J. Dairy Sci. 95:2523–2530
http://dx.doi.org/10.3168/jds.2011-4993

Mastitis alert preferences of farmers milking with automatic milking systems

H. Mollenhorst,*[1,2] L. J. Rijkaart,† and H. Hogeveen*†
*Department of Farm Animal Health, Faculty of Veterinary Medicine, Utrecht University, PO Box 80151, 3508 TD Utrecht, the Netherlands
†Business Economics Group, Wageningen University, PO Box 8130, 6700 EW Wageningen, the Netherlands

ABSTRACT

The aim of this study was to assess farmers' preferences for the performance characteristics of mastitis detection systems. Additionally, we looked at whether certain groups of farmers could be distinguished with specific preferences. Farmers' opinions concerning mastitis detection systems, as well as general information about the farm and the farmer, were investigated with a standard questionnaire. The second part of the questionnaire was specifically aimed at elucidating preferences. Definitions of time windows and performance parameters, such as sensitivity and specificity, were incorporated into characteristics of a detection system (attributes) that reflect farmers' daily experience. Based on data from 139 farmers, we concluded that, on average, they prefer a clinical mastitis detection system that produces a low number of false alerts, while alerting in good time and with emphasis on the more severe cases. These 3 attributes were evaluated as more important than the 3 other attributes, representing the costs of the detection system, the number of missed cases, and how long before clinical signs alerts need to be given. Variation in importance per attribute, however, was high, denoting that farmers' preferences differ considerably. Although some significant relationships were found between farm characteristics and attributes, no clear groups of farmers with specific preferences could be distinguished. Based on these results, we advise making detection systems adaptable for the farmers to satisfy their preferences and to match the circumstances on the farm. Furthermore, these results support that for evaluation of detection algorithms comparisons have to be made at high levels of specificity (e.g., 99%) and time windows have to be kept small (preferably no more than 24 h).

Key words: adaptive conjoint analysis, automatic milking system, farmer preference, mastitis detection

INTRODUCTION

Detection of clinical mastitis (**CM**) is one of the critical factors in automatic milking systems (**AMS**) and one that needs to be improved considerably (Hogeveen et al., 2010). Because the farmer is not present during the milking process, it is not possible to strip before milking and check the milk visually. This has to be replaced by an automatic mastitis detection system, which consists of sensors that measure certain properties of the milk [e.g., electrical conductivity (**EC**), color of the milk, or milk yield] and an algorithm that transforms data into alerts. Much research has been done in the past decades on the development of better sensors and algorithms (e.g., Maatje et al., 1992; Espada and Vijverberg, 2002; Whyte et al., 2004; Chagunda et al., 2006; Kamphuis, 2010; Steeneveld, 2010).

When evaluating detection systems, epidemiological parameters are often used to characterize detection performance. Sensitivity and specificity are the most common parameters, but also prevalence-sensitive parameters like success rate (synonym for positive predictive value) and false alert rate are used (for definitions, see Hogeveen et al., 2010). For all of these performance parameters, however, it is necessary to properly define the gold standard, including a time window. As Mein and Rasmussen (2008) discuss, no general consensus exists about what the real gold standard is, not even among researchers. Furthermore, almost every study has used a different time window (see for an overview Hogeveen et al., 2010), which means that alerts (or observations of CM, or both) stay valid for different periods of time. The differences in gold standard definition and time window make a fair comparison difficult.

The end users of the detection systems, however, are the farmers, and they seem to be forgotten in the discussion, except that some researchers indicate that farmers are annoyed by the high number of false-positive alerts and would prefer the number of false alerts to be decreased (e.g., Claycomb et al., 2009; Kamphuis, 2010; Steeneveld et al., 2010). In the current study, we wanted to investigate which performance parameters are valued highest by the farmers themselves. To do so, definitions of performance parameters and time windows had to be incorporated into clear characteristics

Received September 29, 2011.
Accepted January 16, 2012.
[1]Corresponding author: erwin.mollenhorst@wur.nl
[2]Current address: Animal Production Systems Group, Wageningen University, PO Box 338, 6700 AH Wageningen, the Netherlands.

Table 1. Descriptive categorical variables used in the study

Variable name	Description (*classes*)
Detection system	Is the automatic milking system (AMS) equipped with SCC estimation or not? (*yes/no*)
Character	Does the farmer characterize himself as precise? (*I want to have everything in perfect order*; *When I have spare time, I will try to get everything in perfect order*; *Just take action when needed. No preventive measures*; *My method of working could be much neater*)
Age	Age of respondent (*below 30*; *30 to 40*; *41 to 55*; *above 56 yr of age*)
Education	Level of education of respondent [*lower* (*technical*); *secondary*; *higher education*]
Identity	Identity of the respondent [(*co-*)*owner*; *employee or family member*]
Experience	How many years of experience the respondent has as an entrepreneur (*0 to 5*; *6 to 15*; *more than 16 yr*; *respondents who were not the owner were placed in a separate class*)
Successor	When respondent is (co-)owner, does (s)he have a successor? [(*probably*) *yes*; (*probably*) *no*; *do not know*; *respondents who were not owners were placed in a separate class*)
Mastitis situation	Perceived mastitis situation [*problematic*; *controllable* (*average*); *good*]
Main indicator	Most preferred indicator used for detecting CM (*AMS*; *non-AMS*)[1]
Second indicator	Second most preferred indicator used for detecting CM (*AMS*; *non-AMS*)[1]
Region	Province in which farm is located (*regrouped to North*; *South*; *East*; *West*)
Grazing system	Grazing system applied (*regrouped to no grazing*; *only day or night*; *day and night*)

[1]The question was asked with more possible answers that were regrouped before analysis; SCC estimation on AMS, color, electrical conductivity, milk production, alerts list udder health, alerts list visiting pattern, and weight loss were classified as AMS; SCC from test-day records and visual observations of the cows were classified as non-AMS.

of a detection system. These characteristics must be presented so that, subsequently, their utility could be quantified. When farmers' preferences, as represented by the utility values, are known, objectives for research and development could be defined accordingly.

The aim of this study was to assess farmers' preferences for performance characteristics of mastitis detection systems. Additionally, we looked at whether certain groups of farmers could be distinguished with specific preferences.

MATERIALS AND METHODS

Data Collection

From a customer (farmer) database of Lely Industries NV (Maassluis, the Netherlands), a manufacturer of AMS, 480 farmers were selected to be invited to complete the questionnaire. These 480 farmers were selected by taking a random stratified sample. The strata included were years of experience in milking with an AMS, defined as year of first purchase (before 2005, in the years 2005 to 2009, or from 2009 onwards) and the region farmers lived in (4 regions, covering all of the Netherlands, were defined, based on postal code).

The farmers were invited by letter to participate in the questionnaire. As a first step, the farmers were asked to send us an e-mail with farm size, number of years of experience with AMS, and whether or not they wanted to participate. Besides explaining the aims of the study, the letter offered a reward for participation—a gift voucher (€20)—to help motivate farmers to participate. Farmers who agreed to participate were sent a user name, password, and the link to the web-based questionnaire by e-mail.

Questionnaire

Farmers' opinions concerning mastitis detection systems, as well as general information about the farm and the farmer, were investigated with a standard questionnaire. Questions were asked about, for example, farm size, labor, bulk tank SCC, actual mastitis situation at the farm, information sources used for detecting CM, level of education, age, experience, and farmer attitude (precise or not). Details of the variables and classes are given in Table 1 for the categorical variables and in Table 2 for the continuous variables.

The second part of the questionnaire, specifically aimed at elucidating preferences, consisted of an adaptive conjoint analysis (**ACA**; Sawtooth Software Inc., 2011). This is a method adopted from marketing research that determines desirable features (and price) of a new product. A product is assumed to comprise characteristics (named attributes), each with its own levels (e.g., color is an attribute with black, white, or red as levels). First, ACA asks for consumer preference for levels within each attribute, and importance of each attribute. With this information, each level of each attribute receives a utility value. Using and updating these utilities, paired questions are asked (preferences of levels between each attribute are determined) resulting in final utility values, which can be compared with each other. The importance of an attribute is calculated from the difference in utility value of the most and least preferred level of that attribute in comparison to the other attributes. Concluding, ACA computes consumer utility values for each level within an attribute. The utility value of a complete product is then assumed to be the sum of the utilities for each level of each attribute the product comprises. More details on the