Motivation of Dairy Farmers to Improve Mastitis Management

N. I. Valeeva,^{*1} T. J. G. M. Lam,[†] and H. Hogeveen^{‡§}

^{*}Section of Markets and Networks, Agricultural Economics Research Institute, Wageningen University and Research Center, 6706 KN Wageningen, the Netherlands

[†]Dutch Udder Health Center, and Animal Health Service, 7400 AA Deventer, the Netherlands

[‡]Business Economics Group, Wageningen University and Research Center, 6706 KN Wageningen, the Netherlands

[§]Department of Farm Animal Health, Utrecht University, 3508 TD Utrecht, the Netherlands

ABSTRACT

The aims of this study were 1) to explore different motivating factors and to quantify their importance in decisions of farmers on improving mastitis management, 2) to evaluate different quality payment schemes as extra incentive mechanisms for farmers, and 3) to link the motivating factors to farmer characteristics. Data on characteristics of farmers were obtained through a traditional paper-based questionnaire ($n = 100$). Data on the factors motivating farmers to improve mastitis management were collected in a computer-interactive mode. Adaptive conjoint analysis was used to investigate perceptions of farmers of the importance of factors. Factors that are internal to the farm performance and the individual farmer provided more motivation than external factors implying esteem and awareness of the whole dairy sector performance. Internal nonmonetary factors relating to internal esteem and taking pleasure in healthy animals on the farm were equally motivating as monetary factors affecting farm economic performance. The identified difference in perceptions of farmers of importance of extra financial incentive based on bulk milk somatic cell count (BMSCC) depending on whether farmers think in terms of quality premium or penalty for a lower and a higher BMSCC, respectively, suggested that farmers are expected to be more motivated by a price decrease for milk with a greater BMSCC than by a price increase for milk with a lower BMSCC. In this respect, quality penalties were found to be more effective in motivating farmers than quality premiums. Two-stage cluster analysis of individual perceptions resulted in 3 distinct clusters according to motivation of farmers: premium- or penalty-oriented motivation, motivation to have an efficient (well-organized) farm that easily complies with regulatory requirements, and basic economic motivation. The

obtained results highlight possible areas of improvement in incentive and educational programs aimed at improving mastitis management.

Key words: mastitis management, motivation, conjoint analysis, cluster analysis

INTRODUCTION

Currently, sufficient control practices are available for improving mastitis management on the farm and for decreasing bulk milk SCC (BMSCC; LeBlanc et al., 2006). Despite the influence of these practices on the reduction in mastitis and BMSCC (Hutton et al., 1990; Goodger et al., 1993; Barkema et al., 1998) as well as recommendations from research and extension for their implementation, the level of compliance still can be a barrier to improving mastitis management on the farm and to reducing BMSCC (Olde Riekerink et al., 2005). Many farmers think their knowledge of existing management practices for controlling mastitis on the farm is good (Kuiper et al., 2005). It may, however, be naïve to assume that all the practices will be automatically implemented, because this would involve an increase in production costs. Ultimately, a reduction in mastitis will result in economic benefits for farmers (Allore and Erb, 1998; Yalcin et al., 1999; Seegers et al., 2003). Furthermore, individual decisions of farmers on implementing recommended practices are also driven by other factors (e.g., self-esteem) that do not necessarily result in monetary returns (Cavazos, 2003; Kuiper et al., 2005). Until now, however, little knowledge has been available on the significance of such factors in keeping farmers motivated to improve mastitis management, whereas many studies exist dealing with monetary factors. In particular, several studies have evaluated the positive effect of existing and changing quality payment structures on reducing BMSCC by focusing either on quality premiums (Nightingale and Schukken, 2005; Rodrigues and Ruegg, 2005) or quality penalties (Schukken et al., 1992; Sérieyns and Blanche, 2005; van Schaik et al., 2005). These studies, however, were observational and carried out after a particular

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¹Corresponding author: natasha.valeeva@wur.nl

quality payment scheme had been introduced or changes in the prevailing ones had been made. There is a paucity of research that incorporates the behavioral side of the choice of the farmer of different schemes of quality payment, whereas the evidence of these aspects relating to human decision processes is described in economic literature (McFadden, 1999). The so-called frame effect, or effect of descriptions of choice options, is one of the choice behavioral concerns that were found in previous studies on decisions of individuals [see Rabin (1998) for a review of such studies]. One important aspect of this effect relates to loss aversion, which refers to the tendency for people to strongly prefer avoiding losses rather than acquiring gains. Due to this loss aversion, 2 logically equivalent choice options in terms of the outcomes (but not transparently equivalent in terms of description) lead individuals to make different choices. A frame that highlights the losses is usually less attractive (Rabin, 1998). In this view, it is critical to understand how farmers actually react to different payment schemes when the schemes are logically (i.e., in terms of financial consequences) but not transparently (i.e., quality premium or quality penalty) equivalent before payment schemes are introduced or changed.

Additionally, few studies have examined the correlates of different motivating factors for improving mastitis management. If different farmers are motivated by different factors, then a one-size-fits-all approach to stimulate the improvement of mastitis management is unlikely to perform as expected. Without more detailed explanations of the motivating factors, the ability to encourage adoption of mastitis control practices by farmers will be limited. The success of the efforts to motivate effective implementation of recommended practices depends critically on whether new initiatives generate consistent rather than opposing incentives for individual farmers.

The objectives of this study, therefore, were 1) to explore different motivating factors and to quantify their importance for farmers in their decisions regarding improving mastitis management, 2) to evaluate different quality payment schemes (quality premiums vs. quality penalties) as extra incentive mechanisms for farmers, and 3) to link the motivating factors to characteristics of individual farmers.

MATERIALS AND METHODS

Survey Design

Survey development was based on a review of the scientific literature and feedback from 2 quality assurance managers of the major Dutch dairy companies. The survey instrument, including all supporting mate-

rials, was pretested on 2 farmers from the pilot group of the Dutch Udder Health Center. A follow-up individual discussion with each farmer was held to ensure that farmers understood their task, easily became familiar with the applied techniques, and that their interpretation of the questions was consistent with the intent of the researchers. The farmers also reviewed the motivating factors for completeness to ensure that all factors had been addressed.

The survey consisted of a traditional paper questionnaire and a computerized questionnaire. The paper questionnaire covered information on farm size; milk quota; number of dairy cows; labor used on the farm; BMSCC level; farmer age, education, and experience; availability of a potential successor; and perceptions of farmers of mastitis risk. Specifically, level of concern of farmers about mastitis risk on their farm was considered in terms of occurrence of serious problems with mastitis during the previous 2 yr (1 = never, 5 = always) and capability of managing mastitis problems to decrease BMSCC (1 = certainly not able, 5 = certainly able). In these questions, no specification of mastitis problem was provided.

The computerized questionnaire had a clear focus on motivation of farmers to improve mastitis management to decrease BMSCC. The questionnaire dealt with motivation concepts differentiated by 8 factors: a) job satisfaction, b) overall situation on the farm, c) economic losses, d) animal health and welfare awareness, e) ease in meeting regulatory requirements, f) dairy product quality and image, g) extra financial incentive based on BMSCC, and h) recognition for a job well done. The first factor chosen, job satisfaction, reflects the experience gained from discussions with farmers. It concerns intangible feelings of farmer pleasure of doing the right thing (in this study, applying good mastitis management), which is experienced by farmers as a reward in itself. The factor overall situation on the farm implies the tangible aspects of improved mastitis management on the farm, for example, a more efficient milking process, fewer problems with other animal diseases, and fewer problems during calving. The factor economic losses reflects possible reduction of the economic losses from mastitis (e.g., losses associated with reduced milk production, culling of chronically infected cows, drug treatment). The factor animal health and welfare awareness implies that awareness of the farmer's own cows suffering from pain and discomfort due to mastitis influences the decision of the farmer to improve mastitis management. The choice of ease in meeting regulatory requirements reflects the intention of the farmer to comply with requirements for farm milk quality assurance by, among others, improved mastitis management. In the Netherlands, for example, improved farm

milk quality assurance schemes introduced by dairy companies in 2006 and General Food Law (European Commission, 2002) that must be gradually adopted by January 2007 include such requirements. The factor dairy product quality and image concerns the consideration of the farmer of improving mastitis management as a way of improving the overall quality and image of dairy products. The factors extra financial incentive based on BMSCC and recognition for a job well done reflect rewards that can be created to encourage farmers to improve mastitis management by introducing different price premium or penalty levels for a particular BMSCC, and providing recognition such as awards or articles published in a specialist magazine, respectively.

To examine the behavioral reaction of the farmer to different quality payment schemes as extra incentive mechanisms, computerized questionnaires were developed for the premium or penalty scenarios. The 2 questionnaires were identical, except for the questions dealing with the factor extra financial incentive based on BMSCC. This factor was framed in terms of a hypothetical but actually possible price premium or a price penalty in the premium or penalty scenarios, respectively, given that the total amount paid to farmers was the same, which ensured the logical equivalence of the scenarios. In reality, the milk payment system in the Netherlands is based, among others, on BMSCC. A penalty is imposed for elevated geometric mean BMSCC (> 400,000 cells/mL) of the 3 last months. No premium system is in place. There are no differences in payment systems among Dutch dairy companies.

Measuring Motivation of Farmers

The computerized questionnaire was designed in accordance with adaptive conjoint analysis (ACA), which is one of the available conjoint techniques. The conjoint approach assumes that preference elicited from one or more individuals can be represented by a subjective utility function, which is a monotonic function of interval scale utilities that are simple additive functions of subjective utility values, so-called part-worths, associated with different levels of the factors of which the preference consists (Lattin et al., 2003). Within the traditional conjoint approach, a set of hypothetical stimuli is constructed, in which each stimulus represents some predetermined combination of factors. Respondents are asked to make judgments about their overall preference by assigning a unique rank to each stimulus. By varying the choices that respondents have to make from stimuli in systematic ways, part-worth coefficients for an implied ranking function that best explains the observed rankings can be estimated. Subsequently, part-worths

can be used to determine the relative importance of factors influencing the preference for the stimuli. In this sense, conjoint techniques are often used in marketing and consumer studies to identify the relative importance of different attributes of which a particular product consists. Also, the use of such techniques has been demonstrated for determining the importance of risk factors concerning animal diseases (Horst et al., 1996), animal welfare attributes (Den Ouden et al., 1997), and food safety-improving attributes (Valeeva et al., 2005). For a more comprehensive overview of conjoint analysis, see Churchill (1999).

The motivation of dairy farmers for improving mastitis management to decrease BMSCC is also multifactorial in nature. As previously mentioned, this study considered farmer motivation as a set of 8 motivating factors each consisting of 2 or 3 levels. For instance, the motivating factor recognition for a job well done comprised 3 levels: a) extra recognition by the dairy processing industry by publishing an article in a specialist magazine, b) extra recognition by the dairy processing industry by providing a special certificate or award, and c) no extra recognition. By following the conjoint approach, a motivation concept was modeled as a function of the part-worths of the levels of motivating factors.

Selection criteria for the model to estimate part-worths differ by application. This study applies ACA, which combines both self-explicated (i.e., respondents rate the importance of the difference between the best and worst level for each motivating factor separately) and conjoint approaches (i.e., respondents indicate paired-comparison preferences for partial motivation concepts consisting of 2 or 3 factors at a time). The main advantage of ACA is its ability to measure more factors than is possible using a traditional conjoint model (maximum of 6). Also, ACA collects individual-level data in a computer-interactive mode that increases respondents' interest in, and involvement with, the task (Green and Srinivasan, 1990).

The ACA questionnaire included 4 sections: a rating of levels within motivating factors, a series of self-explicated questions, the paired-comparison questions, and motivating intention to improve mastitis for calibration motivation concepts. A detailed description of a typical analytical procedure of the ACA questionnaire, including scales used in each section, can be found in Valeeva et al. (2005). In brief, the first 3 sections collected data and estimated part-worths of each level of the motivating factor for each farmer. The estimation process can be formalized in terms of an additive, main effects part-worth model. The ACA procedure adapts the paired-comparison questions based on intermediate estimates of the part-worths. These intermediate estimates are

based on an ordinary least squares regression using the self-explicated and paired-comparison data and ensure that the pairs of motivation concepts are nearly equal in estimated utilities. Part-worths are updated after each question. Details of the model of the ACA process, regression layout, and updating part-worth procedure are provided by Green et al. (1991). The final ACA section investigated the (internal) predictive validity of the estimated part-worths. For 5 calibration motivation concepts, the correspondence (R^2) between scores predicted by the ACA model, based on part-worths, and scores stated by farmers was determined.

Data Collection

The target population for this study was dairy farms that included the entire range of BMSCC. To collect the data, 4 workshops were organized at 4 different locations in the north, south, east, and west of the Netherlands in February 2006. The locations were selected to cover areas containing a significant share of the total milk supply in the Netherlands.

The sampling frame was the database of the Dutch Milk Control Station, in which anonymous monitoring BMSCC data for 2005 and the first 2 digits of the zip code were listed for a total of 16,615 farms supplying milk to the 2 largest cooperative dairy companies (Campina and Royal Friesland Foods) in the Netherlands. For 15,629 of the farms, the complete data on 24 BMSCC bimonthly measurements were available. From these, 6,105 farms situated within an 80-km area of each workshop location were selected based on the zip code digits for the north (Royal Friesland Foods), south (Campina), east (Royal Friesland Foods), and west (Campina). To guarantee representation for farms with different BMSCC in the final sample, a systematic sample of 100 farms was drawn from each group. This involved selecting every k th farm after a random start, with the farms arrayed from the lowest to the highest BMSCC (Churchill, 1999).

The 2 dairy companies approached the selected 400 farmers to request participation in the workshop. The invitation contained a short study description and was distributed with a university letterhead and an enclosed letter from the corresponding dairy company and a reply form. An allowance of €100 for traveling expenses and time spent was assured to encourage participation. The farmers were also guaranteed that their responses would be anonymous and confidential. Of the farmers approached, 115 initially agreed to participate, whereas 28 refused or were not able to participate in the workshop, and the remaining 257 farmers did not react at all. Ultimately, a total of 100 farmers took part in the workshops; the other 15 farmers of those who

initially agreed to participate did not show up to a workshop with or without a prior notice. Specifically, 23, 26, 13, and 38 farmers participated in the workshops organized in the north (penalty scenario), south (penalty scenario), east (premium scenario), and west (premium scenario), respectively.

The workshops, lasting 2 h, started with an introduction, including research background, survey design, and motivating factors considered, followed by instructions concerning the computerized questionnaire. As the preceding paragraph indicates, at each workshop, farmers completed the computerized questionnaire for 1 of 2 possible scenarios (i.e., either a premium or a penalty scenario). The locations for each scenario were basically chosen at random; planning of more or less equal sample size per scenario was the only selection criterion. During the workshop introduction, participants, therefore, were informed only about the scenario they were supposed to deal with. To reduce the possible influence caused by the actual farmers experience with the penalty system and to not make them worried about possible introduction of a new premium system, the hypothetical background of the scenario with respect to the factor extra financial incentive based on BMSCC was emphasized. After the introduction, the participants had a paper-based session, followed by the computer-based session. During the computer-based session, farmers worked individually with a personal computer so that interaction with others was avoided.

Data Analysis

Before performing statistical analysis, data were examined for potential outliers concerning farm characteristics (box plots and z -scores; Hair et al., 1998). Within each scenario, data representativeness was then investigated by comparing sample means of general farm characteristics with the Dutch dairy farm population means. The differences between these means were checked using a 1-sample t -test. Then an independent t -test was used to compare differences between the means of the general farm characteristics of the 2 scenarios. Differences were considered significant at $P \leq 0.05$ (Field, 2002).

To explore factors motivating decisions of farmers to improve mastitis management, a 2-step approach was used. In the first step, 2 data samples collected by computerized questionnaire, one each for the premium and penalty scenario, were analyzed using ACA software (Sawtooth Software, 2002). For both samples, the part-worths for each level of each motivating factor were estimated for respondents individually. The relative importance of each factor was derived for every respondent by obtaining the difference between the part-

worths of the most preferred and the least preferred factor level and expressed in terms of a percentage (Churchill, 1999). A paired-samples *t*-test was applied to differences between means of importances of motivating factors within each sample. When the normality assumption for a difference between 2 means of importances of factors was rejected, the Wilcoxon signed-rank test was performed (Field, 2002). Statistical significance was declared at $P \leq 0.05$. Kendall's coefficient of concordance, *W*, was used to examine interrespondent reliability within each sample. Specifically, this coefficient checked the agreement among rank orderings of farmers of the importances of motivating factors provided by the ACA (Churchill, 1999). The behavioral side of the reaction of the farmers to different quality payment schemes was explored by comparing the importances of the factor extra financial incentive based on BMSCC obtained in the 2 scenarios.

In the second step, the groups of farmers with relatively homogeneous perceptions of motivating factors were identified. Within each of the 2 samples, a 2-stage cluster analysis (Punj and Stewart, 1983; Hair et al., 1998) was conducted on the relative motivation importance for each individual. First, hierarchical Ward's minimum variance method, whereby the sum of squared distances between individuals within a cluster is minimized and the square distance between clusters is maximized, was applied. The dendrogram and agglomeration schedule from Ward's method and the interpretability of the obtained solutions were used to establish the most meaningful number of clusters. Second, using the cluster centers from the most appropriate solution from Ward's method, which are the means of the importances of motivating factors per cluster, the nonhierarchical iterative partitioning *K*-means method was used. This method outperforms hierarchical methods if a nonrandom cluster center is specified (Punj and Stewart, 1983). To perform a validity check for stability of the clusters, the obtained cluster solutions were compared with those from a *K*-means clustering in which the initial cluster centers were not provided but iteratively estimated by the procedure (Hair et al., 1998). Then differences between the means of all clustering variables (i.e., the importances of motivating factors) of the corresponding clusters obtained by these 2 *K*-means methods were checked using an independent *t*-test. After finishing the cluster procedure, 1-way ANOVA was used to distinguish differences in importance of each motivating factor among identified groups of farmers. Because group sizes and population variances were different, post hoc Hochberg and Games-Howel pairwise tests were performed to find out which groups differed from each other at $P \leq 0.05$ and at $P \leq 0.10$ (Field, 2002). Using the same procedure, the general

farm characteristics were examined to determine whether farmers with certain types of farms belonged to particular groups.

RESULTS AND DISCUSSION

Surveyed Farmers

Preliminary analysis identified one obvious outlier, which was excluded from the subsequent steps of analysis ($n = 99$). The outlier farm had an unrealistically larger milk quota compared with other farms surveyed. Furthermore, only hired labor was used on this farm. In this sense, the perceptions of the farm manager, who was not directly involved in actions to improve mastitis, could differ from those of farmers dealing with such actions themselves on a daily basis.

Table 1 contains descriptive characteristics of the farmers surveyed in the premium ($n = 51$) and penalty ($n = 48$) scenarios with those of the farmer population being studied. This information shows how well the responding farmers represent the entire population. In both scenarios, arithmetic mean BMSCC is not different from that of the Dutch dairy farm population. Thus, despite a relatively low response rate, survey design was fairly successful in contacting and recruiting a rather representative sample concerning the target farm characteristic.

The average age of the respondents in the premium and penalty scenarios was approximately 42 yr old (44 and 42, respectively), with approximately 23 yr of dairy farming experience (24 and 22, respectively). More than one-fifth of all farmers (23.5 and 22.9% in the premium and penalty scenario, respectively) reported having a successor, whereas many farmers (60.8 and 66.7%, respectively) did not yet know whether they will have a successor. Most of the farmers had an average level of education (58.8 and 68.6% in the premium and penalty scenario, respectively). On average, respondents in both scenarios operated farms that were not significantly different from the average Dutch dairy farm in terms of size, although a slightly but significantly smaller amount of labor was used on the farms of the respondents (Agricultural Economics Research Institute, 2004, 2005; Research Institute for Animal Husbandry, 2005). The greater number of dairy cows and greater milk quota on the farms in the penalty scenario, however, suggested that the farms in this scenario were more intensive than the average Dutch farm. Significant mean differences concerning herd size and milk quota between farms in 2 scenarios indicate that farms in the penalty scenario were also somewhat more intensively operated than farms in the premium scenario. This indicates that farmers who participated in this research did not form a fully representative sample,

Table 1. General characteristics of the surveyed dairy farms and the Dutch dairy farm population per scenario

Characteristic	Premium scenario (n = 51)	<i>P</i>	Penalty scenario (n = 48)	<i>P</i>	Dutch population
Dairy cows, n	65 ^a	NS	82 ^a	<0.05	65 ¹
Milk quota, kg	525,900 ^a	NS	670,125 ^a	<0.05	497,200 ²
Farm size, ha	41.48	NS	46.23	NS	41.40 ²
Labor units	1.40	<0.05	1.49	<0.05	1.69 ^{1,3}
Hired labor	0.03	NS	0.06	NS	0.04 ³
Bulk milk SCC, ×1,000 cells/mL	220	NS	204	NS	211 ⁴
Age of farmer	44	—	41	—	NA ⁵
Dairy farming experience, yr	24	—	22	—	NA
Successor for farm business, %					
Yes	23.5	—	22.9	—	NA
No	15.7	—	10.4	—	NA
Not known yet	60.8	—	66.7	—	NA
Education of farmer, %					
Elementary education	17.6	—	6.3	—	NA
Secondary education	58.8	—	68.6	—	NA
Postsecondary education	23.6	—	25.1	—	NA

^aCommon superscript indicates premium scenario and penalty scenario means differ ($P \leq 0.05$).

¹Source: Agricultural Economics Research Institute (2005).

²Source: Agricultural Economics Research Institute (2004).

³Source: Research Institute for Animal Husbandry (2005).

⁴Source: Milk Control Station database for 16,615 dairy farms supplying milk to Campina and Royal Friesland Foods, 2005.

⁵NA = not available.

thereby somewhat limiting the ability to generalize for the entire population of Dutch dairy farmers. In this context, the results related to the penalty scenario should be considered to reflect more strongly the experience of farmers operating more intensive farms. Note again, however, that surveyed farms do not differ between 2 scenarios and compared with the Dutch average farm in terms of BMSCC, the target farm characteristic in this study.

Analysis of perceptions of mastitis risk as self-reported by farmers showed that a small portion of the farmers (14.1%) express frequent occurrence of mastitis problems. Most farmers (74.7%) believe in their capability of controlling the mastitis situation on the farm. Because of the open definition of mastitis problems in the paper questionnaire, the nature of mastitis problems here is subject to perceptions of farmers, and it might differ among farmers. For instance, these problems might refer to greater BMSCC or to an increase in the number of clinical mastitis cases.

Motivation to Improve Mastitis Management

Based on the initial analysis of individual ACA results, 11 and 6 farmers were removed from the analysis regarding the premium and penalty scenarios, respectively. These respondents showed too low correspondence ($R^2 < 0.6$) between predicted and stated likelihood scores for the 5 calibration motivation concepts that

were evaluated in the final ACA section. The low correspondence indicated that the respondents were not accurate while performing the ACA questionnaire (Huber et al., 1991). Additional evidence of accuracy of respondents, including patterned answers to the paired-comparison questions and reversals in the part-worths, revealed inaccuracy in evaluations of these respondents as well. This inaccuracy could be caused either by misunderstanding of respondents about the ACA task or by lack of interest and serious attention of respondents while performing the task.

Table 2 shows the mean relative importance of the factors that motivate the decision of the farmer to improve mastitis management on the farm. The table contains results for the premium (n = 40) and penalty (n = 43) scenarios (premium scenario and penalty scenario columns). The greater relative importance of a factor implies that farmers consider that factor to be more motivating in their decision to improve mastitis management. In both scenarios, for many motivating factors, the differences between the means of importances of factors are significantly different ($P \leq 0.05$).

From Table 2, it appears that except for the factor extra financial incentive based on BMSCC that was differently presented in the 2 scenarios, farmers largely agree on the most and least motivating factors. The ranked order of motivating factors is the same. The factors judged by farmers to be the most important are job satisfaction and overall situation on the farm. These

Table 2. Mean relative importance (rankings in parentheses) of factors influencing the decision of farmers to improve mastitis management (%)

Item	Premium scenario (n = 40)	Penalty scenario (n = 43)
Job satisfaction	17.4 ^a (1)	14.9 ^{agij} (2)
Overall situation on the farm	15.8 ^{abc} (2)	14.9 ^{bhij} (3)
Economic losses	14.2 ^{bdgi} (3)	14.4 ^{abcehi} (4)
Animal health and welfare awareness	14.0 ^{efgh} (4)	14.5 ^{ck} (5)
Ease in meeting regulatory requirements	12.5 ^{def} (5)	9.6 ^d (6)
Extra financial incentive based on bulk milk SCC	11.4 ^{ehij} (6)	16.4 ^{efgk} (1)
Dairy product quality and image	8.6 ⁱ (7)	8.7 ^d (7)
Recognition for a job well done	6.1 (8)	6.6 (8)
Total	100.0	100.0
Predictive accuracy, mean of the adaptive conjoint analysis model fit (R^2)	0.762	0.779
	$W^1 = 0.287, P < 0.001$	$W = 0.275, P < 0.001$

^{a-k}Means within a column with different superscripts are significantly different ($P \leq 0.05$).

¹ W = Kendall's coefficient of concordance (P = Monte Carlo P -value).

results, together with a relatively high importance attached to economic losses and animal health and welfare awareness, suggest that the improvement of mastitis management is mainly driven by factors that are internal to the farm and the individual farmer. As can also be seen from the table, in both scenarios farmers consider extra financial incentive based on BMSCC as one of the 6 most important factors. This factor, together with economic losses that can also directly influence economic performance of the farm, accounts for around 30% of importance of the 8 considered factors, whereas all internal factors account for about 85% of this importance. This indicates that farmers are not motivated solely by money in their decisions to improve mastitis management. Moreover, internal nonmonetary factors that involve internal esteem and taking pleasure in healthy animals on their farm are equally motivating as monetary factors (also about 30% of the importance). In this context, it is essential to look beyond financial incentives in stimulating motivation of farmers to improve mastitis management.

As shown in Table 2, in both scenarios farmers value dairy product quality and image (around 8%) and recognition for a job well done (around 6%) as the least important motivating factors. Each of these factors has nearly 2 times less importance than the most important factors. These results suggest that factors implying esteem and awareness of performance of the whole dairy sector, which are rather external to the farmer, have relatively little influence on the decision of the farmer to change mastitis management to improve BMSCC. Also, compared with the most important factors, farmers place a significantly lower importance, but to a lesser extent, to the other external factor, ease in meeting regulatory requirements. It should, however, be noted that this factor is not directly linked to regulatory requirements for mastitis control or for achieving a par-

ticular BMSCC on the farm. It rather concerns complying with other legal requirements for farm milk quality assurance, which involves some elements of good mastitis management.

Overall, the results show almost no difference between perceptions of the 2 groups of respondents (Table 2). As was expected, the major observed difference is a result of rather a divergent opinion on the importance of extra financial incentive based on BMSCC. In the questionnaire, this factor was framed in terms of a price premium for one group and in terms of a price penalty for the other group. Table 2 demonstrates that farmers attach a noticeably greater importance to extra financial incentive based on BMSCC when it is formulated as penalty levels (16.4% and ranking 1, penalty scenario column) than as premium levels (11.4% and ranking 6, premium scenario column). This indicates that farmers react differently depending on whether they receive a premium or a penalty as an extra financial incentive for a lower and a higher BMSCC, respectively. In this respect, these outcomes also support the evidence of a framing effect in eliciting preferences of individuals (Rabin, 1998). A predictable influence of this effect can be considered while designing schemes of quality payment to stimulate farmers to improve mastitis management.

The values of Kendall's coefficient of concordance W suggest that there is a significant, though not strong, agreement among the rankings of the farmers both for the premium ($W = 0.287, P < 0.001$) and penalty ($W = 0.275, P < 0.001$) scenarios (Table 2). This indicates variability in opinions of farmers on the importance of motivating factors, which is consistent with the expectation that motivation for improving mastitis management differs among individuals.

The results of Table 2 also show that the average fit of the final ACA models (R^2) for both samples of

Table 3. Factors influencing the decision of farmers on improvement mastitis management to decrease bulk milk SCC (BMSCC) and their relative importance by group per scenario (%)

Item	Premium scenario			Penalty scenario		
	Group 1 (n = 18)	Group 2 (n = 14)	Group 3 (n = 8)	Group 1 (n = 23)	Group 2 (n = 15)	Group 3 (n = 5)
Job satisfaction	20.5 ^a	12.6 ^{ab}	19.1 ^b	12.6 ^{a,x}	16.8 ^x	19.6 ^a
Overall situation on the farm	14.5 ^a	19.7 ^{ab}	12.2 ^b	12.7 ^a	18.5 ^a	14.6
Economic losses	14.1 ^{a,x}	10.1 ^{b,x}	21.7 ^{ab}	18.9 ^{ab}	10.1 ^a	6.4 ^b
Animal health and welfare awareness	11.7 ^x	15.2	17.0 ^x	14.5	16.1 ^x	9.7 ^x
Ease in meeting regulatory requirements	9.8 ^a	16.7 ^{a,x}	10.9 ^x	8.7	11.9 ^a	6.7 ^a
Extra financial incentive based on BMSCC	16.0 ^{ab}	8.0 ^a	6.6 ^b	18.9 ^a	10.1 ^{ab}	24.1 ^b
Dairy product quality and image	7.1	11.2	7.5	6.6 ^{ab}	10.4 ^a	13.3 ^b
Recognition for a job well done	6.3	6.5	5.0	7.1	6.1	5.6
Total	100.0	100.0	100.0	100.0	100.0	100.0
Predictive accuracy, mean of the adaptive conjoint analysis model fit (R^2)	0.808	0.695	0.775	0.786	0.749	0.833

^{a,b}Means within a row with common superscripts per scenario are significantly different ($P \leq 0.05$).

^xMeans within a row with common superscript per scenario are significantly different ($P \leq 0.10$).

respondents is fairly good; 0.762 and 0.783 for the premium and penalty scenarios, respectively. These results imply that the explanatory power of the estimated individual models is adequate. Moreover, these results indicate that the respondents included in the final ACA were rather consistent in expressing their preferences (Huber et al., 1991).

Differences in Motivation Among Farmers

No potential outliers that attach extreme values to the importance of several motivating factors were identified by preliminary analysis before the clustering. For both the premium and penalty scenarios, in the first clustering stage, results from Ward's hierarchical method suggested 3-cluster solutions. In the second stage, refining the clusters using the *K*-means nonhierarchical method resulted in fully identical clusters, compared with clusters identified by the hierarchical procedure. Such correspondence and stability with respect to the equal size and matching profiles of the identified clusters between the hierarchical and nonhierarchical methods confirm that the results are subject to theoretical and practical acceptance (Hair et al., 1998).

Table 3 details the descriptions of the 3-cluster solutions for both scenarios (premium scenario and penalty scenario columns). Results show that identified groups of farmers value 6 out of 8 and 7 out of 8 motivating factors significantly differently ($P \leq 0.10$) in the premium and penalty scenarios, respectively. The identified groups cannot be compared directly across the 2 scenarios as a result of different implications of the factor extra financial incentive based on BMSCC. Nevertheless, some similarities among motivations of farm-

ers toward improving mastitis management can be identified across the 2 scenarios.

According to Table 3, the first group in the premium scenario can be characterized as having premium-oriented motivation. Compared with other farmers in the premium scenario, these farmers attach a significantly stronger importance to a premium as extra financial incentive based on BMSCC (16.0%; $P \leq 0.05$). The factor job satisfaction (20.5%) is valued as the most important motivating factor by these farmers. This factor, however, is not very pronounced, because the difference is statistically significant only when compared with the second group. At the same time, the first group is somewhat less motivated by the factors animal health and welfare awareness (11.7%) and ease in meeting regulatory requirements (9.8%). Comparison of this group with the 3 groups in the penalty scenario (Table 3) identifies some similarities with the third group in the penalty scenario. Likewise, farmers in this group may be described as having a penalty-oriented motivation. Compared with other groups in the penalty scenario, these farmers place more importance on a penalty as extra financial incentive based on BMSCC (24.1%). They also perceive job satisfaction (19.6%) as being a very important motivating factor and animal health and welfare awareness (9.7%) and ease in meeting regulatory requirements (6.7%) as less important. Overall, these results for the first and third groups in the premium and penalty scenarios, respectively, suggest that some farmers are rather motivated by extra financial incentive based on BMSCC. This implies that these farmers (28% of the total sample) could be the most responsive to alternative designs for premium or penalty incentive programs.

The second group in the premium scenario and the second group in the penalty scenario represent farmers

primarily motivated by having an efficient (well-organized) farm that easily complies with regulatory requirements. Farmers in these groups attach significantly greater importance to overall situation on the farm (19.7 and 18.5%) and ease in meeting regulatory requirements (16.7 and 11.9%) compared with other groups in the premium and penalty scenarios, respectively. But at the same time, these farmers consider the monetary motivating factors, such as economic losses (10.1 and 10.1%) and extra financial incentive based on BMSCC (8.0 and 10.1%) in the premium and penalty scenarios, respectively, as significantly less important compared with other farmers. In this respect, it would seem that programs that focus on financial returns are likely to have less effect on these farmers (35% of the total sample).

The third group in the premium scenario and the first group in the penalty scenario exhibit a basic economic motivation. In their decisions to improve mastitis management on the farm, members of these groups are largely inclined to avoid basic economic losses, such as losses relating to milk production, treatment, and culling. Compared with other farmers, they attach a significantly greater importance to economic losses (21.7 and 18.9% in the premium and penalty scenarios, respectively). At the same time, the farmers in these 2 groups give somewhat less credence to extra financial incentive based on BMSCC. Specifically, this factor is perceived as being much less important (6.6%) in the premium scenario, whereas in the penalty scenario, the difference is not very pronounced (18.9%) compared with the other groups. The results indicate that the traditional approach of communicating common economic ground for better mastitis control remains the most appropriate in encouraging farmers from these 2 groups (37% of the total sample) to improve mastitis management.

It is interesting to note that none of the groups in the premium scenario particularly stand out with respect to importance of dairy product quality and image and recognition for a job well done (Table 3). The farmers express almost uniformly low preference for these motivating factors. This is particularly true for recognition for a job well done, which is valued as being least important by all farmers in the premium scenario. Also, all the farmers in the penalty scenario attach uniformly low importance to this factor. This indicates that although farmers may appreciate recognition from the dairy processing company, they are not strongly motivated to change their mastitis management for the sake of this factor. The same applies for satisfaction of farmers with helping to meet the goals of the dairy sector as a whole. These results imply that providing incentives such as milk quality awards or local newspaper articles

is generally not very significant in stimulating farmers to improve mastitis management.

Overall, the above results yield some interesting information for understanding the factors motivating dairy farmers to undertake improvements in their mastitis practices and decrease BMSCC. Comparing the mean relative importance of factors for the whole samples in the premium and penalty scenarios (Table 2) and each of the identified groups with rather different motivations (Table 3) shows that the aggregate results reflected only a rather balanced importance of both internal monetary and nonmonetary factors, whereas the individual groups revealed monetary factors as being those that basically distinguish motivation of farmers. In this sense, the findings emphasize the importance of not only looking at different motivating factors but also looking at these factors across individual farmers.

Validation of Cluster Solutions

For both scenarios, the results of the validity check showed the stability of clusters observed across 2 *K*-means methods. Using the *K*-means method with non-specified centers resulted in the similar clusters, compared with the reported clusters. In other words, the average preferences of individuals assigned to the validation clusters were very similar to preferences of individuals for the corresponding clusters described above (Hair et al., 1998). In particular, there was no significant difference between the means of all clustering variables of the corresponding clusters obtained by the 2 methods, except for 2 variables of the second clusters in each scenario. Moreover, cluster profiles were similar. The cross-tabulation of the cluster assignments from the 2 procedures showed that there was a fairly strong agreement between the 2 assignments: 24 out of 40 (premium scenario) and 28 out of 43 (penalty scenario) observations fall into the 3 cells that reflect the greatest one-to-one correspondence between 2 cluster solutions. These are hit rates of 60 and 65% for the premium and penalty scenarios, respectively, which are reasonably good. This suggests that the obtained cluster solutions are not sample-specific and can be generalized to the population as a whole (Lattin et al., 2003). Furthermore, the similarities in motivations of farmers among the groups identified in the premium and penalty samples as outlined in Table 3 can also be seen as another type of validation. Basically, these 2 samples can be considered as 2 random samples from the same population, one of which is the calibration sample and the other the validation sample (the order does not matter). The fact that cluster centers determined within 1 sample (calibration sample) reflect the tendencies of the clusters determined within another sample

Table 4. Differences in farm characteristics across motivation groups per scenario

Characteristic	Premium scenario			Penalty scenario		
	Group 1 (n = 18)	Group 2 (n = 14)	Group 3 (n = 8)	Group 1 (n = 23)	Group 2 (n = 15)	Group 3 (n = 5)
Dairy cows, n	69	61	75	89	74	74
Milk quota, ×1,000 kg	529	513	627	754	573	606
Farm size, ha	45.39	40.39	42.13	50.13	39.67	46.20
Labor units	1.42	1.32	1.63	1.60	1.41	1.30
Hired labor	0.04	0.00	0.05	0.09	0.01	0.00
Bulk milk SCC, ×1,000 cells/mL	203	201	203	193	201	213
Age of farmer	42	43	43	40	40	43
Dairy farming experience, yr	23	25	24	21	22	24
Occurrence of serious problems with mastitis on the farm during the last 2 yr ¹	2.72	2.64	3.00	2.78	2.87	3.20
Capability of managing mastitis problems to decrease bulk milk SCC on the farm ²	4.00 ^a	3.00 ^{ab}	4.13 ^b	4.09	3.67	4.20

^{a,b}Means within a row with common superscripts are significantly different ($P \leq 0.05$).

¹Mean scores on the statement (Likert scale from 1 = never to 5 = always).

²Mean scores on the statement (Likert scale from 1 = certainly not able to 5 = certainly able).

(validation samples) supports the validity of the obtained cluster solutions.

General Farm Characteristics of the Identified Groups

An examination of the general farm characteristics did not reveal significant differences across the identified groups of farmers in either the premium or penalty scenarios for all the main characteristics examined (Table 4), namely, the number of dairy cows, milk quota, farm size, labor units, BMSCC, age of farmer, and dairy farming experience. The same was largely true for the self-reported risk perceptions associated with mastitis management. Compared with 2 other groups in the premium scenario, however, the second group provides a significantly lower score on the capability of managing mastitis problems to decrease BMSCC on the farm; in the penalty scenario, the differences between the groups are not statistically significant. Although it is difficult to generalize, these results suggest that farmers from the third group in the premium scenario and the first group in the penalty scenario (i.e., farmers with a basic economic motivation) have predominantly larger farms than farmers with other motivations. The basic economic ground seems to be more motivating for larger farms. This can probably be explained by the economies of scale advantage that large farms have. That is, when the marginal cost of milk production decreases, the milk output per farm (i.e., the scale of production) increases. In this context, large farms would also incur lesser costs of improving mastitis (per ton of milk) and, therefore, have greater economic benefits from better mastitis management than small farmers.

This information provides first indication of a possible classification of farmers according to a priori expecta-

tations. Further research, however, needs to be done to better understand reasons for differences in motivation patterns of farmers to be able to respond to emerged groups in the most effective way.

Overall, the outcomes of the study provide valuable insights into the decision-making process of farmers to improve mastitis management in the environment of today. It should, however, be noted that the results reflect the motivation of Dutch farmers, who all fall under the milk quota system. This system assures relative stability in the dairy sector, including rather stable milk prices. Another aspect to be considered while interpreting the study results is the cooperative ownership of dairy companies considered in this research. In this respect, results might be different for farmers operating in the different market environments. In countries like the United States or New Zealand, with a market-driven dairy industry and with a huge competition among private dairy processors, farmers might value motivating factors involving costs of milk production as much more important than in the Netherlands.

The findings, nevertheless, highlight possible ways of improving incentive and educational programs by designing them with a clear understanding of motivation of farmers. In view of the different motivation attitudes revealed in this research, advisors would be wise to explicitly consider the most important ones in design of programs, given the current attitude of farmers. If properly designed, these programs could potentially play an important role in motivating farmers to improve mastitis management. Good communication between advisors and farmers would, however, hold the key to success of such programs.

CONCLUSIONS

Importance of factors that motivate farmers to adopt recommended practices and decrease BMSCC is quanti-

fied. Factors that are internal to farm performance and the individual farmer provide more motivation than external factors implying esteem and awareness of the whole dairy sector performance. Internal nonmonetary factors relating to internal esteem and taking pleasure in healthy animals on the farm are equally motivating as monetary factors affecting farm economic performance. With respect to monetary factors, farmers are expected to be more motivated by a quality penalty system design than by a quality premium system design.

Motivation to improve mastitis management differs across individual farmers. Individual-level analysis identified 3 groups according to motivation of farmers: premium- or penalty-oriented motivation, motivation to have an efficient (well-organized) farm that easily complies with regulatory requirements, and basic economic motivation. This distinction is mainly stipulated by differently valued monetary factors relating to farm economic performance. The identified motivation attitudes do not, however, notably reflect the characteristics of individual farmers and their risk perceptions of mastitis examined in this research.

Clearly, the results of the study reflect the primary motivating factors of the Dutch farmers. The study provides valuable insights into the decision to improve mastitis management in a contemporary environment.

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