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Risk-based audit selection of dairy farms

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ABSTRACT

Dairy farms are audited in the Netherlands on numerous process standards. Each farm is audited once every 2 years. Increasing demands for cost-effectiveness in farm audits can be met by introducing risk-based principles. This implies targeting subpopulations with a higher risk of poor process standards. To select farms for an audit that present higher risks, a statistical analysis was conducted to test the relationship between the outcome of farm audits and bulk milk laboratory results before the audit. The analysis comprised 28,358 farm audits and all conducted laboratory tests of bulk milk samples 12 mo before the audit. The overall outcome of each farm audit was classified as approved or rejected. Laboratory results included somatic cell count (SCC), total bacterial count (TBC), antimicrobial drug residues (ADR), level of butyric acid spores (BAB), freezing point depression (FPD), level of free fatty acids (FFA), and cleanliness of the milk (CLN). The bulk milk laboratory results were significantly related to audit outcomes. Rejected audits are likely to occur on dairy farms with higher mean levels of SCC, TBC, ADR, and BAB. Moreover, in a multivariable model, maxima for TBC, SCC, and FPD as well as standard deviations for TBC and FPD are risk factors for negative audit outcomes. The efficiency curve of a risk-based selection approach, on the basis of the derived regression results, dominated the current random selection approach. To capture 25, 50, or 75% of the population with poor process standards (i.e., audit outcome of rejected), respectively, only 8, 20, or 47% of the population had to be sampled based on a risk-based selection approach. Milk quality information can thus be used to preselect high-risk farms to be audited more frequently.
Key words: bulk milk, audit, sampling, monitoring

INTRODUCTION

Quality assurance programs or certification schemes have gained great importance in the international agribusiness sector (Albersmeier et al., 2009) and are well established within the food supply chain (Deaton, 2004; Jahn et al., 2005; Fulponi, 2006). Specific quality assurance programs or certification schemes have also been developed for dairy farms (Albersmeier et al., 2009; Velthuis and van Asseldonk, 2011). The aim of such programs is to reach a defined performance of the product by implementing process standards demanded by milk processing industries. Dairy process standards focus on multiple factors to enhance hygiene of the milking environment, hygiene of the environment in which cows are housed, hygiene of the milking equipment, udder hygiene, and cow health (Albersmeier et al., 2009). Some dairy certification schemes not only focus on farming aspects that are related to milk quality, but also assess the status of, for example, animal welfare. The certification schemes make this transparent to consumers (Herrick, 1993; Meuwissen et al., 2003). Certificates are granted and extended by means of farm audits. Farms are assessed on numerous process standards using detailed checklists. The standards include the status of farm hygiene, milking equipment, parlor, tank room, feed and water management, and veterinary medicine usage.

The traditional approach is to audit all farms within a certain time period. For example, all dairy farms in the Netherlands are audited every 2 yr. The length of the interval depends on the available audit resources. Audit resources may take the form of, for example, a constrained monetary budget or a constrained number of human-resource hours to carry out inspections.

Increasing demands for efficiency in auditing programs can be met by introducing risk-based principles. The core rationale underpinning a risk-based philosophy is that issues that present higher risks merit higher priority for resources, as these investments will yield higher cost-benefit ratios. With respect to dairy farm audits, this axiomatic foundation implies selecting subpopulations with a higher risk of poor process standards. Farms at risk should be audited more fre-

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Table 1. Summary statistics of number of audits and outcome of all audits and the audits in the analysis (i.e., audits with complete records)

	All audits		Audits in the analysis	
Outcome	No.	%	No.	%
Approved	60,483	94.18	26,922	94.94
Rejected	3,628	5.64	1,388	4.89
Blocked	113	0.18	49	0.17
Total	64,222	100.00	28,358	100.00

quently, whereas farms with enhanced process quality control could be audited less often. The total number of selected farms to be audited and the frequency based on risk-based principles will ultimately depend on the available resources.

An essential element in a risk-based auditing approach is that prior information is available to select subpopulations of farms that are at risk. An obvious predictor is to use bulk milk quality information because bulk milk is tested regularly on several criteria. Product quality control and process quality control of bulk milk are associated (Albersmeier et al., 2009), but information about the extent of this association is too limited to set up a risk-based auditing scheme.

The goal of this study was therefore to quantify the enhanced efficiency of a risk-based sampling scheme on the basis of bulk milk quality tests compared with the traditional audit methodology of testing all farms at the same frequency. To select farms that present higher risks, a prerequisite for a risk-based sampling scheme, a statistical analysis was conducted to test the relation between the outcome of farm audits and the bulk milk test results.

MATERIALS AND METHODS

Data were provided by Qlip NV (Leusden, the Netherlands), the Dutch organization that is responsible for the certification and auditing of dairy farms and that tests all farm milk deliveries to the processors on protein, fat, lactose, urea, SCC, total bacterial count (**TBC**), antimicrobial drug residues (**ADR**), level of butyric acid spores (**BAB**), freezing point depression (**FPD**), level of FFA, and cleanliness of milk (CLN). One data set contained the results of all dairy farm audits and the other contained bulk milk laboratory results of all farm milk deliveries to the processors. The merged time-series data set of 6.5 yr included 64,222 farm audits conducted on 26,556 farms and all related laboratory results of the bulk milk samples 12 mo before the audit. In total, 28,358 complete records were included in the analysis (i.e., farm audit outcome with all laboratory outcomes before the audit).

Farm Audit Data

The outcomes of the audits were classified as approved, blocked, or rejected (Table 1). The majority of audits were classified as approved (approximately 95%). Furthermore, a farm was blocked if no decision had been made yet for various reasons and the final decision (i.e., approved or rejected) was pending because of required additional information or actions. For this study, the 0.17% blocked farms were grouped with the rejected category because they were not directly approved. Approximately 5% out of the 28,358 analyzed farm audits were rejected (or blocked).

Classifying farms as approved or rejected was based on a protocol containing binary checklist items and integer attention points. Each farm audit record included 271 binary checklist items that indicated a possible deviation (designated 1) from the desired farm situation (designated 0; Velthuis and van Asseldonk, 2011). For example, the checklist item "Parlor control room is dirty" has a value of 1 if the auditor observed dirt in the parlor control room, otherwise it has value 0 (which is the desired farm situation). Additionally, the data set included 52 integer variables with the number of attention points given to a specific farm category where the baseline value was 0 (Albersmeier et al., 2009). An approved farm checks almost all checklist items and has limited attention points, both indicating possible deviations from the desired farming situation. Rejected farms have important deviations in terms of failed checklist items and a high number of attention points (Velthuis and van Asseldonk, 2011).

Bulk Milk Laboratory Data

For the routine monitoring of bulk milk, a sample from each bulk milk delivery is taken and analyzed in the laboratory for composition and quality. The analysis on the composition is assessed every delivery and includes fat, protein, lactose, and urea levels. The analysis on quality includes SCC, TBC, ADR, BAB, FPD, FFA, and CLN. A description of the current test procedures applied in the Netherlands is elaborated on