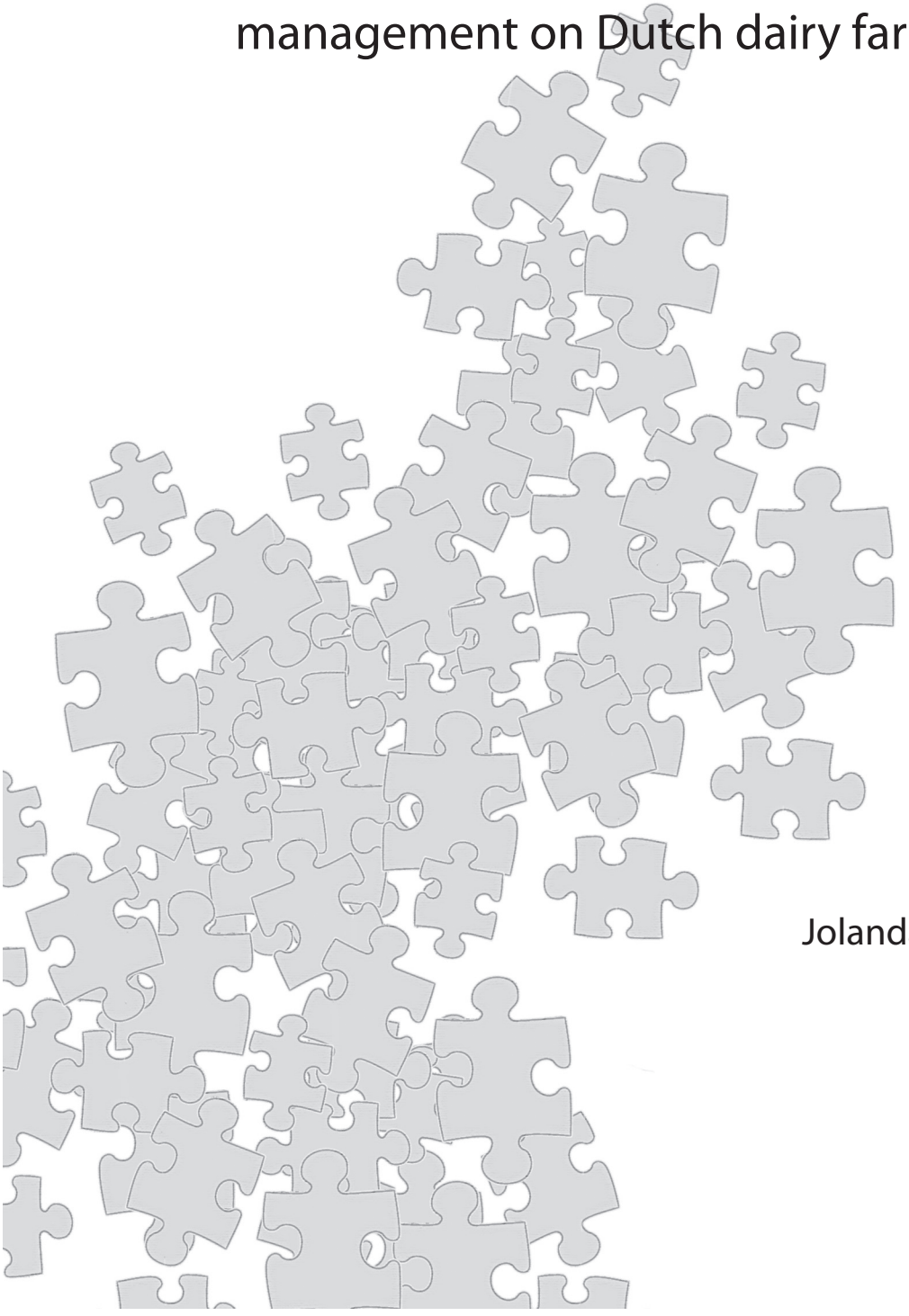
Mastitis and farmer mindset

Towards effective communication strategies to improve udder health management on Dutch dairy farms



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Jolanda Jansen

Thesis

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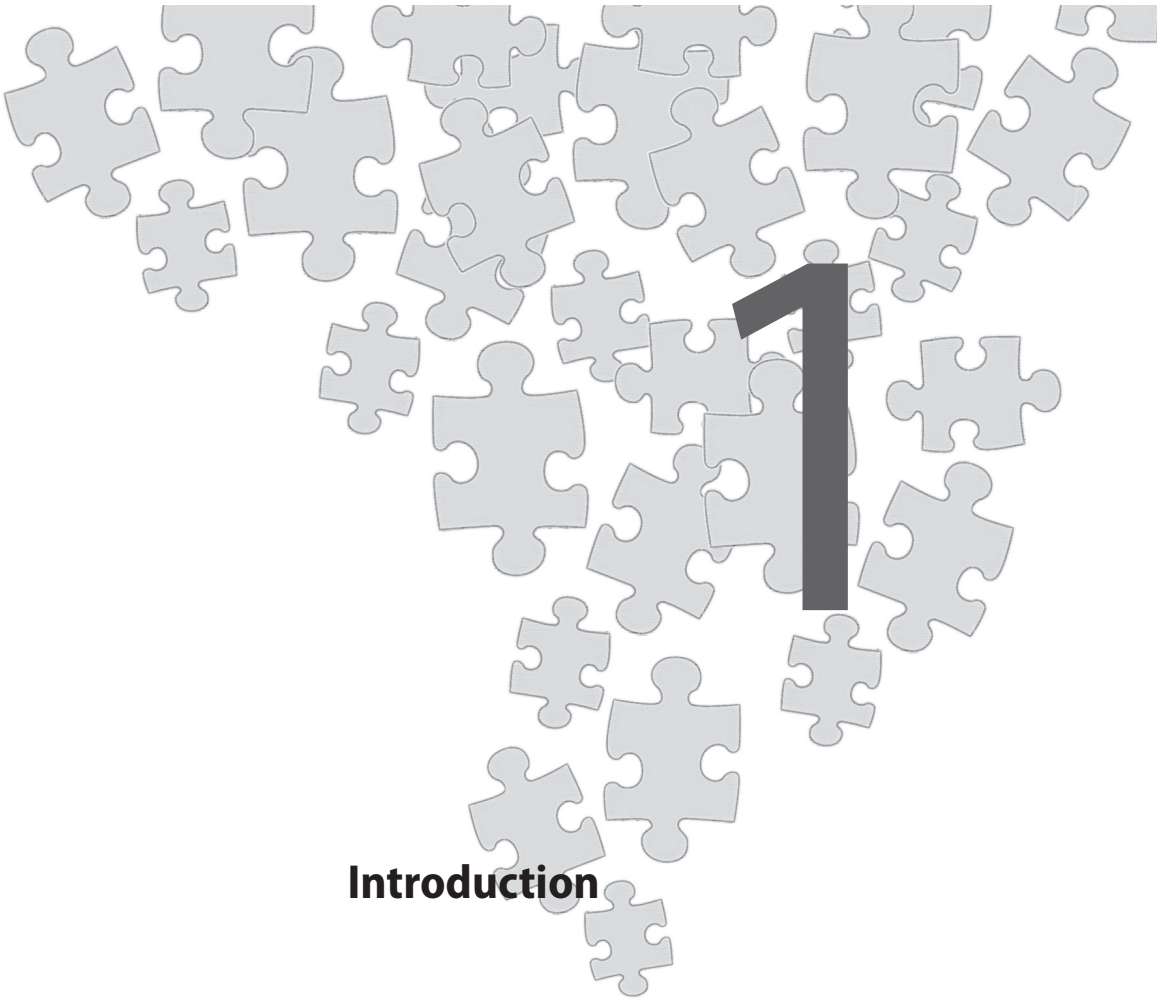

1

Introduction

The aim of this thesis is to understand Dutch dairy farmers' behavior and mindset regarding udder health management and to study the efficacy of various communication strategies. In this introductory chapter, the importance of mastitis prevention is explained, and the background of the national mastitis control program in the Netherlands is described. This program is executed by the Dutch Udder Health Centre (Uiergezondheidscentrum Nederland: UGCN) using various communication strategies to improve udder health. In addition, the focus areas of this thesis are introduced: farmer mindset regarding udder health and its association with herds' udder health status, and the efficacy of various communication strategies to reach motivated and non-motivated farmers.

Mastitis as a main health issue in the dairy industry

From a historical perspective dairy products make major contributions to human welfare, including the provision of cow milk to infants and young children (Maijala, 2000). Most people in developed countries consider dairy products to be safe and healthy. However, consumers are more critical nowadays, and there is increasing pressure on the dairy industry to meet their demands on food safety and food quality issues (LeBlanc et al., 2006). One of the most important health issues in the dairy industry is bovine mastitis (Bradley, 2002; Halasa et al., 2007; LeBlanc et al., 2006). Mastitis is an inflammation of the udder, generally caused by bacteria that enter the udder via the teat canal (Bramley et al., 1996). These bacteria can infect the udder tissue inducing an inflammation that is either subclinical or that shows clinical symptoms, such as visible abnormal milk and/or udder. Subclinical mastitis is diagnosed by bacteriological culturing of milk samples and by counting the number of somatic cells (SCC) in these samples.

Mastitis is a costly disease (Halasa et al., 2007). On average, the losses caused by mastitis range from €164 to €235 per clinical case and from €53 to €182 per subclinical case (Huijps et al., 2008). Besides economic losses, mastitis also leads to frustration for the farmer (Kuiper et al., 2005), a decrease in animal welfare (Kemp et al., 2008), and an increased risk of antibiotic residues (van Schaik et al., 2002), and it influences milk quality (Barbano et al., 2006). Excessive antibiotic use in animal farming is increasingly seen as a threat to public health, because it may lead to the emergence of multiple resistant bacteria (Sischo, 2006; Van Rijen et al., 2008). This may affect citizens' perceptions of the naturalness of dairy production systems, which is the key to societal acceptance (Boogaard et al., 2008). Food safety is a priority of the dairy industry to avoid food scares (Sischo, 2006). Consequently, mastitis prevention is relevant not only for animal welfare, but also for society, the dairy industry, and farmers.

Mastitis management

The best way to prevent mastitis is by consistently implementing efficacious management practices, such as optimization of nutrition, host resistance, environmental conditions, milking equipment, milking technique and hygiene (Bradley, 2002; Huijps et al., 2010; LeBlanc et al., 2006). In addition, proper data handling and goal setting are crucial in disease prevention programs. An increase in mastitis incidence usually occurs due to either an increase in infection pressure or a decrease in cows' resistance. Although the latter can often be caused by factors outside the farmer's control (such as weather), it usually indicates that farm management is not optimal. Although numerous quantitative studies have demonstrated the effect of farm management practices on mastitis (Barkema et al., 1999; Barnouin et al., 2005; Chassagne et al., 2005; Elbers et al., 1998; Green et al., 2007; Nyman et al., 2007; Wenz et al., 2007), the management factors identified in these studies explain only part of the variance in mastitis incidence on farms.

Preventive as well as problem solving approaches, based on known risk factors for mastitis, sometimes fail for reasons that are not immediately understood by the health professionals connected with the dairy herd (Vaarst et al., 2002). Comparative studies, for instance, demonstrated that dairies with the same facilities, feed, genetic base, and environmental circumstances had differences in productivity; the main difference between these farms was the herd manager (Seabrook, 1984). Sligo et al. (2005: 463) formulated this as: "Take two dissimilar farmers, put them in the same context and what they might be able or want to derive from their environments might differ radically". Why some farmers, even though it would considerably improve their results, do not implement effective mastitis management practices remains elusive (Barkema et al., 1999).

Improving udder health using policy instruments

The causes of variation in mastitis incidence on herd and cow level are not yet fully understood. However, this does not restrain the dairy sector from implementing policies to reduce mastitis. As udder health can be improved by changing farmers' management and thus by changing farmers' behavior (e.g. the implementation of mastitis control practices), several policy instruments can be used (Van Woerkum et al., 1999, see Figure 1.1). Compulsory behavioral change is facilitated by coercion such as regulations and restrictive provisions (Van Woerkum et al., 1999). It is well known that compulsory behavioral change will probably only last as long as the coercion exist. Therefore, voluntary behavioral change is preferable.

Voluntary behavioral change is facilitated by motivation (Van Woerkum et al., 1999). People can be internally and/or externally motivated. External motivation can

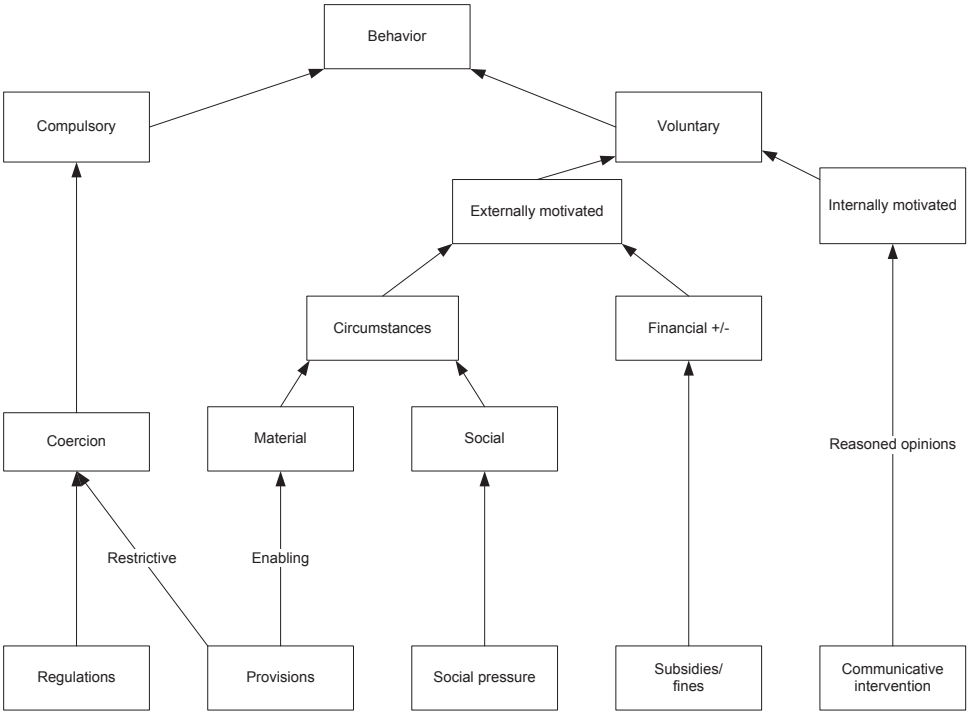

Figure 1.1 Behavioral change by policy instruments (Van Woerkum et al., 1999; see also Leeuwis, 2004).

be accomplished by financial stimuli such as bonuses and penalties related to bulk milk somatic cell count (BMSCC) (Valeeva et al., 2007). Currently in the Netherlands a penalty is imposed for a geometric mean BMSCC above 400,000 cells/ml. This policy is effective in reducing the number of herds with a BMSCC above this threshold level. However, this does not solve all udder health problems, because serious clinical mastitis problems may occur in herds with a low BMSCC (Barkema et al., 1998). In addition, milk of individual cows with clinical or subclinical mastitis can be withhold from the bulk and thus are not represented in the BMSCC.

Circumstances also can support the motivation of farmers. They can be influenced by social pressure, such as demands from consumers, and by provisions, such as milk sample record systems. Internal motivation can be influenced by various communicative interventions aimed at persuading farmers to change their behavior.

The Dutch mastitis control program

The policy to control udder health by external motivation through the BMSCC penalties did not prevent udder health gradually decreasing (Van der Zwaag et al.,

2005). With an incidence rate of 31% cases of clinical mastitis per 100 cows per year in 2004 (Van den Borne et al., 2010) and average costs of €210 per case (Huijps et al., 2008) mastitis costs approximately €100 million per year in the Netherlands (Van der Zwaag et al., 2005). Together with increasing consumer demands in relation to animal welfare, antibiotic resistance, food safety, and food quality, this motivated the Dutch Dairy Association (Nederlandse Zuivel Organisatie), the Dutch Dairy Board (Productschap Zuivel) and the Dutch Federation of Agriculture and Horticulture (Land- en Tuinbouw Organisatie Nederland) to establish the UGCN in 2005, with the aim of executing a five-year national intervention program to improve the udder health situation in the Netherlands.

To reach this goal, the program consisted of two parts: research on udder health, and various strategies to change farmers' management. Policy instruments such as regulations, more stringent BMSCC threshold levels, or bonuses on milk quality were beyond the reach of this program. This meant that primarily communication strategies towards farmers and veterinarians were used as instruments to change farmers' behavior in order to improve udder health in the Netherlands.

The mastitis control program was comprised of two main communication strategies to change farmers' behavior (Lam et al., 2007). The first strategy included on-farm study groups and the development of comprehensive education materials for farmers who were interested in participating in programs to improve udder health management. This strategy focused on the broader goal of improving udder health by educating farmers using comprehensive science-based and rational argumentation about mastitis prevention and treatment. The backbone of this type of knowledge transfer to farmers via study groups was formed by veterinarians acting as intermediaries between UGCN and farmers. Of the approximately 300 veterinary practices in the Netherlands serving dairy farmers, over 200 participated in the program, serving approximately 17,000 of 20,000 dairy farmers in the country. Of these, over 3,000 participated in the on-farm study groups organized by their local veterinarian.

The second strategy included straightforward mass media campaigns that focused on a single aspect of mastitis prevention, such as campaigns on stimulating the use of milking gloves during milking and the use of a standardized mastitis treatment protocol. Several stakeholders, such as agricultural suppliers or veterinary pharmaceutical companies, were involved in these campaigns in which hardly any rational argumentation was used.

In addition to these two main strategies, the UGCN used many other ways to reach farmers such as articles in various media, websites, newsletters, organization of workshops, open farm days and symposia, udder health awards for excellent udder health achievements, and the development of a practical guide on udder health (Hulsen and Lam, 2008).

The importance of understanding the 'human factor'

When programs to change farmers' behavior are initiated, it is often assumed by policymakers that behavior is predictable and easy to influence using a combination of policy methods (Burton, 2004; Leeuwis, 2004). As already mentioned, there is variation among the udder health status of farms, even though they are affected by the same policy measures. It is obvious that changing a farmer's behavior is not as simple as just implementing policy instruments or establishing an Udder Health Centre.

From a social-psychological perspective, behavior can be influenced by various factors following several persuasive theories, models, and frameworks (Cameron, 2009; Fishbein and Yzer, 2003). Several studies in the agricultural domain also suggest that whether and how management practices are implemented on a farm depends on the farmer's personality, attitudes, beliefs, values, intentions, skills, knowledge, perceived norms, and perceived self efficacy towards the management practice (Andersen and Enevoldsen, 2004; Barkema et al., 1999; Barnouin et al., 2004; Beaudeau et al., 1996; Dohoo et al., 1984; Leeuwis, 2004; Nyman et al., 2007; Reneau, 2002; Seabrook, 1984; Tarabla and Dodd, 1990; Vaarst et al., 2002; Van der Ploeg, 1999; Wenz et al., 2007). All these factors, and probably more, comprise the 'human factor' which, for the sake of convenience, is summarized as 'farmer mindset' in this thesis. It is assumed that high quality milk is produced by those farmers who have a 'milk quality mindset' (Reneau, 2001; 2002).

The mindset differs from farmer to farmer and is also perceived differently by farm advisors (Andersen and Enevoldsen, 2004). Because "farming practices are shaped in a series of social interactions between different people at various points in time and in different locations, within the context of a wider social system" (Leeuwis, 2004: p65) farm advisors, like veterinarians, can have a large influence. In most herds, experience about mastitis is gradually built up in collaboration between the farmer and the veterinarian, and both contribute to this common experience with their backgrounds and former experiences (Vaarst et al., 2002). Farm advisors, such as veterinarians, generally are well aware of the influence of the farmer's mindset on production and diseases of dairy cattle (Barkema et al., 1999), but they perceive difficulties in proactively influencing farmer mindset (Botha et al., 2008; Mee, 2007; Noordhuizen et al., 2008).

Although many agricultural science studies indirectly implicate farmer mindset as a determining factor explaining mastitis incidence, only a limited number of studies have attempted to directly correlate farmer mindset with milk quality (Beaudeau et al., 1996; Reneau, 2001, 2002; Rougoor et al., 1999). Exploratory research by Tarabla and Dodd (1990) and Bigras-Poulin et al. (1985) has shown that farmers' attitudes, values, and socio-demographic profile explain a similar or greater amount of the variation in some farm performance characteristics than just farm management variables. These

studies, however, did not analyze which aspects of farmer mindset are important and how this relates to the incidence of diseases such as mastitis. The efficacy of current policies and programs to control or improve udder health by reaching farmers and changing farmer mindset is currently unknown.

General aim

It is assumed that a herd's udder health status is associated with the mindset of farmers. There is, however, hardly any knowledge available on how farmer mindset affects udder health. It seems that optimizing udder health management on the farm encompasses more than the dissemination of technical information about best management practices to dairy farmers. Therefore, it is considered valuable to analyze if, and how, a mastitis control program using various communication strategies to improve udder health, affects farmer mindset. Understanding these issues can contribute to an optimization of future programs designed to control livestock diseases.

> *This thesis aims to understand Dutch dairy farmers' behavior and mindset regarding udder health management and to study the efficacy of various communication strategies.*

Thesis outline

In the studies presented in this thesis, a variety of qualitative and quantitative methods was used, combining social and veterinary sciences to gather data on farmer mindset towards mastitis and data on the efficacy of various communication strategies. In this interdisciplinary and practice-based approach, every study was initiated on the basis of observations and experiences during the execution of the Dutch udder health program and/or on the basis of emerging questions that followed from the previous studies. Results and recommendations derived from the studies were reported to the UGCN and as much as possible implemented to further improve the program, which led to a strong interaction between science and practice.

A longitudinal survey on farmer mindset and mastitis incidence using questionnaires was executed to study farmer mindset and behavior towards udder health in 2004 and 2009. The results of the baseline survey in 2004 are presented in Chapter 2. This study aimed to determine, to quantify, and to specify the extent to which farmer mindset, over and above farmers' behavior, explains the variation in mastitis incidence. The results in Chapter 2 suggested a need for effective communication strategies to change the farmer mindset on udder health. Therefore, a study was conducted to evaluate two different communication strategies implemented by the UGCN using telephone surveys and online questionnaires; this is described in Chapter 3. The aim of that study was

to understand how communication strategies could be used to improve udder health, their potential efficacies, and the extent to which motivation is required when both strategies are used. The results in Chapter 3 show that, at that time, not all farmers were reached by the UGCN communication strategies. Therefore, Chapter 4 presents the results of in-depth interviews with farmers who were presumed to be hard to reach on udder health information according to their veterinarians. The aim of this study was to provide insight into the mindset and information-seeking behavior of this group of farmers. The results of this study suggested that the role of veterinarians as proactive udder health advisors and their communication skills needed to be further investigated. Therefore, Chapter 5 presents results of a survey and in-depth interviews with dairy cattle practitioners. The aim of this study was to explore their communication skills by observing veterinarian–farmer conversations during herd health advisory visits, and to identify their perceptions on their role as udder health advisors.

Chapter 6 presents the results of the longitudinal study in 2009 to monitor changes in elements of farmer mindset and behavior since the baseline survey in 2004, with the aim of evaluating the overall effects of the program. Finally, in Chapter 7 the findings of the different studies within this thesis are discussed with respect to its general aim. In addition, the main conclusions are summarized and general implications for future research and for future animal disease control programs are discussed.

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2

Explaining mastitis incidence in Dutch dairy farming: the influence of farmers' attitudes and behavior

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ABSTRACT

When mastitis incidence increases, either infection pressure has increased or cows' resistance has decreased. This usually indicates that farm management is not optimal. Numerous quantitative studies have demonstrated the effect of management practices on mastitis. In most of these studies, the identified risk factors could explain only part of the variance in mastitis incidence on farms. Several studies suggest that the unexplained variance is caused by farmers' attitudes towards different aspects of mastitis treatment and preventive behavior. This study aims to determine, to quantify and to specify the extent to which farmers' attitudes, over and above farmers' behavior, are factors that explain the variation in mastitis incidence, measured in terms of the quantifiable effect of management factors.

An extensive survey on self-reported attitudes, behavior and mastitis incidence was conducted on 336 Dutch dairy farms. Results of multiple linear regression analyses show that farmers' self-reported behavior and attitudes together explain 48%, 31% and 23% of the variation within, respectively, the average farm bulk milk somatic cell count (BMSCC), the clinical mastitis incidence and the combined clinical and subclinical mastitis incidence. Both behavior and attitudes explain part of the variance. However, most of the variance in all three dependant measures is explained solely by the attitude variables.

The variation in BMSCC value is best explained by (1) farmers' normative frame of reference about mastitis, (2) farmers' perceptions about the control of mastitis and (3) the perceived effect of a BMSCC penalty level. The variation in clinical mastitis is best explained by farmers' perceptions about mastitis control. The variation in the combined clinical and subclinical mastitis incidence rate is best explained by the perceived effect of a BMSCC penalty level and the frequency of contact with others.

The results of this study show that farmers' attitudes are a better measure than farmers' self-reported behavior to explain and predict differences in mastitis incidence between farms. Consequently, this association implies that future research and animal health promotion programs should take into account not only farmers' behavior, but also farmers' attitudes. This study provides a first empirical investigation into the social processes applicable to mastitis incidence and is therefore considered a good starting point for future research to further investigate the causal effect of attitude change on farmers' behavior and animal health.

INTRODUCTION

An increase in mastitis incidence usually occurs due to either an increase in infection pressure or a decrease in cows' resistance. The latter can be caused by factors outside the farmer's control (such as weather), but it usually indicates that farm management is not optimal. Although numerous quantitative studies have demonstrated the effect of farm management practices on mastitis (Barkema et al., 1999; Barnouin et al., 2005; Chassagne et al., 2005; Elbers et al., 1998; Green et al., 2007; Nyman et al., 2007; Wenz et al., 2007), the risk factors identified in these studies can only explain part of the variance in mastitis incidence on farms.

Preventive as well as treatment programs, based on known risk factors for mastitis, sometimes fail for reasons that are not immediately understood by the health professionals connected with the dairy herd (Vaarst et al., 2002). Why some farmers, even though it would benefit their results, do not implement effective mastitis management practices is not always known (Barkema et al., 1999). Several studies suggest that whether and how these mastitis management practices are implemented on a farm probably depends on the human factor of the farmer: his management style and accompanying dispositions and beliefs (i.e. attitudes) towards different aspects of mastitis treatment and preventive behavior (Andersen and Enevoldsen, 2004; Barkema et al., 1999; Barnouin et al., 2004; Beaudeau et al., 1996; Dohoo et al., 1984; Leeuwis, 2004; Nyman et al., 2007; Reneau, 2002; Seabrook, 1984; Tarabla and Dodd, 1990; Vaarst et al., 2002; Van der Ploeg, 1999; Wenz et al., 2007).

In the social science field, the impact of the human factor on behavior is widely studied using constructs such as peoples' attitudes, knowledge, beliefs, values, goals and intentions (Jaccard and Blanton, 2005). Attitude, in particular, is well known as an important factor in creating and changing behavioral intentions and actions (Ajzen and Fishbein, 2005). The term attitude is used for evaluative tendencies, which can both be inferred from and have influences on cognitive beliefs, affective associations and overt behavior (Albarracin et al., 2005; Kiviniemi et al., 2007). In this study, the construct of attitude is used as a collective term for these cognitive beliefs and affective associations in which issues such as knowledge, beliefs, values, goals and intentions are included.

Although many agricultural science studies indirectly implicate attitude as a determining risk factor for mastitis incidence, there have been few studies that have attempted to directly correlate farmers' attitude with milk quality (Beaudeau et al., 1996; Reneau, 2001; 2002; Rougoor et al., 1999). Preliminary research undertaken by the Dutch Udder Health Centre (Van der Zwaag et al., 2005) suggests that farmers' attitude may indeed be more correlated to mastitis incidence than farmers' behavior (Kuiper et al., 2005). In addition, a recent study by Nyman et al. (2007) suggests that farmers' attitude towards mastitis treatment and milk production influences the incidence rate of veterinary-treated mastitis more than environmental factors such as housing

conditions. Moreover, exploratory research by Tarabla and Dodd (1990) and Bigras-Poulin et al. (1985) has shown that farmers' attitudes, values and socio-demographic profile explain a similar or greater amount of the variation in some farm performance characteristics than just farm management variables. Unfortunately, these studies fail to explain which attitude is important and how this specifically relates to the incidence of diseases such as mastitis. Although many studies already suggest an important effect of attitude on farm performance, the direct effect of farmers' attitude on clinical and subclinical mastitis incidence has, so far, hardly been investigated.

In this study, three questions, including both behavioral and attitudinal items, are posed in order to explain the variance in different mastitis incidence indicators between farms. First, is it possible to explain mastitis incidence by using self-reported behavior and attitude of farmers? Second, does farmers' attitude have a quantifiable added value, over and above farmers' behavior, in explaining the variation of mastitis incidence? Third, which specific behavioral and/or attitudinal variables are then most important in explaining this mastitis variance? The answers to these questions will contribute to the understanding of mastitis problems and provide leads for effective communication strategies in mastitis control programs.

MATERIALS AND METHODS

General

An extensive survey was carried out as part of the Dutch udder health program. The independent variables about both attitude and behavior were obtained with a questionnaire. The dependent variables of mastitis incidence indicators were observed by the farmer or measured via test-day records and bulk milk somatic cell count (**BMSCC**) data.

Participants

Criteria for farms to participate in the study were: (1) an average farm size > fifty cows, (2) the age of the farmer had to be < 57 years and (3) farms had to participate in the regular test-day recording, with test-day intervals of 3-6 weeks. These criteria were used to ensure that the farms would be able to participate in the Dutch udder health program over the coming years. The selection resulted in a random sample from which 543 farmers were contacted by telephone to ask them to participate. Subsequently, 378 participants completed a questionnaire on attitudes and behavior and gave the research team permission to collect their mastitis data. The reasons that farmers gave for not cooperating with the survey were that they were either too busy or not interested. After one year of data collection, complete records of 336 farms

were available for analysis – a total response rate of 62%. Reasons for missing data in the survey were: (1) farmers had quit farming or reorganized the farm, (2) farmers had neither the time nor the inclination to fill in the papers and (3) farmers provided incomplete data, such as incomplete or missing forms.

Mastitis data as dependent variables

Three different mastitis indicators were used in this study as dependent variables to provide insight into the mastitis status of the farms: (1) clinical mastitis incidence rate, (2) average BMSCC in the period preceding the survey (April 2004 - July 2004) and (3) a combined clinical and subclinical mastitis incidence rate.

The clinical mastitis incidence rate was calculated as the number of clinical cases divided by the number of days at risk. A clinical case was defined as a cow with visual abnormalities in the milk and/or quarter. Clinical mastitis cases were reported from July 2004 until June 2005 by all farmers at each test-day recording, indicating whether or not a cow had clinical mastitis in the interval between test days, regardless of the quarter of infection and the number of clinical mastitis cases in that cow in that period. Additionally, after the initial data collection, all farmers were asked to complete the collected data with the specific date and the quarter of the infection; 187 farmers responded. Both datasets were combined into a new dataset of all 336 farms with clinical mastitis occurring both at the cow and/or quarter level. Clinical mastitis cases occurring within two weeks of each other in the same quarter were excluded from the analysis for the dataset at the quarter level. Cow days at risk were calculated as the total number of days a cow was present at the farm during the study.

The clinical mastitis incidence rate, in the combined clinical mastitis dataset, was then calculated at herd level using the following equation, and was expressed as the incidence rate per 100 cows at risk per year per farm:

$$\text{Clinical mastitis incidence rate} = \left(\frac{new}{dar}\right) \times 365 \times 100 \qquad (1)$$

new = number of new cases of clinical mastitis a year at cow or quarter level; dar = number of days at risk for clinical mastitis.

For the second mastitis indicator, the fortnightly BMSCC data were used to calculate the average BMSCC for the three months preceding the survey. The BMSCC data preceding the survey were considered most appropriate because the questionnaire covered this period[1].

1 Average BMSCC data were collected for a further 12 months after the survey. However, these data correlate highly (r =.80, P<.001) with the data preceding the survey, the results are similar and therefore not shown.

For the third mastitis indicator, the combined clinical and subclinical mastitis incidence rate, farm data for both clinical and subclinical mastitis were analyzed. To calculate this indicator, the number of new clinical and subclinical mastitis cases was divided by the number of days at risk. In this combined measure, a new case of mastitis was considered to be a new case of clinical mastitis as described above, or a new case of subclinical mastitis, based on composite somatic cell counts (**CSCC**), gathered from the regular test-day recording. A new case of subclinical mastitis was defined as an increase above a threshold value of 150,000 cells/ml for heifers and 250,000 cells/ml for multiparous cows, after being two consecutive test days below these threshold values, regardless of the dry period. These threshold values are generally used in The Netherlands. Therefore, cows could experience clinical or subclinical mastitis more than once in the same lactation. The combined mastitis data were also corrected for cow days at risk. A cow was defined to be at risk if it had a low SCC and no clinical mastitis. The combined mastitis incidence was then calculated at herd level using the following equation and was expressed as an incidence rate per 100 cows at risk per year per farm:

$$\text{(sub)clinical mastitis incidence} \quad \left(\frac{(newclin + newsubclin)}{darmast}\right) \times 365 \times 100 \qquad (2)$$

Newclin = number of new cases of clinical mastitis a year; Newsubclin = number of new cases of subclinical mastitis a year; Darmast = number of days at risk for clinical and/or subclinical mastitis.

Attitudinal and behavioral data as independent variables

The data were collected using a structured questionnaire on self-reported attitudes and behavior as well as demographic items. A team of veterinarians, farmers, animal health experts, communication experts and social psychologists developed this questionnaire which contained 55 items regarding behavior and 123 items about attitude. Insights about farmers' self-reported behavior regarding mastitis were obtained by asking about actual actions, such as "do you clean the teats before milking?" or "how often do you clean the cubicles?". Insights about self-reported attitude were mainly derived by asking about perceptions and opinions such as "I worry about mastitis" and "what is the most annoying aspect of mastitis?"

The attitude and behavior items were mostly measured by statements that the farmers rated on a five-point Likert scale (Likert and Hayes, 1961) according to how much they agreed or disagreed with the statements, for example: "I worry about mastitis" (1= completely disagree to 5=completely agree). These items are assumed to be interval data (De Heus et al., 1995). In addition, binominal items were used to

see whether farmers answered yes (1) or no (0) to a certain question, e.g. "do you disinfect all teats after milking with a spray or dip?" Finally, some items were measured continuously, e.g. age and BMSCC level, or by categorizations in groups, e.g. type of milking parlor. The categorical and ordinal items were transformed into dummy variables. Farmers' normative frame of reference was measured by asking farmers when, at which value, they perceive a problem with BMSCC and clinical mastitis, and when they are satisfied.

All the items from the questionnaire were used to develop a set of independent variables by principal component analysis (**PCA**) to explain the variation in mastitis incidence. The final set of independent variables used in the correlation and regression analyses are shown in the appendices (2A and 2B).

Data analysis

All three mastitis outcomes were checked for normality. Bulk milk somatic cell count (BMSCC) levels of participating farms preceding the survey were shown to be normally distributed with skewness 0.38 and kurtosis -0.01. The Kolmogorov-Smirnov test was not significant $P>0.61$ and the histogram and Q-Q plot gave no reason for concern.

The combined clinical and subclinical mastitis incidence rate was also shown to be normally distributed with skewness 0.53 and kurtosis 0.25. The Kolmogorov-Smirnov test was not significant $P>0.23$ and the histogram and Q-Q plot gave no reason for concern.

The clinical mastitis incidence rate was, however, strictly speaking, not normally distributed, with skewness 0.96 and kurtosis 1.30. The Kolmogorov-Smirnov test was significant $P>0.03$ and the histogram was slightly positively skewed. However, the Q-Q plot gave no reason for concern. Therefore, it was decided to assume a normal distribution and to check the residuals of the multiple models for randomness.

The final data analysis is based on three steps: (1) reducing the number of variables from the questionnaire and reducing multicolinearity among variables by PCA, (2) correlation analysis with this reduced dataset to determine associations with mastitis indicators, (3) regression analysis with the variables that correlated significantly with at least one of the mastitis indicators.

For the first step, PCA with Varimax rotations and reliability analyses were performed on items which were measured on the same Likert scale (Dohoo et al., 1997; Field, 2005). The PCA analyses showed a Kaiser-Meyer-Olkin measure of sampling adequacy (**KMO**) of .68, with a significant result for Bartlett's test of sphericity (Chi-square = 6223.80, Df = 2346, $P<.001$). In addition, a sample size of 336 and no extreme multicolinearity and singularity showed that the use of PCA to reduce variables was justified.

Factors with an eigenvalue >1 (Kaiser criteria (Dohoo et al., 1997; Kaiser, 1960))

were included and tested for reliability using Cronbach's α >0.55 as the threshold value for combining items in the same measure. These new multiple item measures were computed for all farmers by taking the average score of the underlying variables. The multiple item measures were used in further analyses. Items which could not be grouped based on PCA and reliability were regarded as independent variables and were included individually in the analyses. As shown in Appendix 2A and Appendix 2B, the PCA and reliability analyses resulted in 46 behavioral variables including two multiple-item measures, and 95 attitudinal variables including 12 multiple-item measures.

For the second step, after the PCA, the data were split in two main parts for the analyses: (1) 46 self-reported behavioral variables from the questionnaire and (2) 95 self-reported attitude variables from the questionnaire. In these analyses, the three mastitis indicators (clinical mastitis incidence rate, BMSCC and combined clinical and subclinical mastitis incidence rate) were used as dependent variables and the self-reported measures of attitudes and behavior as independent variables. To select the variables from both behavioral and attitudinal variables with a significant ($P<.05$) association with one of the dependent variables, zero-order bi-variate two-tailed Pearsons' correlations were calculated. Use of Spearmans' correlation instead of Pearsons' did not change the number of variables included in the regression analyses.

For the final step, to test whether and how much farmers' attitudes as well as their behavior explained the between-farm variation in mastitis incidence, multiple linear regression analyses were performed using the stepwise method as the model building process. All attitudinal and behavioral variables that were used in the regression analyses were significantly correlated ($P<.05$) to at least one of the mastitis indicators (Dohoo et al., 1997). In the first model, only behavioral variables, in the second model only attitudinal variables, and in the third model all variables, were included. All models were corrected for whether the data were collected at cow or quarter level, by forcing this as a variable into every model. The model was checked for normality and autocorrelation using Durbin Watson tests for independent errors, variance inflation factor (VIF), tolerance levels, Cook's distance and standardized residuals (Q-Q plot and histogram). All data were analyzed using SPSS (SPSS 12.0.1 for Windows, SPSS Inc. Chicago, IL, USA).

RESULTS

General description of mastitis status

An exploration of the mastitis indicators showed that the average clinical mastitis incidence was 30.3 cases per 100 cows at risk per farm per year (SD 17.70). Furthermore, the average BMSCC preceding the survey was 191,890 cells/ml (SD 61.04) and the

average combined mastitis incidence was 99 cases per 100 cows at risk per farm per year (SD 29.83). The average herd size of the participants was 77 dairy cows (SD 23.86). Less than two percent of the respondents had an organic farming system. The farmers were on average 41 years old (SD 8.35). Almost all farmers had completed their secondary education; 68% of these had completed intermediate professional agricultural education and 13% had completed higher professional agricultural education. Milking systems, such as automatic milking systems or carrousel milking parlors, were used by, respectively 1% and 3% of the farmers.

Correlation analyses

Tables 2.1A and 2.1B show that, respectively, 21 of the 46 behavioral variables and 34 of the 95 attitudinal variables correlated significantly with one of the mastitis indicators. These variables are included in the multiple linear regression analyses.

Explaining the variance of mastitis incidence

As indicated in Table 2.2, the results of the multiple linear regression analyses show that farmers' self-reported behavior and attitudes together explain 48%, 31%, and 23% of, respectively, the variation within the average farm BMSCC, the clinical mastitis incidence rate and the combined clinical and subclinical mastitis incidence rate. The variables from the final set of independent data did not correlated more highly than .34 with each other. The model was further checked for normality and autocorrelation: Durbin Watson tests for independent errors were close to 2.0, the largest VIF was 1.5, with an average close to 1, the lowest tolerance level was 0.67, Cook's distance was below 1.00 in all models, 95% of all cases had standardized residuals between values of -2 and +2, and 99% of all cases had standardized residuals between -3 and +3, histograms and Q-Q plots of standardized residuals gave no reason for concern. On the basis of the above, we can conclude that the model fits of the regression analyses conducted were appropriate, even though the clinical mastitis incidence rate was initially not normally distributed.

Although behavioral variables, as well as attitudinal variables, were able to predict unique variance in all mastitis indicators, the results show that the variance in mastitis incidence is mainly explained by farmers' attitudes. As shown in Table 2.2, 47% of the variance in BMSCC, 30% of the variance in the clinical mastitis incidence rate and 17% of the variance in the combined mastitis incidence rate was explained by just the attitude variables.

Table 2.1A Pearson's correlations of mastitis indicators and survey variables about farmers' behavior in The Netherlands

	Behavioral variables	Dependant variable		
		Clinical mastitis[a]	BMSCC[b]	Combined mastitis[c]
Milking procedures				
1	Checking milk machine vacuum every day	.05	-.04	-.08
2	Milking mastitis cows separately or last	-.01	-.07	-.11*
3	Wearing gloves during milking	.02	-.18**	-.10
4	Disinfecting all teats after milking with dip or spray	.11	-.19**	-.02
5	Preventing all cows from lying down after milking	.12*	-.14**	-.04
6	Cleaning udders before milking with dry towel	-.13*	-.00	-.03
7	Cleaning udders before milking with paper towel	.15**	.02	.01
8	Forestripping cows before milking	.12*	-.01	-.04
Diagnosis				
9	Most important way of diagnosing clinical mastitis is forestripping every cow	.13*	-.03	-.05
10	Most important way of diagnosing subclinical mastitis is checking cell count records	.14*	-.03	-.05
Treatment and actions				
11	Mastitis treatment plan available	.00	-.13*	.03
12	Strictly finish antibiotic treatment	.05	-.12*	. 03
13	Delayed treatment of subclinical mastitis cows when milk quota is not full	.07	.10	.14*
14	No actions are taken as long as there are no serious mastitis problems	-.17**	.07	.06
15	Changed management because of former mastitis problems	.07	-.04	.12*
16	Percentage of mastitis cases from which milk samples are taken for bacteriology	.08	-.19***	-.12*
Checking cell count records				
17	Individual cows' cell count records are not checked when BMSCC is low.	-.13*	.23***	.17**
18	Always check the number of new attention cows	.05	-.18**	-.16**
Other				
19	Frequency of cleaning cubicles every day	-.03	-.15**	-.18**
20	Frequent contact with others about mastitis	.10	.04	.15**
21	Accounting for udder health parameters when selecting bulls for mating	.19***	-.07	.00

Loadings are Pearsons' correlation coefficients *P<.05 **P<.01 ***P<.001, two tailed

[a] Incidence rate of clinical mastitis cases per 100 cows per year

[b] Average fortnightly bulk milk somatic cell count (BMSCC) for the three months preceding the survey

[c] A combination of clinical and subclinical mastitis incidence per 100 cows per year

The best explanatory variables for mastitis incidence

To explain the clinical mastitis incidence rate, attitudes played a significant role in the final model. The variation in clinical mastitis was best explained by farmer perception of control of mastitis (β=.38, *P*<.001). Table 2.2 shows that the only behavioral variable which turns out to be significant in the final model is variable 11: Accounting for udder health parameters when selecting bulls for mating.

To explain the variance in BMSCC, attitudinal variables also seemed to be most important. The variation in BMSCC value was best explained by (1) the farmers' normative frame of reference about mastitis (β=.33, *P*<.001), (2) farmers' perception about control of mastitis (β=.25, *P*<.001) and (3) the perceived effect of a BMSCC penalty level (β=.24, *P*<.001). Table 2.2 shows that the only behavioral variable which turns out to be significant in the final model is variable 4: Individual cows' cell count records are not checked when BMSCC is low.

The variation in the combined mastitis incidence rate was best explained by variable 15: Perceived effect on farmers' behavior if BMSCC penalty level decreases (β=.25, *P*<.001) and by variable 9: Frequent contact with others about mastitis (β=.24, *P*<.001). Model 3 of Table 2.2 shows that a farm's combined mastitis incidence rate has more significant behavioral variables related to mastitis than the other two mastitis indicators – clinical mastitis and BMSCC prior to the survey.

The level of data collection (cow vs. quarter) had a significant positive effect on the clinical mastitis incidence rate (β=.15, *P*<.01). This variable was not significant in the other models for BMSCC and combined mastitis incidence rate.

DISCUSSION

Mastitis is not only a technical issue

From a historical perspective, agricultural extensionists, researchers and veterinarians assumed that agriculture was a separate activity executed by an individual farmer, based primarily on rational, technical and economic considerations (Leeuwis, 2004). Although these rational choices still play a role in farm management, we have learned that farmers' decision making based on these considerations is not always clear and understandable (Vaarst et al., 2002). Nowadays, many studies suggest the effect of the human factor on farm performance (Bergevoet et al., 2004; Leeuwis, 2004; Willock et al., 1999). Barkema et al. (1999) studied management styles and their associations with BMSCC and clinical mastitis. Their study showed that farmers that were regarded as "clean and accurate" were associated with lower BMSCC levels, whereas farmers regarded as "quick and dirty" were associated with higher BMSCC levels. They concluded that management did have an influence on the implementation of measures to prevent mastitis.

Table 2.1B Pearson's correlations of mastitis indicators and survey variables about farmers' attitudes in The Netherlands

	Attitudinal variables	Dependant variable		
		Clinical mastitis[a]	BMSCC[b]	Combined mastitis[c]
Normative frame of reference				
1	Perceived frame of reference BMSCC [d]	.00	.50***	.24***
2	Satisfaction level percentage subclinical mastitis cases per test day	.03	.23***	.08
3	Satisfaction level percentage clinical mastitis cases per year	.20***	.03	.04
Perceived effect of BMSCC penalty level decreasing to 350,000				
4	Perceived effect on farmers' behaviour if BMSCC penalty level decreases	-.04	.48***	.36***
5	No change in clinical mastitis treatment when penalty level decreases to a BMSCC of 350,000	.05	-.22***	-.04
6	Treat subclinical mastitis cows more quickly when penalty level decreases to a BMSCC of 350,000.	-.02	.12*	.06
7	The best way to decrease BMSCC nationally is to decrease the penalty level	.11*	-.06	-.04
8	The best way to decrease BMSCC nationally is to give a bonus for low BMSCC milk	.11	-.15**	-.13*
9	The best way to decrease BMSCC nationally is to have a free visit from a mastitis expert every month	-.09	.21***	.08
Perception of control				
10	Perceived lack of control of mastitis	.25***	.33***	.23***
11	Mastitis is a troublesome disease	.12*	.06	.12*
12	Worry about mastitis	.18**	.10	.08
13	Worry about costs of mastitis	.16**	.10	.06
14	Most annoying aspect of mastitis is the financial consequence	.16**	.03	.12*
15	Most annoying aspect of mastitis is uncertainty about cow's recovery	.01	.08	-.11*
16	Most annoying aspect of mastitis is that cows suffer	-.13*	-.04	-.02
17	Bad luck plays an important role in a mastitis outbreak	.16**	-.01	.05
18	Mastitis causes are difficult to influence	.05	.06	.11*
19	Had a serious mastitis problem once	.09	.11	.16**
Knowledge				
20	Perceived knowledge of mastitis treatment	.10	-.19***	-.07
21	Perceived knowledge about the effect of farm management on mastitis	-.08	-.12*	-.02
22	Knowledge about feeding and mastitis	-.05	-.12*	-.09
23	Check cubicles instead of milking procedures when facing an *S. aureus* infection	-.13*	.02	-.03
24	Perceived enough knowledge about mastitis to prevent problems	-.08	-.14**	-.13*
25	Education level	.06	-.12*	-.10

	Attitudinal variables	Dependant variable		
		Clinical mastitis[a]	BMSCC[b]	Combined mastitis[c]
Communication				
26	Want to know more about mastitis via discussion with colleagues	-.11*	.03	.03
27	Interest in mastitis	.20***	.02	.16**
Farmers' context				
28	Interest in stockmanship	.03	-.11*	-.01
29	High milk production per cow is important farm goal	.21***	-.00	-.00
30	Interest in animal breeding	.11*	-.11*	-.05
31	Interest in pasture management	-.04	-.18**	-.09
32	Farmers' year of birth	-.07	-.08	-.12*
Other				
33	Bacteriology of milk samples is too expensive	.01	.10	.15**
34	Too little time to work on mastitis prevention	-.06	.15**	.12*

Loadings are Pearsons' correlation coefficients *P<.05 **P<.01 ***P<.001, two tailed.
[a] Incidence rate of clinical mastitis cases per 100 cows per year.
[b] Average fortnightly bulk milk somatic cell count (BMSCC) for the three months preceding the survey.
[c] A combination of clinical and subclinical mastitis incidence per 100 cows per year.
[d] The average of the perceived problem level of BMSCC and the perceived satisfaction level of BMSCC.

The aim of this study was to use Dutch dairy farmers' behavioral and attitude items to explain and to quantify the variance in mastitis incidence between their farms. The results suggest that indeed mastitis can be explained to a certain extend by farmers' attitudes and behavior and that attitudes have a quantifiable added value in these models. In our study, farmers' attitudes explain 17% to 47% of the variance in mastitis indicators, and farmers' self-reported behavior explains 12% to 14% of the variance. This supports an early study by Bigras-Poulin et al. (1985), also showing the effect of attitudes on farm performance. They found that socio-psychological variables explained 11% to 25% of the variation, and management variables explained 0% to 16% of the variation in reproductive performances of the herd. These results support our findings that attitudes should be taken into account in studies of farm performances. In addition, research by Tarabla and Dodd (1990) has shown that, in most of their models, the variables relating to farmers' attitudes explained a similar or greater amount (between 14% and 35%) of the variation in farm performance than the group of management variables (between 14% and 26%). Although their study design was slightly different (clinical mastitis was not included), Tarabla and Dodd concluded that social variables could explain why there is still a large variation in milk quality and milk production among farmers after years of improvements in the dairy sector.

Table 2.2 Mastitis incidence explained by attitude and behavior of Dutch dairy farmers with multiple linear regression analyses

		Clinical mastitis [a]			BMSCC preceding survey [b]			Combined mastitis [c]		
	Model	1	2	3 (total)	1	2	3 (total)	1	2	3 (total)
Behavioral variables										
1	Wearing gloves during milking (always)				-.13*					
2	Cleaning udders before milking with paper towel	.15*								
3	Most important way to detect clinical mastitis is forestripping all cows before milking	.13*								
4	Individual cow's cell count records are not checked when BMSCC is low				.18**		.14**			
5	No actions are taken as long as there are no serious mastitis problems	-.19**								
6	Delayed treatment of subclinical mastitis cows when milk quota is not full							.12*		
7	Percentage of mastitis cases from which milk samples are taken for bacteriology				-.12*			-.19**		-.14*
8	Strictly finish antibiotic treatment				-.13*					
9	Frequent contact with others about mastitis							.26***		.24***
10	Frequency of cleaning cubicles every day				-.19**			-.22***		-.16**
11	Accounting for udder health parameters when selecting bulls for mating	.15*		.15**						
Attitudinal variables										
12	Satisfaction level percentage subclinical mastitis cases					.11*				
13	Satisfaction level percentage clinical mastitis cases		.17**	.19**						
14	Perceived frame of reference BMSCC [d]					.30***	.33***			
15	Perceived effect on farmers' behaviour if BMSCC penalty level decreases					.26***	.24***		.29***	.25***

16	No change in clinical mastitis treatment when penalty level decreases to a BMSCC of 350,000					-.15**	-.15**			
17	The best way to decrease BMSCC nationally is to decrease the penalty level		.12*	.11*		.11*	.11*			
18	Perceived lack of control of mastitis		.37***	.38***		.24***	.25***		.15*	.16*
19	Bad luck plays an important role in a mastitis outbreak		.16**	.15**						
20	Most annoying aspect of mastitis is uncertainty about cow's recovery								-.13*	
21	Worry about mastitis		.16*	.14*						
22	Had a serious mastitis problem once								.12*	
23	Perceived knowledge of mastitis treatment		.19**	.17**						
24	The best way to decrease BMSCC nationally is free visit from mastitis expert every month		-.14*	-.14*		.18***	.18***			
25	High milk production per cow is important farm goal		.17**	.16**						
26	Too little time to work on mastitis prevention		-.18**	-.19**						
27	Data collection clinical mastitis: including quarter and date of infection	.19**	.18**	.15**						
	Model *F*	7.55***	11.12***	11.01***	7.95***	31.16***	32.04***	10.34***	13.51***	14.94***
	Df	(5,235)	(10,230)	(11,229)	(5,235)	(7,233)	(7,233)	(4,236)	(4,236)	(5,235)
	R^2	.14	.33	.35	.15	.48	.49	.15	.19	.24
	Adjusted R^2	.12	.30	.31	.13	.47	.48	.14	.17	.23

Coefficients are standardized regression weights (betas). Exclude cases listwise. *P<.05**P<.01***P<.001
Only those variables are presented that were significant in at least one model of the multiple linear regression analyses using a stepwise model building process.
[a] Incidence rate of clinical mastitis cases per 100 cows per year.
[b] Average fortnightly bulk milk somatic cell count (BMSCC) for the three months preceding the survey.
[c] A combination of clinical and subclinical mastitis incidence per 100 cows per year.
[d] The average of the perceived problem level of BMSCC and the perceived satisfaction level of BMSCC.

Figure 2.1 is a visual representation of our belief that farmers' behavior and external factors (e.g. weather) influence mastitis. Farmers' behavior itself can be explained by attitudinal factors, such as opinions, values, beliefs, knowledge, etc., but also by external factors, such as the weather or a farmer's social environment (Ajzen and Fishbein, 2005). In this survey, only a small part of the mastitis variance was explained by farmers' self-reported behavior. A larger part was explained by farmers' attitudes. It can be argued that these attitudes represent behavior in a better way than the self-reported behavior itself. This study therefore suggests that self-reported behavior insufficiently explains farm management and farm performances, and that attitudes are a better indicator of why there are differences in mastitis status between farms. Interestingly, this study shows that mainly attitudes regarding farmers' frame of reference (i.e. what is normal on the farm) and farmers' perception of control have strong associations with mastitis incidence. Regarding the farmers' normative frame of reference, this study indicates that belief as to what constitutes a serious mastitis problem differs among farmers. These normative beliefs trigger action on the part of individual farmers. Only when farmers regard the mastitis incidence on their farms as problematic will they take action.

As far as farmers' perception of control is concerned, social psychological research has shown that a lack of feeling of control (or perceived behavioral control) could curb their capacity to act upon the real situation (Ajzen, 1991). Therefore, mastitis control becomes a self-fulfilling prophecy; as long as farmers do not believe they can control the situation, they will not feel able to take (preventive) measures, and consequently will have more problems and less control of the situation. This leads us to the question of cause and effect. This study shows only associations between attitudes and mastitis incidence. Further empirical research is needed to study the direct effect of an attitudinal change on mastitis incidence.

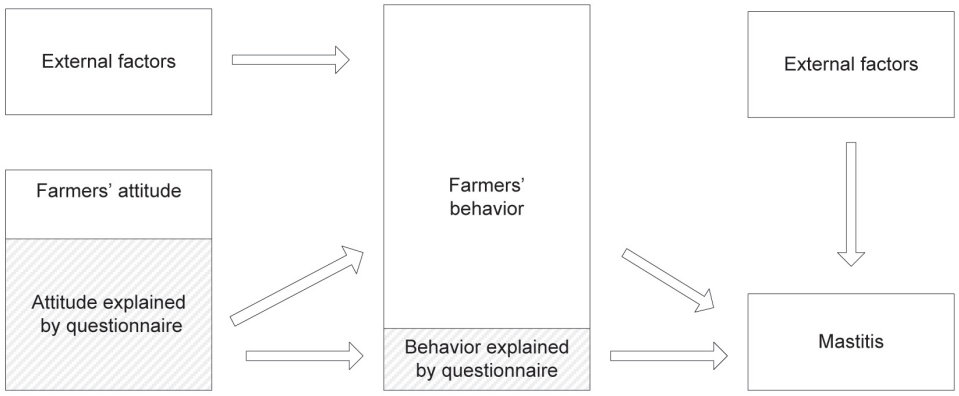

Figure 2.1 Relationship between attitude, behavior and mastitis.

The difference between different forms of mastitis

This study has shown the different forms of mastitis associated with different attitudes and behavior of farmers. The results suggest that apparently it is easier to explain BMSCC values than mastitis incidence by self-reported attitude and behavior. An explanation could be that the human factor, in addition to the cow factor and the pathogen factor, is more important in BMSCC control than in clinical mastitis control, possibly because BMSCC levels can more easily be managed (e.g. by excluding high SCC milk from the tank or by culling cows with clinical and subclinical mastitis).

In addition, the results show that the variance in clinical mastitis problems is explained by different attitudes and behavior than the variance in BMSCC. In particular, the attitude towards the penalty level is important for explaining on-farm BMSCC values; this supports the findings of Valeeva et al. (2007) describing penalty levels as the most important motivational factor to decrease BMSCC.

Some limitations of the study

Despite the fact that the results of this study are supported by findings in the literature, this study has its limitations. The studied population was a random sample among younger farmers with larger herds. This approach was specifically adopted to include all farmers who were expected not to stop farming in the coming years and therefore could contribute to milk quality in The Netherlands. Additionally, all farms participated in CSCC recording every 3-6 weeks, whereas other intervals or no testing for CSCC also exist in The Netherlands. The results of this study may therefore not apply to the whole Dutch dairy sector. In addition, the farmers participating in this study could be different than the average Dutch farmers, because they were willing to participate (selection bias).

It is important to note that this study was based on self-reported attitudes and behavior of farmers. It is possible that socially desirable answers were reported by the farmers, and this could have led to a bias in the results. It is also important to note that, although the survey was extensive and developed with mastitis experts, the total dataset of farmers' attitudes and behavior regarding mastitis could be incomplete; this could explain why the survey was not able to explain more than 50% of the variance in mastitis incidence. Furthermore, it should also be taken into account that, although in this study farmers' behavior and attitudes were presented as independent variables, self-reported behavior and attitudes can be related.

Another critical note concerns the collection of mastitis data, where clinical mastitis was defined as a cow or a quarter with abnormal milk and/or udder. Farmers may have diagnosed clinical mastitis differently, or could have missed a case. This could have resulted in an overestimation or underestimation of the incidence rate of clinical mastitis. However, Lam et al. (1993) conclude that farmer-diagnosed clinical mastitis

can be used as an information source for clinical mastitis. As to the use of BMSCC as an indicator for subclinical mastitis on a farm, it can be argued that other data, such as the arithmetic average test-day somatic cell counts of the herd (HSCC), are better parameters (Lievaart et al., 2007). Consequently, it can be assumed that, in this study, the effect of farmers' attitude and behavior is underestimated, because the real HSCC level is supposed to be higher than the BMSCC because of the influence of individual cow yield and farmers withholding the milk from high SCC cows. Finally, the results of this study indicate observed relationships, but the causality of these relationships is difficult to determine. However, despite these limitations, the results are consistent with findings in the literature and provide insight into farmers' behavior and attitudes and their effect on mastitis incidence.

Applications for mastitis control programs and future research

Currently, most mastitis control programs focus on influencing farmers' behavior. The application and actual prevention of dairy health problems require the farm to be understood as an integrated system and, most of all, require farmers to be educated and motivated to implement the right management practices (Chase et al., 2006; LeBlanc et al., 2006). The results of this study imply that more attention should be paid to farmers' attitude and motivation when designing effective (mastitis) control programs in the future.

This study indicates an association between farmers' attitudes and mastitis incidence and suggests that in communication towards farmers about disease prevention more efforts should be made to improve farmers' normative frame of reference and their feeling of being in control of the mastitis situation. Moreover, mastitis control programs should differentiate between the forms of mastitis. Farmers with clinical mastitis problems, farmers with high BMSCC levels and farmers with both problems need to be addressed differently because different attitudes and behavior play a role. However, more research is needed to measure the direct effect of these different communication strategies on mastitis incidence.

In addition to mastitis control programs, future epidemiological studies should take into account farmers' attitudes when explaining the difference between farms, because management style can confound the relationship between actual risk factors and disease incidence (Barkema et al., 1999). Moreover, this study shows that self-reported behavior is not a good explicator of mastitis incidence. An often-used alternative to (self-reported) questionnaires about farmers' behavior is to observe farmers' behavior. However, even then it is difficult to describe farmers' real behavior, because the observer may influence the farmer. The results of this study suggest that measuring farmers' attitudes may be a good alternative to describe real behavior when studying risk factors for mastitis.

CONCLUSION

This study shows that farmers' attitudes and self-reported behavior explain the variation in mastitis incidence to a certain extent. The results indicate that farmers' attitudes explain a significantly larger part of the variation in mastitis incidence than farmers' self-reported behavior. In particular, the perceived feeling of control, the perceived effect of the BMSCC penalty level and the normative frame of reference are important in explaining the variation in mastitis incidence. Furthermore, the results suggest that BMSCC levels are better explained by attitudes and self-reported behavior than clinical and subclinical mastitis incidence. The results show that clinical mastitis incidence is associated with different attitudes and behavior than BMSCC.

It can be concluded that farmers' attitudes are a better measure to explain differences in mastitis incidence between farms than farmers' self-reported behavior and should therefore be taken into account in future research and animal health promotion. This study, therefore, provides an important empirical investigation into the social processes applicable to mastitis incidence and is consequently considered a good starting point for future research. Moreover, it lays the foundation for effective communication strategies in mastitis control programs.

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Appendix 2A Survey variables regarding Dutch dairy farmers' self-reported behavior after principal component analyses and reliability analyses

		Mean	SD
Milking procedures			
1	Average number of dairy cows milking every day	76.97	23.86
2	Checking milk machine vacuum every day [a]	2.78	1.43
3	Performing a "wet-check" of milking machine [b]	.35	.53
4	Milking deviant cows separately or last [c]	.49	.78
5	Wearing gloves during milking [c]	.36	.74
6	Cleaning udders before milking with dry towel [d]	.43	.50
7	Cleaning udders before milking with paper towel [d]	.41	.49
8	Cleaning udders before milking with alcohol tissue [d]	.04	.20
9	Cleaning udders before milking with a dip [d]	.00	.00
10	Cleaning udders before milking with something else [d]	.12	.33
11	Forestripping all cows before milking [e]	1.21	.66
12	Disinfecting all teats after milking with dip or spray [d]	.85	.36
13	Preventing all cows from lying down after milking [d]	.57	.50
Diagnosis			
14	Most important way of diagnosing clinical mastitis is to forestrip every cow [d]	.38	.49
15	Most important way of diagnosing clinical mastitis is to forestrip the high cell count cows [d]	.09	.28
16	Most important way of diagnosing clinical mastitis is to observe cow and udder [d]	.73	.45
17	Most important way of diagnosing clinical mastitis is to use automatic instruments (such as conductivity sensors) [d]	.05	.10
18	Most important way of diagnosing clinical mastitis is to look for flocks on the filter [d]	.51	.50
19	Most important way of diagnosing clinical mastitis is to do something else [d]	.12	.32
20	Most important way of diagnosing subclinical mastitis is to observe cow and udder [d]	.32	.47
21	Most important way of diagnosing subclinical mastitis is to use automatic sensors (such as conductivity sensors) [d]	.06	.24
22	Most important way of diagnosing subclinical mastitis is to test by using California Mastitis Test [d]	.19	.39
23	Most important way of diagnosing subclinical mastitis is to look for flocks on the filter [d]	.15	.34
24	Most important way of diagnosing subclinical mastitis is to look at individual cell count records [d]	.97	.16
25	Most important way of diagnosing subclinical mastitis is to do something else [d]	.02	.15
Treatment and treatment actions			
26	Mastitis treatment plan available [f]	.35	.65
27	The first thing I do when a cow has a high cell count is to treat directly with antibiotics [d]	.08	.26
28	The first thing I do when a cow has a high cell count is to treat only when cell count is very [d] high	.26	.44

Appendix 2A continues on next page

		Mean	SD
29	The first thing I do when a cow has a high cell count is to wait always until the next cell count record [d]	.55	.50
30	The first thing I do when a cow has a high cell count is to take milk samples for bacteriology per quarter [d]	.16	.37
31	The first thing I do when a cow has a high cell count is do something else [d]	.23	.42
32	Percentage of clinical/subclinical mastitis cases from which milk samples are taken for bacteriology [g] (α=.74)	11.02	18.33
33	Always treat a clinical mastitis case with antibiotics [h]	4.38	.74
34	Strictly finish antibiotic treatment [i]	4.56	.78
35	Change antibiotics regularly [i]	2.65	1.34
36	Change spray or dip regularly [i]	1.64	1.10
37	Use dry-off therapy based on antibiotics [j]	1.90	.34
38	No actions are taken as long as there are no serious mastitis problems [i]	3.12	1.43
39	Delay treatment of subclinical mastitis cows when milk quota is not full [i]	1.93	1.36
40	Change management because of former mastitis problems [i]	3.64	1.44
Checking cell count records			
41	Individual cows' cell count records are not checked when BMSCC is low [i]	2.11	1.33
42	Always check the number of new attention cows [i]	4.23	.95
43	Always watch BMSCC very carefully [i]	4.72	.61
Other			
44	Frequency of cleaning cubicles every day	2.27	.73
45	Frequent contact with others about mastitis [h] (α=.60)	2.32	.59
46	Accounting for udder health parameters when selecting bulls for mating [i]	3.25	1.42

Note: scale of measurements are described by superscript, items with α levels are factor scores derived from PCA and reliability analyses

[a] 0=never, 1=only during mastitis problems, 2=once a month, 3=only once a week, 4=almost every day
[b] 0=never, 1=only during mastitis problems, 2=every year
[c] 0=never, 1=only during mastitis problems, 2=always
[d] 0 (no), 1 (yes)
[e] 0=never, 1=sometimes, 2=always
[f] 0=no, 1=yes but not on paper, 2=yes and on paper
[g] percentage
[h] 1 (never) to 5 (always)
[i] 1 (disagree) to 5 (agree)
[j] 0=never, 1=only with high cell count cows, 2=all cows

Appendix 2B Survey variables regarding Dutch dairy farmers' attitudes after principal component analyses and reliability analyses

		Mean	SD
Normative frame of reference			
1	Perceived frame of reference bulk milk somatic cell count (BMSCC) [a] (α=.64)	217.96	46.37
2	Satisfaction level percentage subclinical mastitis cases per milk product registration control [b]	9.44	6.60
3	Satisfaction level percentage clinical mastitis cases per year [b]	13.56	7.14
Perceived effect of BMSCC penalty level decreasing to 350,000			
4	Perceived effect on farmers' behavior if BMSCC penalty level decreases [c] (α=.56)	2.86	.96
5	No change in clinical mastitis treatment when penalty level decreases to a BMSCC of 350,000 [c]	3.98	1.26
6	Treat subclinical mastitis cows more quickly when penalty level decreases to a BMSCC of 350,000 [c]	3.65	1.31
7	The best way to decrease BMSCC nationally is to decrease the penalty level [d]	.19	.39
8	The best way to decrease BMSCC nationally is to give a bonus for low BMSCC milk [d]	.73	.45
9	The best way to decrease BMSCC nationally is to increase the penalties [d]	.20	.40
Diagnosis			
10	Clinical mastitis is easy to diagnose [c]	4.34	.87
11	Subclinical mastitis is easy to diagnose in the milking parlor [c]	1.49	.88
Perception of control			
12	Perceived lack of control of mastitis [c] (α=.71)	2.66	.75
13	Mastitis is a troublesome disease [c]	4.53	.77
14	Bad luck plays an important role in a mastitis outbreak [c]	2.38	1.09
15	Mastitis causes are difficult to influence [c]	2.92	1.14
16	Easily decrease BMSCC if I want to [c]	2.72	1.36
17	Had a serious mastitis problem once [c]	.73	.45
18	I would like to decrease the number of mastitis cases [c]	4.67	.62
Worries			
19	Worry about mastitis [c]	3.53	1.13
20	Every mastitis case worries me [c]	4.02	1.02
21	Most annoying aspect of mastitis is the worries that it generates [d]	.07	.29
Effect of treatment			
22	A treatment plan is useful [d]	.65	.48
23	The current antibiotics work less effectively than they used to [c]	3.26	1.30
24	Most annoying aspect of mastitis is uncertainty about cow's recovery [d]	.30	.46
25	Transport cows prematurely because of clinical mastitis [e]	2.38	.63
26	Transport cows prematurely because of subclinical mastitis [e]	2.50	.72
Effect of mastitis on cows			
27	Most annoying aspect of mastitis is that cows suffer [d]	.07	.26
28	Cows suffer from mastitis [c]	4.45	.80

Appendix 2B continues on next page

		Mean	SD
Labor			
29	Too little time to work on mastitis prevention [c]	2.26	1.12
30	Most annoying aspect of mastitis is the extra labor needed [d]	.24	.43
31	Every mastitis case means lots of work [c]	4.61	.72
Bacteriology			
32	Bacteriology of milk samples is not useful [c] (α=.71)	2.97	.88
33	Bacteriology of milk samples is too expensive [c]	3.71	1.14
34	It takes too long before the results of milk sample bacteriology return [c]	3.85	1.05
35	If there is an outbreak of mastitis then I would like to know which bacteria cause it [c]	4.20	.96
36	The best way to decrease BMSCC nationally is to make bacteriology of milk samples free [d]	.60	.49
Costs of mastitis			
37	Every mastitis case costs a lot of money [c]	4.73	.61
38	Estimated costs of clinical mastitis [f]	2.72	.91
39	Worry about costs of mastitis [c] (α=.74)	3.71	1.00
40	Most annoying aspect of mastitis is the financial consequence [d]	.21	.41
Knowledge			
41	If there is a mastitis outbreak I know what causes it [c]	2.52	1.24
42	Perceived knowledge of mastitis treatment [g] (α=.75)	3.28	.58
43	Perceived knowledge about the effect of farm management on mastitis [g] (α=.71)	3.83	.54
44	Perceived knowledge about feeding and mastitis [g]	2.78	1.03
45	Perceived enough knowledge about mastitis to prevent problems [c]	2.92	1.07
46	With *S. aureus* infection: you have to look at the hygiene of the cubicles (wrong answer) [d]	.15	.36
47	With *S. aureus* infection: you have to look at hygiene of milking procedures (right answer) [d]	.74	.44
48	With *S. aureus* infection: I don't know what to do [d]	.11	.32
49	With *E. coli* infection: you have to look at the hygiene of the cubicles (right answer) [d]	.80	.40
50	With *E. coli* infection: you have to look at the hygiene of milking procedures (wrong answer) [d]	.10	.30
51	With *E. coli* infection: I don't know what to do [d]	.10	.30
52	Education level [h]	4.06	1.16
Communication			
53	Interest in mastitis [c] (α=.66)	3.97	.63
54	Preferred way of increasing mastitis knowledge: discussion with colleagues [d]	.28	.45
55	Preferred way of increasing mastitis knowledge: magazines [d]	.72	.45
56	Preferred way of increasing mastitis knowledge: special website [d]	.17	.38
57	Preferred way of increasing mastitis knowledge: lecture from mastitis expert [d]	.42	.49
58	Preferred way of increasing mastitis knowledge: reading mastitis handbook [d]	.23	.43
59	Preferred way of increasing mastitis knowledge: a free mastitis helpdesk [d]	.04	.20
60	Preferred way of increasing mastitis knowledge: a video course [d]	.02	.14
61	Preferred way of increasing mastitis knowledge: a self-support CD-ROM [d]	.05	.21
62	Preferred way of increasing mastitis knowledge: a free visit from a mastitis expert every month [d]	.11	.32
63	Preferred way of increasing mastitis knowledge: a course on mastitis [d]	.28	.45
64	Importance of information sources to increase mastitis knowledge other than vet or magazines [i]	2.74	.82
65	The best way to decrease BMSCC nationally is a free visit from a mastitis expert every month [d]	.32	.47

		Mean	SD
66	The best way to decrease BMSCC nationally is to increase information [d]	.34	.47
Contact with the veterinarian			
67	Good relationship with veterinarian [c] (α=.83)	4.47	.56
68	Number of routine visits from the veterinarian per year	10.72	6.84
69	Number of emergency visits from the veterinarian per year	8.90	6.66
70	The amount of money willing to pay for a mastitis course organized by the veterinarian [j]	1.06	.95
71	Preferred way of increasing mastitis knowledge: better support from the veterinarian [d]	.59	.49
Farmers' context			
72	Interest in stockmanship [k] (α=.77)	3.91	.53
73	Interest in animal breeding [k]	3.42	.84
74	Interest in pasture management [k]	3.70	.77
75	Interest in chemicals balance sheets [k]	2.92	.80
76	Interest in machinery [k]	2.85	.92
77	Interest in off-farm income [k]	2.33	1.13
78	Interest in accountancy [k]	3.39	.85
79	Interest in labour planning [k]	3.37	.84
80	Important farm goal: high milk production per cow [i]	3.47	.96
81	Important farm goal: keeping farm management simple [i]	4.17	.81
82	Important farm goal: reduce debts [i]	3.18	1.15
83	Important farm goal: increase in off-farm income [i]	2.12	1.07
84	Important farm goal: make succession easy [i]	3.22	1.38
85	Important farm goal: increase number of farm hectares [i]	2.59	1.10
86	Important farm goal: get high net return [i]	4.66	.62
87	Goal is to intensify farm production [i] (α=.72)	3.43	.83
88	Number of full-time labour units on farm	1.69	.64
89	Farmers' year of birth 19…	62.60	8.35
90	I have problems filling my quota sometimes [c]	1.82	1.23
Other			
91	The best way to decrease BMSCC nationally is to get subsidy for culling high cell count cows [d]	.27	.44
92	The best way to decrease BMSCC nationally is to finance more scientific research [d]	.13	.34
93	The best way to decrease BMSCC nationally is something else [d]	.09	.29
94	Most annoying aspect of mastitis is something else [d]	.10	.31
95	A good analysis of individual cell count records is very important [c]	4.39	.85

Note: scale of measurements are described by superscript, items with α levels are factor scores derived from PCA and reliability analyses

[a] average BMSCC satisfaction and problem level *1000 cells/ml

[b] percentage

[c] 1 (disagree) to 5 (agree)

[d] 0 (no), 1 (yes)

[e] 1 (never) to 5 (always)

[f] 1=< €100, 2=€100-€200, 3= €200-€300, 4=€300-€400, 5=>€400

[g] 1 (poor) to 5 (excellent)

[h] 1 (primary school) to 7 (university)

[i] 1 (not important) to 5 (very important)

[j] 0=0, 1=max €50, 2=max €100, 3=max €150, 4=max €200, 5=max >€200

[k] 1 (none) to 5 (very much)

3

Evaluation of two communication strategies to improve udder health management

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ABSTRACT

Worldwide, programs to improve udder health are implemented using communication tools and methods that inform and persuade dairy farmers. This study evaluates two communication strategies used in a mastitis control program in the Netherlands. To improve farmers' udder health management, tools such as instruction cards, treatment plans, checklists and software were developed following an argument-based comprehensive 'central route'. These tools were used during on-farm study group meetings for farmers organized by veterinarians and also during individual veterinarian-farmer interactions. The second strategy aimed at adopting a single management practice to increase the use of milking gloves during milking. This approach followed a straightforward 'peripheral' route that used implicit persuasion techniques.

Results of an online survey of 374 Dutch dairy farmers show that most farmers are able and willing to use the educational management tools to increase udder health on their farms. They evaluated the tools positively regardless of the mastitis problems on their farms. This seems to indicate that the central route of communication is most effective when farmers are motivated to work on udder health in general.

Results of repeated random telephone surveys before, during and after the campaign on milking gloves show that the use of gloves increased from 20.9% to 42.0% of the respondents. Their opinion about milking gloves also favorably changed, indicating that a relatively short peripheral campaign on a single action can have a sustained effect on farmers' behavior.

Both communication strategies seem to be potentially successful in disseminating knowledge to a specific target group of farmers and in changing that group's behavior. However, to reach as many farmers as possible, the strategies should be combined. When optimizing these strategies, both farmers' motivation to work on udder health and the aim of the campaign should be considered. When aiming at improving general udder health management, the central route seems to be effective if farmers are already motivated to optimize their udder health management. For farmers who are less motivated to work on udder health, the peripheral route seems to be most effective when aiming to change a single management practice. The evaluated communication strategies are examples of how management practices to control mastitis can be effectively communicated to farmers. As such, this study contributes to optimizing future programs to control and prevent diseases.

INTRODUCTION

Mastitis is one of the main health issues in dairy production and remains a major challenge for the global dairy industry (Bradley, 2002; LeBlanc et al., 2006). Worldwide, programs to control mastitis are implemented using both well-known and newly developed communication tools and methods to inform and to persuade farmers. In these udder health programs, much effort is put into developing education materials and informative tools such as udder health quick scans, illustrated fact sheets and treatment protocols. In addition, specific management practices, such as wearing milking gloves during milking, are recommended. Scientists and veterinarians are constantly debating how to improve both the scientific content of educational tools and the effectiveness of recommended management practices, such as the best milking procedures or treatment plans. Although practical udder health tools, research outcomes and best-practices should be technically optimal, they have to be used by farmers to be effective. Thus, it is important to communicate these issues and tools effectively in order to improve farm management. Evaluation of extension education programs is necessary to optimize future campaigns that seek to control and prevent diseases by changing farmers' management practices (Chase et al., 2006).

According to fundamental social psychological theories, two different communication strategies can be distinguished when the adoption of behavior, for example udder health management practices, is desired : (1) a comprehensive traditional 'central' route, which assumes that people make rational decisions based on scientifically-proven information and argumentation, and (2) a more indirect and unconscious 'peripheral' route that includes cues or heuristics that automatically and unconsciously persuade farmers to change their behavior without using rational argumentation or reasoning (Petty and Cacioppo, 1986; Petty and Wegener, 1999; Bargh and Morsella, 2008). The most current interventions aiming at changing people's behavior on udder health follow the central route. However, this route may have limited effect (Leeuwis, 2004; Webb and Sheeran, 2006) because rational decision-making to change behavior requires a basic motivation to think rationally and to elaborate on provided arguments (Petty and Cacioppo, 1986). According to this theory, farmers need to be motivated to work on udder health so that they are willing to process and to implement information such as education materials and informative, science-based udder health tools. However, if people are not motivated, they still may be persuaded to change their behavior by the peripheral route. Cialdini (2001) shows that cues such as authority or expertise (e.g. if my veterinarian says so, it must be right), or cues of social proof (e.g. if all farmers are doing it, then it must be good) are able to influence people without them being aware of it.

To date, no research has been done on how central and peripheral communication strategies can be used to improve udder health, what their potential efficacies are and to

what extent motivation is required when the traditional central route of communication is used. This study aims to explore these issues by the separate evaluation of two implemented communication strategies used in a specific program to improve udder health management in the Netherlands.

MATERIALS AND METHODS

The udder health program

In 2005, a project was started to improve udder health in the Netherlands: the five-year mastitis control program of the Dutch Udder Health Centre (**UGCN**). The program consists of both central and peripheral communication strategies to change farmers' behavior (Lam et al., 2007). For the central route, on-farm study groups and comprehensive education materials were developed for farmers who were interested in participating in programs to improve udder health management. This strategy focused on the broader goal of improving udder health by educating farmers using comprehensive science-based and rational argumentation about mastitis prevention and treatment. In 2008, almost 200 veterinary practices participated in the program. Through these veterinary practices, more than 17,000 dairy farmers (approximately 78% of all Dutch dairy farmers) were informed about the udder health program, of which 3,169 farmers (18%) participated in the on-farm study groups organized by their veterinarian.

For the peripheral route, a straightforward mass media campaign was developed that focused on one single aspect of mastitis prevention: the use of milking gloves during milking. The campaign was developed by UGCN in cooperation with two main agricultural suppliers, a research institute (Animal Sciences Group at Wageningen University), and the Dutch Federation of Agricultural and Horticultural Organizations (**LTO**). In this campaign the argumentation for why milking gloves contribute to udder health was very limited; mostly implicit persuasion techniques, such as distribution of free samples, were used to persuade farmers to wear gloves during milking.

The central route: distribution of informative and educational tools

For the central route, 14 tools were evaluated (see Table 3.1). Most of the 14 evaluated tools were discussed during the on-farm udder health study groups and focused on five themes: Infectious Pressure (udder health assessment questionnaire), Planning and Goal Setting (mastitis cost calculator, udder health objectives flyer), Treatment (clinical mastitis treatment protocol, treatment evaluation, illustrated fact sheets on California Mastitis Test, milk sampling technique and injection technique), Resistance

(resistance assessment questionnaires), and Milking and Milking Technique (self-evaluation test, illustrated fact sheets on milking procedures and teat condition assessment). Additionally, a practical guide to first-rate udder health was developed (Hulsen and Lam, 2008). Some tools were also discussed on an individual basis with the veterinarian and some were distributed through the UGCN website (see Table 3.1). The overall goal of these educational tools and the on-farm study group meetings was to improve udder health on these farms by changing the knowledge, attitude and behavior of farmers.

To evaluate the central route, a quantitative online questionnaire was distributed among dairy farmers who were associated with a veterinary practice that participated in the udder health program. Therefore, all participants had access to and could have had knowledge about the program and the tools evaluated. The online questionnaire was developed by mastitis experts and communication researchers. The outcomes of

Table 3.1 Percentage of Dutch dairy farmers, either participating or not participating in udder health study groups, being familiar with the evaluated educational tools

	Dairy farmers familiar with the educational tools, %		
Practical tool[1]	Study group participants (N=108)	No study group participants (N=229)	*P*-value[2]
Clinical mastitis treatment protocol [3, 4, 5]	92.5	75.8	< 0.001
Illustrated fact sheet California Mastitis Test (CMT) [3, 4]	92.5	56.7	< 0.001
Practical guide on udder health [4, 5]	66.0	55.3	0.067
Illustrated fact sheet milk sampling technique [3, 4]	79.2	48.4	< 0.001
Illustrated fact sheet milking procedures and teat condition [3, 4]	81.1	43.8	< 0.001
Illustrated fact sheet injection technique in dairy cows [3, 4]	81.1	42.7	< 0.001
Teat condition assessment form [3, 4]	78.3	42.9	< 0.001
Evaluation form of clinical mastitis treatment [3, 4]	60.4	27.5	< 0.001
Resistance assessment- summary questionnaire [3, 4]	62.3	14.7	< 0.001
Udder health assessment questionnaire [3, 4]	42.5	22.3	< 0.001
Resistance assessment- detailed questionnaire [3, 4]	56.6	11.1	< 0.001
Udder health objectives (flyer) [3, 4]	34.9	12.0	< 0.001
Mastitis Cost Calculator (software) [3]	16.0	13.4	0.529
The Milking Mirror (self evaluation test on computer) [3]	17.9	9.3	0.025

[1] Sorted on average familiarity with the tools among all respondents.
[2] *P*-value based on Pearson Chi-Square between study group and no study group participants.
[3] Available on the udder health program website.
[4] Distributed to participating veterinary practices as study group material and for individual on farm consultancy.
[5] Distributed directly to all Dutch dairy farmers.

eight workshops with farmers and veterinarians also provided input for the survey. The online survey contained questions about (1) general demographic information about farm and farmer; (2) self-reported geometric bulk milk somatic cell count (**BMSCC**); (3) self-reported incidence of clinical mastitis, defined as abnormal milk and/or udder; (4) motivations and attitudes towards udder health; (5) relationship with the veterinarian; and (6) evaluation of and experience with each of the 14 practical tools. To evaluate the tools, the farmers were given a picture and a clear description of each and asked if they were familiar with the tool ('do you know this tool') and if they were interested in using it ('do you think this tool is interesting to use'). Motivation and attitude, as well as the relationship with the veterinarian, were scored using statements (e.g., 'It's important to improve udder health on my farm') and by asking for the farmer's level of agreement on a five-point Likert scale (Likert, 1932).

A random selection of 2,913 out of 17,210 farmers associated with the involved veterinary practices were sent the internet address of the survey either by e-mail (if their e-mail address was known) or by standard mail in October 2007. After three weeks and one reminder, 467 farmers completed the survey of which 72% responded by e-mail and 28% by standard mail. To include only professional dairy farmers, 93 respondents were excluded from the analysis because they were younger than 18, had less than 10 dairy cows or only produced milk for their own household consumption. This resulted in a final dataset of 374 dairy farmers.

Descriptive analyses were used to explore farmers' familiarity with the tools and their reasons for appreciating the tools. Pearson Chi Square was used to test the difference in familiarity with practical tools between study group and non-study group participants. Two-tailed Spearman correlation analyses were performed to explore the relationships between farmers' motivation, their attitudes, their relationship with the veterinarian and/or mastitis problems, and their interest in using the tools. The farmers' interest in the general use of the tools was quantified by the number of individual evaluated tools that a farmer was interested in. Data were analyzed with SPSS 15.0 (SPSS Inc., 2007).

The peripheral route: mass media campaign on milking gloves

For the peripheral route, a campaign to increase the use of milking gloves during milking was evaluated. This campaign aimed at changing farmers' behavior through peripheral cues like distribution of free samples and humorous postcards. The campaign consisted of four main strategies: (1) launch of the campaign and a website during a national agricultural fair, (2) two humorous postcards were sent to farmers during the campaign to remind them to wear gloves, (3) visits to approximately 75% of the Dutch dairy farms by the agricultural suppliers offering free samples of milking

gloves, and (4) a 25% discount on gloves ordered from the campaign website. The campaign ran from November 2007 until April 2008.

To evaluate the peripheral route, a telephone survey was conducted among randomly selected Dutch dairy farmers at three different moments in the course of the campaign: t_0 pre-test before the start of the campaign in November 2007 (N=287), t_1 immediately after the campaign in April 2008 (N=300), and finally, t_2 at one year after the start in December 2008 (N=327). Farmers were asked open questions about the use of milking gloves, about their opinion on milking gloves and about their perception on the advantages of milking gloves. The interviewer scored the answers under the given categories.

Prior to the analyses, all answer categories were recoded into dummy variables and treated as individual variables with mean scores ranging from 0 (no) to 1 (yes). Descriptive analyses were used to explore the data. One way ANOVA analyses were performed using Bonferroni contrast post-hoc tests to test whether farmers' mean scores at t_0, t_1 and t_2 differed significantly. These mean scores were converted into percentages when displayed in the results table. Missing data were excluded from these analyses. Although the assumption of homogeneity of variance was broken for most variables, the robust tests of equality of means using Welch and Brown-Forsythe statistics did not show deviant *P*-values. Therefore, ANOVA's F-statistics are reported. Data were analyzed with SPSS 15.0 (SPSS Inc., 2007).

RESULTS

Potential effectiveness of the central route: evaluation of practical tools

The results of the survey showed that most dairy farmers (91%) were familiar with the udder health program, mainly through farm magazines (68%) or their veterinarian (61%). The average respondent was 43 years old and owned 72 dairy cows producing 8,570 kg milk/cow per year. Of the respondents, 32% participated in the udder health study groups. The average self-reported geometric mean BMSCC was 193,300 cells/ml with 24.1 clinical mastitis cases per 100 cows per year. The respondents differed from the 2007 Dutch average, which was 66 dairy cows producing 7,879 kg milk/cow per year and a geometric mean BMSCC of 220,000 cells/ml. The results did not show a significant difference in self-reported udder health status between respondents who did or did not participate in the study groups. On average, the farmers in this survey were satisfied with a BMSCC of 176,280 cells/ml and an annual clinical mastitis incidence of 13.5 cases per 100 cows. On average, they perceived udder health as a problem at a BMSCC of 266,200 cells/ml or at an annual clinical mastitis incidence of 27.9 clinical mastitis cases per 100 cows.

Regarding farmers' attitudes, only 3% of the respondents agreed that it was not important to improve udder health, and 95% acknowledged the financial benefits of a decrease in mastitis. However, only a few farmers thought that they could easily reduce the number of clinical mastitis cases (10%) or the BMSCC level (19%). Most respondents (73%) liked being informed about the latest developments in udder health management. A small group of farmers (13%) stated that they had more important things on their mind than mastitis.

Table 3.1 shows the familiarity of farmers with the evaluated practical tools and the way they were distributed to the farmers. Study group participants were, in general, more familiar with the tools than farmers who did not participate in study groups. The results also show that farmers were more familiar with illustrated fact sheets than with questionnaires and software. The materials distributed to all farmers by mail were better known than the materials distributed only through the website. The results also show that although most materials were available at the veterinary practice or on the website, not all farmers were aware of these tools.

Regardless of how familiar the farmers were with the tools, they were also asked about their potential interest in the using the tools, based on a picture and description of the tool. The farmers were, on average, interested in 6.4 of the 14 tools. Study group

Table 3.2 Farmers' interest in the use of practical tools (N=374)

	Dairy farmers interested in the use of the tool, %		
Practical tool	Yes	No	Don't know
Practical guide on udder health	66.8	8.7	24.5
Illustrated fact sheet California Mastitis Test (CMT)	62.5	22.1	15.4
Illustrated fact sheet milking procedures and teat condition	49.6	23.5	26.9
Illustrated fact sheet injection technique in dairy cows	48.7	27.6	23.7
Mastitis Cost Calculator (software)	46.4	20.5	33.1
The Milking Mirror (self-evaluation test on computer)	44.7	13.7	41.6
Resistance assessment- summary questionnaire	44.5	15.7	39.8
Teat condition assessment form	43.7	27.2	29.1
Udder health assessment questionnaire	42.8	14.1	43.1
Illustrated fact sheet milk sampling technique	42.7	32.7	24.6
Clinical mastitis treatment protocol	42.3	20.8	36.9
Resistance assessment- detailed questionnaire	40.3	16.8	42.9
Evaluation form of clinical mastitis treatment	38.5	28.4	33.1
Udder health objectives (flyer)	28.9	28.7	42.4

participants were interested in more tools (7.8) than farmers who did not participate in study groups (5.7, $P < 0.001$). As Table 3.2 illustrates, farmers seemed to be interested in using most tools, with the exception of setting udder health objectives on a pre-designed form (flyer) and evaluating the effect of treatment. The practical guide on udder health and the illustrated fact sheet California Mastitis Test (CMT) were most frequently scored as interesting to use. For some tools, such as the udder health assessment questionnaire and the milk mirror self-evaluation test, many farmers did not know whether they were interested in using them (see Table 3.2).

The importance of farmers' motivation when following the central route

Spearman correlation analyses were performed to explore whether farmers' motivation is an important condition for being interested in using practical tools (see Table 3.3). The results show a positive relation between farmers' general interest in improving udder health and the number of tools which they were interested in. Furthermore, farmers' perception about the cost-effectiveness of preventing a high BMSCC and clinical mastitis incidence is associated with the interest in using tools. Additionally, both the farmers' perceived acceptable level of BMSCC and having a goal for udder health are associated with the interest in using the practical tools. The results also show that being familiar with the Dutch udder health program, participating in the study groups, as well as considering the UGCN an important source of information are also positively associated with the interest in the practical tools.

To explore in more depth their interest in using tools, farmers were asked to provide reasons why these tools appealed or did not appeal to them. Important reasons for liking a practical tool were the awareness it created about problems and solutions (51.7%), positive expectations that a tool would effectively help to decrease mastitis (29.4%), and the perception that the tool was easy to use (16.8%). Cooperation with the veterinarian when using the tool was an important reason for 10.5% of the farmers, while no need to cooperate with the veterinarian was important for 9.9% of the farmers. Less important reasons to appreciate the tools were the tool's appearance (9.3%) and the perception that it may not be time consuming (5.1%).

The following were the main reasons why farmers found a tool unappealing: the content was already known (36.6%), the perception that tools did not help to decrease mastitis (28.2%), and overlap with management systems (12.6%). Too much paperwork or administration (8.0%), the perceived difficulty to use a certain tool (6.3%), and the perception that a tool may be time consuming (5.9%) were less important reasons for not appreciating the tools. The need for cooperation with the veterinarian (0.4%) and the perception that the tool had to be used without cooperating with the veterinarian (0.0%) were not important for not appreciating the tools.

Table 3.3 Survey variables with mean scores, range and median, and the Spearman Correlation with the total number of educational udder health tools a farmer was interested in (N=374)

Survey variable	Mean (range)	SE	Median	r_s	*P*-value[1]
It's important to improve udder health on my farm [2]	4.14 (1 - 5)	0.04	4	0.319	< 0.001
I have more important things on my mind than mastitis [2]	2.23 (1 - 5)	0.05	2	- 0.260	< 0.001
Participation in udder health study group [3]	0.32 (0 - 1)	0.03	0	0.251	< 0.001
The Dutch Udder Health Centre is an important source of information [2]	3.85 (2 - 5)	0.04	4	0.243	< 0.001
I want to be informed about the latest udder health news [3]	0.73 (0 - 1)	0.02	1	0.230	< 0.001
I know the Dutch Udder Health Centre [3]	0.91 (0 - 1)	0.02	1	0.225	< 0.001
The decrease of clinical mastitis is financially beneficial[2]	4.31 (1 - 5)	0.03	4	0.204	< 0.001
The decrease of bulk milk SCC is financially beneficial [2]	3.51 (1 - 5)	0.05	4	0.186	< 0.001
I learn a lot about udder health from my veterinarian [2]	3.51 (1 - 5)	0.04	4	0.172	0.001
Prevention of mastitis costs more than it brings in [2]	2.15 (1 - 5)	0.06	2	- 0.171	0.001
I have formulated a goal for udder health [3]	0.62 (0 - 1)	0.03	1	0.170	0.001
The bulk milk SCC level that I am satisfied with (*1000 cells/ml)	176,30 (50 - 350)	2,63	150	- 0.159	0.002
My veterinarian should play a more active role on my farm [2]	2.61 (1 - 5)	0.04	3	0.150	0.004
Milk production (kg/cow/year)	8,570 (5,500 - 11,700)	50.19	8,500	0.145	0.005

[1] Only statistically significant survey variables ($P < 0.01$) are shown. Loadings are Spearman's correlation coefficients r_s, two-tailed, with the sum of all individual educational tools which a farmer was interested in.
[2] Answers ranging from disagree (1) to agree (5).
[3] Answer options no (0) and yes (1).

Potential effectiveness of the peripheral route: evaluation of the milking gloves campaign

Table 3.4 shows the evaluation results of the peripheral campaign on milking gloves. The results reveal that the use of gloves increased from 20.9% at the beginning of the campaign (t_0) to 36.7% immediately after the end of the campaign (t_1). One year after the start of the campaign, the use of gloves further increased to 42.0% (t_2). The percentage of farmers never using gloves decreased from 74.1% at t_0, to 41.7% at t_1, and to 32.2% at t_2. Additionally, the opinion of farmers about gloves changed. The percentage of farmers who thought that gloves were not useful decreased from 39.4% at t_0 to 18.3% at t_2. The number of farmers who thought that wearing gloves was very

Table 3.4 The use of gloves during milking and farmers' opinion about wearing gloves during milking measured at the beginning of the campaign (t_0), immediately after the campaign (t_1), and 1 yr after the start of the campaign (t_2)

Question		% Dairy farmers			
		t_0	t_1	t_2	
	Answer category	(N=287)	(N=300)	(N=327)	*P*-value[1]
Wearing gloves during milking	No, and I do not intend to	74.2[a]	41.7[b]	32.2[c]	< 0.001
	No, but I want to try	1.7[a]	6.0[b]	2.8[a]	0.013
	No, but I have tried	0.3[a]	8.3[b]	17.8[c]	< 0.001
	Yes, sometimes	2.8[a]	7.3[b]	5.2[ab]	0.045
	Yes, always	20.9[a]	36.7[b]	42.0[b]	< 0.001
Opinion about wearing gloves	Not useful	39.4[a]	14.2[b]	18.3[b]	< 0.001
	Inconvenient	36.6	35.8	37.9	0.862
	Causes a lot of waste	0.0	0.4	0.0	0.309
	Is too expensive	0.4	0.8	0.3	0.676
	Is for wimps	0.0	0.8	0.0	0.095
	That's really good	23.6[a]	48.1[b]	43.3[b]	< 0.001
Most important advantage of wearing gloves	Is hygienic	39.1[a]	38.4[a]	24.5[b]	< 0.001
	Better for hands	6.0[a]	21.8[b]	28.8[b]	< 0.001
	Prevents mastitis	0.7[a]	18.3[b]	11.3[c]	< 0.001
	No advantage	31.1[a]	9.4[b]	24.8[a]	< 0.001
	Worse for hands	2.6[a]	0.4[b]	0.0[b]	0.005
	More than one advantage	1.3[a]	3.1[a]	8.9[b]	0.001
	Other…	19.2[a]	2.2[b]	1.8[b]	< 0.001

[a-c] Percentages within a row with different superscript are statistically different ($P < 0.05$).
[1] *P*-values are based on One-Way ANOVA analyses on mean scores at t_0, t_1, and t_2, using Bonferroni post-hoc test. Before analyses, farmers' answers were recoded into dummy variables (0=no and 1=yes) and mean scores are presented in the table as percentages.

good increased considerably (23.6% at t_0 and 43.3% at t_2). The percentage of farmers who thought that wearing gloves prevented mastitis also increased (0.7% at t_0 and 11.3% at t_2), as did the percentage of farmers who thought that wearing gloves was better for their hands (6.0% at t_0 and 28.8% at t_2).

DISCUSSION

To increase our knowledge on optimization of knowledge-transfer, two communication strategies to improve udder health management are evaluated in our study. Both strategies are potentially effective in reaching dairy farmers and changing their behavior. However, the effect of the traditional central route, which uses argument-

based educational tools, is highly dependant on the farmers' intrinsic motivation to work on udder health (Petty and Cacioppo, 1986; Petty and Wegener, 1999). The results of the evaluation of the central route show that farmers' familiarity with the tools and their interest in using the tools are associated with several motivational factors, such as perceived importance of improving udder health, perceived economic benefits of udder health improvement, and the need to be informed about the latest udder health information. Thus, to maximize the effect of the central route of communication, informative and educational products have to be offered to those who are motivated to work on udder health. To use the central communication strategy more effectively, efforts can be made to increase farmers' motivation. Two social psychological factors that are argued by social psychological literature as being indispensable in motivating people to work on health promotion are the belief in a personal health threat (perceived susceptibility and perceived severity of the disease), and belief in the effectiveness of health behavior (perceived benefits and perceived barriers of the prevention of the disease) (Rogers, 1983; Janz and Becker, 1984; Griffin et al., 1999). We assume that the mechanisms behind this model also apply to udder health promotion. For example, farmers who think that their cows are not susceptible or who think that mastitis is not a severe animal health or economic problem can be less motivated to change mastitis management. Moreover, if required mastitis management measures are perceived as difficult or not resulting in any animal health or economic benefit or a reduced risk of getting milk quality penalties, farmers will not be motivated to change their mastitis management (Valeeva et al., 2007; Huijps et al., 2008).

Our study supports the importance of both motivational factors. Considering the 'personal health threat', we found that farmers perceived very different problem and acceptance levels of BMSCC and clinical mastitis. Interestingly, no significant relationship existed between farmers' self-reported BMSCC or clinical mastitis incidence and the interest in or the familiarity with the practical tools. The BMSCC level that was perceived as acceptable, however, did show a significant association with the interest in using tools. This indicates that farmers' frame of reference about acceptable and problem levels of mastitis are important to consider when stimulating farmers' motivation (Leeuwis, 2004; Jansen et al., 2009).

Support for the importance of the 'belief in effectiveness of measures' can also be found in the fact that farmers evaluated the practical tools based on their expected efficacy to improve udder health. The educational tools should create awareness of possible problems and solutions and should help to improve udder health. Our study confirms that farmers are not interested in information that they already know (Griffin et al., 1999). When using the central communication strategy with educational tools and study groups, farmers' motivation can be increased by communicating a convincing frame of reference about acceptable and problem levels of mastitis and by using arguments on

the effectiveness of the recommended tools and management measures.

Even if the proposed measures to increase farmers' motivation are taken, not all farmers are willing to use all the educational tools and to rationally think and elaborate on the arguments to improve their udder health management. Therefore, in addition to the farmers' motivation, the aim of the campaign is important when choosing a communication strategy. When the communication strategy focuses on generally achieving a complex goal (e.g. improvement of udder health on a farm) and a long term, sustainable behavior change, the traditional central route using science-based arguments is thought to be most effective (Petty and Cacioppo, 1986; Petty and Wegener, 1999). However, this does not mean that a campaign cannot be successful if farmers are less motivated. Complex goals may not be met, but less ambitious goals, for example, aiming at changing behavior step-by-step, may be achievable (Sheeran, 2002). Single management practices (e.g. wearing milking gloves during milking) and short-term behavior change can be more easily adopted than a combination of multiple single actions to achieve a certain goal (Sheeran, 2002) and can be communicated using a peripheral route (Petty and Cacioppo, 1986; Petty and Wegener, 1999). As the results of the second study on the milking gloves campaign show, a relatively short peripheral campaign on a single management practice can be quite effective in changing farmers' behavior. The glove campaign's main focus was to communicate that farmers just have to wear gloves during milking without giving specific arguments about why to use gloves. Wearing milking gloves is associated with good udder health (Rodrigues et al., 2005) and is recommended by veterinarians and extension specialists. The campaign, however, aimed at changing the farmers' norm of not wearing gloves to one of wearing gloves 'just because it's good'.

The results show that not only the use of gloves changed, but also the opinion of farmers about the use of gloves changed even though no arguments were given in the campaign. It seems that farmers were convinced that wearing gloves was good because of the peripheral campaign. Based on Festinger's classic cognitive dissonance theory (1957), it can be speculated that this result is partly explained by farmers' unconscious willingness to be consistent in their thoughts and behavior. Due to the campaign many farmers started to wear gloves and during the survey they were specifically asked about their attitudes towards gloves. It seems that the farmers' responses included arguments to convince themselves why they use gloves, although they may not have consciously elaborated on these arguments beforehand.

Contrary to the central route, communication using peripheral change is generally considered to be temporary, susceptible to counter persuasion and cannot predict future behavior (Petty and Wegener, 1999). Surprisingly, this was not the case for the milking gloves campaign. Even though there is a stronger effect on attitudes right after the campaign, the use of milking gloves increased more after the end of the campaign. Even with this result, the question remains as to whether this increase is an effect of the

campaign itself and not an ongoing trend in Dutch dairy farming. However, a survey showed that only 16% of the Dutch dairy farmer used gloves during milking in 2004 (Jansen et al., 2004), increasing by 1-2% a year until the start of the campaign at the end of 2007. During the campaign the use of gloves almost doubled and continued to increase after the campaign had ended even though free samples or discounts were no longer available. This shows that a substantial amount of farmers continued to buy milking gloves themselves even when extrinsic cues such as free samples were no longer present. These findings suggest internalization of the new behavior and as such a profound and sustainable effect of the campaign. When trying to explain the effect of the campaign, literature shows that greater campaign effects are found in campaigns with greater reach and exposure and where there is a secular trend in society that supports the campaign (Snyder and Hamilton, 2002; Snyder et al., 2004). In our situation, the udder health program started in 2005 and their efforts to reach and motivate farmers could indeed have provided a general support for this peripheral campaign. Other reasons for the success of the campaign might be the peripheral cues that were used, such as a visit from trained sales representatives who offered free samples and the power of using authorities such as UGCN, a university and the farmers association LTO as senders of the message (Cialdini, 2001).

It can be argued that the perceived authority and expertise of the veterinarian can be an important cue to work on udder health promotion and as such stimulates farmers to follow the central as well as the peripheral route. In the Dutch program, veterinarians play an important intermediary role between the udder health program and farmers in providing the knowledge and practical tools to farmers. The veterinarian seems to be a successful intermediary because of his technical knowledge and the opportunity to approach farmers easily. However, large differences between practices exist in the way they utilize this type of pro-active services (Lam et al., 2007; Mee, 2007). Based on the success of some participating practices and the results of this study, veterinarians clearly have ample opportunity to use practical tools in their daily communication with farmers and to distribute them among motivated farmers.

In general, the proposed communication strategies seem to be potentially effective in changing farmers' behavior. In this study, we did not measure the extent to which a single behavioral change affects the mastitis incidence on a farm. Mastitis is a farm-specific, complex and multi-factorial disease, and the effect of farmers' behavioral change on mastitis incidence needs to be further investigated. That said, we suggest that a combination of successive peripheral campaigns on different single management practices may be suitable for solving complex animal health issues in the long term. However, efforts need to be made to support the peripheral and central communication strategies by increasing farmers' motivation and providing effective measures for disease prevention.

CONCLUSION

This study shows that communication strategies to change farmers' management practices can be improved when both the aim of the strategy and farmers' motivational differences to work on udder health are taken into account. When aiming at complex, multifactor issues such as the general goal to improve udder health, the traditional central route using educational tools seems to be effective in reaching the motivated farmers. In addition to the central route, the peripheral route can be applied to influence farmers' behavior by including implicit persuasion techniques in campaigns instead of arguments. This route is especially effective on single management practices and when aiming at a less complicated message. To reach as many farmers as possible, both communication strategies should be used. The communication strategies described in this paper are examples of how management practices to control mastitis can be effectively communicated to farmers. As such, this study contributes to an optimization of future programs to control and prevent diseases.

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4

Debunking the myth of the hard-to-reach farmer: effective communication on udder health

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ABSTRACT

Worldwide, programs to control mastitis are implemented using different strategies to reach farmers. Even though education materials and best practices may be technically optimal, they need to be used to be successful. Thus, effective communication with farmers is essential in order to change their behavior and to improve their farm management.

During a Dutch national mastitis control program, a substantial number of farmers seemed to be hard to reach with information on udder health. Consequently, this study was designed to provide insight into the attitude and motivation of such farmers.

In the period October 2007 to July 2008, 24 in-depth semi-structured interviews were conducted with farmers that their veterinarians considered to be difficult to approach with advice on udder health management (8 practices, 3 farmers from each practice). The interviews included questions about the farms and the farmers, their attitude and behavior regarding mastitis, and their information sources and social environment.

The results show that so-called hard-to-reach farmers were not always badly informed about udder health and did not always experience problems with mastitis. These ostensibly unreachable farmers are not a homogeneous group and can be divided into 4 categories based on their trust in external information sources regarding mastitis, and their orientation towards the outside world: proactivists, do-it-yourselfers, wait-and-see-ers, and reclusive traditionalists. There are ample opportunities to reach hard-to-reach farmers provided that the communication strategies are tailored to their specific needs. There is especially much to gain in communication with do-it-yourselfers and wait-and-see-ers, but this demands a more proactive role on the part of veterinarians and extension specialists. Different types of farmers need to be approached in different ways and through different channels with information on udder health. Consequently, this study can contribute to an optimization of future programs to control and prevent diseases.

INTRODUCTION

Mastitis is one of the main health issues in dairy production (Bradley, 2002; LeBlanc et al., 2006). As a result, mastitis control programs are implemented in various countries using different strategies to reach farmers. Most of these control programs focus on the development of education materials and recommendations for best practices. However, although this information may be technically optimal to decrease mastitis, to be implemented it has to be effectively and consistently communicated to farmers (Chase et al., 2006; LeBlanc et al., 2006). Mastitis control programs worldwide find that, despite all efforts, not all farmers are reached by mastitis information. A study of a national mastitis control program in the Netherlands showed that a substantial group of farmers did not participate in the organized udder health study groups and were not familiar with the developed education materials (Lam et al., 2007; J. Jansen, unpublished data). Veterinarians seem to have similar experiences and mention that it can be difficult to reach farmers who apparently have no demand for information (Mee, 2007). There always seems to be a group of farmers that are hard to reach with mastitis information. It may be assumed that these so-called hard-to-reach farmers are not well informed about mastitis prevention and, because of this lack of information, they could have more than average udder health problems. However, hardly any research has been done on this subject, and little is known about this group of hard-to-reach-farmers and their motivation, attitude, and information sources in the context of mastitis prevention. In general, it can be expected that the personality, attitude, motivation, and objectives of the farmers influence their farm management and udder health (Barkema et al., 1999; Leeuwis, 2004), and that these issues do not follow simple, rational cause-effect patterns (Andersen and Enevoldsen, 2004). On the whole, farmers' perspectives are rarely studied, probably because they are complex, context-related, and contain many non-quantifiable elements (Vaarst et al., 2002). Consequently, qualitative methods rather than quantitative surveys should be used to include farmers' perspectives in evaluations of agricultural extension (Andersen and Enevoldsen, 2004; Burton, 2004).

Using qualitative semi-structured interviews, this exploratory study aims to provide insight into the attitudes, motivations, and information-seeking behavior of farmers who are presumed by their veterinarian to be unreachable in relation to udder health information. Having a better understanding of these features of this group will contribute to the optimization of future programs to control and prevent mastitis and other animal diseases.

MATERIALS AND METHODS

The setting: the Dutch National Mastitis Control Program

In 2005, a project was initiated to improve udder health in The Netherlands: the 5-year mastitis control program of the Dutch Udder Health Centre (UGCN). This program consists of knowledge transfer to farmers, veterinarians, and extension specialists in addition to fundamental and applied research on mastitis. The program includes various communication strategies to reach as many farmers as possible and to change farmers' behavior regarding mastitis management (Lam et al., 2007; J. Jansen, unpublished data). The communication strategies used in the udder health program consist of two main routes: a direct approach via articles in farm magazines, presentations at agricultural fairs, and mailings to all dairy farms, and an indirect approach via veterinarians as intermediaries between UGCN and the farmer. Particular attention was paid to the indirect route, because interpersonal communication by trusted information sources is proven to be very effective (Leeuwis, 2004). In addition, the farmer considers the veterinarian as an important and highly respected information source with regard to udder health, and veterinarians have easy access to farmers to talk about udder health when they visit farms (Jansen et al., 2008; Kuiper et al., 2005). Therefore, veterinarians were chosen as the preferred interpersonal connection between UGCN and the farmer, and they play an important role in the udder health program.

During the program, thematic study-group education materials were developed for veterinarians who were supported to set up on-farm study-group meetings. In 2008, almost 200 veterinary practices participated in the program. Through these veterinary practices, more than 17,000 dairy farmers (approximately 78% of all Dutch dairy farmers) had direct access to the udder health program, of which 3,169 farmers (approximately 14% of all Dutch dairy farmers) participated in the on-farm study groups organized by their veterinarian.

Selection of dairy farmers

To select dairy farmers that were hard to reach with udder health information, 8 veterinary practices that participated in the udder health program were visited and asked to mention at least 4 dairy farmers in their practice that they perceived to be hard to reach within the program and on udder health information in general. They were asked to describe their relationship with that specific farmer and the udder health situation on these farms. Of the reported farmers, 37 were randomly contacted, until 24 (3 per practice) were willing to participate in this study. Thirteen farmers did not want to participate because they were either too busy or were not interested.

The qualitative interviews

Qualitative interviews are a methodology to get a better understanding of individual farmers' mindsets, e.g. their opinions, values, attitudes, and motivations, rather than quantifying these factors among a representative group of people (Strauss and Corbin, 1990). It is an explorative method to understand the farmers' point of view and specifically the relationships between aspects in their reasoning (Wester and Peters, 2004). The conducted interviews were semi-structured, meaning that farmers were initially asked general questions, such as: "To what extent is mastitis a problem for you?" In addition, depending on the farmer's answers, more specific questions were asked to explore the farmer's opinion about the topic raised (Hektoen, 2004; Vaarst et al., 2002; Vaarst and Sørensen, 2009). During the interview, the following topics where discussed: 1) description of farm and farmer, 2) farmer's risk perception, 3) prevention and treatment of mastitis, 4) farmer's need for information, 5) use of mastitis information sources, 6) farmer's interaction with veterinarian, and 7) farmer's familiarity with, and opinion about, the udder health program. A full description of the interview structure can be found in Appendix 4A. All farmers were visited between November 2007 and June 2008 and were interviewed by the same person (second author). The interviewed farmers were responsible for the herd management on the farms. The length of the interviews varied from 26 to 78 minutes were digitally recorded.

Data analyses

All interviews were transcribed in full. Grounded theory analysis was used to analyze the data (Strauss and Corbin, 1990), following Wester and Peters' 4-step methodology (2004). First, the data were explored to get an overview of all farmers' answers to the questions asked. Second, the data were specified, using main themes or sensitizing concepts that frequently cropped up in farmers' answers. As a third step, the data were reduced by categorizing the farmers within these concepts. As a fourth and last step, the sensitizing concepts were compared with each other and were integrated to formulate a theory based upon the transcribed interviews.

RESULTS

Descriptive results

The average interviewed farmer was 42 years old (min. 27, max. 62) and milked 88 dairy cows (min. 52, max. 145) on 54 hectares of land (min. 35, max 95). The average milk production quota was 714,000 kg milk/year varying from 400,000 to 1,130,000 kg/year. The most commonly used milking parlor was a fishbone milking parlor

(n=18), followed by a side-by-side parlor (n=4). One farm used an automatic milking system. All but one participated in a test day milk recording scheme. All farms were family farms managed by one farmer with on average 1 fulltime employee, mostly a family member. The farmers had attended secondary agricultural school (n=3), vocational agricultural education (n=14), or higher agricultural education (n=7). The abovementioned parameters do not deviate from Dutch national averages.

In 16 cases, the udder health status of the interviewed farmers was either unknown (n=9) or considered unsatisfactory (n=7) by their veterinarian. Eight farms were graded by their veterinarian on a scale from 1 (worst) to 10 (best), resulting in an average score of 5.8 (n=8). Some of the farmers themselves considered their udder health status as unsatisfactory (n=2), sufficient (n=2), or difficult to describe (n=1), but most farmers graded themselves; this resulted in an average score of 7.1 (n=19). Many farmers perceived more mastitis problems than in the past (n=10), some perceived similar problems (n=8), and some perceived fewer problems (n=6). All farmers stated that they would change their farm management either if they approached the bulk milk somatic cell count (BMSCC) penalty level (400.000 cells/ml) or if they encountered many clinical mastitis cases.

The farmers varied in their opinion about the treatment of mastitis. Some stated that it was easy (n=9), others thought it depended on the case (n=9), or considered it difficult (n=6). Most farmers stated that they did many things to prevent mastitis, such as post-milking teat disinfection and dry-off therapy with antibiotics. They mentioned various causes for mastitis on their farms, such as overcrowded cowsheds, non-optimal milking machines, breeding strategy, and weather conditions. The farmers stated that the most effective way to decrease mastitis was to cull problem cows, but that for economic, sustainability, or emotional reasons this was not always done. They also bemoaned the lack of farm-specific effective solutions, other than that of culling problem cows. When, however, such preventive measures were suggested by the interviewer, they were disputed by the farmers, because they considered them not useful (e.g. milking gloves), too expensive (e.g. bacteriological culturing of milk, dry-off therapy, cleaning udders with 1 paper towel per cow, better feeding), too much work (e.g. pre-stripping cows, milking high cell count cows separately), or they thought that the measures were not suitable for their current housing system (e.g. decrease overcrowding, renovate milking parlor). When asked whether they ought to pay more attention to mastitis prevention, 5 of the 24 farmers agreed.

Farmers stated that farm magazines were their most important information source for general information about udder health, whereas the veterinarian was the primary source in the case of specific questions. All farmers have contact with their veterinarian during the compulsory health monitoring visits 4 times a year, and during emergency call-outs. Four farmers participated in regular monthly herd health visits and half of the interviewed farmers participated in PiR-DAP – a Dutch program to share milk

inspection reports online with their veterinarian. Farmers considered the relationship with their veterinarian to be good (n=17) or mediocre (n=7). None of the farmers expressed the need for more advice from the veterinarian.

To exchange information on udder health with colleagues, the farmers participated in study groups (n=12), or talked about mastitis issues with colleagues individually (n=4). They did not know the udder health situation on other farms. Some farmers had a specific need for more mastitis information (n=2), others stated that the available information on udder health was not useful because it was too much of the same, and no effective solutions were provided (n=3). Farmers sometimes disputed the received information (n=15) either because it could not be applied on their own farm, or because they did not believe that the proposed measures would help to decrease mastitis. Some farmers (n=9) felt that they received contradictory information on how to deal with problems from, e.g., the veterinarian, the local feed advisor, or the milk equipment advisor.

If farmers could spend money on a national udder health program, they would invest in subsidized personal and expert-based support for problem farms (n=9), research for more effective measures to control and prevent mastitis, e.g. to increase the general resistance of the cow by feeding and breeding policies (n=9), or they would not invest and depend on free market processes to decrease the number of problem farms (n=4).

Results of in-depth analysis of the interviews

After exploration of the interview transcripts, two main sensitizing concepts were derived by specification of all farmers' answers in the interviews: farmers' orientation towards the external world and their trust in external relationships. After reduction of the data, farmers were categorized using these concepts.

The first concept encompasses farmers' orientation towards the external world. From the interviews it appeared that some farmers were very open towards other farmers and information sources (e.g. "I have a lot of contact with colleagues throughout the whole country, even internationally; I get a lot of information from them"). Other farmers were very closed and mainly focused on the situation on their own farm, (e.g. "Colleagues? I never look at what colleagues are doing, I don't care, they have to think for themselves and so do I").

Farmers were categorized under this heading based on the answers they gave about: 1) participation in study groups, 2) participation in regular herd health visits by the veterinarian, 3) participation in the sharing of milk inspection reports online with their veterinarian, 4) visiting open farm days, 5) having interaction with colleagues about mastitis, including being active on boards and committees, and 6) using different information sources, such as farm magazines and the Internet (see Table 4.1). Farmers were scored on these issues as + (positive perception or participation in

Table 4.1 Division of hard-to-reach farmers into two sensitizing concepts based on the results of qualitative semi-structured in-depth interviews

		Orientation towards information from the external world [b]						Trust in information sources [b]		
Farmer ID	Type of farmer[a]	Exchange milk inspection reports [c]	Herd health visits	Study groups	Visit open farm days	Use of different information sources	Interaction with colleagues	Relationship veterinarian	Perception of external information	Perception on PiR-DAP[c], study group, and herd health visits
1	WAS	+	-	-	-	-	-	+	+	+
2	WAS	+	-	+	-	-	-	+	+	+
3	WAS	-	-	+	0	0	0	+	+	+
4	WAS	-	-	-	-	0	-	+	+	+
5	WAS	-	-	+	-	-	-	+	+	+
6	DIYS	+	-	-	+	+	-	-	+	0
7	DIYS	-	-	-	+	+	-	-	-	-
8	DIYS	+	-	+	+	+	-	-	-	+
9	DIYS	+	-	+	+	0	-	+	-	0
10	DIYS	+	-	-	+	+	-	-	-	0
11	DIYS	+	-	+	+	+	+	-	0	+
12	RT	-	-	-	-	-	-	+	-	-
13	RT	-	-	-	-	0	-	-	-	-
14	RT	-	-	-	-	-	-	-	-	-
15	RT	-	-	+	-	0	-	-	-	-
16	RT	-	-	-	-	-	-	-	-	-
17	RT	-	-	0	+	-	-	-	-	-
18	PRO	+	-	0	+	+	-	+	+	+
19	PRO	+	+	-	+	+	0	+	+	+
20	PRO	+	-	+	+	+	-	+	+	+
21	PRO	+	+	+	+	+	-	+	+	+
22	PRO	+	+	+	+	+	+	+	+	+
23	PRO	-	-	+	+	+	+	+	+	+
24	PRO	+	+	+	+	+	+	+	+	+

[a] WAS = Wait-and-see-er, DIYS = Do-it-yourselfer, RT = Reclusive traditionalist, PRO = Proactivist

[b] Scores are interpretations of farmers perceptions, + = a positive perception or participation; 0 = a neutral perception; - = a negative perception or participation.

[c] This is a commercial online system to send milk inspection reports to the local veterinarian. This system is called PiR-DAP in the Netherlands.

these activities), 0 (neutral perception), or – (negative perception or no participation in these activities).

With regard to the second sensitizing concept, farmers' trust in external relationships, it appeared that some farmers had trust in information sources and the information they received (e.g. "My veterinarian takes his time, we talk about many things and I can ask him everything, he gives advice and that goes well"). Several other farmers distrusted the information sources and the information they received (e.g. "Most of the times those vets like to treat immediately, too soon in my opinion, it costs you lots of money and only the vet benefits from it behind your back"), and other farmers had a more general distrust of organizations (e.g. "If they [dairy organizations] come with new ideas, there has to be a snag somewhere. They don't do it for the farmer, no, they don't").

Farmers were categorized under the second heading based on the answers they gave about 1) their relationship with their veterinarian, 2) their perception of external information, and 3) their perception of activities such as study groups, regular herd health monitoring visits by veterinarians, and exchange of information with others (see Table 4.1). Farmers were scored on these issues as + (positive perception), 0 (neutral perception), or – (negative perception).

Integration of the categorizations under the two headings resulted in 4 different groups of farmers: proactivists, do-it-yourselfers, wait-and-see-ers, and reclusive traditionalists (see Figure 4.1). Comparison of the different groups of farmers revealed no differences on demographic factors such as education level, age, farm size, etc. The groups did, however, vary on udder health characteristics (see Table 4.2).

Proactivists

A prototypical proactivist can be illustrated by the following quote: "Obviously, it is important that people from outside look at your farm, otherwise they cannot think along with you". Of the 24 farmers interviewed, 7 were categorized as proactivists. Proactivists were outward oriented, well informed and interested in all kinds of new developments. They were almost all member of a study group, and some even participated in multiple study groups. Colleagues and peers were important information sources, and they discussed udder health openly. Most farmers in this group rated the Internet as an important information source, and they did not mind sharing milk inspection reports with their veterinarian online. They all stated that they had a positive relationship with their veterinarian, but did not see their veterinarian as the only and most important information source because they used many different sources. All but one farmer in this group stated that they disagreed with the available information sometimes. Reasons for these farmers not participating in udder health program study groups included their not encountering mastitis problems, being too busy, or having the feeling that they already knew enough and did not acquire any

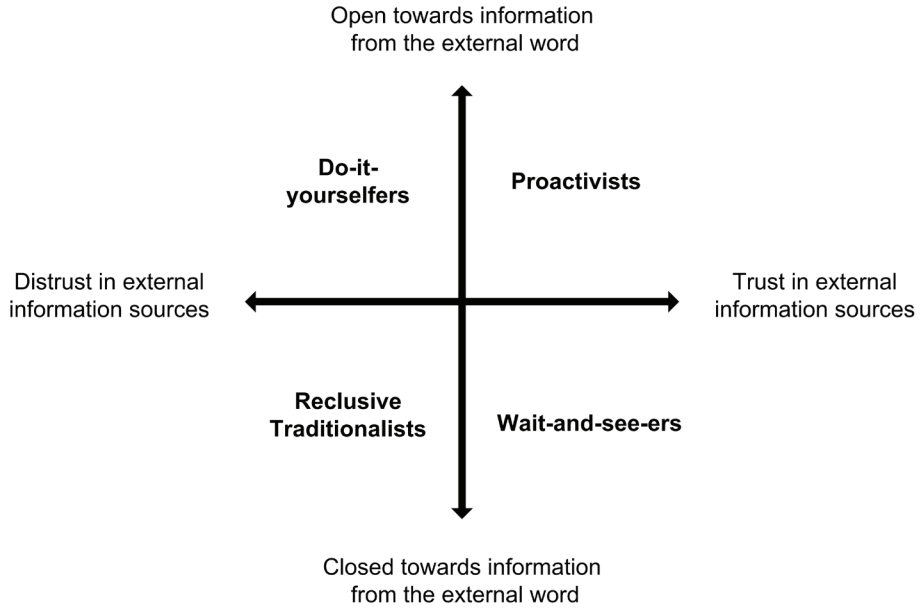

Figure 4.1 Different types of hard-to-reach farmers based on 24 qualitative semi-structured interviews.

new information from such groups. Only 3 farmers in this group perceived mastitis as one of the main health problems on their farm (see Table 4.2).

Do-it-yourselfers

A prototypical do-it-yourselfer can be illustrated by the following quote: "The cost price of milk, that's what it's all about, and I don't see that the veterinarian can bring the cost price down." Of the 24 farmers interviewed, 6 were categorized as do-it-yourselfers. These farmers were active and well informed, but had a critical attitude towards external information. They often disagreed with the available information and all but one perceived that they got a lot of contradictory information. They relied more on their own knowledge and experiences than on information from others. Although some of them were members of a study group, they did not talk much about their own mastitis situation with colleagues. Their most important information sources were the farm magazines and some also used the Internet. Their relationship with their veterinarian was very pragmatic and businesslike. Although many farmers in this group participated in online sharing of milk inspection reports with their veterinarian, they perceived the costs of the standard herd health visits as an important argument for having as little contact as possible with the veterinarian. When problems occurred, they did not hesitate to contact the veterinarian or another advisor as long as they saw the added

Table 4.2 Four types of hard-to-reach farmers and their self-reported udder health status, derived from qualitative semi-structured interviews

Farmer ID	Type of farmer[a]	Mastitis as most important problem[b]	Self reported clinical mastitis incidence[c]	Average self-reported BMSCC (cells/ml)	Farmer is satisfied with BMSCC level[d]	Satisfaction level of BMSCC	Farmers self-reported grade for udder health[e]	Veterinarian-reported grade for udder health[e]
1	WAS	2	19	250,000	no	150,000	satisfactory	5
2	WAS	2	23	240,000	no	140,000	7	unsatisfactory
3	WAS	1	52	325,000	no	200,000	6	unknown
4	WAS	1	60	225,000	no	125,000	7	unknown
5	WAS	2	unknown	250,000	no	150,000	6	4
6	DIYS	0	9	200,000	yes	-	8	unknown
7	DIYS	1	11	193,000	yes	-	-	7
8	DIYS	0	23	170,000	yes	-	7	unknown
9	DIYS	2	45	200,000	no	100,000	7	5.5
10	DIYS	0	55	240,000	yes	-	satisfactory	unknown
11	DIYS	1	40	300,000	no	200,000	5	unsatisfactory
12	RT	0	7	160,000	yes	-	8	5
13	RT	0	13	160,000	yes	-	8	unknown
14	RT	1	19	128,000	yes	-	8	4.5
15	RT	2	28	230,000	yes	-	6.5	unsatisfactory
16	RT	2	44	300,000	no	200,000	7	unknown
17	RT	2	69	300,000	yes	-	7	unsatisfactory
18	PRO	2	25	250,000	no	175,000	5	unsatisfactory
19	PRO	2	40	300,000	no	125,000	unsatisfactory	unsatisfactory
20	PRO	0	8	210,000	no	150,000	7.5	7
21	PRO	0	9	150,000	yes	-	8	8
22	PRO	0	12	175,000	yes	150,000	7	6.5
23	PRO	0	25	200,000	yes	-	9	unknown
24	PRO	2	27	275,000	no	125,000	6	unsatisfactory

[a] WAS = Wait-and-see-er, DIYS = Do-it-yourselfer, RT = Reclusive traditionalist, PRO = Proactivist
[b] 0 = No, mastitis is not the main problem on the farm, 1 = Yes, it is an important problem, but there are other problems as well, 2 = Yes, it is the most important problem.
[c] Clinical mastitis incidence is calculated as number of cases reported by the farmer per 100 cows per year.
[d] Farmers' satisfaction with their current BMSCC (bulk milk somatic cell count) level.
[e] Perceived udder health status on the farm, scored from 1 (very bad) to 10 (very good).

value of their advice. Three farmers did perceive mastitis as one of the main problems on their farm (see Table 4.2).

Wait-and-see-ers

A prototypical wait-and-see-er can be illustrated by the following quote: "It would have been useful for us to have joined a study group on udder health, that's a fact. But it just didn't happen… And I could think of excuses such as 'I was too busy' or 'I didn't have time', but you should make time for it. But I didn't." Of the 24 farmers interviewed, 5 were categorized as wait-and-see-ers. This group was in general open to advice from others, but rarely acted on their own initiative to search for information and to change the management on the farm. Farmers in this group stated that they were easy to approach by others and had a good relationship with their veterinarian. Three farmers did not share online milk inspection reports with their veterinarian, or did not know whether they participated in that system. The 2 farmers who did exchange information in fact never used it during visits from their veterinarian. Two farmers participated in study groups. The other farmers did not participate because they had not been asked to join or because it just came to nothing. They all read the farm magazines. Some perceived the information received by mail as most important. They did not perceive the information they got as contradictory. All farmers in this group perceived mastitis as one of the main problems on their farm (see Table 4.2).

Reclusive traditionalists

A prototypical reclusive traditionalist can be illustrated by the following quote: "I don't like it when other people are looking into my farm business. I'm very much on my own." Of the 24 farmers interviewed, 6 were categorized as reclusive traditionalists. This group of farmers was very inward oriented. They did not like the interference of others on their farm. They had few contacts with other farmers and did not feel the need to compare their farm with others. The interviewed farmers did not seek alliance with other farmers. They stated that they tried to prevent visits from veterinarians and other advisors as much as possible because they thought that these people had a hidden agenda to make money. They did not like exchanging information with others because they felt uncomfortable when others had access to their farm data. They perceived the relationship with their veterinarian as poor, costs being the main reason for having as little contact as possible. The farmers in this group did not participate in regular herd health visits from their veterinarian. They were visited for the obligatory monitoring health visits, which they tried to keep as short as possible. Four farmers in this group, the only ones in this study, did not see the added value of a national mastitis control program. Their most important information source was the farm magazines. They appreciated them and read them thoroughly. Four farmers in this category perceived mastitis as one of the main health problems on the farm (see Table 4.2).

DISCUSSION

On the basis of the model derived from the qualitative semi-structured interviews, 4 groups of farmers can be distinguished among the ostensibly hard-to-reach farmers. Although most of them do consider mastitis as a problem and perceive udder health as important, they vary in the way they use information sources and deal with mastitis problems on their farms. In general, the udder health situation of the farmers in this survey does not seem to deviate from the Dutch national average, although their veterinarians often thought that the udder health status of these farms was unsatisfactory.

The hard-to-reach farmers lack motivation, not information

The results of this study show that hard-to-reach farmers feel that they have enough knowledge to deal with mastitis and that they can easily have access to udder health information when they need it. This raises the question of why farmers who do perceive mastitis problems are not motivated to change their farm management. Such intention-behavior discrepancies have rarely been studied in the field of veterinary medicine and agri-industry (Dernburg et al., 2007). From the interviews it can be concluded that most farmers either feel that the problem is not serious enough, or are not convinced of the efficacy of the proposed prevention measures on their farms. This corresponds with findings on farmers' entrepreneurial behavior change in general (Gielen et al., 2003). Although farmers in this study have a strong demand for simple, short-term, effective solutions, they know that mastitis is a multifactorial and complex disease and that a simple panacea does not exist. This reinforces farmers' beliefs that preventive measures are neither effective nor practical. This perception is one of the main reasons why recommended measures are not adopted (Chase et al., 2006; Garforth et al., 2006; Rehman et al., 2007). It also corresponds to the health belief model (Dernburg et al., 2007; Janz and Becker, 1984), which shows that changing a health behavior depends on one's belief in a health threat and in the effectiveness of available preventive measures. It can be hypothesized that farmers who perceive a lack of effective measures then automatically also perceive the problem as less important because, in order to reduce cognitive dissonance, they accept that they cannot solve it (Cameron, 2009; Festinger, 1957). When the problem is perceived as less important, the information will not be considered relevant by the farmer and therefore will not reach the farmer (Griffin et al., 1999; Moore and Payne, 2007).

Furthermore, in studies exploring whether or not a certain udder health situation is perceived as a problem, it should be taken into account that farmers are part of a wider social context, being influenced by many institutions, legislation, and common law (Leeuwis, 2004). Farmers' motivation to work – or not to work - on udder health depends on many external factors, such as incentives for BMSCC, milk price, and

quota regulations (Valeeva et al., 2007), in addition to internal factors, such as their management style and attitudes (Barkema et al., 1999; Jansen et al., 2009).

How to define hard-to-reach farmers?

The analyses of the interviews showed that hard-to-reach farmers are not a homogeneous group. The 4 different types of farmers used many different information sources, and they did not perceive a lack of information on udder health. The results of this study suggest that hard-to-reach farmers may not be as difficult to reach as is often assumed. Being hard to reach can be interpreted in several ways. First, hard to reach does not mean that they are not reached by any information at all. Apparently these farmers receive a lot of information. Seen from the perspective of the sender of the message, hard to reach can mean either that there is no contact with the farmer at all, or that farmers do not apply the available information on mastitis prevention measures. It seems that the definition of hard-to-reach farmers is more ambiguous than initially expected. As a consequence, it can be suggested that the hard-to-reach farmers in this study have been selected on the basis of the definition of hard to reach as perceived by different veterinarians. Some veterinarians may have selected farmers for this study because they never have contact with them (e.g. the reclusive traditionalists), or because they have contact, but the farmer is not willing to adopt the veterinarian's advices (e.g. the proactivists and do-it-yourselfers). Because this study is not a quantitative representation of all dairy farmers in the Netherlands, it is a moot point whether the 4 types discerned in our sample of hard-to-reach farmers are specific to hard-to-reach farmers, or whether they exist among all farmers in The Netherlands, as many different types of farmers exist (Barkema et al., 1999; Beaudeau et al., 1996; Van der Ploeg, 1999).

The selection of farmers via the veterinarian may have led to a biased selection of hard-to- reach farmers, because farmers who are hard to reach by the veterinarian are not necessarily hard to reach by other information sources, e.g. the proactivists, the do-it-yourselfers, and the wait-and-see-ers. When we define hard to reach as having hardly any access to the farmer in the first place, only the reclusive traditionalists seem to fall into this category, and they seem to be only a small proportion of all interviewed farmers. However, it should be taken into account that 13 farmers were approached but were not willing to participate. These farmers may also belong to the reclusive traditionalists, indicating that this group maybe larger than suggested by the results of this study.

How to reach the hard to reach?

The results of this study show that there is much variation among farmers and the information sources they use. This needs to be taken into account in communication strategies used in future udder health improvement programs. It is advisable to aim

directly at different types of farmers by segmentation and customization of the type and content of the message to the various farmers' perceptions, such as their goals, attitudes, and motivations (Bergevoet et al., 2004; Chase et al., 2006; Hawkins et al., 2008). This so-called tailored communication is proven to be effective in many behavior change interventions (Noar et al., 2007). Based on the results of this study, several suggestions can be made about ways to reach hard-to-reach farmers. When asked how they would like to spend money on a national mastitis program, the interviewed farmers in general stated that they preferred free visits from mastitis experts and having access to the latest research outcomes on, e.g., the increase in cows' natural resistance to mastitis. However, to effectively disseminate these research results, the 4 types of hard-to-reach farmers need to be addressed differently.

The proactivists can be reached by making information easily accessible via the Internet or via newsletters. This group of farmers likes to read about the latest hot topics in research. One-to-one contact can also be beneficial provided that the advisor is considered by the farmer as an expert in his or her field. As this group uses a variety of information sources of which the veterinarian is only one, information about disease prevention should be distributed via multiple channels, such as the animal feed industry, or milk equipment suppliers.

Do-it-yourselfers also use a variety of information sources, but they are more critical about the information they receive and state that they receive contradictory information. For this group, extensive argumentation accompanied with clear cost-benefit information seems to be most appropriate. The most important thing is to communicate a consistent message. As they rely on experience in practice, communication with this group can be effective, for example, during open farm days, demonstrations of products, distribution of free samples, and interaction with colleagues when visiting other farms. This group of farmers also read farm magazines.

The wait-and-see-ers seem to be reluctant about change in general. Although they are open to new information and do perceive mastitis problems, they rarely take the initiative to act. Because these farmers are open to advice and see that there is much to gain in respect of udder health, intensive personal support may be a key initiative for this group. The veterinarian basically is the most suitable person for such intensive contact because these farmers' relationship with their veterinarian is good. Veterinarians, however, need to be proactive with respect to these farmers, and they need to have sufficient communication skills to reach these farmers (Mee, 2007). Only then is it possible to develop farm-specific goals and a step-by-step action plan together with the farmer.

The reclusive traditionalists seem to be the most difficult group to communicate with. This group can be expected not to be easily motivated by others to work on udder health because they have little trust in personal contact with others. Therefore, farm magazines and mailings seem to be the best way to disseminate information to these farmers, including

personalized, free, objective, and independent practical information, as they often read such information with interest. However, in general, such linear information sources are less effective in changing farmers' behavior than extension through interpersonal contact (Gielen et al., 2003). The reclusive traditionalists can be seen as the late majority or laggards in adoption processes (Rogers, 1995), and behavior changes in the short term should not be expected; this means that long-term communication strategies and repetition of messages are necessary to reach these farmers. Moreover, life-changing events, such as building a new cowshed or the transfer of the farm management from father to son, can be an effective starting point for radical changes in farm management (Osler, 2006).

CONCLUSION

The results show that farmers who were presumed to be hard to reach by veterinarians were not a homogenous group. They were not always badly informed about udder health and did not always experience udder health problems. They could be divided into 4 categories based on their trust in external information sources regarding mastitis, and their orientation towards the outside world: proactivists, do-it-yourselfers, wait-and-see-ers, and reclusive traditionalists. When communication strategies of animal disease prevention programs are adjusted to the different types and needs of the farmers, ample opportunities exist to reach these farmers. There is especially much to gain in communication with do-it-yourselfers and wait-and-see-ers, but this demands a proactive role for veterinarians and extension specialists. Different types of farmers need to be approached in different ways and through different canals with information on udder health in order to effectively change their mastitis management.

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Appendix 4A Interview structure

Interview topic	Main question asked	Sub-questions could be asked to further define the farmer's opinion
Description of farm and farmer	Could you describe your farm?	- Size (e.g. number of cows, milk quota, land) - Housing and milking system - Off-farm activities - Age and education level farmer - Age of the farm, number of employees - Future perspectives - Membership farmers' organizations and unions - Participation in milk recording scheme - Participation in online system to share milk inspection reports with the veterinarian (PiR-DAP)
Risk perception	To what extent is mastitis a problem for you?	- What do you think of the statement "mastitis is the biggest health problem in Dutch dairy farming"? - What do you think of the mastitis situation on your farm? - Do colleagues have more or fewer mastitis problems? - Do you talk about mastitis with colleagues? - What is the most annoying aspect of mastitis? - What grade would you give yourself with respect to whether mastitis is better or worse than in the past? - Number of sub-clinical and mastitis cases a year - BMSCC - Satisfaction level for BMSCC - At what level of sub-clinical and clinical mastitis will you change your farm management?
Prevention and treatment of mastitis	Can you talk about mastitis treatment and prevention on your farm?	- How do you treat mastitis? What do you do when you suspect a mastitis case? - What are the most important causes on the farm, are they easy to influence? - What do you do to prevent mastitis (e.g. milking routine, dry-off therapy, bedding material)? Do you perceive treatment and prevention as easy? - What do you do with chronic high cell count cows? - Do you change your management when you receive information about mastitis prevention? - What is the influence of external circumstances such as milk price, milk quota regulations?

Appendix 4A continues on next page

The need for information	What do you think about the attention given to treatment and prevention of mastitis in the media	- Do you think you know enough about the treatment and prevention of mastitis? Do you need more information? - Do you think you should do more about mastitis? What are the reasons? - Why do you, or why do you not, use Pir-DAP and standard herd health visits from your vet? - Do you think that farmers have a need for more information on mastitis? From whom should it come?
Use of mastitis information sources	What is the most important information source?	- Who do you first contact when you have mastitis problems? - What is the role of information on the Internet, farm magazines, or via standard mail? - Do you actively search for information, and what are you looking for? - Is there more or less attention given to mastitis in the media? - What do you think of this information, e.g. is it clear, useful, implementable? Do you disagree with the information? - Some farmers seem to be hard to reach with mastitis information, can you suggest why?
Interaction with the veterinarian	How important is the veterinarian as information source for you?	- How do you interact with your veterinarian in practice? - Can you describe your relationship? - Can you describe the role of the veterinarian as consultant, should he or she be more proactive? - Do you have the need for more information from your veterinarian on mastitis issues? - Should the veterinarian be more focused on treatment or more focused on prevention of mastitis?
Familiarity with, and opinion about, the udder health program	Do you know that there is a national udder health program ?	- Do you know the Dutch Udder Health Centre? - What do you think of the program? Is the money well spent? - What do you do yourself to benefit from the udder health program ? - Have you visited their webpage? - Did you participate in a study group on udder health? - Do you think that farmers' organizations and animal health organizations have an accurate impression of the mastitis problems and the way to solve them? - What if you were able to set up such a program, how would you do that?

5

Improving udder health management: veterinarians' perceptions and communication skills

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ABSTRACT

Dairy farmers perceive the veterinarian as the most important contact person regarding mastitis issues and as the preferred information source concerning udder health. Therefore, veterinarians can play a significant role in udder health programs by transferring knowledge on mastitis prevention and control practices. Using qualitative and quantitative research methods, this study aims to identify veterinarians' perceptions on their role as udder health advisor and to explore the communication skills that they apply in their herd health advice. Results of 91 questionnaires and 10 in-depth interviews with Dutch veterinarians specializing in cattle show that they have the intention of working on mastitis prevention and feel that this falls within their professional remit. However, in daily practice veterinarians seem to prefer a curative, demand-driven approach. Consequently, veterinarians appear to be ambivalent about mastitis prevention. Tension exists between their willingness to be proactive and their actual behavior. They cope with this ambivalence and tension by citing a variety of arguments, e.g. perceived lack of confidence and competence in their advisory capability or their perceived self-identity as a curative veterinarian.

To further study veterinarians' competences, during regular herd health visits 17 veterinarian–farmer conversations were taped, transcribed, and evaluated on the basis of 5 standard advisory skills: 1) Having a clear structure in the conversation (e.g. agenda setting, follow-up of previous advice); 2) Active listening (listening, paraphrasing, and asking searching questions); 3) Providing SMART goals (specific, measurable, achievable, realistic, time bound); 4) Having a balanced interaction between farmer and veterinarian (number of questions, agenda setting, and amount of speech); 5) Paying attention to farmers' opinions and values. The results show that most conversations lacked a proper structure. None of the 17 conversations included active listening. In addition, the balance in the conversations varied considerably, and less than 1% of all spoken sentences were devoted to eliciting farmers' opinions and values.

The results of this study show that, although veterinarians are considered the preferred udder health advisors by their clients, in daily practice there is room for improvement. Veterinarians could improve their advising skills by adopting a customer-oriented, proactive approach and by applying elementary communication techniques in their advice. Improvement of these skills could contribute to an optimization of veterinary consultancy and to the improvement of knowledge transfer to dairy farmers, with a consequent optimization of the effect of mastitis control programs.

INTRODUCTION

Mastitis prevention is considered as one of the main issues in dairy production (Bradley, 2002; LeBlanc et al., 2006). Besides economic losses, animal welfare, antibiotic usage, milk quality, and the image of the dairy sector are important reasons to improve udder health. Worldwide, various mastitis control programs are implemented, aimed at preventing udder health problems. These control programs use different strategies to reach dairy farmers and to motivate them to improve their udder health management (Jansen et al., 2010a). One such strategy is to involve the local veterinarian as a trusted intermediary (Kuiper et al., 2005) to inform and to persuade farmers to change their farm management. The farmer considers the veterinarian as an important and highly respected information source with regard to udder health, and veterinarians have easy access to farmers to talk about udder health when they visit farms (Jansen et al., 2008; Kuiper et al., 2005). Therefore, veterinarians have the opportunity to play a significant role in a mastitis control program by transferring knowledge and motivating farmers to implement mastitis control practices (Lam et al., 2007).

The changes in dairy farming worldwide, with increasing herd size and increasing production efficiency, lead to changing demands from farmers and consequently to a change in the veterinary profession. The focus of veterinary medicine is shifting from reactive to proactive veterinary care in various ways: from treatment to prevention, from responding to emergencies to monitoring general health management, and from contact with individual animals to communication with the herd manager (LeBlanc et al., 2006; Noordhuizen, 2001). The increasing demand on veterinarians as intermediary between animal health organizations and farmers in programs that focus on changing farm management is another example of the evolution in veterinary medicine and agricultural extension (Botha et al., 2008; Klerkx and Jansen, 2010). As a result, the profession of the veterinarian is changing, requiring new knowledge and skills (Noordhuizen, 2001). Currently, many veterinarians are struggling with this new role (Cannas da Silva et al., 2006; Mee, 2007; Noordhuizen et al., 2008). To adapt to these challenges in daily practice and to remain effective in the future, veterinarians need a customer-oriented approach, including communication and marketing skills to motivate farmers to implement their advice (Cannas da Silva et al., 2006; Kristensen and Enevoldsen, 2008; Latham and Morris, 2007; Noordhuizen, 2001; Shaw et al., 2004a).

Mastitis prevention requires both farmer and veterinarian to play a proactive role. Often, a suboptimal management situation can be improved to decrease the risk of mastitis and consequently to improve udder health. Theoretically, when the veterinarian sees room for improvement, he or she would be keen to advise without being asked and would be inherently focused on prevention rather than cure. Ideally, veterinarians would apply state of the art communication techniques that are essential for a constructive conversation with the farmer. It seems that veterinarians are aware

of the need and the opportunities to be a proactive udder health advisor, but find it hard to act upon this awareness in daily practice (Cannas da Silva et al., 2006; Jansen et al., 2010b; Lam et al., 2007; Mee, 2007).

This study aims to identify veterinarians' perceptions on their role as udder health advisor and to explore their proactive advising skills in practice. Understanding the perceptions and communication skills of veterinarians in their role as udder health advisors will provide a lead for further improvement of (udder) health programs.

MATERIALS AND METHODS

The setting: a national mastitis control program

In 2005, a project was initiated to improve udder health in The Netherlands: the 5-year mastitis control program of the Dutch Udder Health Centre (**UGCN**). The program includes various communication strategies to reach as many farmers as possible and to change farmers' behavior regarding mastitis management (Jansen et al., 2010a; Lam et al., 2007). The communication strategies used in the udder health program consist of two main routes: a direct approach via articles in farm magazines, presentations at agricultural fairs, and mailings to all dairy farms, and an indirect approach via veterinarians as intermediaries between UGCN and the farmer. Veterinarians were chosen as the preferred interpersonal connection between UGCN and the farmer on the basis of farmers' perceptions about the importance of the veterinarian as udder health information source (Jansen et al., 2010b; Lam et al., 2007) .

During the program, thematic study-group educational material was developed, and veterinarians were supported to set up on-farm study-group meetings (Lam et al., 2007). The UGCN program started in 2005 with 10 pilot veterinary practices that cooperated in an extensive program to test the developed tools and study-group material. After 1 year, the second phase of the program started with 50 new veterinary practices, and in 2007 the program was open to all veterinary practices in the Netherlands. In 2008, almost 200 veterinary practices participated in the program. Through these veterinary practices, more than 17,000 dairy farmers (approximately 78% of all Dutch dairy farmers) had direct access to the udder health program, of which 3,169 farmers (approximately 14% of all Dutch dairy farmers) participated in the on-farm study groups organized by their veterinarian (Jansen et al., 2010a).

Survey on veterinarians' perceptions

To quantify veterinarians' perceptions, a baseline survey on knowledge, attitude, perceived behavioral control, and behavior was conducted at the start of the UGCN

program in 2005. A questionnaire was sent to 91 specialist cattle veterinarians from 30 veterinary practices, including 41 veterinarians from the 10 involved pilot practices and 50 veterinarians from 20 control practices, where each pilot practice was matched with 2 control practices on size and region. The questionnaire consisted of 125 variables regarding behavior and intentions, attitude, knowledge, subjective norm, and perceived behavioral control. Most variables were measured by statements to which the respondent could answer on a Likert-scale (Likert and Hayes, 1961), scoring from 1 (disagree) to 5 (agree). The quantitative data from the questionnaire were analyzed by descriptive statistics using SPSS (SPSS 12.0.1 for Windows, SPSS Inc. Chicago, IL, USA).

In-depth interviews on udder health advice

Qualitative research using in-depth interviews was used to validate and illustrate the findings of the quantitative survey (Kristensen et al., 2008). Ten individual veterinarians from 10 randomly selected practices of the 50 practices in the second phase of the UGCN program were interviewed in 2007. The main purpose of the semi-structured interview was to explore how veterinarians perceived their role as udder health advisor and how they dealt with farmers that they perceived as hard to reach (Jansen et al., 2010b). These hard-to-reach farmers did not participate in UGCN study groups, and the veterinarians found it hard to give them effective udder health advice. Open questions were used in these informal interviews such as: How is standard herd health advice organized in your practice? How do you perceive your role as advisor, have there been any changes over time? When do you perceive a farmer as hard to reach and what do you do when confronted with such a farmer? These and other questions led to a reflection by the veterinarian on his role as advisor. The verbatim citations of veterinarians in these interviews are used to validate and illustrate the findings of the quantitative survey.

Veterinarians' communication skills

To analyze the application of important communication skills, during regular herd health visits 17 veterinarian–farmer conversations of 9 veterinarians from 4 practices in the northern provinces of the Netherlands were digitally recorded and transcribed in full. The conversations lasted on average 96 minutes, varying from 54 to 166 minutes. These veterinarians represented a convenience sample based on their willingness to cooperate with the survey, and their proximity to the study area. All but 1 of the veterinarians were male, and all farmers were male. In 7 of the 17 conversations a third person was present, such as a nutritionist or a family member. During the different analyses, only the interaction between the farmer and the veterinarian was taken into account. After the conversation, the farmers were asked how they evaluated the

standard herd health visits by their veterinarian. None of the participants reported being influenced by the presence of the researcher (third author).

The conversations were evaluated on the basis of a selection of standard verbal advisory skills, as presented in Table 5.1. The following are considered essential communication skills for providing effective advice: 1) having a structured conversation, 2) active listening, 3) setting SMART goals, 4) specifically asking for farmers' goals and opinions by open questions, and 5) having a balanced interaction in number of words, questions, and agenda setting between the persons involved (Hargie, 2006; Kleen, 2008; Latham and Morris, 2007; Martin, 2006; Shaw, 2006; Shaw et al., 2004b).

Table 5.1 Methodology used to evaluate veterinarians' communication skills

Communication skills	Description	Basis of evaluation
Structured conversation	1. Informal opening of conversation	Use of a social opening, e.g. "How are you?"
	2. Formal opening of conversation, including discussion on agenda points	Use of a professional opening, e.g. "When preparing this meeting I noticed some issues that I would like to discuss with you."
	3. Discussing farmers' needs	Use of questions such as "What is important for you?" "What would you prefer?" "What issues would you like to discuss?"
	4. Follow-up on previous meeting	Use of follow-up on previous advice, e.g. "Let's see about the action points from our last meeting."
	5. Summarizing advice and discussing follow-up	Use of a summary at the end of the conversation, e.g. "So to summarize, you treat the next heifers before they enter the cowshed, and next time we will evaluate the effect on lameness."
Active listening	Listening, paraphrasing, and asking further questions	Use of active listening, e.g. "So if I understand correctly, 4 calves had diarrhea last week. How did you treat them?"
SMART goals	Set goals that are specific, measurable, achievable, realistic, and time bound	Use of SMART goals, e.g. "So at the end of 2010 the number of attention cows per months is 10%."
Eliciting farmers' goals and opinions	Asking open questions about farmers' opinions and values	Use of questions such as "Why do you think that?"
Balanced interaction between farmer and veterinarian	1. Number of (open) questions asked	Counting the total number of questions asked by farmer and veterinarian and counting the number of open questions.
	2. Number of new issues raised	Counting the total number of new issues brought up by farmer and veterinarian, e.g. "And what about the fertility of the cows?"
	3. Amount of speech	Counting the number of words as a percentage of the total number of words in the conversation.

A structured conversation is characterized by: an informal opening: creating a pleasant atmosphere; a formal opening and agenda setting: creating clarity and including space for issues that the farmer wants to discuss; discussing farmers' needs: to match expectations and to determine how the advisor can help; follow-up on a previous meeting: to evaluate the effectiveness of previous advices; and closing of the meeting: to summarize advice and to determine action points for the next meeting.

Active listening includes paraphrasing the farmer's expressions to ensure mutual understanding, followed by searching questions to gain more insight into the issue at stake. In this study, nonverbal active listening (e.g. inviting body language, nodding) was not evaluated. SMART goals are goals formulated in a way that can be evaluated easily in the future. These goals should be specific, measurable, achievable, realistic, and time bound. Furthermore, farmers' goals and opinions can be elicited especially by asking open questions (e.g. questions starting with why, what, when, where, how). Finally, a balanced conversation is characterized by the amount of speech, the number of questions, and the new issues raised during the conversation.

Structured conversation, active listening, and setting smart goals were measured dichotomously for all 17 conversations, by counting whether these skills were used or not used during the conversation. Eliciting farmers' goals and opinions by open questions and the balance in the conversation were measured by counting words, sentences, and number and type of questions on a continuous scale. These counts were converted into percentages. For these analyses, uniform conversations are necessary to be able to compare them without too many confounding factors. Consequently, 6 conversations were not included because more conversation partners besides the farmer were present and therefore the conversation balance and number and type of questions between only farmer and veterinarian could not be calculated. One of the remaining 11 conversations was between a female veterinarian and a male farmer. This conversation was also excluded from the analyses on conversation balance and type of questions as gender is an important confounding factor in interaction between people, and communication styles of physicians and veterinarians are proven to be different between men and women (Fassaert et al., 2007; Miller, 2008; Roter and Hall, 2004; Tannen, 2008).

RESULTS

Veterinarians' perceptions on their role as udder health advisor

Results of the questionnaire (N=91) show that, in general, udder health is discussed for 82% of the herds. Most veterinarians have access to the udder health figures for their clients' farms. In 63% of the standard herd health visits, the veterinarians use these figures to prepare their advice. However, veterinarians mentioned in the interviews

that asking for these figures beforehand does not necessarily mean that udder health is discussed during the herd visit; it depends on the farmer's response (e.g. "When I ask about mastitis and bulk milk somatic cell count during the monthly visits and the farmer is happy, it is ok for me. Then I don't talk about it any more").

Table 5.2 shows veterinarians' perceptions on their role as advisor. All participating veterinarians are of the opinion that udder health improvement and advice is part of their professional remit (99%), e.g. "We are pre-eminently the best advisors on udder health". They are highly motivated to work on udder health (97%), have the perception that they often take the initiative to talk about udder health (80%), and also worry about mastitis (78%), e.g. "It [giving preventive advice] is really fun, much more fun than when you have been taken by surprise." However, the interviews showed that some veterinarians doubt the usefulness of preventive advice (e.g. "...but I also have the feeling that it [preventive veterinary medicine] is wishful thinking on the part of our profession, because the curative part is still very important"). One veterinarian specifically mentioned having less interest in advice (e.g. "I did not become a veterinarian because I like to talk to people. I became a veterinarian because I like to help animals").

Table 5.2 Veterinarians' perceptions on udder health advice (N=91)

	Frequency (%)[1]		
Veterinarians perceptions	(partly) Disagree	Neutral	(partly) Agree
Increase in udder health comes within the remit of veterinarians	0	1	99
I am highly motivated to work on udder health	0	3	97
I worry about mastitis	4	18	78
I have a lot of influence to improve udder health	5	53	42
It is easier to advise farmers with clear udder health problems	4	20	76
I have a need for more knowledge on udder health	0	24	76
Post graduate courses on udder health are important for me	3	19	78
Farmers' trust in the knowledge of their advisor is important for implementation of the advice	8	6	86
The communication skills of the veterinarian are important for the implementation of the advice	5	7	88
The more advisors, the smaller the chance a farmer implements the advice	10	24	66
It is relevant to discuss udder health with the other farm advisors quarterly	33	39	28
I often take the initiative to talk about udder health	0	20	80
Bad farm management is a good reason to start talking about udder health	15	42	43
When a farmer does not perceive a problem, I will still take action to talk about udder health	23	53	24

[1] Scored from 1 (totally disagree) to 5 (totally agree). Values 1 and 2 are combined, as well as values 4 and 5.

Veterinarians acknowledge that communication skills (88%) and the farmer's trust in the veterinarian's knowledge (86%) are important for the implementation of the advice by the farmer (e.g. "It is difficult to achieve success. You tell them and explain to them and they nod approval, but after a while they relapse into old habits"). Table 5.2 shows that 42% of the veterinarians think they have a lot of influence to improve udder health, but other veterinarians are not so sure about their influence (e.g. "I don't know how to convince a farmer that he really needs to implement a certain measure. I can talk for hours, but finally the farmer makes the decision"). Results of the interviews show that veterinarians seem to be uncertain about their skills as advisor (e.g. "Beforehand I prepare the meeting and think about what to say to the farmer. When I arrive, and try to start the conversation, the farmer immediately interrupts me and wants me to check out one of his cows. So my intentions are good, but the farmer just doesn't want to hear it. Then I don't know what to do anymore"). A veterinarian stressed his uncertainty about his skills and mentioned that natural talent is a prerequisite for giving effective advice (e.g. "Some people are, by nature, more self-confident. I think they [the farmers] really like that. Although what you tell them might be crap, as long as you state it with confidence").

The veterinarians in this survey mentioned that they need more knowledge on udder health (76%) and that post graduate courses are important (78%), e.g. "A low cell count cannot be good, that is what I hear from several farmers, however, I cannot support that scientifically". More specifically, although they perceive that they have knowledge on mastitis prevention and treatment in general, they perceive that they have less knowledge on general preventive farm management measures such as housing, milking procedures, and nutrition (see Table 5.3).

Table 5.3 Veterinarians' perceived knowledge regarding mastitis prevention and control (N=91)

	Frequency (%)				
Perceived knowledge	Very limited	Limited	Average	Good	Very good
Knowledge of prevention of mastitis in general	0.0	1.1	36.3	57.1	5.5
Knowledge of treatment of mastitis in general	0.0	1.1	28.6	62.6	7.7
Interpretation milk quality and test-day records	0.0	2.2	24.2	61.5	12.1
Epidemiology of mastitis pathogens	0.0	1.1	39.6	47.3	12.1
Veterinary drugs	0.0	2.2	29.7	56.0	12.1
Laboratory work (e.g. bacteriological culturing)	0.0	5.5	40.7	45.1	8.8
Housing and barn climate	0.0	1.1	35.6	57.8	5.6
Milking technique	0.0	13.3	60.0	22.2	4.4
Milking machine	2.2	29.7	48.4	17.6	2.2
Nutrition	6.6	18.7	47.3	26.4	1.1

Veterinarians consider that giving advice to farmers with clear udder health problems is easier (76%), e.g. "Look, a farmer needs to perceive a problem, and then he is open to things. If he does not perceive a problem, then you also don't need to start talking about it". When a farmer does not perceive a mastitis problem, 24% of veterinarians say that they still try to discuss udder health. Veterinarians use different reasons to take the initiative to discuss udder health (see Table 5.4). Acute problems are perceived as important reasons to initiate such a discussion, whereas general farm management issues are perceived as less important (e.g. "We are mainly there to solve problems. A farmer wants us to fix things, and then leave the farm as soon as possible, because we are expensive. Veterinary drugs and treatments remain our core business").

The in-depth interviews (N=10) provided additional information above and beyond the questionnaire on veterinarians' perceived barriers to providing udder health advice proactively. An important issue revealed by these interviews was the responsibility for the herd health. Veterinarians feel that in the end the farmer is responsible for animal health and well-being (e.g. "I am not a person who endlessly keeps trying. If people show me that they don't need it, then well, they are their cows, it is their farm"). In the interviews, the veterinarians also often mentioned that they were demand driven. They use this argument to support their curative and reactive approach (e.g. "I am not a missionary. Look, the farmer is my client, and I am the service provider. I provide the services the farmers want. I don't talk to a blank wall or something like that. That makes no sense; it only leads to frustration for me and to the farmer getting also a little tired of me. On these farms it is something like 'you ask, we serve'. If a farmer wants something on udder health, then I will hear it, he probably will call me once"). Another barrier that was revealed during the interviews was the

Table 5.4 Reasons for veterinarians to initiate discussion about udder health with farmers (N=91)

		Frequency (%)				
	Reasons to initiate discussion	Bad reason	Barely a reason	Reasonable reason	Good reason	Very good reason
Curative	A sudden rise of bulk milk somatic cell count	0.0	0.0	2.2	37.0	60.9
↑	A sudden rise of clinical mastitis	0.0	0.0	1.1	39.1	59.8
↑	Bacteriological survey results	0.0	0.0	11.1	52.2	36.7
↑	A sudden increase in sales of mastitis treatment therapies	2.2	2.2	33.0	41.8	20.9
↓	Observations during compulsory (legal) periodical farm visits	8.8	15.4	33.0	25.3	17.6
Preventive	Bad management (e.g. milking technique or barn hygiene)	1.1	14.3	41.8	35.2	7.7

perceived competition with other advisors, such as the nutritionist from the feed-mill industry (e.g. "A farmer will ask his nutritionist for advice and not me, because he does not have to pay for that, that's already paid for in the price of the cattle feed").

Veterinarians' communication skills in practice

The study of veterinarians' communication skills in practice shows that all 17 conversations could be characterized as having an open, relaxed, and informal atmosphere. When asked, the dairy farmers were satisfied with the herd health visits from their veterinarian and scored on average 6.3 on a scale from 1 (not satisfied) to 7 (very satisfied). Nevertheless, the results show that in most taped conversations the structure in comparison to what is considered effective was far from optimal (see Table 5.5).

All conversations commenced with an informal opening, but only 3 out of 17 veterinarians specifically employed a formal opening, including agenda setting. The needs of the farmer were discussed in 3 out of 17 conversations, including the meetings on the construction of a new barn.

Follow-up on advice offered during previous visits was mostly not given, nor was there a proper closing of the conversations. In 1 taped conversation, a SMART goal was formulated. In none of the 17 taped conversations did the veterinarians actively listen by paraphrasing farmers' opinions, followed by further questions.

The results of this study also show that the balance in the conversations varied considerably among conversations (see Figure 5.1). On average, the veterinarian accounted for 55% of the total amount of speech (min. 30%, max 88%), for 80% of the agenda setting (min. 0%, max 100%), and for 68% of the questions (min. 33%, max 100%). The farmers' opinions and values were elicited in less than 1% of all spoken sentences, and 6 out of 10 veterinarians did not ask open questions at all. The average number of open questions by the veterinarian was 4% of the total number of questions.

DISCUSSION

Veterinarians' ambivalent perceptions about being a proactive advisor

Programs to improve animal health that include the veterinarian as the main intermediary put great demands on him or her (Botha et al., 2008; Klerkx and Jansen, 2010). Generally, they are often expected to have a broad knowledge of farm operations, a deep insight into nutrition and related disorders, extensive problem analysis skills, and a great cooperative attitude towards other farm advisors (Noordhuizen, 2001). The results of this study show that, although most veterinarians basically have the

Table 5.5 Veterinarians' communication skills during on-farm veterinarian–farmer conversations

Visit no.	Duration (min) [1]	Conversation partner[2]	Reason visit[3]	Informal opening	Formal opening	Discussing needs	Follow up previous meeting	Summary and follow-up	SMART[4] goals	Active listening
1	64	1	1	Yes	Yes	-	-	-	-	-
2	98	1	1	Yes	Yes	-	Yes	-	-	-
3[5]	96	1,2,3	2	Yes	-	Yes	- [6]	Yes	-	-
4[5]	166	1,2	2	Yes	-	Yes	- [6]	Yes	-	-
5	148	1	1	Yes	-	Yes	-	-	-	-
6	130	1	1	Yes	-	-	-	-	-	-
7	67	1	1	Yes	-	-	-	-	-	-
8	124	1	1	Yes	-	-	-	-	-	-
9[5]	115	1,2	1	Yes	Yes	-	-	-	-	-
10[5]	106	1,3	1	Yes	-	-	-	-	Yes	-
11	90	1	1	Yes	-	-	-	-	-	-
12	54	1	1	Yes	-	-	-	-	-	-
13	66	1	1	Yes	-	-	-	-	-	-
14	63	1	1	Yes	-	-	-	-	-	-
15[5]	67	1,2	1	Yes	-	-	-	-	-	-
16[5]	100	1,2	1	Yes	-	-	-	-	-	-
17[5]	70	1	1	Yes	-	-	-	-	-	-

[1] Total duration of the conversation.
[2] Conversation partner of veterinarian: 1 = dairy farmer, 2 = family member, 3 = nutritionist from feed supplier.
[3] Reason of herd visit: 1 = regular herd health visit, 2 = advice on constructing a new barn .
[4] SMART goals are goals that are specific, measurable, achievable, realistic, time bound.
[5] These conversations were excluded in the balance analysis as presented in Figure 5.1.
[6] Not applicable, as these conversations were the first meetings.

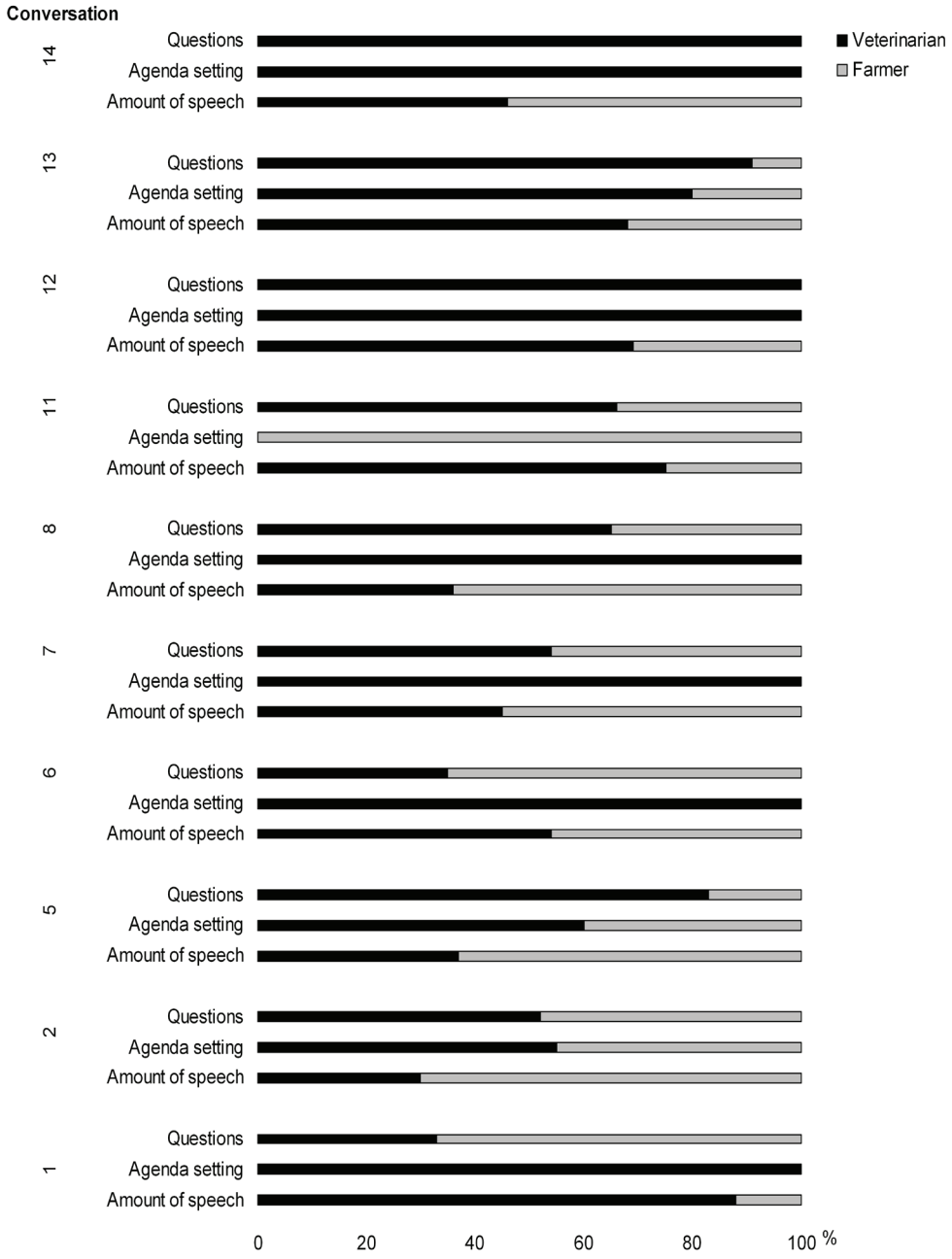

Figure 5.1 Balance in farmer–veterinarian conversations on the number of questions, the number of new issues raised, and the amount of speech, as a percentage of the total conversation.

behavioral intention to be a proactive udder health advisor, they often seem unable to translate that intention into action. Veterinarians mention that, when a problem exists that is acknowledged by the farmer, advice is easier to provide. This suggests that the curative and demand-driven approach of veterinarians is still preferred.

In general, it seems that tension exists between veterinarians' socially desirable intention to be a proactive advisor and their natural preference for a demand-driven approach. Veterinarians seem therefore to experience cognitive dissonance (Festinger, 1957), which means that their values (i.e. what they ought to do) do not correspond with their behavior. So, for example, veterinarians are willing to be proactive and preventive but seem to act mostly reactively and curatively in practice. As a result, people use many strategies to cope with such ambivalence, using several arguments to defend their behavior (Carver et al., 1989; Festinger, 1957). As presented in this study, veterinarians mention many barriers that constrain their proactive advising behavior. Most of these barriers are external, such as the perceived lack of willingness and motivation on the part of the farmer, the perceived inconsistency of information on udder health, the perceived (economic) competition with other advisors, and the perceived expectations of farmers and colleagues about their role as veterinarian. Some barriers mentioned are internal, such as their perceived lack of knowledge and effective communication skills, their perceived self-identity as a professional curative-oriented veterinarian, and their tendency to shift the responsibility for udder health to the dairy farmer. These barriers seem to correspond to the results of other studies (Cannas da Silva et al., 2006; Cattaneo et al., 2009; Mee, 2007).

The results of this study suggest that the curative and demand-driven approach relates to the perceived identity of the veterinary profession. Some veterinarians do not perceive preventive advice as their core business. For veterinarians, it can be difficult to distinguish different roles and responsibilities that they may have towards farmers and animals. Our findings suggest that they indeed seem to struggle with doing well as a veterinarian (farmers' interest as a guiding principle to make profit) and to do good (animal health and disease prevention as guiding principle), while being part of a changing society (De Graaf, 2005; Garforth et al., 2003; Klerkx and Jansen, 2010; Yeates, 2009). Although the veterinarians in our study are favorably disposed towards udder health advice, further research is needed to study how their advice in practice is influenced by the various perceptions of their professional roles.

Low perceived self-efficacy

The results of this study suggest that veterinarians feel uncertain about their communication skills; this concurs with similar findings in other studies (Cannas da Silva et al., 2006; Gardner and Hini, 2006; Latham and Morris, 2007; Mee, 2007; Noordhuizen et al., 2008). The recorded farmer–veterinarian conversations indeed

show that ample opportunities exist for veterinarians to increase their elementary advisory skills.

Veterinarians should focus on clearly structuring the conversation, because a structured approach in the conversation is important for an efficient herd health advice visit (Cerf and Hemidy, 1999; Kremer et al., 2001; Vollebregt et al., 2001). This can be improved by having a formal opening in which the agenda for the meeting is discussed. Follow-up on advice from previous meetings should be part of this agenda, as well as a proper closing in which all SMART formulated advice is summarized and action points are set for the next meeting. SMART goals are needed to be able to discuss and evaluate, e.g., strategies to improve animal health in the short and long term (Noordhuizen et al., 2008).

More specifically, veterinarians should actively listen and ask more open questions to get more insight into farmers' needs, demands, values, and opinions (Shaw et al., 2004b). Previous studies show that verbal and nonverbal active listening is associated with client satisfaction and a better disclosure of the client's mindset (Fassaert et al., 2007). Eliciting farmers' goals and opinions is important in order to be able to customize advice to farmers' interests and demands. In particular, asking open questions facilitates the in-depth expression of opinions, attitudes, thoughts, and feelings (Hargie and Dickson, 2004).

This study shows that the balance between veterinarian and farmer varies among conversations. Having a balanced conversation is important, because in an ideal advisory conversation both parties contribute equally to the conversation regarding the amount of speech, the number of questions, and the new issues raised during the conversation (Shaw et al., 2004b). In some conversations, the veterinarian accounted for all questions or determined all the new issues that were raised during the conversation and consequently seemed to leave no space for the farmer to contribute to the conversation.

As this qualitative analyses is an exploratory study to investigate in-depth possible patterns within conversations, and consequently did not aim to be representative of the whole population, we acknowledge that more research (quantitative as well as qualitative) is needed to further investigate the representativeness of our findings, the possible differences between male and female veterinarians, and differences between conversations with and without external persons being present.

It could be suggested that the results are an over- rather than an underestimation of veterinarians' communication skills, because these veterinarians were selected on the basis of their willingness to cooperate with this study. It can be expected that veterinarians who are not confident about their advisory skills would not allow an external person to observe and record the meeting. Moreover, because of the presence of the communication researcher, the veterinarians were probably more aware of their

role as advisor and were trying to do their best in their communication with the farmer, even though they stated that the presence of the researcher did not influence them.

Although the veterinarians' communication skills may not follow established guidelines on effective advice giving, farmers stated that they were satisfied with their veterinarian and his or her role as advisor. Although it can be assumed that in this context farmers were willing to give socially desirable answers, this research supports earlier findings in the Netherlands (Jansen et al., 2008), showing that farmers perceived their relationship with their veterinarian as good, highly trust the veterinarian's knowledge, and perceived the veterinarian as the most important and most frequently contacted person regarding udder health. Therefore, veterinarians' perception that farmers are not willing to listen to advice when the veterinarian takes the initiative seems unjustified. Of course, a proactive attitude on the part of veterinarians does not guarantee the implementation of that advice by farmers, but who puts udder health on the farmer's agenda if the veterinarian fails to take the initiative (Jansen et al., 2010b)? The results of this study suggest that passive veterinarians lead to passive farmers. It is, however, also interesting to study the opposite: are proactive veterinarians capable of giving good udder health advice leading to active farmers? In other words, will an improvement in veterinarians' verbal and nonverbal communication skills lead to better adoption of advice by farmers and therefore to better udder health? Although theories suggest that improvement of verbal and nonverbal communication skills will lead to providing better advice (Latham and Morris, 2007), more empirical research is needed to determine the potential effect of applying these communication skills on the adoption of advice by farmers and on farmers' satisfaction with their veterinarian (Shaw et al., 2004a,b).

Implications for mastitis control programs

When including veterinarians in disease control programs, one should take into account that the changing of management measures that affect the whole farming system requires strong interaction between advisor and farmer (Ingram and Morris, 2007; Leeuwis, 2000). Regular advisor–farmer contacts are a potentially powerful way to achieve a change in farm management because of a) the high frequency of service contacts between farmers and advisors, b) the familiarity with each others' context, personal characteristics, preferences, beliefs, aspirations, and competencies that builds up over the years, and c) the relationship of trust that develops (Leeuwis, 2004; Sligo and Massey, 2007). This interaction can be shaped in several ways, depending on the positions farmer and advisor take in the process of knowledge construction (Ingram, 2008). Results of the Dutch udder health program have shown that farmers who had intensive contact with their local veterinarian, by participation in study groups organized by him or her, significantly increased their herds' udder health (Lam et al., 2007).

Although veterinarians as herd health and management advisors play an important role in establishing better udder health, there are several constraints in integrally incorporating attention to mastitis control in such contacts. These relate, for example, to the competences of the advisor as shown in this study, but also relate to the possibility of addressing preventive management in a commercial, demand-driven, farmer–advisor relationship in a demanding society (Botha et al., 2008; Ingram, 2008; Ingram and Morris, 2007; Mee, 2007). As the veterinarians in this study seem to prefer to work with motivated farmers with a specific demand, one should take into account how the less motivated farmers can be reached (Jansen et al., 2010a,b) when designing a mastitis control program. Although improved communication skills could contribute to an increase in veterinarians' efficacy in reaching the less motivated farmers, other strategies are also needed to reach these farmers, such as peripheral marketing campaigns on targeted behavior or cooperation with other farm advisors (Jansen et al., 2010a,b).

CONCLUSION

In theory, veterinarians seem to be the best udder health advisors; however, in daily practice there is room for improvement. Although most veterinarians have the intention of working on mastitis prevention and feel that proactive udder health advice comes within their professional remit, they seem to prefer a curative, demand-driven approach. Veterinarians cope with this ambiguity between their intentions and actual behavior by citing many barriers. Veterinarians could transform these perceived barriers into opportunities by adopting a customer-oriented, proactive approach and by applying elementary communication techniques in their advice.

The results of this exploratory study show that, although most dairy farmers are satisfied with their veterinarian, ample opportunities exist to further improve veterinarians' advisory skills to meet the current and future demands of proactive, preventive herd health advisory work. These issues need to be taken into account when national animal health programs use veterinarians as intermediaries to reach farmers and to change farmers' behavior.

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6

The effect of a national mastitis control program on farmers' attitudes, knowledge, and behavior in the Netherlands

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ABSTRACT

Over the years, much effort has been put into implementing mastitis control programs in herds. To further improve such programs, we need to understand farmers' attitudes, knowledge, and behavior regarding udder health, and the way this can be influenced by mastitis control programs. This study aimed to explore the effect of a national mastitis control program on Dutch farmers' attitudes, knowledge, and behavior regarding mastitis.

In this study, 378 randomly selected dairy farmers completed a survey on attitudes, knowledge, and behavior regarding mastitis before the start of a national mastitis control program (2004), and 204 of them completed a similar survey in the final year of the program (2009). Statistical analyses show that, although the average annual bulk milk somatic cell count (**BMSCC**) remained the same, farmers' attitudes, knowledge, and behavior changed significantly. Farmers' problem level of BMSCC decreased from 285,000 cells/ml in 2004 to 271,000 cells/ml in 2009. More farmers perceived that they had sufficient knowledge about the prevention of mastitis (34% in 2004 vs. 53% in 2009) and they more often perceived that they knew the cause of a mastitis problem (25% in 2004 vs. 37% in 2009). Application of mastitis control measures increased significantly during the program. The use of milking gloves, for instance, increased from 15% to 46%, the use of a standardized mastitis treatment protocol increased from 7% to 34%, and cubicles are cleaned more often (2.28 vs. 2.51 times/day).

Most changes in attitudes, knowledge, and behavior did not differ between groups of dairy farmers with an initially low (≤ 162,000 cells/ml), medium (163,000 to 205,000 cells/ml), or high (> 206,000 cells/ml) BMSCC. The high BMSCC group significantly decreased their annual BMSCC level by 15,000 cells/ml. Regression analysis showed that a decrease in BMSCC levels was associated with a change in farmers' perceptions (e.g. increased perceived knowledge about the effect of the milking machine on mastitis) and with a change in certain management practices (e.g. disinfecting all teats after milking).

The results show that a national mastitis control program is able to affect farmers' attitudes, knowledge, and behavior regarding mastitis and could therefore contribute to udder health improvement in the long term.

INTRODUCTION

Over the years, much effort has been put into the implementation of mastitis control programs in herds. Evaluation of such extension education programs is necessary to optimize future campaigns (Chase et al., 2006). The aim of a mastitis control program is to improve management practices by influencing farmers' behavior in order to reduce mastitis incidence and to improve milk quality (Barkema et al., 1998; Barkema et al., 1999; Jansen et al., 2009). When an attempt is being made to influence people to change their behavior, many theories from social psychological sciences may be applied. One well known theory in this context is the theory of planned behavior (Ajzen, 1991), which has been applied before in agricultural research (Beedell and Rehman, 2000; Burton, 2004; Ellis-Iversen et al., 2010) and in studies on behavioral interventions (Armitage and Conner, 2001; Hardeman et al., 2002). According to this theory, attitudes and knowledge (e.g. 'how do I feel about mastitis?'), perceived social norms (e.g. 'how do others feel about mastitis?'), and perceived behavioral control (e.g. 'can I do something about it?') influence behavioral intentions and actual behavior (e.g. to deal with mastitis prevention). A study on Dutch dairy farmers' attitudes, knowledge, norms, perceived behavioral control, and behavior regarding mastitis showed that the variance in the farms' mastitis situation – measured in terms of bulk milk somatic cell count (**BMSCC**) and clinical mastitis incidence – is indeed associated with these behavioral determinants (Jansen et al., 2009). In particular, farmers' perceived norms on satisfaction and problem levels of mastitis, as well as their perceived control of mastitis, were positively associated with the farms' real mastitis situation (Jansen et al., 2009). These results correspond to the theory of planned behavior. It can therefore be suggested that, to change farmers' behavior in order to improve udder health, behavioral determinants such as farmers' attitudes, knowledge, norms, and perception of control need to be influenced. Consequently, to evaluate and to improve mastitis control programs it is necessary to study the program-induced change in behavioral determinants, which may be influenced by the farms' initial udder health situation.

This study aims to determine whether farmers' attitudes, knowledge, norms, perception of control, and behavior have changed since the start of a national udder health program, whether these changes differ between herds with different udder health situations at the start of the program, and whether these changes explain a decrease or an increase in BMSCC levels.

MATERIALS AND METHODS

The udder health program

In 2005, a project was initiated to improve udder health in The Netherlands: the

5-year mastitis control program of the Dutch Udder Health Centre (UGCN). The communication strategies of the udder health program consist of two main routes to reach as many farmers as possible: an extensive direct multi-media approach using e.g. articles in farm magazines, campaigns to stimulate specific preventive measures, presentations at agricultural fairs, and mailings to all dairy farmers, and an indirect approach through veterinarians as intermediaries between UGCN and farmers (Jansen et al., 2010). In 2008, 200 out of 326 veterinary practices participated in the program serving about 17,000 dairy farmers (approximately 85% of all Dutch dairy farmers), of which 3,169 farmers (approximately 16% of all Dutch dairy farmers) participated in on-farm study groups on udder health issues organized by their veterinarian.

Participants

Between April and July 2004, an extensive baseline survey was conducted on farmers' attitudes, knowledge, and behavior, in which 378 Dutch dairy farmers participated (response rate 69.6%), as described by Jansen et al. (2009). These farmers' fortnightly BMSCC data from April 2004 to April 2005 were used to calculate the initial average annual BMSCC. After the baseline study was completed, the UGCN approach towards these farmers did not differ from its approach to other farmers in the country. Between April and July 2009, the same farmers were asked to participate in a similar survey, resulting in a dataset of 207 dairy farmers that participated in both surveys. These farmers' BMSCC data for 2009 were used to calculate the 2009 average annual BMSCC. The reasons for 171 farmers not participating in the 2009 survey were: 1) farmers did not have the time or the inclination to fill in the forms (24%), 2) farmers could not be reached (22%), 3) farmers perceived surveys as useless, not relevant, or had a bad experience when participating in other studies (21%), 4) had quit farming (9%), 5) personal circumstances (9%), or 6) other reasons (15%). The non-responders did not differ significantly from the responders with regard to their annual BMSCC in 2004 ($P = 0.58$). However, non-responders had less interest in mastitis treatment and prevention, were less interested in reading mastitis articles, had less contact with independent consultants and the Animal Health Service, and had a more negative opinion about the value of the veterinarians' advice during the baseline survey in 2004 ($P < 0.05$).

Questionnaire

The data on farmers' attitudes, knowledge, and behavior were collected in 2004 and in 2009 using a structured questionnaire containing 50 items regarding behavior and farm demographics, and 76 items about farmers' attitudes, knowledge, and information

sources (Jansen et al., 2009). The attitude and behavior items were measured using various methods such as binary variables, open questions, and statements that the farmers rated on a 5-point Likert scale according to how much they agreed or disagreed with the statements (Likert, 1932). When frequencies are presented in the results section, scores 1 (disagree) and 2 (partly disagree) are combined, as well as scores 4 (partly agree) and 5 (agree).

Statistical analyses

To compare farmers' answers between 2004 and 2009 in general, non-parametric Wilcoxon signed-rank tests ($P \leq 0.05$) were performed. In addition, for each survey variable, gain scores were calculated by subtracting the value in 2004 from the value in 2009. A positive gain score means an increased score on that question. To compare differences in gain scores between farmers with different BMSCC levels during the baseline survey, the herds were divided into 3 groups of equal size: the lowest, middle, and highest 33.3% of the 12 month average BMSCC level. Consequently, the following threshold values were used: low BMSCC (≤ 162,000 cells/ml, n = 64), medium BMSCC (> 162,000 and ≤ 205,000 cells/ml, n = 65) and high BMSCC (> 206,000 cells/ml, n = 65). The BMSCC values of 13 farms in 2004 were unknown; they were excluded from this part of the analysis. To compare differences between the 3 groups regarding their change in attitudes, knowledge, and behavior over time, non-parametric Kruskal-Wallis analyses were performed. Furthermore, Wilcoxon signed-rank tests ($P \leq 0.05$) were performed to determine whether the gain scores within a group deviated significantly from zero.

To explain the changes in annual BMSCC levels between 2004 and 2009 by changes in farmers' attitudes, knowledge, and behavior a stepwise linear regression analysis was performed. In this regression analysis, the gain score of BMSCC was used as a dependent variable and all the gain scores of the survey variables were used as independent variables. The initial BMSCC level at the baseline survey was forced into the regression model as a continuous variable, as it is assumed that it is easier to considerably decrease BMSCC from initially high BMSCC levels than from initially low levels. The gain score on BMSCC was assumed to be normally distributed, as Kolmogorov-Smirnov ($P > 0.200$) and Shapiro-Wilk ($P > 0.901$) tests showed non-significant results. The regression model was checked for normality and autocorrelation using the Durban Watson test for independent errors, the average variance inflation factor, tolerance levels, Cook's distance, and test of normality of the standardized residuals (Kolmogorov-Smirnov, P-P and Q-Q plot and histogram). All data were analyzed using SPSS (SPSS 15.0.1 for Windows, SPSS Inc. Chicago, IL, USA).

RESULTS

Overall differences between 2004 and 2009

In general, the results show that the mean annual BMSCC of the baseline survey in 2004 (187,000 cells/ml) did not change significantly compared to 2009 (194,000 cells/ml, $P = 0.20$). However, compared to 2004, aspects of farmers' attitudes, knowledge, behavior, and the type of information sources used had changed significantly ($P \leq 0.05$) (see Table 6.1). During that period, farmers increased the number of milking cows (78 vs. 88 cows), while the total manpower per herd stayed the same, at approximately 1.65 fulltime equivalents. This change manifested itself in the attitude towards mastitis. Extra work was more often perceived as the most annoying aspect of mastitis (26% vs. 49%), and more farmers stated that it was important to keep the farm management simple (79% vs. 88%). With regard to farmers' norms, their problem level of BMSCC changed; farmers perceived a problem at 285,000 cells/ml in 2004 compared to 271,000 cells/ml in 2009. Farmers' perceptions on how to decrease the national BMSCC also changed between the baseline and the end survey. More farmers mentioned that they would prefer a bonus for a low BMSCC (71% vs. 86%), and fewer farmers' stated that they would prefer an increase in fines (19% vs. 11%).

In the 2009 survey, farmers perceived that they had more knowledge about controlling mastitis problems than in 2004 (34% vs. 53%), and they stated that they more often knew the causes when a mastitis problem occurred (25% vs. 37%). Compared to 2004, more farmers claimed to have sufficient knowledge about the influence of nutrition on mastitis (24% vs. 29%), and more claimed to know that they had to focus on the hygiene of milking procedures when there were *S. aureus* problems (76% vs. 84%).

With regard to farmers' behavior, farmers started to use udder health characteristics more often when selecting bulls (46% vs. 61%). The use of milking gloves increased from 15% to 46%, the use of a herd-specific mastitis treatment protocol increased from 7% to 34%, and cubicles were more often cleaned (2.28 vs. 2.51 times/day). More farmers used blanket dry-cow therapy with antibiotics (85% vs. 94%), and automatic measurements of milk quality by the milking machine were more often used to diagnose clinical (4% vs. 13%) and subclinical (4% vs. 10%) mastitis. The percentage of farmers who engaged in foremilk stripping on all cows decreased (33% vs. 27%) as well as the percentage of farmers who prevented cows from lying down after milking (56% vs. 46%).

With regard to farmers' information sources, they reported using the internet more often (8% vs. 25%), whereas the importance of other information sources such as the veterinarian remained stable. Information sources such as farm magazines, independent consultants, and the Dutch GD Animal Health Service had decreased in importance.

Comparing low, medium, and high BMSCC farmers

Of the 126 variables in the survey, 15 are different for farmers with a different initial BMSCC level (Table 6.2). Comparison of Table 6.1 and Table 6.2 shows that most overall changes in farmers' attitudes, knowledge, and behavior apply to all farmers, regardless of their initial BMSCC level. No significant differences could be found between groups regarding their gain scores on behavior and on problem and satisfaction levels of mastitis.

In contrast with the overall mean, the annual BMSCC level of the low BMSCC farmers increased significantly (134,000 cells/ml vs. 158,000 cells/ml), the BMSCC level of the medium BMSCC farmers maintained the same level (185,000 cells/ml vs. 192,000 cells/ml), and the BMSCC level of the high BMSCC farmers decreased significantly (243,000 cells/ml vs. 228,000 cells/ml).

The high BMSCC group differed from the low group because the gain scores of the high group showed a decrease in interest in mastitis issues between 2004 and 2009. For the high BMSCC group, the financial consequences of mastitis became more annoying, and the results of bacteriological culturing of milk samples were perceived as more difficult to interpret. The medium BMSCC group differed from the low and the high group regarding their decreased use of information sources such as farm magazines and the Animal Health Service. The medium BMSCC group perceived increased knowledge on treatment of subclinical mastitis and was more confident about the recovery of a mastitis cow. The low BMSCC farmers perceived decreased knowledge on mastitis and milking procedures and became more interested in mastitis information and contact with others about mastitis than the farmers in the medium and high BMSCC groups.

Factors associated with an increase or decrease in BMSCC

A regression analysis was performed to study factors that were associated with an increase or decrease in BMSCC levels on individual farms. The average gain score of BMSCC was 5,290 cells/ml, ranging from a decrease of -140,130 cells/ml to an increase of 168,170 cells/ml. As indicated in Table 6.3, the results of the stepwise linear regression analysis showed that the changes in farmers' attitudes, knowledge, and behavior explained 45% of the variation in the change in BMSCC levels. Farmers' initial BMSCC level is an important predictor for this variation; the higher the initial BMSCC level, the lower the gain score on BMSCC. In other words, a high initial BMSCC level seems to be associated with a decrease in BMSCC over the years.

Some changes in farmers' attitudes are associated with a change in BMSCC. Farmers who perceived bacteriological testing as more expensive over the years were associated with an increase in BMSCC levels. Farmers who became more positive about increased penalties for BMSCC were associated with a decrease in BMSCC. Also,

Table 6.1 Dairy farmers' attitudes, knowledge, behavior and the use of information sources before (2004) and after (2009) a Dutch national mastitis control program (N=207)

Survey variable	Mean 2004 (SD)		Mean 2009 (SD)		*P*-value
Attitudes					
Satisfaction level % of cows with subclinical mastitis at milk inspection report	9.83	(7.18)	6.40	(4.95)	<0.001
Problem level BMSCC (*1,000 cells/ml)	285.00	(57.21)	271.00	(63.83)	0.005
I would certainly read an article about mastitis in my farm magazine [1]	4.48	(0.68)	4.32	(0.85)	0.005
I would like to see more mastitis articles in my farm magazine [1]	3.48	(1.00)	3.32	(0.95)	0.013
Bacteriological testing is useful because it gives a direction to the treatment that follows [1]	3.96	(1.05)	3.67	(1.21)	0.008
Most annoying aspect of mastitis: the extra work [2]	0.26	(0.44)	0.49	(0.50)	<0.001
Most annoying aspect of mastitis: uncertainty about cow's recovery [2]	0.30	(0.46)	0.14	(0.34)	<0.001
The best way to decrease the national BMSCC is to have a bonus for low BMSCC [2]	0.71	(0.46)	0.86	(0.35)	0.012
The best way to decrease the national BMSCC is to increase the penalties [2]	0.19	(0.39)	0.11	(0.31)	<0.001
The best way to decrease the national BMSCC is to have free visits from mastitis experts [2]	0.34	(0.47)	0.25	(0.43)	0.008
Importance of increasing farm size with milk quota [3]	4.19	(0.85)	3.45	(1.19)	0.035
Importance of keeping farm management simple [3]	4.15	(0.82)	4.45	(0.76)	<0.001
Knowledge					
I know enough to prevent mastitis problems [1]	2.93	(1.12)	3.45	(1.02)	<0.001
I know what the causes are when I have mastitis problems [1]	2.44	(1.18)	2.90	(1.14)	<0.001
Mastitis causes are hard to influence [1]	2.95	(1.07)	2.54	(1.08)	<0.001
With *S. aureus* problems you have to look at hygiene of milking procedures [2]	0.76	(0.43)	0.84	(0.37)	0.029
I think that the results of BO are difficult to interpret [1]	2.92	(1.27)	3.20	(1.36)	0.012
Perceived knowledge about the influence of feeding on mastitis [4]	2.73	(1.05)	2.89	(0.94)	0.025
Behavior					
Number of dairy cows	78.22	(26.43)	88.03	(31.80)	<0.001
When I have problems filling my milk quota, I treat cows with subclinical mastitis less fast[1]	1.97	(1.32)	2.66	(1.50)	<0.001
I have a standardized treatment plan for mastitis [2]	0.07	(0.25)	0.34	(0.48)	<0.001
When selecting bulls I take udder health parameters into account [1]	3.31	(1.40)	3.59	(1.32)	0.002

Frequency of cleaning the cubicles per day	2.28	(0.72)	2.51	(0.80)	<0.001
I always use dry-off therapy with antibiotics [2]	0.85	(0.35)	0.94	(0.24)	<0.001
I always wear gloves during milking [2]	0.15	(0.35)	0.46	(0.50)	<0.001
I clean the teats with a dry towel before milking [2]	0.39	(0.49)	0.31	(0.47)	0.005
I prevent all cows from lying down after milking [2]	0.56	(0.50)	0.46	(0.50)	0.005
Foremilk stripping all cows before milking [2]	0.33	(0.47)	0.27	(0.45)	0.007
Not foremilk stripping any cows at all [2]	0.15	(0.35)	0.00	(0.00)	<0.001
I diagnose clinical mastitis by foremilk stripping all cows [2]	0.38	(0.49)	0.27	(0.45)	<0.001
I diagnose clinical mastitis by automatic measurements of milk quality by the milking machine [2]	0.04	(0.21)	0.13	(0.34)	<0.001
I diagnose subclinical mastitis by observation of the cow and udder [2]	0.35	(0.48)	0.17	(0.38)	0.046
I diagnose subclinical mastitis by automatic measurements of milk quality by the milking machine [2]	0.04	(0.19)	0.10	(0.20)	<0.001
Percentage of bacteriological surveys of milk samples of subclinical mastitis cows	13.55	(23.64)	9.17	(19.65)	0.007
Information sources					
Important mastitis information source: internet [3]	1.88	(0.97)	2.64	(1.15)	<0.001
Important mastitis information source: animal health service [3]	3.64	(1.22)	3.33	(1.20)	0.005
Important mastitis information source: colleagues [3]	3.22	(1.11)	3.01	(1.03)	0.008
Important mastitis information source: independent consultants [3]	2.19	(1.26)	1.94	(1.15)	0.008
Important mastitis information source: farm magazines [3]	3.95	(0.90)	3.80	(0.85)	0.021
Talking about mastitis with colleagues [5]	2.93	(0.77)	2.78	(0.76)	0.017
Talking about mastitis with independent consultants [5]	1.54	(0.83)	1.40	(0.75)	0.041
Talking about mastitis with the Animal Health Service [5]	1.76	(0.87)	1.60	(0.80)	0.042

Results of Wilcoxon signed-rank tests to compare farmers' response in 2004 and 2009
[1] Scored from 1 (disagree) to 5 (agree)
[2] Binary variable: 0 = no, 1 = yes
[3] Scored from 1 (not important) to 5 (very important)
[4] Scored from 1 (poor) to 5 (excellent)
[5] Scored from 1 (never) to 5 (very often)

Table 6.2 Low, medium, and high BMSCC farmers' changes in BMSCC, attitudes, knowledge and behavior between 2004 and 2009 (N=191)

	Overall gain score	Gain scores per BMSCC group			*P*-value between groups
		Low (n=64)	Medium (n=65)	High (n=65)	
BMSCC annual average (*1,000 cells/ml)	5.29	**24.83**	6.11	**-15.27**	<0.001
I am interested in mastitis control and prevention[1]	-0.11	-0.09	0.14	**-0.46**	0.007
Mastitis is an awkward disease[1]	-0.06	0.08	0.06	-0.26	0.057
Most annoying aspect of mastitis: the financial consequences [2]	-0.03	0.06	-0.02	**0.14**	0.066
Most annoying aspect of mastitis: the cows suffer [2]	0.02	-0.06	-0.05	0.09	0.077
Most annoying aspect of mastitis: the uncertainty about a cow's recovery [2]	**-0.17**	-0.08	**-0.32**	-0.13	0.024
The best way to decrease BMSCC is lower penalty level [2]	-0.01	**0.15**	-0.08	-0.10	0.007
Importance of keeping farm management simple [3]	**0.29**	0.11	**0.44**	**0.36**	0.083
Perceived knowledge about mastitis and milking procedures [4]	-0.10	**-0.26**	-0.08	0.03	0.067
Perceived knowledge about the treatment of subclinical mastitis [4]	0.10	0.02	**0.37**	-0.06	0.034
I think that the results of bacteriological tests of milk samples are difficult to interpret [1]	**0.28**	-0.03	0.16	**0.69**	0.030
I would like to see more mastitis articles in my farm magazine [1]	**-0.18**	0.24	**-0.27**	**-0.57**	<0.001
Important mastitis information source: farm magazines [3]	**-0.17**	-0.02	**-0.39**	-0.06	0.075
Talking about mastitis with study group members [5]	-0.02	0.18	-0.03	-0.19	0.054
Talking about mastitis with the Animal Health Service [5]	**-0.12**	0.10	**-0.25**	-0.18	0.094

Results of Kruskal-Wallis analyses comparing gain scores (2009-2004) between groups with a low (≤ 162,000), medium (163,000-205,000), or high (> 206,000) average annual BMSCC starting April 2004. Values in bold are gain scores within a group that are significantly different from zero (Wilcoxon signed-rank test $P \leq 0.05$).
[1] Scored from 1 (disagree) to 5 (agree)
[2] Binary variable: 0 = no, 1= yes
[3] Scored from 1 (not important) to 5 (very important)
[4] Scored from 1 (poor) to 5 (excellent)
[5] Scored from 1 (never) to 5 (very often)

farmers' perceived change in knowledge was associated with a change in BMSCC level. Farmers who perceived an increase in knowledge on the effect of the milking machine on mastitis were associated with a decrease in BMSCC. However, a perceived increase in knowledge on the effect of milking on mastitis was associated with an increase in BMSCC levels. Finally, farmers' changes in behavior were associated with a change in BMSCC levels. Farmers who started disinfecting all teats after milking and who started to treat subclinical mastitis cases immediately after diagnosing them were associated with

Table 6.3 Change of annual BMSCC levels between 2004 and 2009 explained by a change in farmers' attitudes, knowledge, and behavior

			Stepwise linear regression analysis		
Variables included in model	Mean	SD	*B*[1]	*t*-value	*P*- value
BMSCC annual average baseline survey 2004	187,000	49,297	-0.37	-5.13	<0.001
Bacteriological testing of milk samples is too expensive [2, 3]	-0.04	1.37	0.22	3.08	0.003
The best way to decrease the national BMSCC is to increase the penalties [2, 5]	-0.09	0.45	-0.21	-3.02	0.003
Perceived knowledge of the effect of the milking machine on mastitis [2, 4]	-0.10	0.76	-0.36	-4.53	<0.001
Perceived knowledge of the effect of milking on mastitis [2, 4]	-0.09	0.83	0.20	2.45	0.016
Diagnose clinical mastitis by automatic measurements by the milking machine [2, 5]	0.09	0.35	0.30	4.30	<0.001
Disinfecting all teats after milking with dip or spray [2, 5]	0.03	0.34	-0.18	-2.48	0.015
Immediate treatment with antibiotics when a cow has a high somatic cell count [2, 5]	0.03	0.37	-0.22	-3.17	0.002
Not foremilk stripping any cows at all [2, 5]	-0.14	0.35	-0.22	-2.97	0.004
Strip foremilk when I perceive mastitis problems [2, 5]	-0.03	0.30	-0.17	-2.36	0.020

[1] Coefficients are standardized regression weights (betas). Model $F = 10.49$ ($P < 0.001$), Df 10; 117, $R^2 = 0.50$, Adjusted $R^2 = 0.45$
[2] Values of these variables are calculated gain scores (calculated as value 2009 – value 2004)
[3] Scored from 1 (disagree) to 5 (agree)
[4] Scored from 1 (poor) to 5 (excellent)
[5] Binary variable: 0 = no, 1 = yes

a reduction in BMSCC levels. In addition, farmers who started to strip foremilk when mastitis problems occurred were also associated with a reduction in BMSCC levels.

The model was checked for normality and autocorrelation: Durban Watson test for independent errors was 2.0, the average variance inflation factor was 1.1, and the average Cook's distance was 0.02 with all values below 1.0. The standardized residuals were tested using Kolmogorov-Smirnov ($P > 0.20$), and the Q-Q plot and histogram of the standardized residuals gave no reasons for concern. Removing influential cases did not influence the model fit. Consequently, the model fit of the regression analysis was good.

DISCUSSION

The relationship between farmers' perceptions and mastitis

The main aim of this paper was to determine whether farmers' attitudes, knowledge, norms, perception of control, and behavior towards udder health had changed since the start of a national udder health program in the Netherlands. The results of the

survey show that during the course of the mastitis control program farmers indeed changed. Figure 6.1 (adapted from Jansen et al., 2009) shows how farmers' attitudes, knowledge, and behavior in relation to mastitis can be influenced by a mastitis control program and how this – though no effects were found in this study – could influence udder health in the long term. The figure includes behavioral determinants of the theory of planned behavior as well as the importance of external factors (Ajzen and Fishbein, 2005; Ellis-Iversen et al., 2010; Jansen et al., 2009).

The results of this study show that farmers' perceptions changed during the course of the mastitis control program. In particular, their attitude towards problem and satisfaction levels of BMSCC changed favorably. This is important because these normative values are strongly associated with their actual BMSCC and are expected to influence the farms' udder health status in the long term (Jansen et al., 2009). The results also show that farmers' perceived behavioral control or self efficacy regarding mastitis increased. In other studies, self efficacy has been shown to be a useful predictor of both behavioral intentions and behavior (Armitage and Conner, 1999, 2001). Therefore it can be assumed that farmers perceive that they are better able to deal with mastitis problems than in 2004; this consequently could influence their future response to mastitis problems. In line with that, some important management practices that are associated with mastitis control, such as increased hygiene by cleaning the cubicles more frequently, increased use of gloves during milking, increased use of a proper dry-off therapy, and increased selection of sires based on udder health parameters, have changed during the course of the control program. These changes in behavior do not differ between farmers with different initial BMSCC levels before the start of the program. The efforts of the control program seem to reach all farmers, regardless of their initial udder health situation. The behavioral changes measured in this survey did not seem to directly affect the average BMSCC status of the farms. This does not mean that BMSCC was not influenced. The results show that mainly farmers with an

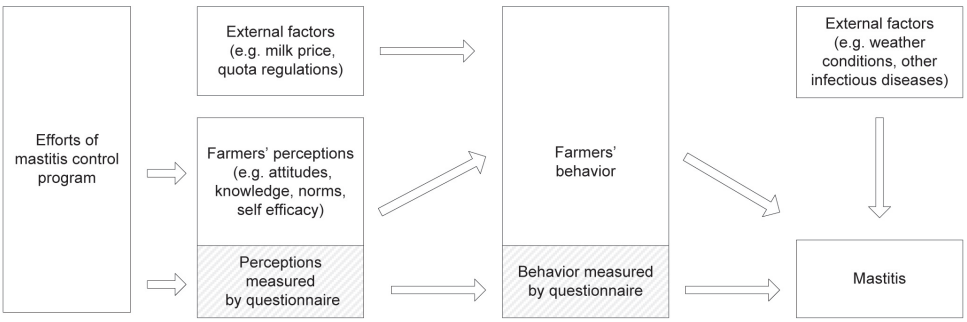

Figure 6.1 Explaining mastitis incidence and the potential influence of a national mastitis control program (adapted from Jansen et al., 2009).

initially high BMSCC decreased their BMSCC considerably. It could be argued that these changes are caused by regression towards the mean. However, the regression analyses show that a decrease in BMSCC is associated with a change in both perceptions and behavior of farmers. It is likely that farmers who have changed their perceptions and behavior, but do not yet have a lower BMSCC, may increase udder health in the long term. It should, however, be taken into account that mastitis is a complex disease and cannot be easily solved in the short term by changing a single management factor; it requires a long-term change in general herd management (Barkema et al., 1999; LeBlanc et al., 2006).

The influence of external factors

Changes in farm management entail a long-term process and depend on contextual factors (Leeuwis, 2004) such as milk price, quota regulations, or infectious disease outbreaks. In this study, 45% of the variation in the decrease or increase in BMSCC could be explained by the survey variables. This result is comparable with a previous study on explained variance in BMSCC levels (Jansen et al., 2009). However, this still means that 55% of the variance in BMSCC change could not be explained by the survey variables. Explanations for this include the limited content of the questionnaire (Jansen et al., 2009) and external factors (see Figure 6.1). During the five years of the program, external factors such as fluctuating milk prices and uncertainty about quota regulations probably influenced farmers' behavior. Milk quota utilization is an important factor in farmers' decision making regarding treatment of mastitis (Vaarst et al., 2002). The results indeed show that farmers waited longer to treat subclinical mastitis cows when they had problems filling their milk quota, and this could have influenced their BMSCC status. Moreover, the results show that herds increased in size and that labor efficiency became more important during the course of the program. These factors may lead to an increase in BMSCC because less time may be available to apply mastitis control practices. Other external factors such as the weather or infectious diseases can also influence the BMSCC of herds, as evidenced by the Blue Tongue Virus that emerged in the Netherlands in 2006 (Elbers et al., 2009).

The role of the national mastitis control program

It is debatable whether the changes in farmers' perceptions and behavior have been caused by the national mastitis control program or by a secular trend in society, as the results cannot be compared to a control group of farmers who were not affected by the program. Although the study herds were initially randomly sampled from the Dutch dairy herd population, the farmers who participated in both surveys may not be representative of the whole population. These farmers were willing to participate

and were more interested in udder health management. Also, herds that disappeared between both surveys may have had worse udder health than herds that continued and were included in the last questionnaire. Although the responders' BMSCC in 2004 did not differ from that of the non-responders, selection bias may have led to an overestimation of the effects of the national udder health program.

Studies on activities within this national mastitis control program using different study populations showed a profound campaign effect on the behavior of farmers regarding e.g. the use of gloves during milking (Jansen et al., 2010). Evaluations of national programs should take into account that, in general, campaigns that aim to change people's behavior have small to moderate effects (Noar, 2006) and that a campaign's goal to change 20% of a population's behavior would probably result in failure (Snyder et al., 2004). In this study, some management practices of farmers changed by more than 20% between both surveys; this indicates a strong effect. In general, a campaign is considered successful when people's attitudes and beliefs are affected (Noar, 2006; Snyder et al., 2004) because the first step in behavioral change is a change in behavioral determinants such as perceived attitudes, knowledge, norms, and self efficacy. This study has shown that by means of a mastitis control program an important first step towards better udder health has been made.

CONCLUSION

The results of this study show that a national mastitis control program can be successful in changing farmers' attitudes, knowledge, and behavior regarding mastitis. Although the overall results suggest no general decrease in BMSCC levels in the 5-year period, they do indicate an association between a decrease in BMSCC levels and a change in farmers' attitudes, knowledge, and behavior. Although more research is needed to study the long-term impact of these changes, this study can contribute to an increased understanding of the effects of animal health programs.

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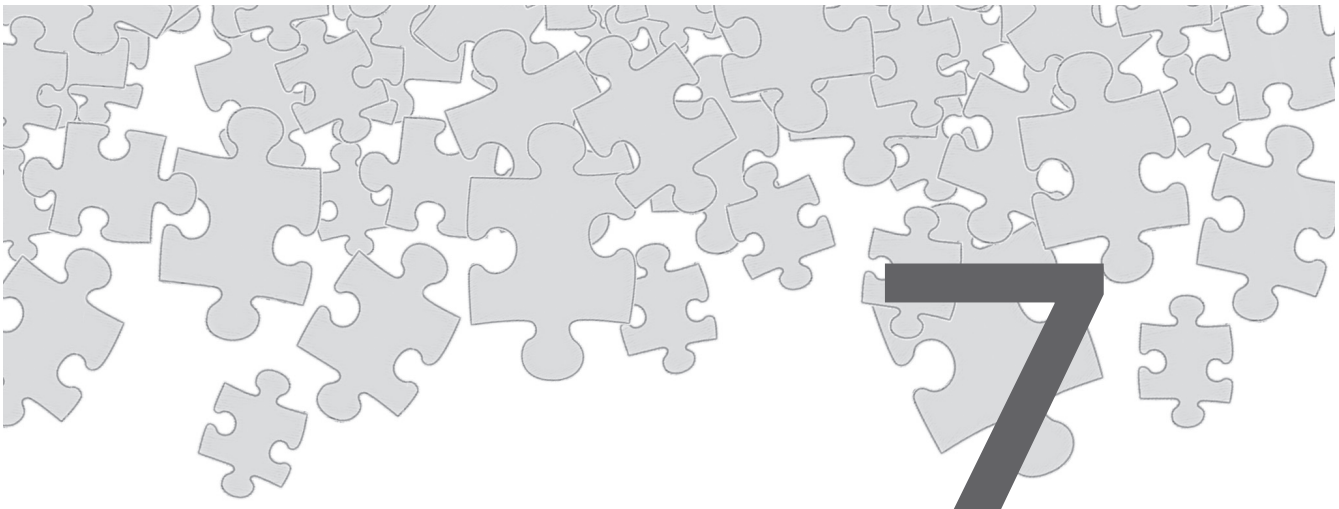

7

General discussion and conclusions

This thesis aims to understand Dutch dairy farmers' behavior and mindset regarding udder health management, and to study the efficacy of various communication strategies. In this chapter the main findings of the thesis are discussed. The chapter starts by describing farmer mindset towards mastitis. In addition, the role of communication as an intervention instrument is evaluated, including the role of veterinarians, and suggestions for future research are provided. The chapter concludes by summarizing the main findings of this thesis and the implications for future disease control programs.

Farmer mindset towards mastitis

From a historical perspective, agricultural extension specialists, researchers, and veterinarians assumed that agriculture was an activity executed by an individual farmer, based primarily on rational, technical, and economic considerations (Burton, 2004; Leeuwis, 2004). Although such rational choices still play a role in farm management, we have learned that farmers' decision making about mastitis management based on these considerations is not always clear and understandable (Vaarst et al., 2002). Why some farmers, even though it would benefit their results, do not implement effective mastitis management practices is not always known (Barkema et al., 1999), but it is often assumed that, besides these deliberate rational considerations, other farmer mindset factors play a role (Andersen and Enevoldsen, 2004; Barkema et al., 1999; Barnouin et al., 2004; Beaudeau et al., 1996; Dohoo et al., 1984; Leeuwis, 2004; Nyman et al., 2007; Reneau, 2002; Seabrook, 1984; Tarabla and Dodd, 1990; Vaarst et al., 2002; Van der Ploeg, 1999; Wenz et al., 2007).

Farmer mindset comprises a variety of social psychology constructs such as the farmer's personality, attitudes, beliefs, values, intentions, skills, knowledge, perceived norms, and perceived self efficacy, see e.g. the Theory of Planned Behavior (Ajzen, 1991; Ajzen and Madden, 1986; Fishbein and Yzer, 2003) and the Health Belief Model (Garcia and Mann, 2003; Janz and Becker, 1984; Sun et al., 2006), which are both frequently used to explain people's health behavior (Armitage and Conner, 2001; Noar et al., 2008; Painter et al., 2008). All these factors, and probably more, comprise the 'human factor' which, for the sake of convenience, is summarized as 'mindset'.

The survey conducted in Chapter 2 provides insight into farmer mindset about mastitis and the effect on mastitis incidence. Our findings suggest that indeed mastitis can be explained to a certain extent by farmer mindset and behavior and that mindset explains a substantial part in these models. In this study, elements of farmer mindset explain 17% of the variance in clinical mastitis incidence and 47% of the variance in bulk milk somatic cell count (BMSCC), while farmers' self-reported behavior explains, respectively, 12% and 14% of the variance of these parameters. Our findings are supported by studies by Bigras-Poulin et al. (1985) and Tarabla and Dodd (1990)

that also showed the effect of farmer mindset on farm performance. However, the complexity of mastitis makes it difficult to explain 100% of the variance in udder health between herds, even if both the mindset and the behavior of the farmer are included in explanatory models. Thus, it should be borne in mind that, even if all recommended management practices are applied perfectly (Bradley, 2002), and even if the mindset towards udder health is optimal, mastitis cases may still occur.

For a mastitis control program, it is important to influence elements of farmer mindset in order to change farmers' management practices to improve udder health. Figure 7.1 is a visual representation of our advancing insight into the relationship between the mastitis control program and the udder health status on a farm, and explains why only a part of the variance in udder health can be explained by our surveys (adapted from Ajzen and Fishbein, 2005; Ellis-Iversen et al., 2010; Fishbein and Yzer, 2003; Jansen et al., 2009). The figure shows that a mastitis control program can affect elements of farmer mindset and therefore behavior and udder health. It also shows that institutional factors, such as quota regulations, influence farmers' decision making. Moreover, some external factors, such as hot and humid weather, have a direct effect on udder health. Although feedback loops are not shown in this figure, it should be taken into account that the udder health status and external factors also affect farmer mindset and behavior.

The results in Chapter 2 suggest that elements of farmer mindset represent actual behavior in a better way than the self-reported behavior itself. On the basis of our findings it can be argued that self-reported behavior insufficiently explains farm management and farm performance. It seems that farmer mindset is a better indicator of the differences in udder health status between farms, although measuring elements of mindset, behavior, and (sub)clinical mastitis by using questionnaires and BMSCC data has its limitations.

As farmer mindset is associated with herds' udder health status, it is important to know what elements within this mindset are specifically important regarding

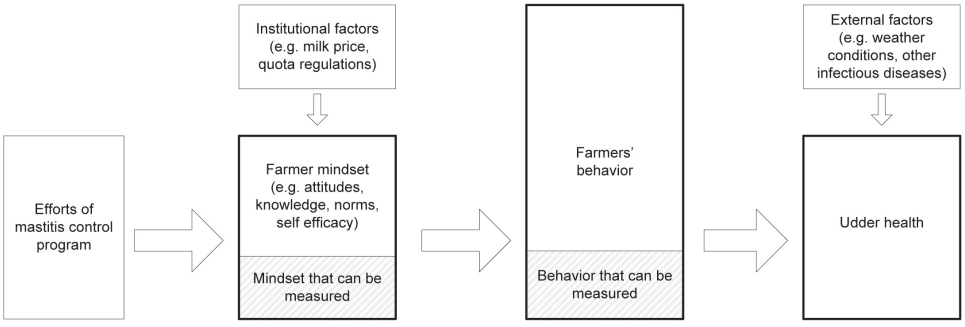

Figure 7.1 Advancing insight into the potential efficacy of mastitis control programs to improve udder health and the limitations of evaluative surveys.

mastitis prevention. The results of this thesis suggest that farmers perceive mastitis as an important problem. The baseline survey in 2004 (see Chapter 2) showed that 92% of the farmers surveyed wanted to decrease mastitis on their farms, 58% of the respondents worried about mastitis, and 60% had changed some of their management practices because of udder health problems in previous years (Jansen et al., 2004). In addition, 79% of the farmers were interested in the prevention of mastitis. However, only 38% of the respondents thought that they should actually do more about mastitis prevention. Although most farmers considered mastitis as a serious problem, farmers perceived themselves as having low behavioral control, as only 32% of the farmers perceived that they had enough knowledge to prevent mastitis problems.

The results of the studies described in this thesis suggest that two factors of farmer mindset seem to be important behavioral determinants for mastitis prevention: belief in a personal health threat (influenced by perceived susceptibility and perceived severity of the disease), and belief in the effectiveness of health behavior (influenced by perceived benefits from, and perceived barriers to, prevention of the disease). Interestingly, these factors are also known to be indispensable in motivating people to work on their own health and are included in the so-called Health Belief Model, that is presented in Figure 7.2 (Garcia and Mann, 2003; Griffin et al., 1999; Janz and Becker, 1984; Rogers, 1983; Sun et al., 2006).

The mechanisms behind this Health Belief Model seem to correspond to important behavioral determinants such as attitudes, norms, and perceived self efficacy from the Theory of Planned Behavior (Ajzen, 1991; Ajzen and Madden, 1986; Fishbein and Yzer, 2003; Garcia and Mann, 2003; Sun et al., 2006) and seem to apply to udder health management as well. For example, farmers who think that their cows are not susceptible or who think that mastitis is not a severe animal health or economic problem

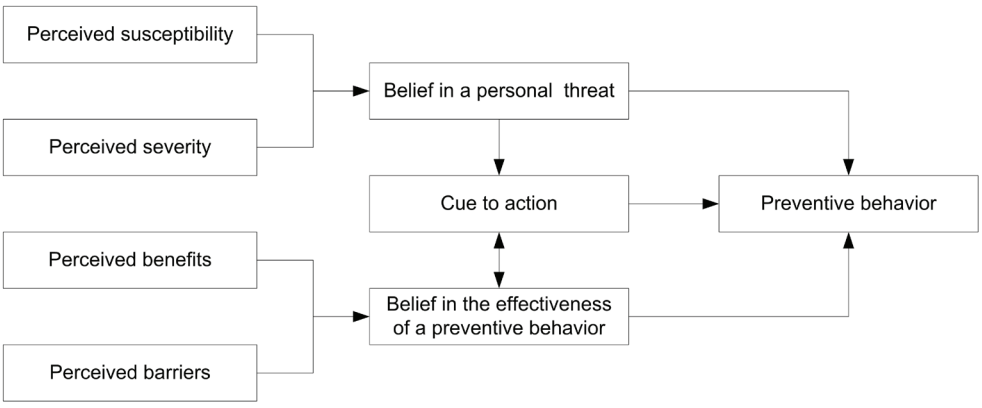

Figure 7.2 The Health Belief Model (Janz and Becker, 1984, adapted by Koelen and Van den Ban, 2004).

probably are less motivated to change their udder health management. In addition, if required mastitis management measures are perceived as difficult or as hardly resulting in animal health or economic benefit, farmers may not be motivated to change their mastitis management (Garforth et al., 2006; Huijps et al., 2008; Valeeva et al., 2007).

The studies conducted in this thesis support the importance of perceived threat and perceived effectiveness as part of farmer mindset regarding mastitis management. As regards the perceived threat of mastitis problems, the results in Chapters 2, 3, and 4 show that farmers' normative frame of reference (i.e. when is a problem perceived?) varies among farmers, is associated with farmers' interest in working on mastitis prevention, and explains a substantial part of the variance in mastitis incidence. Regarding belief in the effectiveness of the health behavior, Chapter 2 shows that farmers' perception of behavioral control has strong associations with mastitis incidence. Moreover, Chapter 3 shows that farmers' interest in mastitis prevention is associated with the expected efficacy of recommended management tools in improving udder health. The results in Chapter 4 also show that most farmers either feel that the mastitis problem is not serious enough or are not convinced of the efficacy of the proposed prevention measures on their farms.

To further explore the relevance of the constructs of the Health Belief Model in relation to farmer mindset regarding udder health management, we conducted an additional study. In this study 32 extended semi-structured interviews were held with a random selection of dairy farmers who participated in the 2009 survey (Jansen et al., 2010). During the interview, farmers were asked open questions about their perceptions on mastitis and their reasons for working or not working on mastitis prevention, in order to explore farmers' reasons for improving udder health. The interviews were transcribed in full and were analyzed following the Health Belief Model (Janz and Becker, 1984, see Figure 7.2).

The results are presented in Figure 7.3 and show that farmers' perceived threat and perceived efficacy of recommended measures indeed are the main arguments for working or not working on mastitis prevention. This corresponds with findings on farmers' entrepreneurial behavior change in general (Gielen et al., 2003) and with findings on farmers' response to information on economic losses associated with BMSCC levels (Van Asseldonk, 2010). It is important to note that farmers perceive clinical mastitis and subclinical mastitis as two different problems associated with different preventive measures (see also Chapter 2).

Associated with the perceived threat and perceived efficacy of measures are cues for action, such as milk price (e.g. high milk price can delay or stimulate treatment), milk quota (e.g. the need for extra milk delays treatment), information from a variety of sources (e.g. colleagues, farm magazines, fodder specialists, and veterinarians), life changing events (e.g. new partnerships, drastic renovations), or coincidence (e.g.

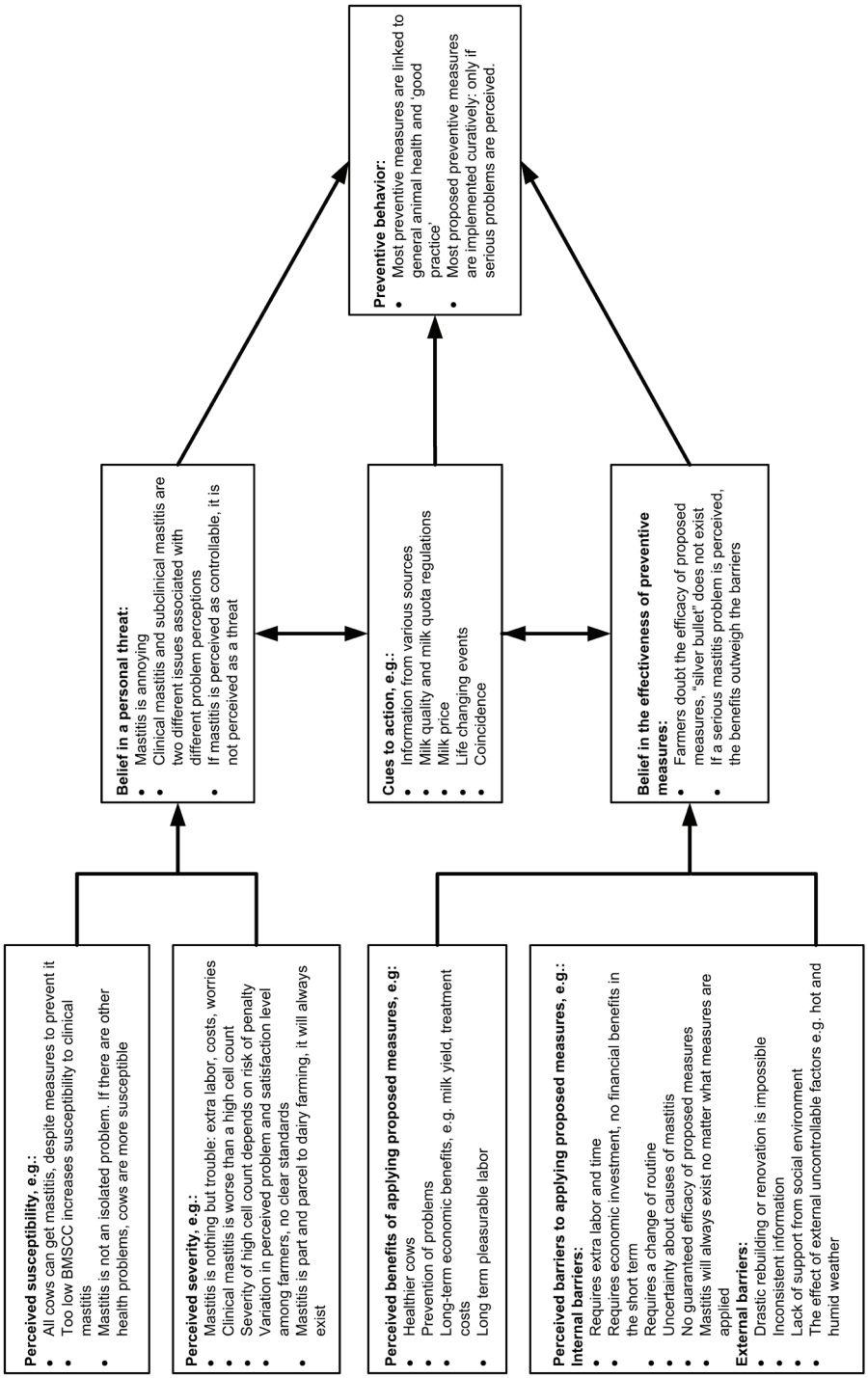

Figure 7.3 Dairy farmers' perceptions towards management measures to improve udder health, based on analyses of 32 in-depth interviews by applying constructs of the Health Belief Model (adapted from Janz and Becker, 1984).

change of dipping agent because the usual one is temporarily out of stock). It seems that farmers are motivated to work on udder health, especially to prevent clinical mastitis, but that they perceive a lack of effective and easily implementable solutions to improve udder health in general.

The results of the additional 32 interviews presented in Figure 3 suggest that farmers have ambivalent perceptions towards their intention to work on udder health and their actual behavior. It seems that some farmers are in a state of cognitive dissonance (Cameron, 2009; Festinger, 1957) and use several social-psychological coping strategies to reduce the dissonance between their perceptions and actual behavior (Carver et al., 1989). For example, the interviewed farmers proposed many internal barriers (e.g. lack of time or disruption of established routines) and external barriers (e.g. limitations of the current housing, lack of support) to defend why they are not doing what they ought to do. These proposed barriers match with barriers to the implementation of zoonotic control programs (Ellis-Iversen et al., 2010). Interestingly, when a farmer perceives serious udder health problems general measures to improve udder health will be implemented and thus are used mostly curatively rather than preventively. This implies that when the problem is perceived as important enough, the benefits outweigh the barriers.

Although the interviewed farmers in this study voice a strong demand for simple, short-term, effective solutions, they know that mastitis is a multifactorial and complex disease and that a simple panacea does not exist (Bradley, 2002). This seems to reinforce farmers' beliefs that preventive measures are neither effective nor practical. This perception is one of the main reasons why recommended measures are not always adopted (Chase et al., 2006; Garforth et al., 2006; Rehman et al., 2007).

The effect of communication strategies as intervention instrument

The Dutch Udder Health Centre (Uiergezondheidscentrum Nederland: UGCN) was established to improve udder health in the Netherlands. Within this program, several communication strategies were used to change farmers' behavior. The results in Chapter 6 show that elements of farmer mindset did change during the course of the mastitis control program. In particular, it seems that important factors such as the perceived threat (e.g. when are problems perceived) and perceived efficacy of management measures (e.g. the perceived influence on mastitis causes) changed favorably. This is important because, as already stated, normative values and self efficacy are strongly associated with actual BMSCC (see also Chapter 2) and are expected to influence farms' udder health status in the long term. In addition, these factors have been shown to be a useful predictor of both behavioral intentions and behavior (Armitage and Conner, 1999, 2001; Fishbein and Yzer, 2003). It can be assumed that farmers feel that they are better able to deal with mastitis problems than in 2004 and therefore

are more motivated to work on udder health; this consequently may influence their future response to mastitis problems. In line with that, some important management practices that are associated with mastitis control have changed during the course of the control program, such as increased frequency of cleaning the cubicles, increased use of gloves during milking, increased use of a proper dry-off therapy, and increased use of udder health parameters in the selection of sires.

The results in Chapter 6 show that a decrease in BMSCC during the course of the program is associated with a change in aspects of both mindset and behavior of farmers, supporting the model proposed in Figure 7.1. It is likely that farmers who have changed their perceptions and behavior, but do not yet have a lower BMSCC, may improve udder health in the long term, as discussed in Chapter 6. It should, however, be taken into account that mastitis is a complex disease and cannot easily be solved in the short term by changing a single management factor; it requires a long-term change in general herd management (Barkema et al., 1999; Bradley, 2002; LeBlanc et al., 2006).

In relation to the efficacy of the various communication strategies, our findings suggest that, in order to reach as much farmers as possible, various strategies need to be deployed. In Chapter 3, two strategies are evaluated that are potentially effective in reaching dairy farmers and changing their behavior using the Elaboration Likelihood Model (Petty and Cacioppo, 1986; Petty and Wegener, 1999). The effect of the traditional central route, which uses comprehensive, rational, science-based educational tools in e.g. study group settings, is highly dependant on farmers' internal motivation to work on udder health (Petty and Cacioppo, 1986; Petty and Wegener, 1999). Our findings show that farmers' familiarity with the tools and their interest in using the tools are associated with aspects of farmer mindset, such as the perceived importance of improving udder health and the perceived economic benefits of udder health improvement. This suggests that for farmers who are less internally motivated such communication strategies are less effective and other ways to reach these farmers need to be explored. Peripheral communication strategies, like the milking glove campaign without using comprehensive science-based argumentation, were found to be useful (see Chapter 3). For this strategy to be successful, farmers' internal motivation is a less important prerequisite (Petty and Cacioppo, 1986; Petty and Wegener, 1999).

The results in Chapter 3 show that a relatively short peripheral campaign on a single management practice can be quite effective in changing farmers' behavior. The results show that not only the use of gloves changed, but also the opinion of farmers about the usefulness of wearing gloves, even though no arguments were employed in the campaign. In contrast to the central route, communication using peripheral change is generally considered to be temporary, susceptible to counter persuasion, and unable to predict future behavior (Petty and Wegener, 1999). Surprisingly, this was not the case

for the milking gloves campaign. Even though there was a stronger effect on attitudes right after the campaign, the use of milking gloves increased further after the end of the initial campaign. This shows that a substantial number of farmers continued to buy milking gloves themselves, even when extrinsic cues such as free samples were no longer present. These findings suggest internalization of the new behavior and consequently a profound and sustainable effect of this strategy.

Using peripheral communication strategies (Petty and Cacioppo, 1986; Petty and Wegener, 1999), multifaceted goals of decreasing a complex disease like mastitis may not be met in the short term (Sheeran, 2002). However, single management practices (e.g. wearing milking gloves during milking) and short-term behavior change can be communicated using a peripheral route, because they are more easily adopted than a combination of multiple actions to achieve a certain goal (Sheeran, 2002). Thus, a step-by-step approach to changing farm management using peripheral communication strategies could be effective. It should be taken into account that ongoing efforts of the udder health program, including the development of educational tools and the implementation of study groups, created a basic awareness among farmers, resulting in an increased efficacy of the peripheral campaigns. This suggests that a combination of both peripheral and central communication strategies is most beneficial.

The results in Chapter 3 show that not all farmers were reached by the udder health program. Chapter 4 presents the results of in-depth interviews with farmers that were considered by their veterinarian as hard-to-reach. The findings show that, although most of them do consider mastitis as a problem and perceive udder health as important, they vary in the way they use information sources and approach mastitis on their farms. Apparently, they do not perceive a lack of information on mastitis and they do not have more mastitis problems than other Dutch dairy farmers; this contrasts with veterinarians' perceptions about these farmers. For this group, trust in external information was found to be an important issue, as well as their orientation towards the outside world. As every farmer is part of a social network and receives information from different sources, it should be possible to reach them through these channels via e.g. local events, intensive coaching by trusted persons, or by publications in farming journals. However, whether or not they will apply the available information depends on their mindset and the way that their mindset is affected by these strategies.

The provided information has to be considered as relevant for farmers in order for them to process and apply it (Noar, 2006). If farmers have aspirations other than improving udder health, they may not be interested in reading the message in the first place. Studies of farmer mindset and the effect of communication strategies should take into account that changes in farm management entail a long-term process and are much influenced by contextual and institutional factors (Leeuwis, 2004) such as milk price, quota regulations, or other infectious disease outbreaks. During the five

years of the program, factors such as fluctuating milk prices and uncertainty about quota regulations probably influenced farmer mindset (Figure 7.1) and acted as cues for action (Figure 7.3). Milk quota utilization, for example, has been described in other countries as an important factor in farmers' decision making regarding treatment of mastitis (Vaarst et al., 2002). The results in Chapter 6 confirm that farmers waited longer to treat subclinical mastitis cows when they had problems filling their milk quota. Moreover, the results show that herds increased in size and that labor efficiency became more important during the course of the program. Other external factors such as the weather or other infectious diseases can also influence the udder health of herds, as shown by the effect of the bluetongue virus epidemic in the Netherlands in 2006 (Elbers et al., 2009). If, instead of mastitis issues, other issues are the focus of the campaign, farmers may be more motivated to adopt a certain management practice, because the information may relate better to their needs, goals, and demands (Klerkx et al., 2006). This could lead to better general farm management, affecting important factors such as infectious pressure and host resistance, and therefore may also have a positive effect on udder health. Thus, udder health does not necessarily need to be the point of departure for communication strategies to improve udder health.

Creating demand and supply for advice via intermediaries

If communication strategies are used to change udder health management, farmers' demand for udder health advice and the supply of advice from the UGCN or its intermediaries, e.g. veterinarians, need to be taken into account. A common way to address issues that are relevant for agricultural extension (e.g. mastitis reduction) is to include private advisors (e.g. the veterinarian) as intermediary between the organization (in this case the UGCN) and the target group (in this case dairy farmers) (Botha et al., 2008; Garforth et al., 2003; Nagel and Von der Heiden, 2004). This is important, because dealing with the complexities of cause and effect in farming systems, and learning to apply practices to a whole farming system, requires strong interaction between advisor and farmer (Ingram and Morris, 2007; Leeuwis, 2000). Regular advisor–farmer contacts are a potentially powerful way to achieve this because of a) the high frequency of service contacts between farmers and advisors, b) the familiarity with each others' context, personal characteristics, preferences, beliefs, aspirations, and competencies that builds up over the years, and c) the relationship of trust that develops (Leeuwis, 2004; Sligo and Massey, 2007). This interaction can be shaped in several ways, depending on the positions farmer and advisor take in the process of knowledge construction (Ingram, 2008).

Our findings show that the veterinarian indeed plays an important role in knowledge transfer to dairy farmers. In our studies, farmers perceive the veterinarian as an appreciated, important, and frequently contacted information source about mastitis

(see Chapter 2). In addition, study groups on udder health for farmers organized by their veterinarian have been successful in decreasing mastitis (Lam et al., 2007). Although veterinarians' regular advisory contacts play an important role in optimizing farm management, there are several constraints in integrally incorporating attention to mastitis prevention in such contacts (Botha et al., 2008; Ingram, 2008; Ingram and Morris, 2007; Mee, 2007). These constraints relate to the advisory competencies and to the room for addressing mastitis prevention in a commercial, demand-driven, farmer–advisor relationship (Botha et al., 2008; Ingram, 2008; Ingram and Morris, 2007; Mee, 2007).

In view of these constraints on an effective advisor–farmer relationship, a number of policy measures have been proposed to improve the interaction between the demand and supply side of the market for advisory services (Botha et al., 2008; Klerkx et al., 2006; Van Woerkum et al., 1999). The proposed measures include: 1) support for advisors in developing social skills and best practice exchange among advisors about how to convey mastitis prevention messages in an interactive facilitative way, 2) raising farmer awareness about the importance of mastitis prevention in order to stimulate demand for services that address this issue; 3) a financial incentive for farmers to create an economic demand for udder health advice, and 4) improving linkages between research and practice, and in general a more coordinated research and extension system in support of udder health advice (Botha et al., 2008; Ingram and Morris, 2007; Mee, 2007). These measures can be applied to the strategies used by the udder health program. Table 7.1 displays the different components of the measures adopted by the UGCN to promote the provision of udder health advice (see also Klerkx and Jansen, 2010).

With respect to the first measure to support advisors, the udder health program developed free-of-charge educational materials for veterinarians to use during study group meetings and when giving individual advice, and veterinarians had the opportunity to attend study group facilitation workshops. Despite the intention to empower veterinarians in individual advisory encounters, most of the educational materials were mainly used in contacts with motivated farmers (Chapter 3). Veterinarians seem to be less successful in reaching farmers that they presume to be non-motivated to work on udder health (Chapters 3, 4, and 5). The results in Chapter 5 show that veterinarians have difficulties in being proactive advisors and applying essential communication skills. Our findings suggest that veterinarians seem to be persistent in their curatively oriented, prescriptive, and reactive expert role that prevails in veterinarian–farmer contacts. Instead of being mere technical experts, veterinarians should take on the role of coach, sparring partner, and facilitator from a reflexive and adaptive position (Cannas da Silva et al., 2006; Leeuwis, 2004; Mee, 2007; Nettle and Paine, 2009; Noordhuizen, 2001). This indicates that opportunities exist to improve

Table 7.1 A selection of measures applied by UGCN to promote the provision of udder health advice (adapted from Klerkx and Jansen, 2010)

Factors to support demand and supply of advice	UGCN activities, e.g.:
Supporting advisors in providing udder health advice	- Lectures for veterinarians and other advisors - Providing supporting materials for successful organization of study groups - Free-of-charge distribution of educational materials to veterinary practices and other advisors - Regular contact with veterinarians and farmers on UGCN advisory panels
Raising farmer awareness of the importance of mastitis	- Study groups facilitated by veterinarians - UGCN as information source with database on udder health management and prevention of mastitis - Articles in farming magazines, newsletters, calendars, posters - Mass media campaigns on e.g. the use of milking gloves and the use of a standardized treatment plan - Udder health workshops, open farm days, symposia
Financial incentive to create demand	- Indirect incentive: decrease mastitis and therefore fewer costs and higher milk production - Indirect incentive: helping to comply with somatic cell count norms, thus preventing fines
Optimizing knowledge system linkages between extension and research	- (Coordinated) exchange between research projects, associated veterinary practices, and professional education for veterinarians and farmers - Central advisory service, including technical information and practical tools on website - Research results are used to optimize communication strategies

the professional education of veterinarians on communication skills (Mee, 2007; Noordhuizen, 2001; Noordhuizen et al., 2008). Provided that veterinarians take the opportunity to advise proactively, they can be important intermediaries. However, within disease control programs, other advisors, in addition to veterinarians, should be addressed in order to optimize the supply of udder health advice.

With respect to the second measure, to increase farmer awareness to stimulate demand for advice, the results of the baseline and end survey presented in Chapters 2 and 6 show that farmers' awareness about mastitis hardly changed during the course of the program; most farmers dislike mastitis and that perception remained stable over time. The longitudinal study also showed an increase in farmers' feeling of control; this suggests that awareness of the efficacy of preventive measures has improved. However, as failure to achieve this awareness is an important barrier to applying preventive measures, future efforts should continue to focus on the awareness of the effectiveness and feasibility of practical measures rather than addressing the importance of the problem.

The third measure to create demand for advice is to use financial incentives. In this mastitis control program, direct financial incentives could not be applied as a policy measure and therefore indirect incentives were used. The most important indirect and positive financial incentive for farmers was the decrease in mastitis incidence, as clinical mastitis costs on average €210 per case (Huijps et al., 2008). The baseline survey in 2004 showed that 95% of farmers perceived mastitis as a costly disease and that 69% of farmers worried about the economic cost of mastitis (see Chapter 2). However, when farmers were asked about the most annoying aspects of mastitis, the economic cost was mentioned in third place (20%), after the additional required labor to treat the animal (24%) and the uncertainty about a cow's recovery after treatment (31%) (Jansen et al., 2004). Consequently, the economic cost of mastitis was not the most important concern for farmers, although it is proposed as an important factor for the adoption of preventive measures. This is supported by findings of Valeeva et al. (2007), who showed that farmers do not perceive the economic cost as the main problem resulting from mastitis. In addition, a study by Van Asseldonk et al. (2010) showed that a majority of dairy farmers perceive economic losses due to elevated SCC as not very relevant to them. Moreover, that study showed that information on economic losses on regular basis does not increase the intention to work on udder health (Van Asseldonk et al., 2010). Therefore, it can be suggested that the decreased economic losses due to mastitis prevention as described in Table 7.1 do not play a major role as an economic incentive.

With regard to the other indirect negative financial incentive, the penalty level for BMSCC did seem to influence farmers' behavior because if the existing level would be decreased from 400,000 cells/ml to 350,000 cells/ml, 65% of the farmers would try to improve udder health, and 67% of respondents would then treat mastitis cows sooner. The perception on these penalties was found to be associated with herds' udder health status (see Chapter 2). This is supported by others research showing that penalties in relation to milk quality seem to have more impact on behavioral change than bonuses (Valeeva et al., 2007; Huijps et al., 2010). However, lowering the penalty threshold level in the Netherlands is difficult due to the lack of support within the dairy sector, and the perceived need for compatibility with European threshold levels.

The fourth measure includes the optimization of the connection between research and the extension activities of the UGCN. The UGCN's main activities are comprised of research and communication interventions in practice. The combination and coordination of research projects, ranging from molecular biology to clinical veterinary medicine, cattle breeding, and genetics, and to economics and communication science research, are unique in the context of disease control programs. The planning and execution of these studies, as well as the communication interventions is co-supervised by a farmers' panel and a veterinarians' panel to create a direct linkage between science

and practice. The findings of this thesis as well as those of other research projects have been implemented as much as possible in order to optimize the program. Several campaigns to influence farmers' behavior in relation to mastitis prevention measures (such as wearing milking gloves and herd treatment protocols) have been developed in cooperation with suppliers of e.g. pharmaceuticals, feed, and farm management systems, involving these as important stakeholders. Networks between stakeholders have been established by e.g. cooperation between veterinarians, milking machine specialists and fodder experts who could be consulted in the event of specific problems, or to give study group lectures. It was expected that the stimulation of network building amongst advisors closest to farmers would result in taking over some of the UGCN work by the veterinarians and other input suppliers. There have been, however, only a few autonomous initiatives by veterinarians and other stakeholders; this indicates that an organization like the UGCN is still necessary to initiate and to coordinate initiatives to improve udder health.

Our findings show that, although several measures were included in the udder health program, mastitis control is such a complex disease that it is difficult to optimize this intervention by only using communication strategies as policy instrument. These strategies need to be supported by a full mix of policy instruments including regulations, subsidies, and penalties to optimize the efficacy of changing farmer mindset and behavior (Snyder et al., 2004; Van Woerkum et al., 1999), provided that such policy measures are clear, integrated, and stable (Leeuwis, 2004; Valentine et al., 2007).

Implications for future research

The results of this thesis suggest that farmer mindset is important in explaining a herd's health status, and that this mindset comprises a variety of social psychological constructs of which the perceived threat (including perceived susceptibility and severity) and perceived effectiveness of preventive measures (including perceived benefits and barriers) seem to be most determinant. These constructs are frequently used to explain people's health behavior (Armitage and Conner, 2001; Noar et al., 2008; Painter et al., 2008), see e.g. the Theory of Planned Behavior (Ajzen, 1991; Ajzen and Madden, 1986; Fishbein and Yzer, 2003), and the Health Belief Model (Garcia and Mann, 2003; Janz and Becker, 1984; Sun et al., 2006). They need, however, to be applied more often in the agricultural domain (Burton, 2004; Burton and Wilson, 2006; Garforth, 2010).

Future epidemiological studies should take elements of farmer mindset into account when explaining differences between farms, because it can confound the relationship between actual risk factors and disease incidence (Barkema et al., 1999). In addition, it should be borne in mind that participation in surveys already may include a possible bias in favor of a positive farmer mindset, because generally it are motivated farmers who are willing to participate in this type of studies.

The results in Chapter 2 show that self-reported behavior is not a good explicator of mastitis incidence. Often-used alternatives to (self-reported) questionnaires about farmers' behavior are to observe and to quantifiably measure farmers' behavior. It is, however, very difficult to quantify farmers' behavior, let alone the fact that it is often influenced by the observer. Our findings suggest that measuring elements of farmer mindset may be a good addition or alternative to predict behavior when studying risk factors for diseases. However, as the studies conducted in Chapters 2 and 6 were longitudinal studies without a control group, causal relationships between mindset and udder health can only be suggested and are not proven. Therefore, research is needed to study the direct effect of a change in elements of farmer mindset on mastitis incidence. The effect of the mastitis control program above and beyond secular trends in society, such as e.g. fluctuating prices, uncertain quota regulations, and increasing consumer demands, needs to be further investigated. It would be worthwhile to follow up the surveys of 2004 and 2009 to see whether the changes in farmer mindset and behavior are sustained and whether they result in an improvement of udder health parameters.

This thesis shows that the veterinarian is an important intermediary in communication towards farmers who are motivated to work on mastitis prevention (Chapters 3, 4, and 5). An in-depth social network analysis of dairy farmers could contribute to the understanding of the role of veterinarians and could also identify the role of other farm advisors, e.g. the fodder advisor, in influencing farmer mindset and management. A comparative study between e.g. the veterinarian and other farm advisors could show differences in communication skills and the effect of improvement of these skills on farm management and the relationship with the farmer. Moreover, it would be worthwhile to study the mindset of veterinarians and other advisors and how they are persuaded and informed to work on udder health.

As the Dutch udder health program is currently the only one of its kind that focuses on dairy herd health improvement using a multi- and interdisciplinary approach, it may be worthwhile to study the decision-making processes within this program and to evaluate the role of all stakeholders involved. Lessons learned from this program could contribute to an optimization of future programs designed to improve herd health.

Implications for disease control programs

In the design of effective disease control programs, essential communication principles to change people's behavior as described in Table 7.2, need to be implemented (adapted from Henley and Raffin, 2010; Henley et al., 2007; Koelen and Van den Ban, 2004; Noar, 2006; Noar et al., 2007). First of all, it should be taken into account that a farmer is not a passive absorber of knowledge. Originally, agricultural extension had a strong supply-driven character employing a downstream transfer-of-technology

Table 7.2 Seven principles for designing an effective communication campaign to change behavior (adapted from Henley and Raffin, 2010; Henley et al., 2007; Koelen and Van den Ban, 2004; Noar, 2006; Noar, et al., 2007)

Principles of effective campaign design	
1	*The receiver is an active processor of information* A message will be received differently by different people; the individual mindset affects the way a person attends to, interprets, and accepts a message. Campaigns should include not only a downstream transfer-of-technology approach, but also an upstream approach, taking into account social determinants of people's mindset and behavior.
2	*Different target audiences may respond to different messages differently* Target audiences must be segmented into meaningful subgroups based on important characteristics such as demographic and mindset variables, before the development of targeted messages.
3	*Formative research, including message pre-testing and process evaluation is essential* Research (focus groups/interviews) is needed to understand the target audience. The target audience needs to pre-test the messages to ensure that they are both appropriate and effective. Continuous monitoring and evaluation of outcomes is necessary to study the efficacy of the chosen strategies.
4	*A theoretical framework increases likelihood of success* Campaigns using theoretical frameworks such as the Health Belief Model, the Theory of Planned Behavior, or the Elaboration Likelihood Model are more likely to be successful than those that do not. Theories suggest important determinants around which to develop messages and help ensure that the chosen strategy supports the processes of behavioral change.
5	*Comprehensive, coordinated interventions are most successful* Successful campaigns are comprehensive and coordinated together with other stakeholders, including a variety of strategies and policy measures to support the communication campaign.
6	*Multiple delivery channels and multiple sources increase likelihood of success* Communication campaigns involving a number of message delivery channels and more than one source appear to be more successful than those that do not.
7	*Campaigns must be sustained over time* Communication campaigns need time to achieve and maintain sustainable success. The end of the campaign needs to be flexible depending on monitoring and evaluation of outcomes and should not have a predetermined deadline.

(TOT) approach, in which farmers were seen as passive recipients of information that they should uniformly adopt and apply (Leeuwis, 2004). As this thesis shows, communication strategies need to take into account the complexity of farmer mindset and decision making in order to understand underlying motivations for behavior and to find opportunities for communication strategies. Future programs to motivate farmers to improve animal health should acknowledge that farmers are part of a wide social context. Programs should give attention to cues for action, such as life changing events (Osler, 2006), and should take perceived barriers into account. Arguments on the efficacy of measures, using economic arguments and arguments on practical feasibility, should be used consistently by all stakeholders to stress the profitability and benefits of preventive measures.

A second important principle is the segmentation of target audiences, which is needed to customize communication strategies to farmer mindset (Bergevoet et al., 2004; Chase et al., 2006; Hawkins et al., 2008; Noar, 2006; Noar et al., 2007). This thesis shows that different types of farmers, e.g. proactivists, do-it-yourselfers, wait-and-see-ers, and reclusive traditionalists have different ways of using information sources (Chapter 4). Thus, they should be approached differently and different strategies, for example the central and peripheral routes of the Elaboration Likelihood Model (Petty and Cacioppo, 1986; Petty and Wegener, 1999), should be used to reach farmers with different levels of internal motivation.

A third important principle of effective strategies is to include formative research as a fundamental theme within the program design. Both qualitative and quantitative research is needed not only to understand farmer mindset, but also to mutually develop effective messages together with the farmers and other stakeholders. As the UGCN program shows, cooperation between scientists from different disciplines can lead to new insights. It may lead to a shift away from the more traditional approach, using e.g. science-based arguments, to a more interactive approach in which various stakeholders including farmers and veterinarians cooperate. This can lead to a new normative frame of reference on udder health and to the development of preventive measures that are perceived effective in improving udder health. Moreover, research is needed to be able to monitor and evaluate the progress being made (Noar, 2006). These data are essential in developing new approaches if the current approach has limited effect.

Another important principle of effective campaigns is the use of theories such as models from social psychology. These theories provide insight into important behavioral determinants (Armitage and Conner, 2001; Garforth, 2010; Noar et al., 2008; Painter et al., 2008), see e.g. the Theory of Planned Behavior (Ajzen, 1991; Ajzen and Madden, 1986; Fishbein and Yzer, 2003), the Health Belief Model (Garcia and Mann, 2003; Janz and Becker, 1984; Sun et al., 2006), and the Elaboration Likelihood Model (Petty and Cacioppo, 1986; Petty and Wegener, 1999). The findings of this thesis show that such theories can have added value in understanding farmer mindset and can therefore contribute to the development of effective communication strategies.

The fifth and sixth principles of effective campaigns are the development of comprehensive interventions, including multiple stakeholders and multiple channels. Currently, most animal health programs still focus on influencing farmers' behavior according to the traditional TOT approach. This approach, however, has become increasingly criticized because it ignores the highly interactive and locally specific nature of knowledge construction. Nowadays, it is recognized that, to achieve more sustainable agricultural practice, advisors and farmers, as well as other stakeholders, need to engage in a process of joint experiential learning to which all parties equally contribute knowledge (Bouma, 2010; Eshuis and Stuiver, 2005; Leeuwis, 2004). The

findings of this thesis show that, when a complex disease such as mastitis is being addressed, an approach integrating different disciplines as well as provisions and policy instruments is needed. This also has consequences for the way a disease control program is designed. By addressing different stakeholders as equal partners instead of informative consultants, communication strategies can be designed that are more effective in changing farmers' behavior than traditional TOT strategies that reach only the internally motivated farmers. This implicates that veterinarians do not necessarily need to be the only intermediary in disease control programs. Efforts should be made to build networks among stakeholders to tailor and to customize communication strategies to farmer mindset (Bergevoet et al., 2004; Chase et al., 2006; Hawkins et al., 2008; Noar, 2006; Noar et al., 2007).

A last principle for designing effective campaigns is the need for sustainment over time. Sustainable behavioral change needs a long-term approach and therefore complex interventions with a high societal relevance should not aim to finish within a certain limited time frame. Consistent rehearsal of the same message and follow-up on previous activities is needed over longer periods, sometimes even generations, including continuous monitoring and evaluation of the progress being made (Noar, 2006). A sudden end of disease control programs would suggest that the disease is not considered as an important issue anymore, and this could result in a lack of trust among stakeholders about cooperating with new initiatives in the future, because of uncertainty about the longevity of these initiatives and supporting policies (Leeuwis, 2004; Valentine et al., 2007). This implicates that disease control programs need to be institutionalized to be most effective in improving animal health in the long term.

Concluding remarks

This thesis provides insight into Dutch dairy farmers' behavior and mindset towards udder health management, and into the way these can be affected by communication strategies. Elements of farmer mindset are important determining factors in mastitis control, including the perceived threat (i.e. "Do I have a problem?") and the perceived efficacy of preventive measures (i.e. "Can I solve the problem easily?"). These issues need to be addressed in communication strategies. Veterinarians can be important intermediaries in communication about udder health improvement, provided that they are aware of their role as pro-active advisor and apply the accompanying communication skills.

To be effective, a disease program should do more than distributing technical information about best management practices to dairy farmers. Prevention of complex diseases, such as mastitis, requires customized communication strategies as well as an integrated approach between various stakeholders and different scientific disciplines. Such programs need to be supported by a combination of several policy measures

to change farm management on the long term, because farmers are part of, and are influenced by, a wide institutional context. The findings of this thesis can contribute to the optimization of future programs designed to control and prevent livestock diseases.

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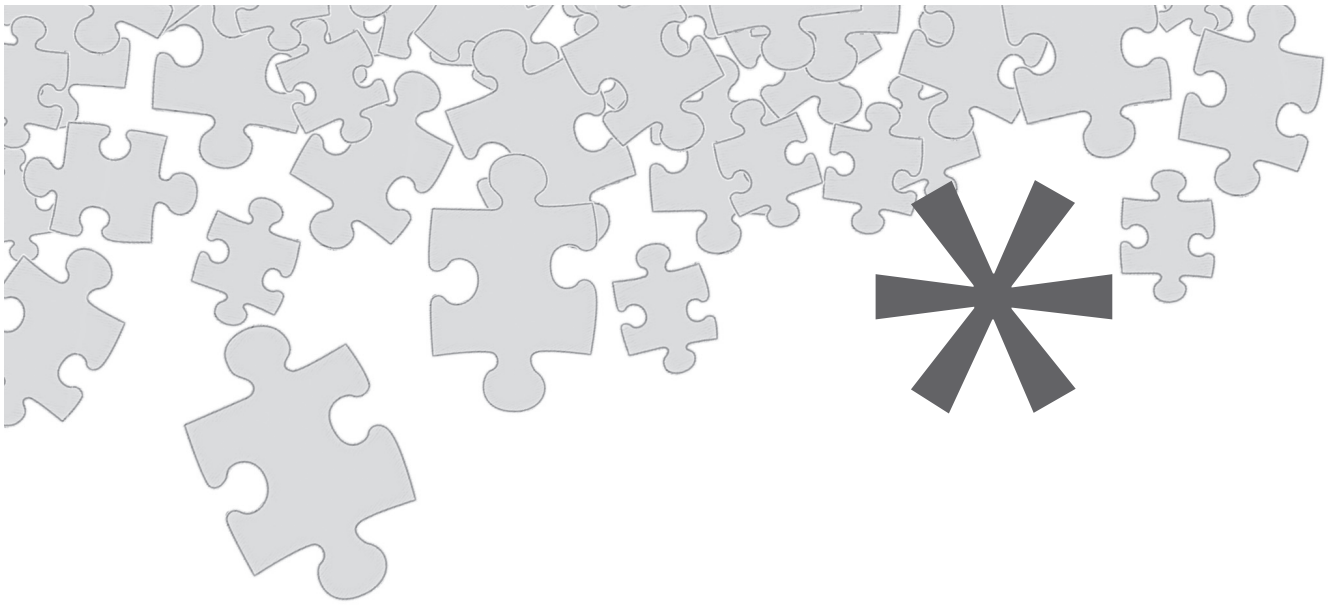


Summary

Mastitis (udder inflammation) is considered one of the main health issues in the dairy industry. It is a costly disease that also has an impact on animal welfare, on milk quality, and on farmers' pleasure in their work. Furthermore, antimicrobial treatments as a result of mastitis, are the biggest contribution for antibiotic use in the dairy industry. Antibiotic use should be limited as much as possible due to the risk of both, antibiotic contamination of milk and the development of bacterial resistance. Consequently, mastitis prevention is relevant for animal welfare, for society, the dairy industry, and farmers.

Why some farmers, even though it would benefit their results, do not implement effective mastitis management practices is not always known. It is assumed that 'farmer mindset', including farmers' attitudes, beliefs, values, knowledge, perceived norms, and perceived self efficacy, influences farmers' behavior and therefore their herds' udder health status.

Worldwide, several projects have started to influence farmers' behavior to improve udder health. In 2005, the Dutch Udder Health Centre (UGCN) was established to execute a national program to improve udder health in five years, aiming at better implementation of the current knowledge on mastitis prevention by deploying various communication strategies to reach farmers and to change their mindset. This thesis aims to understand Dutch dairy farmers' behavior and mindset regarding udder health management and to study the efficacy of various communication strategies.

In the studies presented in this thesis, a variety of qualitative and quantitative methods was used, combining social and veterinary sciences to analyze data on farmer mindset towards mastitis and on the efficacy of various communication strategies. In this interdisciplinary and practice-based approach, studies were initiated on the basis of observations and experiences during the execution of the national udder health program and on the basis of emerging questions that followed from the previous studies. Results and recommendations derived from the studies were as much as possible implemented to further improve the udder health program, which led to a strong interaction between science and practice.

Chapter 2 shows the results of the baseline survey in 2004 (N=378) that aimed to determine, to quantify, and to specify the extent to which farmer mindset, over and above farmers' behavior, explains the variation in mastitis incidence. The results indicate that elements of farmer mindset explain a significantly larger part of the variation in mastitis incidence than farmers' self-reported management measures. In this study, questions on farmer mindset explain 17% of the variance in clinical mastitis incidence and 47% of the variance in bulk milk somatic cell count (BMSCC), while questions on farmers' management measures explain 12% and 14%, respectively, of the variance of these parameters. In particular, the perceived feeling of control, the perceived effect of the BMSCC penalty level and the perceived problem and satisfaction

levels are important in explaining the variation in mastitis incidence. Furthermore, the results show that BMSCC levels are better explained by mindset variables and self-reported behavior than clinical and subclinical mastitis incidence are. The results show that clinical mastitis incidence is associated with other mindset and behavior variables than BMSCC. The large variation in mindset and behavior of farmers provided leading information in the development of communication strategies to improve udder health via the UGCN program.

In **Chapter 3** two different communication strategies implemented by UGCN were evaluated: 1) reaching farmers via a traditional route, using various educational tools, such as instruction cards and checklists with explicit technical knowledge, that were mainly used in study groups on udder health, and 2) a campaign to increase the use of gloves during milking, using various implicit persuasion principles and marketing techniques. The results of various telephone surveys (N=287, N=300, N=327) and a questionnaire (N=374) show that, to be effective, traditional communication strategies using comprehensive education materials can be successful, but require internal motivation to work on udder health. These strategies therefore only reach a part of the farmer population. Results of the evaluation of the other strategy, the milking gloves campaign, shows that the use of gloves increased from 16% in 2004 to 42% in 2009 without using science based knowledge. In addition, farmers' opinions about wearing gloves changed favorably. The results in Chapter 3 show that communication strategies to change farmers' management practices can be improved when both the aim of the strategy and farmers' motivational differences to work on the topic are taken into account. When aiming at complex, multifactor issues such as improving udder health, the traditional route using educational tools seems to be effective in reaching the motivated farmers. In addition to this strategy, persuasive campaigns can be used to influence farmers' behavior by including implicit persuasion techniques instead of comprehensive technical argumentation. This route is especially effective on single management practices and when aiming at a simple straightforward message such as the wearing of gloves during milking. For this route, internal motivation is no prerequisite. In general, the results indicate that to reach as many farmers as possible, both communication strategies should be used.

Chapter 4 presents the results of in-depth interviews with 24 farmers who were presumed to be hard to reach on udder health information according to their veterinarians. The aim of this study was to provide insight into the mindset and information-seeking behavior of this group of farmers. The results show that so-called hard-to-reach farmers did not perceive a lack of information on udder health, nor did they have a deviant udder health status. These ostensible unreachable farmers are not a homogeneous group and can be divided into four categories based on their trust in external information sources regarding mastitis, and their orientation towards the outside world: proactivists, do-it-

yourselfers, wait-and-see-ers, and reclusive traditionalists. The results suggest a large variation in the group of farmers that is considered as hard-to-reach. This may also be influenced by the differences in veterinarians' perceptions on hard-to-reach farmers. Thus, it may be so that the four groups of farmers described, exist among all Dutch dairy farmers, and not necessarily only among the hard-to-reach farmers. There seems to be ample opportunities to get in touch with hard-to-reach farmers provided that communication strategies are tailored to their specific needs. There is especially much to gain in communication with do-it-yourselfers and wait-and-see-ers, but this demands a proactive role on the part of veterinarians and extension specialists. Different types of farmers need to be approached differently in mastitis control programs, not necessarily with udder health as the point of departure, and not necessarily via their veterinarian. The results of this study show that the role of veterinarians as udder health advisors is very important and needs to be further studied.

Chapter 5 presents results of a survey (N=91) and in-depth interviews (N=10) with dairy cattle practitioners. The aim of this study was to identify their perceptions on their role as udder health advisors, and to explore their communication skills by observing 17 veterinarian–farmer conversations during herd health advisory visits. Veterinarians potentially are important for communication on udder health with farmers, because they are farmers' most important information source regarding mastitis, and because they perceive udder health advice as part of their professional remit. Nevertheless, veterinarians have difficulty in pro-actively approaching farmers that they presume to be non-motivated (see also Chapter 4). They seem to prefer a curative and demand driven approach. Consequently, veterinarians appear to be ambivalent about mastitis prevention. Tension exists between their willingness to be proactive and their actual behavior. They cope with this ambivalence and tension by citing a variety of arguments, e.g. perceived lack of confidence and competence in their advisory capability or their perceived self-identity as a curative veterinarian. Their communication skills, which belong to important advisory competences, were explored by analyzing herd health advice visits. The results show that most conversations lacked a proper structure. None of the 17 conversations included active listening. In addition, the balance in the conversation between veterinarian and farmer, e.g. their contribution to the amount of spoken text and the number of questions asked, varied considerably. Open questions were hardly asked, and less than 1% of all spoken sentences were devoted to eliciting farmers' opinions and values. These results suggest that veterinarians' elementary communication skills, like asking open-ended questions about farmer mindset and summarizing and follow-up of advice, could be improved. More attention on the communication skills of veterinarians is needed to optimize their role as advisors in the dairy industry.

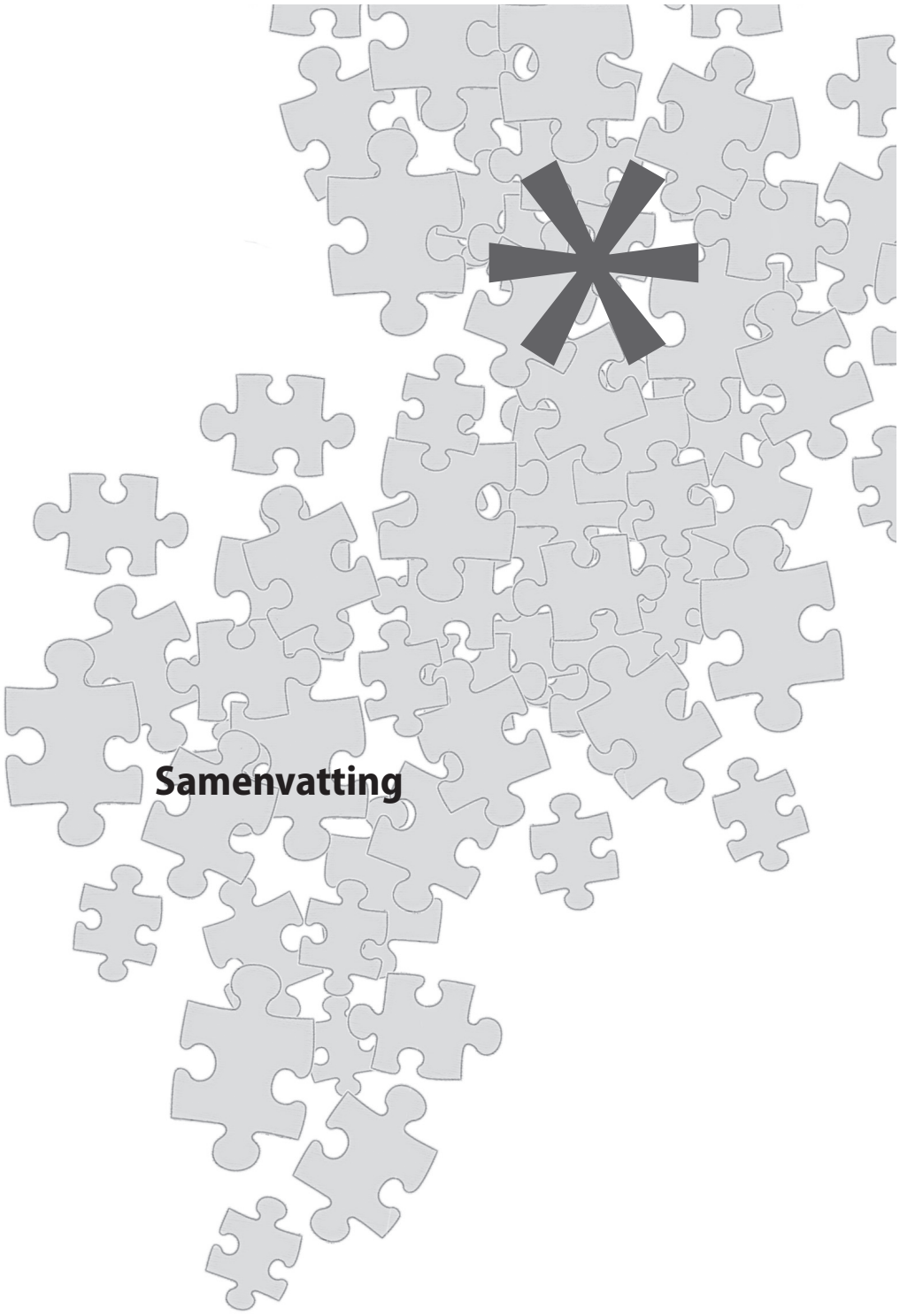
Chapter 6 presents the results of the longitudinal study in 2009 (N=207) to monitor changes in elements of farmer mindset and behavior since the baseline survey in 2004,

with the aim of evaluating the overall effects of the national udder health program. Although the average annual BMSCC did not change substantially, farmers' mindset and behavior did change significantly. Farmers' problem level of BMSCC decreased, more farmers perceived that they had sufficient knowledge about the prevention of mastitis, and they more often perceived that they knew the cause of a mastitis problem. Application of mastitis control measures, such as the use of milking gloves and the use of a standardized mastitis treatment protocol increased significantly during the program. Taking the initial average BMSCC level in 2004 into account, most changes in mindset and behavior were found in all groups of dairy farmers, regardless of an initially low, medium, or high BMSCC. The high BMSCC group significantly decreased their annual BMSCC level by 15,000 cells/ml. Regression analysis showed that a decrease in BMSCC levels was associated with a change in farmers' mindset (e.g. increased perceived knowledge about the effect of the milking machine on mastitis) and with a change in the application of certain management practices (e.g. disinfecting all teats after milking).

Finally, in **Chapter 7** the main findings of the different studies within this thesis are discussed and general implications for future research and for future animal disease control programs are described. The results of this thesis show that farmer mindset is a decisive factor in mastitis prevention. In particular, the perceived level of mastitis problems (i.e. "Do I have a problem?") as well as the perceived efficacy of preventive measures (i.e. "Can I solve the problem easily?"), are important determinants that need to be addressed in communication strategies. Veterinarians can be important intermediaries in communication about udder health improvement, provided that they are aware of their role as pro-active advisor and apply the accompanying communication skills.

To be effective, a disease program should do more than distributing technical information about best management practices. Prevention of complex diseases, such as mastitis, requires customized communication strategies as well as an integrated approach between various stakeholders and different scientific disciplines. Such programs need to be prolonged and supported by a combination of several policy measures to consistently change farm management in the long run, because for example milk price, milk quota and financial incentives on milk quality norms, like bonuses and penalties, have a strong influence on farmer mindset. It should therefore be taken into account that farmers are part of, and are influenced by, a wide societal and institutional context.

This thesis provides insight into Dutch dairy farmers' behavior and mindset towards udder health management, and into the way these can be affected by communication strategies. The findings of this thesis can contribute to the optimization of future programs designed to control and prevent livestock diseases.



Samenvatting

Mastitis (uierontsteking) wordt beschouwd als één van de meest voorkomende gezondheidsproblemen in de melkveehouderij. Het is niet alleen een kostbare ziekte, maar het heeft ook invloed op het dierenwelzijn, op de melkkwaliteit en op het werkplezier van de veehouder. Het behandelen van mastitis met antibiotica veroorzaakt het grootste deel van het antibioticagebruik in de melkveehouderij. Het gebruik van antibiotica dient zo veel mogelijk beperkt te worden vanwege het risico op antibioticaresiduen in de melk en vanwege de mogelijke ontwikkeling van resistente bacteriën. Mastitispreventie is daarom relevant voor dierenwelzijn en voor de maatschappij, de zuivelindustrie en de melkveehouders.

Het is niet altijd duidelijk waarom veehouders effectieve maatregelen om mastitis te voorkomen niet toepassen op hun bedrijf, zelfs als het ten goede zou komen aan hun bedrijfsresultaat. Aangenomen wordt dat de 'mindset' van veehouders (gevormd door onder andere zijn meningen, percepties, overtuigingen, normen en waarden, kennis en ervaren controle) invloed heeft op zijn gedrag en daarmee op de uiergezondheid van het vee.

Wereldwijd zijn diverse projecten gestart om het gedrag van melkveehouders te beïnvloeden om zo de uiergezondheid te verbeteren. In 2005 is het Uiergezondheidscentrum Nederland (UGCN) opgericht om een nationaal meerjarenplan uiergezondheid uit te voeren, met als doel om de uiergezondheid van melkvee te verbeteren door een betere toepassing van de huidige kennis van mastitispreventie. Om dit te bereiken werden diverse communicatiestrategieën toegepast om boeren te bereiken en hun mindset te veranderen. Dit proefschrift heeft als doel om inzicht te krijgen in het gedrag en de mindset van Nederlandse melkveehouders met betrekking tot mastitis. Daarnaast wordt de effectiviteit van verschillende communicatiestrategieën bestudeerd.

In dit proefschrift zijn diverse kwalitatieve en kwantitatieve methoden gebruikt waarin sociale en veterinaire wetenschappen werden gecombineerd om gegevens te verzamelen en te analyseren. In deze interdisciplinaire en praktijkgerichte benadering werden onderzoeken geïnitieerd op basis van observaties en ervaringen tijdens de uitvoering van het meerjarenplan uiergezondheid en op basis van vragen die ontstonden tijdens het onderzoek. Resultaten en aanbevelingen werden zo mogelijk direct toegepast om het meerjarenplan uiergezondheid verder te verbeteren. Dit heeft geleid tot een sterke interactie tussen wetenschap en praktijk.

Hoofdstuk 2 gaat over de resultaten van de nulmeting in 2004 (N=378). Deze nulmeting was gericht op het bepalen, kwantificeren en specificeren van de mindset en het gedrag van veehouders met betrekking tot mastitis. Daarnaast was het doel om te bepalen in hoeverre de mindset van veehouders, bovenop de zelfgerapporteerde managementmaatregelen, de mastitisincidentie op een melkveebedrijf verklaart. De resultaten laten zien dat elementen van de mindset een significant groter deel van de variatie in mastitisincidentie verklaren dan het zelf gerapporteerde gedrag. In dit

onderzoek verklaren vragen over de mindset van veehouders 17% van de variatie in klinische mastitisincidentie, en 47% van de variatie in het tankcelgetal, terwijl de vragen over managementmaatregelen respectievelijk 12% en 14% van de variatie in deze waarden verklaren. In het bijzonder het gevoel van controle over de situatie, het effect van een verandering van de boetegrens van het tankcelgetal, en de normen die de veehouder hanteert als streefwaarde en als een probleemsituatie, zijn belangrijke elementen van de mindset die een groot deel van de verschillen in mastitisincidentie tussen melkveebedrijven verklaren. De resultaten van dit onderzoek laten tevens zien dat vragen over managementmaatregelen en de mindset van veehouders het tankcelgetalniveau beter voorspellen dan dat ze de incidentie van klinische en subklinische mastitis voorspellen. Uit de resultaten blijkt dat klinische mastitis en het tankcelgetalniveau beide met een aantal andere elementen van de mindset en het management samenhangen. De grote verscheidenheid in mindset en management van veehouders met betrekking tot mastitis leverde belangrijke aanknopingspunten voor de ontwikkeling van diverse communicatiestrategieën om uiergezondheid te verbeteren.

In **Hoofdstuk 3** worden twee verschillende communicatiestrategieën geëvalueerd: 1) het bereiken van veehouders via een traditionele route waarin educatieve materialen werden gebruikt gericht op technische kennis, zoals instructiekaarten en controlelijsten, die voornamelijk werden toegepast in studiegroepen over uiergezondheid, en 2) een campagne om het gebruik van handschoenen tijdens het melken te bevorderen, waarin gebruik wordt gemaakt van impliciete overtuigingsprincipes en marketingtechnieken. De resultaten van diverse telefonische enquêtes (N=287, N=300, N=327) en een vragenlijst (N=374) laten zien dat traditionele communicatiestrategieën waarin veelomvattende educatieve materialen worden gebruikt effectief kunnen zijn, mits veehouders intern gemotiveerd zijn om met uiergezondheid aan de slag te gaan. Zulke strategieën bereiken daardoor slechts een deel van de veehouders. Evaluatie van de effectiviteit van de andere strategie, de melkershandschoenencampagne, laat zien dat dergelijke campagnes wel degelijk effectief kunnen zijn: het gebruik van handschoenen tijdens het melken is toegenomen van 16% in 2004 tot 42% in 2009 zonder in de campagne expliciet gebruik te maken van technisch-wetenschappelijke kennis. Daarnaast laten de resultaten zien dat de mening van veehouders over melkershandschoenen positief is veranderd. De bevindingen in Hoofdstuk 3 impliceren dat communicatiestrategieën die gericht zijn op het veranderen van het bedrijfsmanagement van veehouders verbeterd kunnen worden door rekening te houden met zowel het doel van de strategie als de variatie in motivatie van veehouders om met het onderwerp aan de slag te gaan. Wanneer een strategie zich richt op complexe multifactoriële problemen zoals uiergezondheid, lijkt de traditionele route met educatieve materialen het meest geschikt in het bereiken van de gemotiveerde veehouders. Om echter ook minder gemotiveerde veehouders

te bereiken kunnen campagnes gebruikt worden waarin het gedrag van veehouders wordt beïnvloed via impliciete overtuigingstechnieken in plaats van via een uitgebreide technische benadering. Deze impliciete route is vooral effectief bij het stimuleren van de toepassing van een enkelvoudige managementmaatregel, zoals het melken met handschoenen en wanneer een ongecompliceerde eenvoudige boodschap wordt gebracht. Interne motivatie om met uiergezondheid aan de slag te gaan is hierbij nauwelijks van belang. In het algemeen laten de resultaten van dit onderzoek zien dat beide strategieën gelijktijdig moeten worden toegepast om zoveel mogelijk veehouders te bereiken.

In **Hoofdstuk 4** zijn de resultaten gepresenteerd van 24 diepte-interviews met veehouders die door hun eigen dierenarts als moeilijk bereikbaar worden ervaren. Het doel van dit onderzoek was inzicht te verkrijgen in de mindset en in de informatiebronnen van deze groep veehouders. De resultaten laten zien dat de geïnterviewde 'moeilijk bereikbare' veehouders zich niet slecht geïnformeerd voelden over uiergezondheid en dat de uiergezondheid van hun veestapel niet per definitie afweek van het Nederlands gemiddelde. Deze veronderstelde moeilijk bereikbare veehouders zijn klaarblijkelijk geen homogene groep en kunnen onderverdeeld worden in vier categorieën gebaseerd op hun vertrouwen in externe informatiebronnen en hun oriëntatie naar de buitenwereld: proactivisten, doe-het-zelvers, afwachters en de teruggetrokken traditionalisten. De resultaten laten veel variatie in deze groep veehouders zien. Dit kan ook deels veroorzaakt worden door de verschillende opvattingen over moeilijk bereikbare veehouders tussen dierenartsen. Het is dan ook waarschijnlijk dat deze vier groepen onder alle Nederlandse veehouders voorkomen, en niet alleen bij de veronderstelde 'moeilijk bereikbare' groep. Er lijken volop mogelijkheden te bestaan om in contact te komen met 'moeilijke bereikbare' veehouders, mits de gebruikte communicatiestrategieën gericht zijn op hun specifieke behoeften. Er is vooral veel te winnen in de communicatie naar de doe-het-zelvers en de afwachters, maar dit vergt een proactieve rol van de dierenarts en andere bedrijfsadviseurs. Verschillende typen veehouders moeten verschillend worden benaderd in uiergezondheidsprogramma's. Dit betekent ook dat om bepaalde managementmaatregelen te bevorderen uiergezondheid niet persé het enige uitgangspunt hoeft te zijn en dat de communicatie naar de veehouder niet persé alleen via de dierenarts hoeft te lopen. De uitkomsten van het onderzoek laten zien dat de rol en de vaardigheden van dierenartsen als uiergezondheidsadviseur erg belangrijk zijn en dat meer onderzoek op dit gebied nodig is.

In **Hoofdstuk 5** zijn de resultaten getoond van een enquête (N=91) en diepte-interviews (N=10) met rundveedierenartsen. Het doel van dit onderzoek was om inzicht te krijgen in de percepties van dierenartsen over hun rol als uiergezondheidsadviseur. Daarnaast zijn de 17 gesprekken van dierenartsen met veehouders tijdens de bedrijfsbegeleiding geobserveerd om hun communicatievaardigheden in kaart

te brengen. Dierenartsen zijn potentieel belangrijk in de communicatie over uiergezondheid, omdat ze de meest belangrijke informatiebron zijn voor veehouders als het over mastitis gaat en omdat dierenartsen uiergezondheidsadvies als hun professionele taak beschouwen. Dierenartsen hebben echter moeite met het proactief benaderen van veehouders waarvan zij veronderstellen dat die niet gemotiveerd zijn (zie ook Hoofdstuk 4). Dierenartsen lijken de voorkeur te hebben voor een curatieve en vraaggestuurde benadering. Het gevolg is dat dierenartsen een tegenstrijdigheid laten zien ten opzichte van mastitispreventie, omdat er een spanning is tussen de wil om een proactieve uiergezondheidsadviseur te zijn, en hun daadwerkelijke gedrag. Dierenartsen gaan met deze tegenstrijdigheid om door diverse argumenten aan te dragen, zoals de onzekerheid over de eigen competenties als adviseur en de beroepsidentiteit als dierenarts. Een van de belangrijkste competenties van een adviseur zijn de communicatievaardigheden. Gedurende observaties van adviesgesprekken tussen dierenartsen en veehouders tijdens bedrijfsbegeleidingsbezoeken zijn deze vaardigheden nader bekeken. De resultaten laten zien dat het in de meeste gesprekken ontbrak aan een goede gespreksstructuur. Verder wordt het actief luisteren, samenvatten en doorvragen in geen enkel gesprek toegepast. De resultaten laten tevens zien dat er tussen de gesprekken veel variatie is in de gespreksbalans, zoals in de totale hoeveelheid gesproken tekst en de hoeveelheid vragen die worden gesteld door veehouder en de dierenarts. Verder worden er nauwelijks open vragen gesteld en minder dan 1% van alle gesproken tekst van de dierenarts gingen over het achterhalen van de mening en ideeën van de veehouder. De resultaten impliceren dat bepaalde elementaire communicatievaardigheden van dierenartsen verbeterd kunnen worden, zoals het stellen van open vragen over de mindset van de veehouder en het samenvatten en opvolgen van advies. De communicatievaardigheden van de dierenarts zouden meer aandacht moeten krijgen om hun rol als adviseur in de melkveehouderij te optimaliseren.

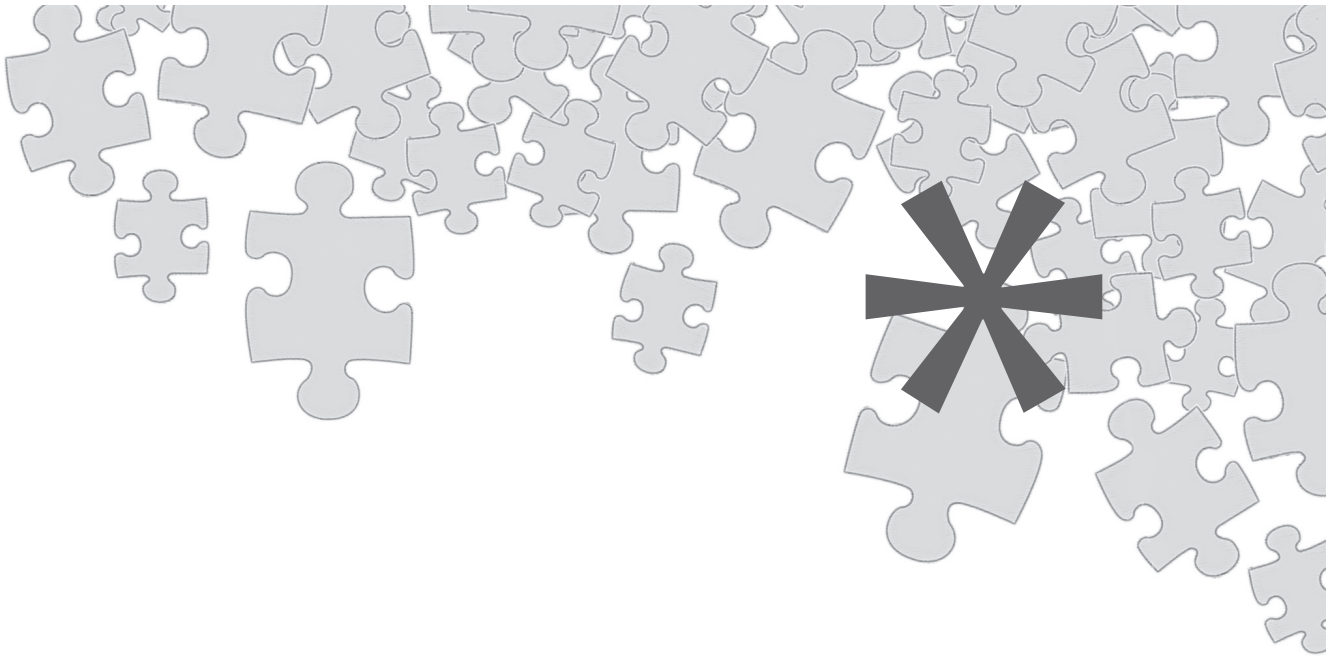
Hoofdstuk 6 gaat over de resultaten van de eindmeting in 2009 (N=207). Deze eindmeting had als doel om de veranderingen in elementen van de mindset te volgen van veehouders die mee hebben gedaan aan de nulmeting in 2004, om uiteindelijk het effect van het meerjarenplan uiergezondheid te kunnen evalueren. Hoewel het gemiddelde tankcelgetal niet noemenswaardig is veranderd, zien we wel significante veranderingen in de mindset en het management van veehouders. Het tankcelgetalniveau wanneer veehouders een probleem ervaren is gedaald, meer veehouders hebben het gevoel dat ze voldoende kennis hebben om mastitisproblemen te voorkomen en veehouders ervaren vaker dat ze de oorzaken van mastitisproblemen goed in beeld hebben. Bepaalde maatregelen ter preventie van mastitis, zoals het dragen van melkershandschoenen en het gebruik van een bedrijfsspecifiek behandelplan, zijn tijdens het programma significant toegenomen. De meeste veranderingen in de mindset en het gedrag van

veehouders verschilden niet tussen veehouders met een oorspronkelijk laag, gemiddeld of hoog tankcelgetal in 2004. De hoge tankcelgetalgroep wist echter het jaarlijkse gemiddelde tankcelgetal significant te verminderen met gemiddeld 15,000 cellen/ml. Regressieanalyses laten zien dat deze vermindering van tankcelgetal samenhangt met een verandering in de mindset van veehouders (bijvoorbeeld de, door de veehouder ervaren, toename in kennis over het effect van de melkmachine op mastitis) en met een verandering in de toepassing van bepaalde managementmaatregelen (bijvoorbeeld het desinfecteren van alle spenen na het melken).

Tenslotte worden in **Hoofdstuk 7** de belangrijkste bevindingen van dit proefschrift bediscussieerd en worden aanbevelingen gedaan voor zowel toekomstig onderzoek als voor toekomstige diergezondheidsprogramma's. De resultaten in dit proefschrift laten zien dat de mindset van melkveehouders een bepalende factor is in mastitispreventie. In het bijzonder de mate van mastitisproblemen die wordt ervaren ("Heb ik een probleem") en de mate waarin preventieve maatregelen als effectief worden beschouwd ("Kan ik het probleem eenvoudig oplossen?") zijn belangrijk. Communicatiestrategieën zullen op deze elementen moeten inspelen. Dierenartsen kunnen een belangrijke rol spelen in de communicatie over uiergezondheid, mits zij zich bewust zijn van hun rol als proactieve adviseur en de bijbehorende communicatievaardigheden effectief toepassen.

Om daadwerkelijk doeltreffend te zijn zouden diergezondheidsprogramma's uit meer strategieën moeten bestaan dan alleen het onder melkveehouders verspreiden van technische informatie over de beste managementmaatregelen. Preventie van complexe ziekten zoals mastitis vergen op maat gemaakte communicatiestrategieën en een geïntegreerde benadering van de diverse belanghebbenden en wetenschappelijke disciplines. Dergelijke programma's moeten langdurig zijn en ondersteund worden door een combinatie van beleidsmaatregelen, om het bedrijfsmanagement op langere termijn en blijvend te veranderen. Daarbij zijn zaken als melkprijs, melkquota en financiële prikkels die gekoppeld zijn aan de gehanteerde normen voor melkkwaliteit, zoals bonussen en boetes, sterk van invloed op de mindset van veehouders. Veehouders zijn nu eenmaal deel van, en worden beïnvloed door, een brede sociaal-maatschappelijke en institutionele context.

Dit proefschrift geeft inzicht in de mindset en het gedrag van veehouders ten opzichte van uiergezondheidsmanagement en in de manier waarop dit beïnvloed kan worden via diverse communicatiestrategieën. De bevindingen van dit proefschrift kunnen bijdragen aan een optimalisatie van toekomstige programma's gericht op het beheersen en voorkomen van dierziekten in de veehouderij.



Dankwoord

Time flies when you are having fun! Vier jaar in een oogwenk voorbij. Als je net begint is het lastig je voor te stellen dat er ooit een proefschrift ligt, maar ineens is het dan zover… het is af! Promoveren doe je niet alleen, zeker niet in een gevarieerd project als dit, waaraan zoveel mensen hebben bijgedragen. Ik wil iedereen heel hartelijk bedanken voor alle support de afgelopen tijd, maar wil een aantal mensen toch in het bijzonder noemen.

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Jolanda

About the author

CURRICULUM VITAE

Jolanda Jansen was born on 9 February, 1983, in Hellevoetsluis, the Netherlands. After completing pre-university education in 2000, Jolanda started to study Animal Sciences at Wageningen University. During this study, she combined courses on animal production systems with courses on communication science. Her first thesis, commissioned by Lely Industries, under supervision of the Communication Science Group, was about reasons for dairy farmers not choosing an automatic milking system. This qualitative study to understand farmers' presumably irrational decision making triggered her interest in this interdisciplinary research. The variety in her disciplinary interests can be recognized in her other research projects, such as a study on the socio-economic impact of Avian Influenza on Vietnamese farmers, for which she spent five months in Vietnam interviewing local farmers, and a study on the environmental impact of Ben and Jerry's ice cream production system for which she built life cycle assessment models for Unilever.

During her internship at GD Animal Health Service, Jolanda was given the opportunity to study Dutch dairy farmers' attitudes, knowledge, and behavior regarding mastitis in close cooperation with the Communication Science Group of Wageningen University. The results of this study eventually led to the development of the five-year program on mastitis control and subsequently to the establishment of the Dutch Udder Health Centre, UGCN. During the last two years of her study, Jolanda was involved in the UGCN program and became a UGCN-funded PhD student at Wageningen University after receiving her Master of Science degree in 2006.

During her PhD study on communication strategies to improve udder health Jolanda worked in close cooperation with the UGCN. This interdisciplinary teamwork resulted in successful campaigns to improve udder health. Moreover, research results were presented at various conferences, leading to intensive discussions, international cooperation, and the establishment of an informal network of scientists interested in social factors relating to disease control.

Furthermore, Jolanda lectured on various occasions to e.g. students, veterinarians, and agricultural advisors, and was a member of the organizing committee of the International Conference on Mastitis Control 2008. Jolanda also participated in the PhD council and was a board member of Mansholt Graduate School of Social Sciences. In this position, she co-organized two successful PhD science days and PhD introduction courses, and initiated the first Wageningen PhD party to bring PhD students together.

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Jansen J. 2010. Communication with- and motivation of the dairy farmer to improve udder health. Presentation for the Udder Health Panel of Boehringer Ingelheim, 26 May 2010.

Jansen, J, 2010. Communicatiestrategieën, theorie en praktijk. Presentation for the LEI Research Institute of Wageningen University, 19 February 2010, Amersfoort, the Netherlands.

Jansen, J., Steuten, C.D.M., Renes, R.J., Lam, T.J.G.M. 2009. Communiceren met verschillende typen veehouders. Presentation Dutch Udder Health Centre UGCN, launch campaign "Mastitis in het vizier", 5 March 2009, Doorn, the Netherlands.

Jansen, J, 2008. Communicatie in de agrarische bedrijfsadvisering. Presentation Wageningen Business School, 31 October 2008, Wageningen, the Netherlands.

Jansen J., Renes, R.J., 2008. Communication in practice: The role of veterinarians in mastitis control programs. Presentation PhD day 2008 Mansholt Graduate School of Social Sciences. 28 May 2008, Wageningen, the Netherlands.

Jansen, J. Doing a PhD: a pleasure or a burden?! Presentations in 2007, 2008 and 2009, KLV Professional Match, Wageningen, the Netherlands.

EDUCATION CERTIFICATE

Completed Training and Supervision Plan

Description	Institute/department	Year	ECTS*
Courses:			
PhD career assessment	WGS	2009	0.3
Workshop challenges for truly interpersonal research	KLI	2008	0.6
Workshops social interaction and social psychology	KLI	2007	0.9
16th ETC-PHHP Summer course on health promotion	ETC-PHHP	2007	8
200,000 and beyond: what somatic cells really tell us	NMC	2007	1
MG3S Introduction course	MG3S	2007	1.5
Project- and Time management	WGS	2007	1.5
Scientific writing	WGS	2006	2
Information literacy	WGS	2006	0.6
PhD competence assessment	WGS	2006	0.3
Mastitis PhD course	UGCN	2006	1
Statistics in a nutshell	IOPS	2006	2
Quantitative research methods	MG3S	2006	4
Qualitative research methods	MG3S	2006	3
Presentations at conferences and workshops:			
Symposium Intervet/UGCN at All Holland Dairy Show NRM	Utrecht, NL	2010	1
Meeting of the Udder Health Panel of Boehringer Ingelheim	Leuvenum, NL	2010	1
5th IDF International Mastitis Conference	Christchurch, NZ	2010	1
Workshop LEI on communication as policy instrument	Amersfoort, NL	2010	1
12th ISVEE	Durban, ZA	2009	1
UGCN Workshop communication skills for veterinarians	Doorn, NL	2009	1
3rd Annual Meeting DMRW	Wageningen, NL	2009	1
International conference on Mastitis control 2008	The Hague, NL	2008	1
MG3S PhD day 2008	Wageningen, NL	2008	1
Wageningen Business School course on Agricultural Consultancy	Wageningen, NL	2008	1

Description	Institute/department	Year	ECTS*
Annual meeting 2008 SVEPM	Liverpool, UK	2008	1
47th Annual Meeting NMC	New Orleans, USA	2008	1
1st Annual Meeting DMRW	Utrecht, NL	2007	1
Heifer Mastitis Conference 2007	Ghent, BE	2007	1
4th IDF International Mastitis Conference	Maastricht, NL	2005	1
Other activities:			
Member PhD study group Mastitis and DMRW at UGCN, WUR, Utrecht University		2006-2010	4
Member PhD council and Board MG3S		2006-2008	4
Teaching and supervising activities		2006-2008	3.5
Writing research proposal MG3S		2006	4
Total (minimum 30)			**57.2**

*One ECTS on average is equivalent to 28 hours of course work
WGS = Wageningen Graduate Schools, KLI = Kurt Lewin Institute, Graduate School in Social Psychology and its Applications, MG3S = Mansholt Graduate School of Social Sciences, ETC-PHHP = European Training Consortium in Public Health and Health Promotion, NMC = National Mastitis Council, UGCN = Dutch Udder Health Centre, IOPS = Interuniversity graduate school Of Psychometrics and Sociometrics, IDF = International Dairy Federation, ISVEE = International Symposium on Veterinary Epidemiology and Economics, DMRW = Dutch Mastitis Research Workers, SVEPM = Society for Veterinary Epidemiology and Preventive Medicine, WUR = Wageningen University and Research centre

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