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Effect of sensor systems for cow management on milk production, somatic cell count, and reproduction

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ABSTRACT

To improve management on dairy herds, sensor systems have been developed that can measure physiological, behavioral, and production indicators on individual cows. It is not known whether using sensor systems also improves measures of health and production in dairy herds. The objective of this study was to investigate the effect of using sensor systems on measures of health and production in dairy herds. Data of 414 Dutch dairy farms with (n = 152) and without (n = 262) sensor systems were available. For these herds, information on milk production per cow, days to first service, first calving age, and somatic cell count (SCC) was provided for the years 2003 to 2013. Moreover, year of investment in sensor systems was available. For every farm year, we determined whether that year was before or after the year of investment in sensor systems on farms with an automatic milking system (AMS) or a conventional milking system (CMS), or whether it was a year on a farm that never invested in sensor systems. Separate statistical analyses were performed to determine the effect of sensor systems for mastitis detection (color, SCC, electrical conductivity, and lactate dehydrogenase sensors), estrus detection for dairy cows, estrus detection for young stock, and other sensor systems (weighing platform, rumination time sensor, fat and protein sensor, temperature sensor, milk temperature sensor, urea sensor, β-hydroxybutyrate sensor, and other sensor systems). The AMS farms had a higher average SCC (by 12,000 cells/mL) after sensor investment, and CMS farms with a mastitis detection system had a lower average SCC (by 10,000 cells/mL) in the years after sensor investment. Having sensor systems was associated with a higher average production per cow on AMS farms, and with a lower average production per cow on CMS farms in the years after investment. The most likely reason for this lower milk production after investment was that on 96% of CMS farms, the sensor system investment occurred together with another major change at the farm, such as a new barn or a new milking system. Most likely, these other changes had led to a decrease in milk production that could not be compensated for by the use of sensor systems. Having estrus detection sensor systems did not improve reproduction performance. Labor reduction was an important reason for investing in sensor systems. Therefore, economic benefits from investments in sensor systems can be expected more from the reduction in labor costs than from improvements in measures of health and production in dairy herds.

Key words: dairy, sensor, milk production, somatic cell count

INTRODUCTION

A sensor system is defined as a device that measures a physiological or behavioral parameter of an individual cow and enables automated, on-farm detection of changes in the condition that is related to a health event and requires action on the part of the farmer (Rutten et al., 2013). Sensor systems are beginning to be used on dairy farms on a larger scale. For instance, activity meters are used to detect estrus (e.g., Firk et al., 2002; O'Connell et al., 2010; Holman et al., 2011) and lameness (Pastell et al., 2009; Chapinal et al., 2010; Miekley et al., 2012). More recently, sensors that measure rumination time (Büchel and Sundrum, 2014) and the weight of cows (van der Tol and van der Kamp, 2010) have been introduced to gain insight into the health of cows. On farms with an automatic milking system (**AMS**), sensors have been used to detect mastitis, whereas on farms with a conventional milking system (**CMS**), sensors are much less likely to be used to detect mastitis. A weighing platform and sensor systems to determine the fat and protein contents in milk are used more frequently on farms with an AMS than on farms with a CMS. The use of sensor systems thus differs for farms using different milking systems (Steeneveld and Hogeveen, 2015).

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Reasons for investing in sensor systems vary. Some farmers use a sensor because it was standard equipment in the AMS, but other farmers have deliberately invested in sensors to improve detection of estrus and diseases or to gain insight into the health and fertility of their herds (Steeneveld and Hogeveen, 2015). Several studies indicate that estrus detection performance can be improved by the use of sensor systems. Sensor systems can detect approximately 80 to 85% of cows in estrus (e.g., Hockey et al., 2010; Kamphuis et al., 2012), whereas visual methods detect only 55% of cows in estrus (Firk et al., 2002).

So far, research on sensor systems has focused on the development of the sensors and the detection performance (for a review, see Rutten et al., 2013). Use of sensor systems can improve estrus and disease detection. It is not known, however, whether using sensor systems also improve measures of health and production, such as average days to first service and average SCC. Therefore, it is not clear whether the use of SCC sensors improves the average SCC of the herd, and whether the use of sensor systems for estrus detection results in a lower average days to first service of the herd. Previous normative studies show that higher estrus detection resulted in a shorter calving interval (Inchaisri et al., 2010; Rutten et al., 2014), but empirical studies on this effect do not exist. Probably, the use of sensor systems increases the milk production level of the herd as well, because it is known that a shorter calving interval results in higher milk production (Auldist et al., 2007) and that a high SCC causes milk production losses (e.g., Halasa et al., 2009). Increased milk production with an AMS has been observed, and this is because an AMS can facilitate more than 2 milkings per day (Kruip et al., 2002; Wagner-Storch and Palmer, 2003; Speroni et al., 2006). It is not known whether sensor systems in an AMS result in any additional milk production above the effect of increased milking frequency.

The objective of this study was to investigate the effect of using sensor systems on measures of health and production in dairy herds (average milk production, SCC, days to first service, and age at first calving). We accounted for whether the sensor systems were on farms with an AMS or a CMS. First, analyses were performed to investigate the effect of using sensor systems for the detection of mastitis on the average SCC and milk production level of the herd. Second, analyses were conducted to investigate the effect of using sensor systems for detection of estrus on the days to first service, age at first calving, and milk production level of the herd. Finally, analyses will be carried out to investigate the effect of other sensor systems on the milk production level of the herd.

MATERIALS AND METHODS

Data Collection

A survey was conducted in the Netherlands in 2013 about the use of sensor systems on dairy farms. A link to the survey was sent by e-mail to 1,672 Dutch dairy farmers. The list with e-mail addresses was provided by a Dutch accounting agency (Accon AVM, Leeuwarden, the Netherlands). The farms were located throughout the Netherlands but the majority of farms were in the north. In total, 512 farms completed the survey (response rate of 30.6%), 202 farms indicated that they had sensor systems, and 310 farms indicated that they did not have sensor systems. The farmers indicated which sensor systems were available on their farms using a predefined list of sensor systems (Table 1). Farms not having at least one of the sensor systems mentioned in this list were defined as farms without sensor systems. For the farms with sensor systems, information was collected on the type of sensor system, whether the sensor system was part of an AMS, and the year of investment. More information about the data collection is described by Steeneveld and Hogeveen (2015).

In total, 414 farms gave permission to use measures of health and production that CRV (Cattle Improvement Cooperative, Arnhem, the Netherlands) had about their farms; CRV provided information about yearly averages for milk production, SCC, and reproduction of those 414 farms for the years 2003 to 2013.

Data Editing

Of the 414 farms, 152 farms had at least one sensor system (year of first investment ranged between 1998 and 2013) and 262 farms did not have any sensor system. An overview of the sensor systems on the 152 farms is given in Table 1. The initial data set consisted of 4,353 farm-years, with information on measures of health and production on the farms.

For the analyses, 4 data sets were created. The data set "Mastitis" consisted of farms with sensor systems for mastitis detection (color sensors, SCC sensors, electrical conductivity sensors, and lactate dehydrogenase sensor; n = 122) and farms without any sensor system (n = 262). To determine only the effect of mastitis detection sensor systems, 27 farms were excluded because they had sensor systems other than those for mastitis detection. In addition, 3 farms were excluded because they did not have complete SCC information. The year of the first investment in sensor systems for mastitis detection was excluded because the month of investment was unknown. The final data set Mastitis consisted of 3,796 farm-years.