
Hypocalcemia	187 (97)	34 (94)	53 (83)	1 (1)	0 (0)	1 (2)	0.567	56 (30)	8 (24)	22 (42)	0.519
Pneumonia in adult cows	103 (54)	31 (86)	51 (80)	11 (11)	2 (6)	5 (10)	0.890	34 (33)	11 (35)	31 (61)	0.004
Retained fetal membranes†	137 (94)	29 (97)	52 (100)	4 (3)	1 (3)	2 (4)	0.865	28 (20)	5 (17)	17 (33)	0.160

*For χ^2 analysis comparing differences among farm classifications. †Data available for only 145, 30, and 52 organic, conventional grazing, and conventional nongrazing herds, respectively.
— = Not determined.
See Table 1 for remainder of key.

with farm classification, RHA, having cows examined for pregnancy, use of a nutritionist, use of vaccines, method used to breed cows, and predominant breed of cows in the herd. Multiple correspondence analysis for likelihood of a herd manager calling a veterinarian to examine a sick cow was performed on data obtained only from Wisconsin farms. Results of the MCA revealed that the category high likelihood of calling a veterinarian to examine a sick cow was closely associated with a cluster of variables that included use of a nutritionist, use of vaccines, having cows examined for pregnancy, use of AI for breeding purposes, and Holstein as the predominant breed of cows in the herd (**Figure 4**). The category medium likelihood of calling a veterinarian to examine a sick cow was loosely associated with organic farms and the same cluster of variables as high likelihood of calling a veterinarian to examine a sick cow. The category low likelihood of calling a veterinarian to examine a sick cow was closely associated with a cluster of variables that included low RHA, other breed as the predominant breed of cows in the herd, and no use of vaccines.

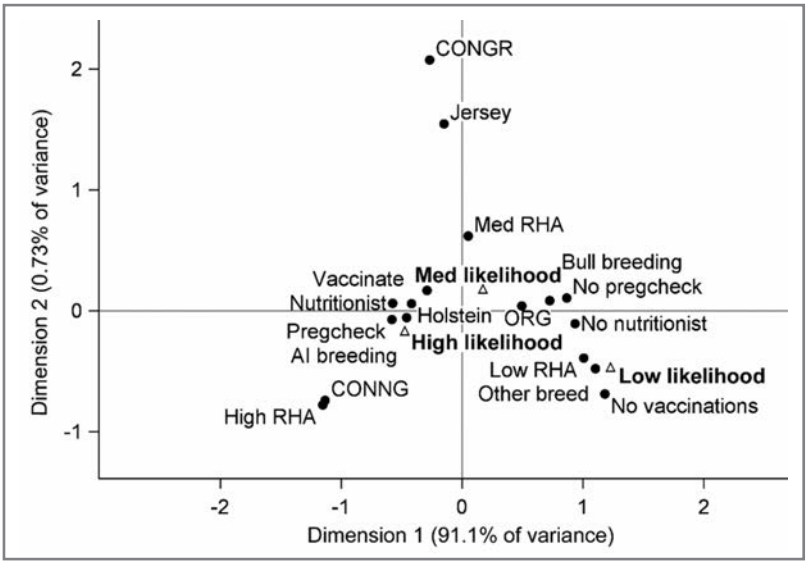

Figure 4—Results of MCA of likelihood of a herd manager to call a veterinarian to examine a sick cow (low likelihood [likelihood value, ≤ 6], med likelihood [likelihood value, > 6 to ≤ 11], or high likelihood [likelihood value, > 11]; open triangles) with various farm variables (black circles) for the Wisconsin dairy farms (organic, n = 96; conventional grazing, 12; conventional nongrazing, 39) in Figure 1. Farm variables that were unconditionally associated with the likelihood of a herd manager to call a veterinarian to examine a sick cow via χ^2 analysis and evaluated with MCA included farm classification, RHA, predominant breed of cows in herd, having cows examined for pregnancy, use of a nutritionist, use of vaccines or homeopathic nosodes, and method used to breed cows. *See* Figure 1 for remainder of key.

Of the 178 farms from which information about sick cows during both the retrospective and prospective data collection periods was obtained, only 2 farms had 0 sick cattle. Farm classification was significantly associated with the percentage of cows with ketosis ($P = 0.031$) and other diseases ($P = 0.008$) that were examined by a veterinarian (**Table 5**). The proportion of cows with ketosis or other nonspecified diseases that were examined by a veterinarian on conventional nongrazing farms was greater, compared with proportion of cows with ketosis or other diseases that were examined by a veterinarian on organic or conventional grazing farms.

Veterinary examination of at least 1 sick cow during the retrospective and prospective data collection periods was significantly associated with farm classification ($P < 0.001$), routinely scheduled veterinary visits ($P = 0.049$), and likelihood of a herd manager calling a veterinarian to examine a sick cow (New York and Oregon farms, $P = 0.015$; Wisconsin farms, $P = 0.002$). In all 3 states, the majority (New York and Oregon farms, 10/15; Wisconsin farms, 36/44) of farms that were classified as having a high likelihood of the herd manager calling a veterinarian to examine a sick cow also had at least 1 cow examined by a veterinarian during the

Table 5—Number of cases of various diseases recorded and the farm-adjusted percentage of affected cows that were examined by a veterinarian during the retrospective and prospective data collection periods for 106 organic, 24 conventional grazing, and 48 conventional nongrazing farms described in Table 1.

	No. (%) of cases of disease recorded			No. (farm-adjusted %) of disease-affected cows that were examined by a veterinarian*			
Disease	Organic	Conventional grazing	Conventional nongrazing	Organic	Conventional grazing	Conventional nongrazing	*P* value
Clinical mastitis†	252 (22)	97 (33)	299 (24)	4 (2)	1 (2)	14 (8)	0.125
Foot problems	379 (33)	52 (17)	170 (14)	44 (17)	5 (9)	13 (8)	0.165
Ketosis	39 (3)	14 (5)	87 (7)	4 (15)	4 (28)	34 (47)	0.031
Metritis	53 (5)	38 (13)	128 (10)	7 (1)	27 (40)	22 (27)	0.240
Hypocalcemia	163 (14)	28 (9)	89 (7)	31 (23)	4 (17)	23 (33)	0.432
Pneumonia	34 (3)	6 (2)	65 (5)	19 (34)	4 (60)	16 (48)	0.565
Other‡	223 (20)	63 (21)	393 (32)	61 (34)	35 (51)	122 (58)	0.008

*Farm adjusted percentages were calculated by the use of general estimating equations with farm included as a random effect in the model to account for clustering of disease-affected cows within farm. †Clinical mastitis data were only obtained during the retrospective data collection period (60 days prior to the farm visit by study investigators). ‡Other diseases included displaced abomasum, retained fetal membranes, dystocia, injury, anorexia, pyrexia, bloat, and hepatic lipidosis.
See Table 1 for remainder of key.

study observation period, whereas the majority (New York and Oregon farms, 13/16; Wisconsin farms, 7/10) of farms that were classified as having a low likelihood of the herd manager calling a veterinarian to examine a sick cow did not have at least 1 cow examined by a veterinarian during the study observation period. Organic farms were significantly ($P < 0.001$) less likely to have at least 1 cow examined by a veterinarian during the study observation period than were conventional grazing and conventional nongrazing farms.

Other types of work performed by veterinarians—The use of a veterinarian to provide training to farm personnel was infrequent and not associated with farm classification; 26 of 228 (11%) organic and conventional grazing herd managers and 12 of 64 (19%) conventional nongrazing herd managers reported that a veterinarian provided training of farm personnel. Conventional grazing (19/36 [53%]) and nongrazing (42/64 [66%]) farms were significantly ($P < 0.001$) more likely to have treatment protocols that were developed by veterinarians than were organic farms (54/192 [28%]). For farms (organic, n = 132; conventional grazing, 26; conventional nongrazing, 54) on which at least 1 cow had died because of an unknown cause within the 3 years prior to the farm visit by study investigators, a veterinarian had performed a necropsy on at least 1 cow on 57 (43%), 11 (42%), and 33 (61%) organic, conventional grazing, and conventional nongrazing farms, respectively.

Discussion

Results of the present study indicated that intensive farm management practices (eg, having cows examined for pregnancy, use of a nutritionist, use of vaccines, use of AI for breeding purposes) were more closely associated with frequency of veterinary usage than was the organic status of the farm. Although conventional farms were not enrolled on the basis of grazing status, a substantial proportion (36/100) of those farms met the criterion for a grazing herd, and stratification of the conventional farms by grazing status resulted in a conventional grazing group of farms that had similar nutritional management as did the organic farms. Thus, the present study had essentially 2 control groups with which organic farms were compared: a group of farms (conventional grazing) with nutritional management that was similar to that of organic farms with the exception that they were not certified organic and a group of farms (conventional nongrazing) that typically had more intensive management.

The proportion of farms for which complete data were obtained did not vary by farm classification (ie, organic, conventional grazing, and conventional nongrazing), herd size, or RHA when controlling for state where the farm was located and enrollment ratio of organic farms to conventional farms. Because the primary unit of interest was farm classification, it is unlikely that incomplete data collection affected the results. Also, results were similar with and without the inclusion of information from those farms for which only retrospective data were available; therefore, we believe that the 111 and 178 farms for which complete data on veterinary visits and sick cows were obtained, respectively, were representative of the overall study population.

In the present study, results of χ^2 analyses indicated that many pairwise combinations of farm variables were significantly associated, which suggested that quantitative multivariable modeling would be complicated. Because we were primarily interested in a qualitative rather than quantitative summary of farm variables associated with veterinary usage among the farm classifications, we chose to use MCA. Multiple correspondence analysis provides a graphic summary of relationships among a large number of categorical variables.[21,22] Variables that are clustered more closely together are more strongly associated, compared with variables that are not clustered together. Additionally, variables that are plotted farther from the origin (0, 0) account for a larger percentage of the variability in that direction, compared with variables that are plotted closer to the origin. However, MCA does not provide quantitative measures for the relationships among variables. Multiple correspondence analysis has been used previously to describe associations between variables for dairy cow hygiene and SCC,[24] risk factors associated with poorly performing cows,[25] and risk factors associated with the bacteriologic quality of bulk tank milk.[26]

During MCA, less intensive farm management practices, such as not feeding grain, not using vaccines, or not using a nutritionist, were located on the positive side of the dimension 1 axis (ie, x-axis), and more intensive farm management practices, such as having cows examined for pregnancy, using vaccines, and using AI for breeding purposes, were located on the negative side of the dimension 1 axis. Veterinary usage was more closely associated with intensiveness of farm management practices, rather than with whether the farm was classified as organic or conventional grazing or nongrazing; farms on which more intensive management practices were used were more likely to use a veterinarian. Prior to the present study, research regarding the motivation of US dairy herd managers to use veterinarians had been lacking. Results of the present study suggested that a herd manager's motivation for calling a veterinarian was complex and may be predicted by the intensiveness of the management practices implemented on the farm. On large dairy farms, the farm management team often includes veterinarians, whose responsibilities include consultation on herd performance and goals, development of animal treatment protocols, and instruction of farm personnel.[27] Veterinarians can be involved in an advisory role on small dairy farms as well, and identification of farms that have implemented intensive management practices may help veterinarians recognize herd managers that are interested in having a veterinarian work with them in an advisory role.

Results of the present study indicated that veterinary usage was associated with whether a farm was classified as organic or conventional grazing or nongrazing in a manner similar to results of other studies, which indicated that organic farms tended to have few veterinary visits/y,[1] and organic herd managers were less likely to call a veterinarian to examine a sick cow[2–4] and schedule routine veterinary visits[13] than were conventional herd managers. In the present study, organic farms used veterinarians the least; however, the results of the MCA suggested that veterinary usage was more closely associated with intensiveness of management practices than whether a farm was classified as organic or conventional. This suggested that there may be potential benefits for veterinarian outreach to organic herd managers, and veterinarians should consider management practices other than organic status when determining the extent of services to offer to dairy herd managers.

In the present study, the fact that farm classification was unconditionally associated with the likelihood of a herd manager to call a veterinarian to examine a sick cow for farms in Wisconsin but not for farms in New York and Oregon was unexpected. We believe that this was an incidental finding, which resulted from the different manner in which herd managers were asked to respond to that question among the states. For farms in New York and Oregon, herd managers were asked to answer that question on a numeric scale, whereas Wisconsin herd managers were asked to answer that question on a qualitative scale. Slight variations in the phrasing of questions can elicit different responses.[28] However, for farms in all 3 states, the likelihood that a herd manager would call a veterinarian to examine a sick cow was associated with the likelihood that a sick cow would be examined by a veterinarian. This finding suggested that the responses to the questionnaires administered in all 3 states captured the actual likelihood that a herd manager would call a veterinarian to examine a sick cow. It is likely that the increased random variation in responses on the numeric scale resulted in the lack of an unconditional association between farm classification and likelihood of a herd manager to call a veterinarian to examine a sick cow for farms in New York and Oregon.

Results of the present study indicated that farms that had routinely scheduled veterinary visits were more likely to have a veterinarian examine at least 1 sick cow during the study observation period than were farms that did not have routinely scheduled veterinary visits. That finding may suggest that herd managers who routinely schedule veterinary visits rely on veterinarians for examination of sick cows to a greater extent than do herd managers who do not routinely schedule veterinary visits. Alternatively, that finding may have been caused by the fact that the cost to have a veterinarian examine and treat a sick cow is less if the veterinarian is already present on the farm for a routine visit than it is if the veterinarian is called specifically to examine a sick cow. Results of another study[10] indicated that the odds of a sick cow receiving veterinary treatment were increased if there was another sick cow in the herd concurrently. Regardless of the motivation, routinely scheduled veterinary visits resulted in increased examination of sick cows by veterinarians, even though veterinarians primarily performed reproductive work during those visits.

As noninvasive methods of examining cows for pregnancy become increasingly available, dairy herd managers may rely less on veterinarians for reproductive work (ie, pregnancy examinations) and veterinarian involvement on dairy farms may decrease, which could negatively impact cattle welfare. Thus, unless veterinarians provide other services valued by dairy herd managers, they risk losing those clients.

In the present study, the frequency of routinely scheduled veterinary visits was more closely associated with herd size than with variables used to reflect intensiveness of farm management. That finding was similar to results of a survey[23] of US organic dairy farms, which indicated that small organic farms were less likely to use regular veterinary services than were large organic farms. In the present study, the standardization of the number of veterinary visits/100 cows allowed us to compare economic efficiency among farms regardless of size because the expense of the routinely scheduled veterinary visit was calculated on the basis of the same unit of production. The estimated cost of routinely scheduled veterinary visits/45 kg of milk produced/y decreased exponentially as the herd size increased and also decreased as milk production per cow increased and number of veterinary visits per year decreased. When comparisons were made on the basis of number of veterinary visits per year, the difference in the estimated cost of a routinely scheduled veterinary visit/45 kg of milk produced/y was greatest at a small herd size. For example, for a 50-cow herd with a mean milk pro-

duction of 7,000 kg/cow/y, the cost for 6 and 12 routinely scheduled veterinary visits/y was $0.05/45 kg of milk produced/y and $0.08/45 kg of milk produced/y, respectively, whereas for a 200-cow herd with a mean milk production of 7,000 kg/cow/y, the cost for 6 and 12 routinely scheduled veterinary visits/y was $0.02/45 kg of milk produced/y and $0.03/45 kg of milk produced/y, respectively. Thus, because of differences in the efficiency of scale, smaller dairy farms would need to earn more income per cow (either by increased milk production or milk quality premiums) to have the same fixed cost for routinely scheduled veterinary visits as larger dairy farms. For small dairy herd managers, the higher cost of routinely scheduled veterinary visits is likely a barrier to routine veterinary usage. Veterinarians who want to increase routine services to smaller dairy farms should identify strategies that reduce the fixed cost per routinely scheduled visit or increase the perceived value of that visit by the herd managers.

Although results of the present study suggested that organic dairy farms used veterinarians less frequently than did conventional grazing and nongrazing dairy farms, MCA revealed that veterinary usage was more closely associated with intensiveness of management practices implemented on farms than with organic status. Therefore, veterinarians should not assume that organic herd managers are unwilling to use veterinary services. Moreover, herd managers that reported having routinely scheduled veterinary visits were more likely to have a veterinarian examine and treat a sick cow than were herd managers that reported having no routinely scheduled veterinary visits. This finding suggested that even though the primary reason for a routinely scheduled veterinary visit was generally reproductive examinations of cows, frequent visits by a veterinarian to a farm resulted in more opportunities for that veterinarian to provide medical care to individual animals.

a. SAS, version 9.3, SAS Institute Inc, Cary, NC.

References

1. Rozzi P, Miglior F, Hand KJ. A total merit selection index for Ontario organic dairy farmers. *J Dairy Sci* 2007;90:1584–1593.
2. Hardeng F, Edge VL. Mastitis, ketosis, and milk fever in 31 organic and 93 conventional Norwegian dairy herds. *J Dairy Sci* 2001;84:2673–2679.
3. Hamilton C, Hansson I, Ekman T, et al. Health of cows, calves and young stock on 26 organic dairy herds in Sweden. *Vet Rec* 2002;150:503–508.
4. Valle PS, Lien G, Flaten O, et al. Herd health and health management in organic versus conventional dairy herds in Norway. *Livest Sci* 2007;112:123–132.
5. Mörk M, Lindberg A, Alenius S, et al. Comparison between dairy cow disease incidence in data registered by farmers and in data from a disease-recording system based on veterinary reporting. *Prev Vet Med* 2009;88:298–307.
6. Olsson SO, Baekbo P, Hansson SO, et al. Disease recording systems and herd health schemes for production diseases. *Acta Vet Scand Suppl* 2001;94:51–60.
7. Nyman AK, Ekman T, Emanuelson U, et al. Risk factors associated with the incidence of veterinary-treated clinical mastitis in Swedish dairy herds with a high milk yield and a low prevalence of subclinical mastitis. *Prev Vet Med* 2007;78:142–160.
8. Vaarst M, Paarup-Laursen B, Houe H, et al. Farmers' choice of medical treatment of mastitis in Danish dairy herds based on qualitative research interviews. *J Dairy Sci* 2002;85:992–1001.
9. Bennedsgaard TW, Klaas IC, Vaarst M. Reducing use of antimicrobials—experiences from an intervention study in organic dairy herds in Denmark. *Livest Sci* 2010;131:183–192.
10. Mörk MJ, Emanuelson U, Lindberg A, et al. Herd and cow characteristics affecting the odds of veterinary treatment for disease—a multilevel analysis. *Acta Vet Scand* 2009;51:34.
11. von Borell E, Sorensen JT. Organic livestock production in Europe: aims, rules and trends with special emphasis on animal health and welfare. *Livest Prod Sci* 2004;90:3–9.
12. USDA Agricultural Marketing Service. National Organic Program. Available at: www.ams.usda.gov/AMSv1.0/nop. Accessed Mar 28, 2011.
13. Mayen CD, Balagtas JV, Alexander CE. Technology adoption and technical efficiency: organic and conventional dairy farms in the United States. *Am J Agric Econ* 2010;92:181–195.
14. Vaarst M, Thamsborg SM, Bennedsgaard TW, et al. Organic dairy farmers' decision making in the first 2 years after conversion in relation to mastitis treatments. *Livest Prod Sci* 2003;80:109–120.
15. Vaarst M, Bennedsgaard TW, Klaas I, et al. Development and daily management of an explicit strategy of nonuse of antimicrobial drugs in twelve Danish organic dairy herds. *J Dairy Sci* 2006;89:1842–1853.
16. Zwald AG, Ruegg PL, Kaneene JB, et al. Management practices and reported antimicrobial usage on conventional and organic dairy farms. *J Dairy Sci* 2004;87:191–201.
17. UW Milk Quality. Project C.O.W. Available at: milkquality.wisc.edu/organic-dairies/project-c-o-w/. Accessed Nov 20, 2012.
18. Pol M, Ruegg PL. Treatment practices and quantification of antimicrobial drug usage in conventional and organic dairy farms in Wisconsin. *J Dairy Sci* 2007;90:249–261.
19. Aday LA, Cornelius LJ. *Designing and conducting health surveys: a comprehensive guide*. 3rd ed. San Francisco: Jossey-Bass, 2006;70–78.
20. National Organic Program. Access to pasture (livestock), final rule. *Fed Regist* 2010;75:7154–7195.
21. Greenacre M. *Correspondence analysis in practice*. 2nd ed. New York: Chapman and Hall/CRC Press, 2007;137–144.
22. Dohoo I, Martin W, Stryhn H. *Veterinary epidemiologic research*. Charlottetown, PE, Canada: AVC Inc, 2003;322–325.
23. McBride WD, Greene C. *Characteristics, costs, and issues for organic dairy farming*. Economic research report 82. Washington, DC: USDA Economic Research Service, 2009.
24. Sant'anna AC, Paranhos da Costa MJR. The relationship between dairy cow hygiene and somatic cell count in milk. *J Dairy Sci* 2011;94:3835–3844.
25. Thomsen PT, Ostergaard S, Houe H, et al. Loser cows in Danish dairy herds: risk factors. *Prev Vet Med* 2007;79:136–154.
26. Elmoslemany AM, Keefe GP, Dohoo IR, et al. Risk factors for bacteriological quality of bulk tank milk in Prince Edward Island dairy herds. Part 2: bacteria count-specific risk factors. *J Dairy Sci* 2009;92:2644–2652.
27. Sumrall DP. Managing people in today's production dairy environment. In: Risco CA, Melendez P, eds. *Dairy production medicine*. Chichester, West Sussex, England: John Wiley & Sons, 2011;303–317.
28. Sheatsley PB. Questionnaire construction and item writing. In: Rossi PH, Wright JD, Anderson AB, eds. *Handbook of survey research*. San Diego: Academic Press, 1983;195–230.