Veterinary herd health management programs on dairy farms in the Netherlands: Use, execution, and relations to farmer characteristics

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ABSTRACT

Veterinary herd health management (VHHM) programs are of growing importance to the dairy industry; they support farmers in the shift from curative to preventive health management, caused by increased herd sizes and quality standards in dairy farming. Farmers participating in VHHM are visited every 4 to 6 wk by their veterinarian, who checks the animals and herd management to intervene in a proactive way with problems regarding animal health and animal welfare. At present, no good overview exists of how VHHM is executed on Dutch dairy farms, and whether different farmers require different types of VHHM. Aims of this study were to (1) map out how many farmers participate in VHHM, (2) describe how VHHM is executed on the farms, and (3) see whether certain farmer characteristics are related to farmers' participation in VHHM. In 2011, a questionnaire was sent to 5,000 Dutch dairy farmers per e-mail. Part 1 of the questionnaire focused on participation in and execution of VHHM and part 2 focused on farmer characteristics regarding external information. Returned questionnaires ($n = 1,013$) were summarized and statistically analyzed. In this study 68.6% of the responding farmers participated in any form of VHHM. The most important activities were fertility checks and advice about fertility; the least important were housing and claw health. Relationships between farmer characteristics (use of and trust in information) and participation in VHHM were found.

Key words: veterinary herd health management, dairy farmer, veterinarian, farmer characteristic

INTRODUCTION

The dairy industry is evolving worldwide: industrialization and increasing competition have not only led to efficient milk production, but also to a whole new farming approach. Attention on dairy farms has shifted from the individual animal toward management on the

herd level (de Kruif and Opsomer, 2004; Noordhuizen and Metz, 2005; LeBlanc et al., 2006)

To cope with these changes, veterinary herd health management (VHHM) programs were set up. They are defined as a combination of (advice on) animal health, milk production, and disease prevention, placed in a framework of farm economics, welfare, food safety, and environment. Regular checks of herd and farm are important therein (Noordhuizen and Metz, 2005; LeBlanc et al., 2006). This definition is broad, but therefore meets the requirements of different dairy farming systems. Worldwide, different systems of dairy farming exist. Some are very extensive (e.g., Austria and New Zealand), whereas others are very intensive (e.g., United States). Some are seasonal (e.g., Ireland and New Zealand), whereas others are year round (e.g., Netherlands and Denmark). Some are run mostly by just 1 farmer (e.g., United Kingdom and the Netherlands) and some use workers (e.g., United States and South America). However, the topics related to (veterinary support) of dairy farming do not change between those systems. As a consequence, the amount of required VHHM skills the veterinarian should (theoretically) possess has increased from clinical medicine to an integral approach of all topics related to dairy farm management.

Not only has the veterinary work changed, but the relationship between veterinarian and farmer has changed as well. Where in the past the veterinarian was called to cure a sick cow, at present he actively approaches the farmer with advice. Farmer characteristics play an important role in the way they carry out farm management practices (Greiner et al., 2009; Ellis-Iversen et al., 2010; Kielland et al., 2010). For instance, the main goal for the farm differs substantially between farmers: whereas some focus mainly on milk production, others prefer a healthy herd, or few problems (Bergevoet et al., 2004; Kristensen and Enevoldsen, 2008). Also, the openness of dairy farmers toward external information influences their compliance to veterinary advice (Jansen et al., 2010b). So, next to technical skills, the veterinarian also should acquire people and communication skills and invest in getting to know the personality of the farmer and his goals and priorities for the farm.

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The modern veterinary practitioner thus possesses good technical skills on all topics related to dairy farming, and is able to understand farmers' drives and way of communicating. The modern dairy farmer is aware of his responsibility toward public health, animal welfare, and food safety, and is open and responsive to veterinary advice. In real life, however, that is often not the case. Farmers do not always adopt good production practices (Young, 2010) or zoonotic control programs (Ellis-Iversen et al., 2010). Veterinarians are not always aware of farmers' goals (Kristensen and Enevoldsen, 2008) and have difficulties communicating advice (Jansen et al., 2010a; Derks et al., 2012b).

It is clear that a gap exists between the ideal for VHHM and reality. At present, however, it is not clear how large the gap is, or how it should be filled. To understand what has to be done to improve VHHM on the farm, it is necessary to have a good overview of which topics are discussed with what frequency. Furthermore, because farmer characteristics appear to play a role in farm management, it is useful to determine which farmer characteristics play a role in adoption of VHHM programs on the farm. Knowing which farmers prefer which topics of VHHM makes it easier for a veterinarian to approach farmers in the right way.

This study had 3 aims: (1) to map out how many farmers participated in VHHM in the Netherlands, (2) to make an inventory of the different types and topics of VHHM that are executed on Dutch farms, and (3) to see whether certain farmer characteristics were related to farmers' participation in VHHM.

MATERIALS AND METHODS

Study Design

In September 2011, 5,000 Dutch dairy farmers with a herd size of at least 40 milking cows, participating in the monthly milk production registration (MPR), were randomly selected by CRV BV (Arnhem, the Netherlands). All farmers received a questionnaire per e-mail. Returned questionnaires were summarized and statistically analyzed.

Data Collection

Questionnaire. The questionnaire was designed using the tailored design method (Dillman, 2000) to improve lay out and response rate. It consisted of 2 distinct parts: part 1 was concerned with the architecture of VHHM on the farm and part 2 with farmer characteristics regarding external information. The questions in part 1 focused on the topics that could be discussed during VHHM (fertility checks, advice on fertility, milk

production, udder health, nutrition, young stock rearing, housing, claw health, and analysis of production numbers). Because such a large variation exists in the execution of VHHM on different dairy farms, the decision whether or not they were participating in VHHM was made by the farmers. Farmers were asked whether they took part in VHHM (yes, regularly; yes, irregularly; no) and if yes, how often. Farmers who said they participate and had the veterinarian on their farm at least every 8 wk were classified as participants.

The questions for part 2 were based on the work of Jansen et al. (2010b), who found that a relationship existed between the way farmers cope with external information and their willingness to follow veterinary advice on udder health. To enhance user friendliness and uniformity, the questions in part 2 were, where possible, constructed with a 5-point Likert scale [strongly disagree, disagree, neutral, agree, and strongly agree; Appendix Table A1, question (Q) 17–20, Q24, and Q26–30] or with yes/no (Appendix Table A1, Q12–16 and Q21–23). For Q11, multiple options were provided (courses, information nights, literature, study clubs, external advisors, internet, and other), and question 6 was open, but later stratified (<once per 2 yr, once per 2 yr, once per year, twice per year, and >twice per year).

The questionnaire was introduced to farmers by an introduction letter through the mail; the questionnaire itself was 1 d later sent per e-mail. The total list of questions can be found in Appendix Table A1.

Farm Data. All farmers selected for this study were participating in the monthly MPR by CRV BV. Participants in MPR receive information on milk yield, SCC, and fertility parameters of individual cows and on the herd level every 4 or 6 wk. Those variables, together with associated veterinary practice, were provided by CRV BV for each farm.

Data Analysis

General Information on the Data Set. With a Student's *t*-test, information on herd performance was compared between respondents and nonrespondents, and between participants and nonparticipants in VHHM. The normality of the data was checked visually and the difference in variance was checked with Levene's test ($P > 0.05$).

Participation in and Execution of VHHM. For each topic that could be discussed (fertility checks, advice on fertility, milk production, udder health, nutrition, young stock rearing, housing, claw health, and analysis of production numbers), 2 parameters were set: first, how many farmers discussed this topic and second, with what frequency this topic was generally discussed.

The Relationship Between Farmer Characteristics and Participation in VHHM. A total of 20 questions from part 2 of the questionnaire, regarding farmer characteristics, were used as predictor variables in a logistic regression model. Outcome variable was participation in VHHM (yes/no). First, all variables were tested in a univariate model (Appendix Table A2). Significant predictor variables ($P < 0.20$) were used in a multivariable model. Variable selection was done using a backward regression. The veterinary practice the farmer was associated with was included in the model as a covariate.

The goodness-of-fit of the data was checked using the Hosmer-Lemeshow test. Multicollinearity was checked with tolerance and variance inflation factor statistics. The crude model was adjusted 3 times by adding a different covariate (first: number of cows; second: veterinary practice size; third: number of cows $\times$ veterinary practice size) through forced entry. The models were compared using the Hosmer-Lemeshow test, Nagelkerke's coefficient of determination, and difference in chi-squared. The final model could be described as follows:

$$\text{VHHM} = \frac{e^{\beta_0 + \beta_1 \times Q_2 + \beta_2 \times Q_3 + \beta_3 \times Q_5 + \beta_4 \times Q_8 + \beta_5 \times Q_{13} + \beta_6 \times Q_{15} + \beta_7 \times Q_{17} + \beta_8 \times AVP}}{1 + e^{\beta_0 + \beta_1 \times Q_2 + \beta_2 \times Q_3 + \beta_3 \times Q_5 + \beta_4 \times Q_8 + \beta_5 \times Q_{13} + \beta_6 \times Q_{15} + \beta_7 \times Q_{17} + \beta_8 \times AVP}},$$

where VHHM represents participation in VHHM yes/no, β_0 represents the estimated intercept, and the regression coefficients $\beta(1-8)$ were estimated for the relevant questions $Q(x)$ and associated veterinary practice (AVP).

The Relationship Between Farmer Characteristics and Level of Participation in VHHM. The 20 questions from part 2 of the questionnaire were used as predictor variables in an ordinal logistic regression model. The number of regularly discussed topics (minimum = 0; maximum = 9) was used as the outcome variable. First, all variables were tested in a univariate model. For the complete model, all variables that were significant ($P < 0.20$) in the univariate model were put in using backward regression (Appendix Table A3). Associated veterinary practice was included in the model as a covariate.

The crude model was adjusted in the same way as the logistic regression model. The models were compared using Nagelkerke's coefficient of determination and the difference in Pearson chi-squared. The final model could be described as follows:

$$\text{NoT} = \frac{e^{\beta_0 + \beta_1 \times Q_5 + \beta_2 \times Q_6 + \beta_3 \times Q_8 + \beta_4 \times Q_{13} + \beta_5 \times Q_{15} + \beta_6 \times NC \times VPS + \beta_7 \times AVP}}{1 + e^{\beta_0 + \beta_1 \times Q_5 + \beta_2 \times Q_6 + \beta_3 \times Q_8 + \beta_4 \times Q_{13} + \beta_5 \times Q_{15} + \beta_6 \times NC \times VPS + \beta_7 \times AVP}},$$

where NoT represents number of discussed topics, β_0 represents the estimated intercept, and the regression coefficients $\beta(1-7)$ were estimated for the relevant questions $Q(x)$, number of cows $\times$ veterinary practice size ($NC \times VPS$) and associated veterinary practice (AVP).

RESULTS

General Information on the Data Set

Five thousand farmers, associated with 270 veterinary practices, were approached to join the study, of which 1,013 returned the questionnaire (20%). No significant difference was observed in the response rate between practices. Nonrespondents had more cows, a higher SCC, a longer calving interval, and fewer kilograms of milk per cow per year than respondents. Participants in VHHM had a higher milk production and a lower SCC than nonparticipants (Table 1).

Participation in and Execution of VHHM

Of the respondents, 695 participated in VHHM (68.6%) and 318 did not. Eighty-five percent of the farmers had their cows checked for pregnancy regularly (Figure 1). Advice concerning fertility took place on 70.9% of the participating farms on a regular basis. Most farmers (65.2%) discussed production numbers with their veterinarian on a regular basis and 19% never discussed them. Topics that were discussed least often on a regular basis were claw health (31%) and housing (25.1%). The use or number of discussed topics did not significantly differ between veterinary practices. No correlation between farm size and number of discussed topics was found.

Table 1. Comparison of general farm data between respondents and nonrespondents of the questionnaire, and between participants and nonparticipants in veterinary herd health management (VHHM)

Variable	Category	n	Mean	SD	Minimum	Maximum	P-value	95% CI
Respondents vs. nonrespondents Number of cows	Nonrespondents	3,987	86	38.2	34	464	<0.01	-6.3; -1.2
	Respondents	1,013	83	31.5	39	289		
	Nonrespondents	3,987	8,400	1,035.9	2,200	12,768	<0.01	6.2; 149.4
	Respondents	1,013	8,478	1,046.3	3,533	11,853		
Milk production (kg of milk/cow per year)	Nonrespondents	3,987	421	25.3	349	628	<0.05	-5.4; -1.9
	Respondents	1,013	417	24.8	364	642		
Calving interval (d)	Nonrespondents	3,984	228	58.2	130	745	<0.01	-11.8; -4.2
	Respondents	1,012	220	51.3	139	565		
SCC (×1,000 cells/mL)	Participants	695	83	31.4	39	289	0.27	-6.5; 1.8
	Nonparticipants	318	81	31.6	39	237		
	Participants	695	8,591	967.1	4,561	11,853	<0.01	-497.7; -223.1
	Nonparticipants	318	8,231	1,165.3	3,533	11,032		
Milk production (kg of milk/cow per year)	Participants	695	416	23.2	364	642	0.15	-0.9; 5.7
	Nonparticipants	318	419	28.0	368	629		
Calving interval (d)	Participants	695	218	48.4	139	472	<0.05	1.7; 15.3
	Nonparticipants	317	226	56.6	152	565		
SCC (×1,000 cells/mL)	Participants	695	218	48.4	139	472	<0.05	1.7; 15.3
	Nonparticipants	317	226	56.6	152	565		

Looking at the combinations of topics regularly discussed during VHHM, the most common form of VHHM was the one in which all topics were discussed (Table 2). Pregnancy checks were performed in all of the most common combinations, followed by advice on fertility, analysis of production numbers, milk production, and udder health. A remarkable finding was that if one of the previously named topics was not discussed, the remaining topics (nutrition, young stock rearing, claw health, and housing) also were not discussed.

Farmer Characteristics Regarding External Information

The farmers in this study acquired information from several sources (Table 3), of which external advisors (26.6%) and the literature (25.3%) were the most important. Eighty-two percent of the farmers actively visited farms outside their region to gain new knowledge. About two-thirds of the farmers (66.9%) would consider becoming a testing farm for a new product or service; 28% had already been a testing farm in the past.

Farmers said they were compliant with external advice (Table 3). Veterinary advice was followed up more often (83.2%) than advice from the feed advisor (78%). Most farmers were willing to discuss new topics when their veterinarian asked them to (83.4%). The professional relationship between farmer and veterinarian can be classified as good: only 4.3% of the veterinarians received a grade below 6 on a scale from 1 to 10, and 60.5% received an 8 or higher. Although the veterinarian is appreciated by the farmer and veterinary advice is followed up quite well, most farmers also indicated that external advice in general did not add up to their own knowledge (55%). Costs were an important reason not to use external advisors (43.2%).

In terms of trust, most farmers appeared to trust their veterinarian and other farmers. Almost all farmers allowed their veterinarian to see their farm data (96.2%), and 59.9% did not mind sharing their farm data with other farmers. Other farmers were not seen as competition (93.8%).

The Relationship Between Farmer Characteristics and Participation in VHHM

After comparing the different multivariate models, the crude model, with no forced entries, fitted the data best; both the Hosmer-Lemeshow test and the chi-squared were highest. The number of cows, veterinary practice size, and the interaction between them were not significant predictors in the model. Farmers that participated in study clubs, tried to improve their farm management, or were open to test new products or ser-

Table 2. Overview of the most common combinations of topics discussed during veterinary herd health management (VHHM), filled out by farmers

n	Pregnancy checks	Advice on fertility	Advice on production numbers	Udder health	Milk production	Nutrition	Young stock rearing	Claw health	Housing
60	x	x	x	x	x	x	x	x	x
40	x	x	x	x	x	x			
33	x								
29	x	x							
18	x	x	x	x	x	x	x	x	
18	x	x	x	x	x	x	x		x
15	x	x	x	x	x				
15	x	x	x	x	x	x	x		
14	x	x	x	x	x	x		x	
12	x	x	x						
11	x	x	x	x					
10	x	x	x	x	x		x		

vices, were more likely to participate in VHHM (Table 4). Also, a good relationship with the veterinarian and compliance with veterinary advice had positive effects on participation in VHHM. However, farmers participating in a board or committee regarding dairy farming were found to be less likely to participate in VHHM.

The Relationship Between Farmer Characteristics and Level of Participation in VHHM

The model with forced entry of number of cows $\times$ veterinary practice size fitted the data best, based on values for Pearson chi-squared and Nagelkerke's coef-

ficient of determination (Table 5). Farmers that had good relationships with their veterinarian had a higher probability of discussing more topics during VHHM. The same was true for farmers who invested in farm management, who were willing to share farm data, or who were open to being a testing farm in the future.

DISCUSSION

This study is the first large-scale study on the present performance of VHHM in the Netherlands and farmer characteristics related to VHHM. Judging from the fit of the logistic and ordinal logistic regression models

Figure 1. Overview of the frequency with which 9 veterinary herd health management (VHHM) topics are discussed during farm visits (n = 627).

Table 3. Frequency distribution of the answers of 1,013 farmers to the 20 questions regarding external information (%)

Question	Agree	Disagree						
I take part in a study club	57.2	42.8						
I take part in a committee/board regarding (dairy) farming	22.2	77.8						
I receive visitors on my farm	51.5	48.5						
I view other farmers as competition	93.8	6.2						
I have been a testing farm for a new product/service	28.0	72.0						
If I were approached to be a testing farm, I would consider it	66.9	33.1						
My veterinarian may see my farm data	96.2	3.8						
	Agree	Neutral	Disagree					
I allow others to visit my farm	18.6	30.7	50.7					
I follow the advice of my feed advisor	78.0	20.5	1.5					
I follow the advice of my veterinarian	83.2	15.3	1.5					
External advice does not add to my own knowledge	55.0	32.2	12.8					
The most important reason not to use external advisors is a financial reason	43.2	28.6	28.1					
I like to be the first to use new developments	20.8	53.1	26.1					
I continuously try to improve farm management	71.3	23.4	5.3					
If I hear about interesting developments in dairy, I look it up on the internet	41.6	35.3	23.1					
If my veterinarian wants to talk about a new topic, I am open to that	83.4	14.8	1.8					
I do not like to share my farm data with other farmers	13.9	26.2	59.9					
	Never	Once/2 yr	Once per year	Twice per year	>Twice per year			
How often do you visit other farms outside your region (> 50km) to gain new knowledge?	18.0	17.1	28.2	19.1	17.7			
	Courses	Information nights	Literature	Study club	Advisor	Internet	Other	
Where do you get information on animal health?	8.6	14.2	25.3	12.8	26.6	12.0	0.5	
	Scale							
	3	4	5	6	7	8	9	10
I grade the relationship with my veterinarian a . . . (1–10)	0.9	0.8	2.6	7.4	27.8	43.9	13.0	3.6

Table 4. Outcomes of a logistic regression analysis with dependent variable [participation in veterinary herd health management (VHHM; yes/no)] and independent variables [the 20 questions (Q) regarding the use of information]¹

Variable	β^2	SE	Wald statistic	Significance (<i>P</i> -value)	Odds ratio
Intercept	0.51	0.56	0.83	0.36	1.66
Q2: I take part in a study club	0.36	0.15	5.85	<0.05	1.44
Q3: I take part in a committee/board regarding (dairy) farming	-0.58	0.17	11.02	<0.01	0.56
Q5: If I were approached to be a testing farm, I would consider it	0.34	0.15	4.74	<0.05	1.40
Q13: My veterinarian may see my farm data	0.87	0.37	5.56	<0.05	2.38
Q15: I grade the relationship with my veterinarian a . . .					
10	—	—	27.84	<0.01	—
3	-1.41	0.91	2.37	0.12	0.25
4	-2.26	0.97	5.43	<0.05	0.11
5	-1.61	0.61	6.91	<0.01	0.20
6	-1.20	0.50	5.87	<0.05	0.30
7	-0.82	0.45	3.33	0.07	0.44
8	-0.42	0.45	0.88	0.35	0.66
9	-0.03	0.49	0	0.95	0.97
Q8: I continuously try to improve farm management					
Agree	—	—	6.25	<0.05	—
Neutral	-0.36	0.31	1.36	0.24	0.70
Disagree	-0.41	0.17	5.71	<0.05	0.67
Q17: I follow the advice of my veterinarian					
Agree	—	—	10.01	<0.01	—
Neutral	-0.60	0.59	1.02	0.31	0.55
Disagree	-0.61	0.20	9.47	<0.01	0.54

¹Information for goodness-of-fit: Hosmer-Lemeshow: $P = 0.92$; Nagelkerke's $R^2 = 0.14$; tolerance statistics: >0.1, variance inflation factor statistics: <10.

²The regression coefficient, representing the relative importance of a predictor in predicting the criterion.

Table 5. Outcomes of an ordinal logistic regression analysis with dependent variable [number of topics discussed during veterinary herd health management (VHHM; 1–9)] and independent variables [the 20 questions (Q) regarding the use of information and forced entry of “number of cows $\times$ veterinary practice size”]¹

Variable	β^2	SE	Wald statistic	Significance (<i>P</i> -value)	Odds ratio
Q5: If I were approached to be a testing farm, I would consider it					
Agree	0.33	0.15	4.53	<0.05	1.39
Disagree	—	—	—	—	—
Q13: My veterinarian may see my farm data					
Agree	1.02	0.47	4.65	<0.05	2.77
Disagree	—	—	—	—	—
Q6: How often do you visit other farms outside your region (>50 km) to gain new knowledge?					
Never	-0.48	0.24	4.11	<0.05	0.62
Once every 2 yr	-0.35	0.23	2.28	0.13	0.7
Once every year	-0.38	0.2	3.59	<0.05	0.68
Twice per year	-0.3	0.22	1.84	0.18	0.74
>Twice per year	—	—	—	—	—
Q15: I grade the relationship with my veterinarian a . . .					
3	-1.14	1.1	1.06	0.3	0.32
4	-1.26	1.29	0.96	0.33	0.28
5	-1.76	0.69	6.48	<0.01	0.17
6	-1.41	0.45	10.04	<0.01	0.24
7	-0.43	0.35	1.46	0.23	0.65
8	0.08	0.34	0.05	0.82	1.08
9	0.25	0.37	0.46	0.5	1.28
10	—	—	—	—	—
Q8: I continuously try to improve farm management					
Agree	—	—	—	—	—
Neutral	-1.07	0.33	10.6	<0.01	0.34
Disagree	-0.48	0.18	7.22	<0.01	0.62
Farm size $\times$ veterinary practice size	<0.01	<0.01	2.61	0.11	1.01

¹Information for goodness-of-fit: Pearson chi-squared goodness-of-fit: $P = 0.77$; Nagelkerke's $R^2 = 0.113$.

²The regression coefficient, representing the relative importance of a predictor in predicting the criterion.

($R^2 = 0.140$ and 0.113 , respectively), farmers' characteristics regarding information do explain part of the variance in participation in VHHM, but not all. One important influence that may have been left out of the picture was (the social and practical skills of) the veterinarian. There are as many different veterinarians as there are different farmers; one may be a good technician, another a good communicator, and a third may be both. Whether or not a farmer starts participating in VHHM may very well depend on how well the veterinarian explains the benefits. Discussion of topics such as, for instance, housing may depend on the veterinarians' knowledge on that topic. Results of a study on Johne's disease control programs show that the level of compliance of farmers is dependent on the quality of the veterinary advice (Sorge et al., 2010).

For this study, it was not possible to examine the specific and unique relationship between veterinarian and farmer, as measuring the strength of this relationship goes beyond one questionnaire. More in-depth qualitative analyses are needed (interviews and recordings of VHHM conversations) to create a golden standard for a well-executed VHHM visit. Asking farmers alone how they perceive their veterinarian is not enough; the work of Jansen et al. (2010a) shows that farmers can be very satisfied with their veterinarian even if communication skills are under par (Jansen et al., 2010a). More research on the effect of this relationship on participation in VHHM is, therefore, needed and the authors recommend viewing the described results in the light of the possible bias created by that relationship.

In the introduction, it was already stated that, although the overall definition of VHHM can be used for dairy farms worldwide, the way dairy farms operate can differ quite a lot between countries. The results of this study are particularly interesting for dairy farming systems that resemble the Dutch situation: mostly family farms of about 80 cows, milking in a year-round system. However, the authors do believe that especially the results of aim 3 (farmer characteristics related to participation) can be extrapolated to other types of dairy farming. Previous studies in the United Kingdom (Hall and Wapenaar, 2012), Canada (Sorge et al., 2010), and New Zealand (Brownlie et al., 2011) have shown that farmers' attitudes play a big role in compliance to herd health programs there as well.

General Information on the Data Set

From the 5,000 questionnaires that were sent out, 1,013 were returned fully completed (20%) and, therefore, 80% of our selected population did not respond. Farmers who did not respond to the survey generally had more cows, lower milk production per cow per year,

a longer calving interval and a higher SCC (Table 1). The differences, however, were small, and the effect of response bias is, therefore, expected to be limited.

Several measures were taken upfront to prevent survey bias: farmers were selected randomly, and the questionnaire was designed using the tailored design method by Dillman (2000). This is a validated method to improve response rate of questionnaires (Dillman, 2000). However, the response rate for this questionnaire was quite low compared with other studies (Lievaart and Noordhuizen, 1999; Bergevoet et al., 2004). One reason for the low response rate may be that we surveyed the farmers in September. In previous research, farmers indicated that the summer months were not good months to receive a survey (Pennings et al., 2002). Second reason for the low response rate may be that the questionnaires were sent by CRV for anonymity reasons. Most dairy farmers receive a lot of information by CRV. The questionnaire may, therefore, have been overlooked or not even opened.

Participation in and Execution of VHHM

Based on the oral information of approximately 20 veterinary practices, the average veterinary practice had about 25 to 50% of its farmers enrolled in VHHM. The percentage of respondents participating in VHHM in this study was, therefore, quite high (68.6%). This may have been caused by response bias: people who are interested in the survey topic tend to respond more easily (Huang et al., 2003; Dillman, 2000). In the results of this survey, VHHM enthusiasts may, therefore, be overrepresented in comparison with the general population of Dutch dairy farmers. No scientific literature exists, however, on the number of farmers participating in VHHM in the Netherlands to compare with our results.

The most common combinations of discussed topics showed a specific pattern of VHHM (Table 2). Farmers that discuss nutrition, claw health, young stock, or housing, are very likely to also discuss milk production, udder health, production numbers, and fertility with their veterinarian. It thus appears as if a distinction exists between primary and secondary topics. Based on literature on animal health economics, it is worth discussing whether some secondary topics, such as claw health and young stock rearing, deserve more attention. On a dairy farm, the difference in net losses due to fertility between good and average farms are up to €34 per cow per year (Inchaisri et al., 2010). The net losses due to foot disorders on an average dairy farm are €75 per cow per year (Bruijnijis et al., 2010). Rearing costs of young stock account for 13% of the total cost price for milk (Mohd Nor et al., 2012), which equals €509.84 per cow per year. Fertility is, thus, not the highest expendi-

ture. Therefore, the authors argue that claw health and young stock are the topics to be discussed in the future, and urge both veterinarians and farmers to pay more attention to those topics.

Farmer Characteristics Regarding External Information

The second part of the questionnaire was based on the work of Jansen et al. (2010b) on hard-to-reach farmers (Jansen et al., 2010b). The first intention was to divide them into the 4 groups (do-it-yourselfers, proactivists, reclusive traditionalists, and wait-and-seers), as described by Jansen et al. (2010b). After validation studies with factor analysis and Cronbach's α , the model did not fit the data. The factor analysis produced 5 factors in which both questions regarding the openness toward external information and those regarding trust in external information were mixed (results in Appendix, Tables A4 and A5). Both sets of questions (openness toward information and trust in information) have also been tested with a Cronbach's α separately. Both did not meet the threshold of 0.70 set upfront (openness toward information: 0.66; trust in information: 0.47) and were, therefore, not combined for further analysis.

Several explanations exist as to why the model of Jansen et al. (2010b) did not fit our data. First, the farmers in the study by Jansen et al. (2010b) were qualified as being hard to reach by their veterinarian. Therefore, it was not expected that the veterinarian had a lot of influence on the farms. In our study, almost 67% of the farmers were enrolled in some form of VHHM. The veterinarian may be a more important sparring partner in our population. A second explanation could be that our questionnaire was not valid for this model. To improve response rate, the questionnaire was kept as short as possible. Therefore, some aspects of information use, a broad topic, may very well not have been covered.

Farmers indicated that external advisors were their most important source of information. They also indicated that advice from veterinarians and food advisors were followed up on and that the relationship with their veterinarian was good. Still, over half of the farmers said that external advice did not add to their own knowledge. These results raise the question whether gaining external information is the main reason for farmers to participate in VHHM. Maybe other factors, such as farm support and prevention of organizational blindness, play a role in a farmers' decision whether or not to participate in VHHM. These factors have been proven important to participants in VHHM (Lievaart and Noordhuizen, 1999; Derks et

al., 2012a,b). It is worth exploring the reasons why farmers pay for veterinary advice, as it might affect the way the farmer needs to be approached. Knowing what drove the farmer to participate in VHHM may facilitate the veterinarians' choice to support decisions, be a fresh pair of eyes, or provide new developments or prevention strategies.

The Relationship Between Farmer Characteristics and Participation in VHHM

The relationship with the veterinarian was a significant predictor for participation in VHHM in the model. To be seen by the farmer as a trustworthy advisor, the veterinarian needs to build up a trustworthy relationship (Maister et al., 2000). Because VHHM is based on preventive advice, the strength of the relationship is an important contributor to the success of VHHM. Participation in VHHM was higher in farmers that took part in study clubs, who were continuously improving farm management and who were willing to participate in a testing program. These results indicate that farmers who were proactive and curious for new developments and information had a higher probability of joining VHHM. However, if farmers were active in a board or committee regarding dairy farming, they were less likely to participate in VHHM, which does not fit the previous hypothesis. Possibly an optimum exists for openness toward external information, at least in our surveyed population. However, no literature exists on farmers' attitudes in relation to the level of participation in preventive veterinary advice to support or oppose our findings.

The Relationship Between Farmer Characteristics and Level of Participation in VHHM

From the ordinal multivariable logistic regression model, it was shown that for the amount of topics discussed, the relationship with the veterinarian was a significant predictor. Also, farmers that were open to being a testing farm and who were continuously trying to improve farm management were more likely to discuss a greater amount of topics. The same reasoning as with participation in VHHM can be applied here. If farmers are more open to new developments and information, they are more interested in talking about different topics. Farmers who allowed their veterinarian to see their farm data were more likely to discuss more topics. This was as expected, as to discuss topics such as milk production, udder health, and fertility management in depth, it is important for the veterinarian to have access to the farm's management data (LeBlanc et al., 2006).

Although much research has been conducted on the attitudes of farmers toward preventive measures, the link between those attitudes and the amount of advice farmers purchase from their veterinarian has not been made before. When more studies on the relationship between (veterinary) advice, personal communication, and farmers' attitudes are conducted in the future, veterinarians can start to differentiate between their farmers, and provide tailor-made VHHM. This is both good for efficiency and effectiveness.

CONCLUSIONS

In this study, approximately two-thirds of the responding dairy farmers received some form of VHHM. Topics that were often discussed were fertility, milk production, and udder health. Topics that were discussed less often were claw health, young stock, and housing, even though economic benefits of improving these topics may be substantial. Personal characteristics of the farmer were related to the use of and participation in VHHM. More research on these relationships may support the veterinarian in marketing VHHM to dairy farmers.

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APPENDIX

Table A1. Questions (Q) in the questionnaire, divided into questions about execution of veterinary herd health management (VHHM), openness toward information, and trust in information

Question number	Part	Category	Question
Q1	1	Execution of VHHM	Do you participate in VHHM programs? (yes/no)
Q2	1		My veterinarian checks my animals for pregnancy (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q3	1		My veterinarian advises me on fertility (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q4	1		My veterinarian advises me on udder health (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q5	1		My veterinarian advises me on milk production (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q6	1		My veterinarian advises me on nutrition (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q7	1		My veterinarian advises me on young stock rearing (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q8	1		My veterinarian advises me on housing (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q9	1		My veterinarian advises me on claw health (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q10	1		My veterinarian advises me on production numbers (yes/no) If yes, how often? (always; regularly; when problems arise; never)
Q11	2	Openness toward information	Where do you get information on animal health?
Q12	2		I take part in a study club
Q13	2		I take part in a committee/board regarding (dairy) farming
Q14	2		I have been a testing farm for a new product/service
Q15	2		If I were approached to be a testing farm, I would consider it
Q16	2		How often do you visit other farms outside your region (>50 km) to gain knowledge?
Q17	2		I like to be the first to use new developments
Q18	2		I continuously try to improve farm management
Q19	2		If I hear about interesting developments in dairy, I look it up on the internet
Q20	2		If my veterinarian wants to talk about a new topic, I am open to that
Q21	2	Trust in information	I receive visitors on my farm
Q22	2		I view other farmers as competition
Q23	2		My veterinarian may see my farm data
Q24	2		I allow others to visit my farm
Q25	2		I grade the relationship with my veterinarian a . . . (1–10)
Q26	2		I follow the advice of my feed advisor
Q27	2		I follow the advice of my veterinarian
Q28	2		External advice does not add to my own knowledge
Q29	2		The most important reason not to use external advisors is a financial reason
Q30	2		I do not like to share my farm data with other farmers

Table A2. Variables that were significant in univariate logistic regression analysis with dependent variable [participation in veterinary herd health management (VHHM; yes/no)]

Variable ¹	β^2	SE	Wald statistic	Significance (<i>P</i> -value)	Odds ratio
Q2: I take part in a study club	0.42	0.05	6.24	0.01	1.13
Q3: I take part in a committee/board regarding (dairy) farming	-0.34	0.16	4.72	<0.05	0.71
Q4: I have been a testing farm for a new product/service	0.33	0.16	4.53	<0.05	1.39
Q5: If I were approached to be a testing farm, I would consider it	0.42	0.14	8.94	<0.01	1.53
Q11: I receive visitors on my farm	0.31	0.14	5.21	<0.05	1.36
Q13: My veterinarian may see my farm data	1.31	0.34	15.13	<0.01	3.70
Q15: I grade the relationship with my veterinarian a . . . (1–10)					
10	—	—	20.21	<0.01	—
3	-1.93	0.84	5.25	<0.05	0.15
4	-2.52	0.92	7.52	<0.01	0.08
5	-1.89	0.58	10.53	<0.01	0.15
6	-1.45	0.48	9.09	<0.01	0.24
7	-0.85	0.44	3.78	0.05	0.43
8	-0.41	0.44	0.91	0.34	0.66
9	0.08	0.48	0.03	0.86	1.09
Q16: I follow the advice of my feed advisor					
Agree	—	—	9.84	<0.01	—
Neutral	-0.47	0.16	8.28	<0.01	0.63
Disagree	-0.76	0.52	2.12	0.15	0.47
Q17: I follow the advice of my veterinarian					
Agree	—	—	39.47	<0.05	—
Neutral	-1.08	0.18	36.39	<0.01	0.34
Disagree	-1.12	0.52	4.58	<0.05	0.33
Q7: I like to be the first to use new developments					
Agree	—	—	6.83	<0.05	—
Neutral	-0.31	0.18	2.87	0.09	0.73
Disagree	-0.53	0.20	6.83	<0.01	0.59
Q8: I continuously try to improve farm management					
Agree	—	—	14.62	<0.01	—
Neutral	-0.57	0.16	13.22	<0.01	0.57
Disagree	-0.50	0.29	2.95	0.08	0.61
Q10: If my veterinarian wants to talk about a new topic, I listen					
Agree	—	—	19.37	<0.01	—
Neutral	-0.47	0.49	0.91	0.34	0.63
Disagree	-0.79	0.18	18.92	<0.01	0.46
Q18: External advice does not add to my own knowledge					
Agree	—	—	3.99	0.14	—
Neutral	0.11	0.15	0.56	0.45	1.21
Disagree	-0.32	0.20	2.49	0.11	0.73
Q19: The most important reason not to use external advisors is a financial reason					
Agree	—	—	5.14	0.76	—
Neutral	-0.10	0.17	0.39	0.53	0.90
Disagree	-0.36	0.16	5.03	0.03	0.70
Q20: I do not like to share my farm data with other farmers					
Agree	—	—	4.74	0.94	—
Neutral	-0.08	0.22	0.13	0.72	0.92
Disagree	0.24	0.20	1.48	0.22	1.27

¹Q = question.²The regression coefficient, representing the relative importance of a predictor in predicting the criterion.

Table A3. Variables that were significant in univariate logistic regression analysis with dependent variable [number of topics discussed during veterinary herd health management (VHHM); 1–9]

Variable ¹	β^2	SE	Wald statistic	Significance (<i>P</i> -value)	Odds ratio
Q2: I take part in a study club (ref. disagree)					
Agree	0.34	0.14	6.03	<0.05	1.40
Q4: I have been a testing farm for a new product/service (ref. disagree)					
Agree	0.29	0.15	3.97	<0.05	1.34
Q5: If I were approached to be a testing farm, I would consider it (ref. disagree)					
Agree	0.50	0.15	11.65	<0.01	1.65
Q11: I receive visitors on my farm (ref. disagree)					
Agree	0.30	0.13	4.89	<0.05	1.35
Q12: I view other farmers as competition (ref. disagree)					
Agree	0.36	0.28	1.70	0.19	1.44
Q13: My veterinarian may see my farm data (ref. disagree)					
Agree	1.05	0.46	5.18	<0.05	2.86
Q6: How often do you visit other farms outside your region (>50 km) to gain new knowledge?					
Never	−0.74	0.22	10.87	<0.01	0.48
Once every 2 yr	−0.46	0.23	4.04	<0.05	0.63
Once every year	−0.49	0.20	6.14	0.01	0.61
Twice per year	−0.34	0.22	2.43	0.12	0.71
>Twice per year	—	—	—	—	—
Q15: I grade the relationship with my veterinarian a . . .					
3	−1.21	1.07	1.26	0.26	0.30
4	−0.50	1.28	0.15	0.70	0.61
5	−1.42	0.68	4.32	<0.05	0.24
6	−1.26	0.44	8.12	<0.01	0.28
7	−0.28	0.35	0.64	0.42	0.76
8	0.22	0.34	0.41	0.52	1.25
9	0.49	0.37	1.81	0.18	1.63
10	—	—	—	—	—
Q7: I like to be the first to use new developments					
Agree	—	—	—	—	—
Neutral	−0.14	0.17	0.67	0.41	0.87
Disagree	−0.51	0.20	6.76	0.01	0.60
Q8: I continuously try to improve farm management					
Agree	—	—	—	—	—
Neutral	−0.65	0.17	14.85	<0.01	0.52
Disagree	−1.13	0.32	12.32	<0.01	0.32
Q9: If I hear about interesting new developments in dairy, I look it up on the internet					
Agree	—	—	—	—	—
Neutral	−0.29	0.15	3.73	0.05	0.75
Disagree	−0.33	0.17	3.7	0.05	0.72
Q10: If my veterinarian wants to talk about a new topic, I listen					
Agree	—	—	—	—	—
Neutral	−0.51	0.21	5.95	<0.05	0.60
Disagree	−0.42	0.53	0.63	0.43	0.66
Q16: I follow the advice of my feed advisor					
Agree	—	—	—	—	—
Neutral	−0.42	0.78	5.85	<0.05	0.66
Disagree	−0.43	0.62	0.48	0.49	0.65
Q17: I follow the advice of my veterinarian					
Agree	—	—	—	—	—
Neutral	−0.81	0.22	13.43	<0.01	0.44
Disagree	−0.14	0.66	0.05	0.83	0.87

¹Q = question; ref. = reference.²The regression coefficient, representing the relative importance of a predictor in predicting the criterion.

Table A4. Factor loadings (distance to factor) of the 20 questions (Q) regarding farmers' attitudes toward information in factor analysis after varimax rotation, eigenvalue, percentage variance, and Cronbach's α per factor¹

Variable	Factor				
	1	2	3	4	5
Q1: Where do you get information on animal health?	0.60*	0.09	0.03	0.21	0.15
Q2: I take part in a study club	0.74*	0.07	0.05	0.00	0.01
Q3: I take part in a committee/board regarding (dairy) farming	0.49*	-0.04	0.18	0.08	0.00
Q4: I have been a testing farm for a new product/service	-0.07	-0.03	0.63*	0.27	-0.01
Q5: If I were approached to be a testing farm, I would consider it	0.07	-0.01	0.40*	0.35	0.10
Q6: How often do you visit other farms outside your region (>50 km) to gain new knowledge?	0.60*	-0.03	0.16	0.24	0.07
Q7: I like to be the first to use new developments	0.10	0.01	0.27	0.66*	0.04
Q8: I continuously try to improve farm management	0.24	0.14	-0.01	0.62*	0.11
Q9: If I hear about interesting developments in dairy, I look it up on the internet	0.09	-0.06	0.02	0.73*	-0.06
Q10: If my veterinarian wants to talk about a new topic, I am open to that	0.18	0.30	0.03	0.28	0.31
Q11: I receive visitors on my farm	0.27	0.06	0.78*	-0.06	0.02
Q12: I view other farmers as competition	-0.14	-0.02	-0.02	-0.04	0.03
Q13: My veterinarian may see my farm data	-0.19	-0.42*	-0.02	0.14	-0.03
Q14: I allow others to visit my farm	0.40*	0.01	0.68*	0.06	0.13
Q15: I grade the relationship with my veterinarian a . . . (1-10)	-0.18	0.58*	0.13	-0.01	0.43*
Q16: I follow the advice of my feed advisor	0.04	0.69*	-0.03	0.04	-0.26
Q17: I follow the advice of my veterinarian	0.01	0.83*	-0.01	0.08	0.02
Q18: External advice does not add to my own knowledge	0.15	0.01	0.00	0.05	0.63*
Q19: The most important reason not to use external advisors is a financial reason	0.03	-0.09	0.07	0.01	0.77*
Q20: I do not like to share my farm data with other farmers	0.39	0.06	0.01	-0.02	0.24
Eigenvalue	3.61	1.79	1.43	1.24	1.16
% Variance	18.06	8.94	7.15	6.19	5.81
Cronbach's α	0.60	0.31	0.61	0.55	0.32

¹Information for goodness-of-fit: Kaiser-Meyer-Olkin test for sampling adequacy: 0.76; Bartlett's test for sphericity: <0.01.

*The cutoff value for the factor loadings was set at >0.40 and, thus, close to the underlying construct (factor).

Table A5. Variables that were significant in univariate logistic regression analysis with dependent variable [participation in veterinary herd health management (VHHM); yes/no] and independent variables (the 20 questions regarding the use of information and forced entry of number of cows $\times$ veterinary practice size)

Variable ¹	β^2	SEM	Wald statistic	Significance (<i>P</i> -value)	Odds ratio
Q2: I take part in a study club	0.42	0.05	6.24	0.01	1.13
Q3: I take part in a committee/board regarding (dairy) farming	-0.34	0.16	4.72	<0.05	0.71
Q4: I have been a testing farm for a new product/service	0.33	0.16	4.53	<0.05	1.39
Q5: If I were approached to be a testing farm, I would consider it	0.42	0.14	8.94	<0.01	1.53
Q11: I receive visitors on my farm	0.31	0.14	5.21	<0.05	1.36
Q13: My veterinarian may see my farm data	1.31	0.34	15.13	<0.01	3.7
Q15: I grade the relationship with my veterinarian a . . . (1–10)	—	—	20.21	<0.01	—
10	—	—	5.25	<0.05	0.145
3	-1.93	0.84	7.52	<0.01	0.08
4	-2.52	0.92	10.53	<0.01	0.15
5	-1.89	0.58	9.09	<0.01	0.24
6	-1.45	0.48	3.78	0.05	0.43
7	-0.85	0.44	0.91	0.34	0.66
8	-0.41	0.44	0.03	0.86	1.09
9	0.08	0.48	—	—	—
Q16: I follow the advice of my feed advisor	—	—	9.84	<0.01	—
Agree	—	—	8.28	<0.01	0.63
Neutral	-0.47	0.16	2.12	0.15	0.47
Disagree	-0.76	0.52	—	—	—
Q17: I follow the advice of my veterinarian	—	—	39.47	<0.05	—
Agree	—	—	36.39	<0.01	0.34
Neutral	-1.08	0.18	4.58	<0.05	0.33
Disagree	-1.12	0.52	—	—	—
Q7: I like to be the first to use new developments	—	—	6.83	<0.05	—
Agree	—	—	2.87	0.09	0.73
Neutral	-0.31	0.18	6.83	<0.01	0.59
Disagree	-0.53	0.2	—	—	—
Q8: I continuously try to improve farm management	—	—	14.62	<0.01	—
Agree	—	—	13.22	<0.01	0.57
Neutral	-0.57	0.16	2.95	0.08	0.61
Disagree	-0.5	0.29	—	—	—
Q10: If my veterinarian wants to talk about a new topic, I listen	—	—	19.37	<0.01	—
Agree	—	—	0.91	0.34	0.63
Neutral	-0.47	0.49	18.92	<0.01	0.46
Disagree	-0.79	0.18	—	—	—

¹Q = question.²The regression coefficient, representing the relative importance of a predictor in predicting the criterion.