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Araştırma Makalesi ***Research Article***

The Financial Impact of Decreased Milk Production Due to Subclinical Mastitis in German Dairy Herds

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Abstract

The mastitis has been identified as the most costly disease in dairy industry. The aim of this study was performed to provide adequate information on the financial loss due to subclinical mastitis in German dairy farms. The data were collected from 12 dairy farms (a total of 7,648 Holstein-Friesian dairy cows) in the Elbe-Elster region, Germany. Their milk composition data were gathered individually once in a month from June 2011 to June 2012. Herde® (Agrosoft GmbH, Germany), a herd management program was used to analyse the data from the economic point of view. The 50,000 somatic cell counts (SCC)/mL of a cut-off value was used to calculate the decrease in milk production emerged in subclinical mastitis. Average figures on an individual basis showed a daily decrease in milk production of 2.98 kg, 5.41 kg and 6.41 kg for cows with 50,001-100,000 SCC/mL, 100,001-250,000 SCC/mL and over 250,000 SCC/mL, respectively. All the reductions in milk yield were statistically significant by using mixed effect ANOVA and Tukey's multiple comparison method. Based on the average milk price in the survey period, a single cow according to the aforementioned SCC classification showed a loss of Euro (€) 294.85, € 536.80 and € 634.40 per lactation in gross milk receipts, respectively. On an average herd level, which was 637 dairy cows in this study, a total decrease of gross milk receipts was calculated to be almost € 241,000 per year. This findings show that the milk production begins to reduce over 50,000 SCC/mL, therefore the generally accepted cut-off value of 100,000 SCC/mL for subclinical mastitis should be re-evaluated.

Introduction

Major losses associated with mastitis have been studied in the past and identified as reduced milk production, milk composition changes, discarded milk, veterinary bills, drug costs, farmers' increased labour, premature disposal and costs for preventive measurements. A milk yield depression has been proven to have the highest impact from an economic point of view and is even of higher importance in case of a subclinical form of mastitis, as costs for discarded milk, drug costs, veterinary bills and increased labour play a rather insignificant role (Huijps et al., 2009; Ózsvári et al., 2003; Seegers et al., 2003; Yalcin, 2000).

The most significant subclinical abnormality of the milk is the increase in the somatic cell counts (SCC), which is the most common measurement of milk quality and udder health (Ózsvári, 2004; Reneau and Leuer, 2010; Ruegg and Pantoja, 2013). An elevated SCC is a practical approach in order to detect subclinical forms of mastitis. A SCC below 100,000 cells/mL is currently set as the physiological accepted limit (Schwarz et al., 2011).

Somatic means the cells arise from the cow's own body cells, and in a healthy mammary gland, lymphocytes and macrophages predominate the somatic cells. The reason for the SCC elevation is in almost all cases the increased concentration of neutrophil granulocytes that represents a reaction of glandular tissue to injury, which is the presence of inflammation (Huijps et al. 2009; Seegers et al., 2003). Prolonged diapedesis of neutrophils damages mammary tissue, resulting in decreased milk production. Financial losses can be quantified by establishing the milk production of cows and measuring the SCC of the milk (Huijps et al., 2009; Ózsvári et al., 2003; Seegers et al., 2003; Yalcin, 2000).

Not only the amount of milk but also the fat and protein content of the milk can show a marked reduction owing to higher SCC. Primiparous cows showed a daily 4.51 g fat and 10.23 g protein reduction due to a new subclinical mastitis infection at a SCC of 200,000 cells/mL. Multiparous cows in the same study had a daily loss of 10.16 g fat and 12.49 g protein during

a period of subclinical mastitis (Halasa et al., 2009) resulting in a lower milk price. Shorter longevity in connection with an increased SCC during the first lactation has also been subject of recent studies (Archer et al., 2013). While a negative correlation between an increased SCC during the first month of the first lactation and longevity has been proven, suggestions to further investigation of lifetime milk yield are still to be made.

In a study performed by Schwarz et al. (2011) showed that subclinical forms of the disease occur far more often than expected. Control programs can diminish the incidence of mastitis and enhance the milk production, but emerge extra costs for farmers (Huijps et al., 2010; Yalcin et al., 1999). Persuading farmers to invest more into preventive medicine, can only be achieved if they receive significant information about the potential financial return. Without sound figures of the economic impact, farmers have nothing to base their decision on.

The main aim of this study was to provide herd managers with reliable information, obtained from a large source and to raise awareness of the often unnoticed financial impact of subclinical mastitis. Another aim was to investigate if SCC over 50,000 cells/mL can already indicate a subclinical case of mastitis and therefore causes a milk yield depression or if the current 100,000 SCC/mL limit is accurate enough.

Materials and Methods

The data were collected from 12 farms in the Elbe-Elster region in East-Germany between June 2011 and June 2012. All data collected were analyzed by the program Herde® (Agrosoft GmbH, Germany), and all the averages and percentages were calculated with Excel® (Microsoft, USA). The total number of Holstein-Friesian dairy cows surveyed in this study was 7,648, of which 6,678 milking cows. The average herd size was 637 cows (min. 337, max. 1,149 cows) and the average number of milking cows was 557. All farms used a free stall housing system and a zero grazing approach was conducted. Six farms used a paddock for their dry cows, of which three provided excess to a separate paddock for the heifers. All farms were free from leucosis, brucellosis, tuberculosis, BHV-1 and unsuspicious to BVD.

The farms had monthly milk tests (milk quantity and milk composition including fat, protein and SCC) carried out under the provincial recording association called LKV (Landeskontrollverband für Leistungs- und Qualitäts-prüfung Sachsen-Anhalt e.V.). They measure the SCC of each individual cow twice on the test day with fluorescent optical measurements via the Fossomatic™. This procedure is based on flow cytometry technology that counts somatic cells in compliance with ISO/IDF and FDA/NCIMS standards.

The average of all individual cow SCC data is nowadays seen as the best measure of subclinical mastitis (Lievaart et al., 2007) that reduces the milk production (Huijps et al. 2009; Ózsvári et al., 2003; Seegers et al., 2003; Yalcin, 2000). Three SCC thresholds were set up in our study, and the lowest one was based on findings that showed inflammatory changes at a SCC of 50,000 cells/mL (Boland et al., 2013; Laevens et al., 1997; Schepers et al., 1997; Schwarz et al., 2011). The threshold of 100.000 cells/mL is the generally most excepted one and still is seen as within the physiological range (Fehling, 2012). A SCC of 250,000 cells/mL is a generally accepted cut-off point for supreme milk price payment in the whole of Germany and other milk exporting countries worldwide and therefore was of higher importance (Penry, 2012).

In our hypothesis the 50,000 SCC/mL cut-off value was used to calculate the decrease in milk production due to subclinical mastitis. The average milk production of three cow groups [50,000-100,000 SCC/mL (Group 2), 100,001-250,000 SCC/mL (Group 3) and over 250,000 SCC/mL (Group 4)] were compared to that of cows with a SCC less than 50,000 cells/mL (Group 1).

Having known the reductions in milk production per cow in the different SCC categories over 50,000 SCC/mL and the average farm milk price, the decreased gross milk receipts due to subclinical mastitis were calculated. Taking into account all the different milk prices for each farm in the surveyed period an average price of Euro (€) 0.3244/kg was calculated.

On the farms cows were fed a total mixed ration according to their stage of lactation (freshly calved, high production, mid lactation, end lactation, just prior to dry off and dried off cows), not individually according to their milk production. Usually cows with a lower milk production show a reduced feed intake, but due to the feeding technique, all possible feed savings caused by reduced milk production owing to subclinical mastitis were not taken into consideration in the loss calculation, that is, the feed cost assumed to be a fixed cost. [Feeding cost came approximately to € 1,408 per cow per year (min. € 1,314; max. € 1,517)].

Statistical analysis

In the statistical model, the mean values of average daily milk yields (kg) were modelled for all SCC groups with mixed effect ANOVA (Brown and Prescott, 2006). Fixed factors were SCC groups and the months when the measurements were made. Random factors were farms and individual animals. The group differences of the modelled daily milk yield means (kg) were

simultaneously tested by Tukey's multiple comparison method (Hothorn et al., 2008).

Results

The average milk yield per lactation of the surveyed population from June 2011 to June 2012 was 9,900 kg (min. 8,469 kg, max. 12,482 kg), the average milk yield per year 8,814 kg (min. 7,256 kg, max. 10,670 kg), respectively. The average length of lactation was 354 days (min. 330 days; max. 381 days). The calving interval was 410 days (min. 387 days; max. 439 days) with an average dry period of 56 days.

The average SCC of the surveyed population from June 2011 to June 2012 was 284,320 cells/mL. The monthly lowest SCC was 200,000 cells/mL, while the highest recorded SCC was 407,000 cells/mL. An average fat and protein contents was measured as 3.97% (min. 3.76%; max. 4.32%) and 3.39% (min. 3.00%; max. 3.52%), respectively. Dairy cows produced on a daily basis an average of 31.98 kg milk. The lowest recorded average daily milk production on a farm was 27.33 kg, the highest one 37.12 kg, which was one of the top 10 producing dairy farms in Germany. Dividing the herds into groups according to SCC showed remarkable differences within the daily milk production (Table 1). All the pairwise differences in the modelled means of daily milk yield between Group 1 and all the other groups were statistically significant at 0.0001 family-wise error rate.

Table 1. Average milk yield according to the SCC

Group	SCC/mL	Average daily milk yield ± SD** (kg)	Average milk yield per lactation* (kg)	Share of the population (%)
1	0-50,000	35.65 ± 8.74	10,873	28.72
2	50,001-100,000	32.67 ± 9.13	9,964	23.52
3	100,001-250,000	30.24 ± 10.21	9,223	24.68
4	250,001-9,999,999	29.24 ± 11.50	8,918	23.08

*305 days lactation; **SD = Standard deviation

The results show that the subclinical mastitis has a large impact on milk yield. Even cows with a SCC below 100,000 cells/mL showed a remarkable production loss of over 8% which really proves that inflammatory changes must be present in cows showing SCC of more than 50,000 cells/mL. Cows that had an average SCC between 100,001-250,000 cells/mL showed a reduced milk production of over 15% even though this is still lower than the average SCC of 284,320 cells/mL of the surveyed farms. (Table 2).

Table 2. Reduced milk production due to higher SCC on cow level

Group	SCC/mL	Average daily milk yield (kg)	Reduction in daily milk production	
			kg	%
1	0-50,000	35.65	-	-
2	50,001-100,000	32.67	2.98	8.36
3	100,001-250,000	30.24	5.41	15.18
4	250,001-9,999,999	29.24	6.41	17.98

Table 3 shows the financial losses per cow considering the reduced milk yield over 50,000 SCC/mL as it is shown in Table 2, while Table 4 presents the decrease in gross milk receipts in an average herd of 637 cows, of which 557 milking cows. The yearly decrease in gross milk receipts was calculated by using the milk yield per lactation and the average calving interval of 410 days, and was estimated to be almost € 241,000.00 per year in an average herd.

Discussion

The cows below 50,000 SCC/mL were presumed to be inflammation free and represented 28.72% of the cows. A subclinical inflammation of the mammary gland

Table 3. Financial losses (in Euro) due to decreased milk production per cow

SCC/mL	Daily decrease in gross milk receipts	Monthly decrease in gross milk receipts	Decrease in gross milk receipts per lactation	Yearly decrease in gross milk receipts
50,001-100,000	0.97	29.00	294.85	262.49
100,001-250,000	1.76	52.65	536.80	477.88
250,001-9999,999	2.08	62.38	634.40	564.77

Table 4. Financial losses (in Euro) due to decreased milk production on herd level

SCC/mL	Daily decrease in gross milk receipts	Monthly decrease in gross milk receipts	Yearly decrease in gross milk receipts
50,001-100,000	131.6	3,949	48,049
100,001-250,000	250.6	7,519	91,480
250,001-9999,999	277.0	8,310	101,105
Total	659.3	19,778	240,634

would not show any clinical signs, but many studies proved that a reduced milk production and an elevated SCC are good indicators (Krömker, 2006; Schwarz et al. 2011; Seegers et al. 2003; Yalcin, 2000). The question could arise if the higher milk yield of cows automatically correlates with lower SCC, as higher amount of milk dilutes the somatic cells. Boland et al. (2013) have considered this aspect, but found no evidence of a dilution affect in their study.

In the present study, cows with SCC of 50,001-100.000 cells/mL showed a reduced daily milk production of 2.98 kg, compared to Group 1 (≤50,000 SCC/mL), and 23.52% of the cows fell into this category. This result is in compliance with the findings of other studies (Boland et al., 2013; Laevens et al., 1997; Schepers et al., 1997; Schwarz et al., 2011) that took the threshold of 50,000 SCC/mL as the cut-off point of subclinical mastitis instead of the current SCC of 100,000 cells/mL. Group 3 (100,001-250,000 SCC/mL) consisted of 24.68% of the surveyed cows and had a daily milk loss of 5.41 kg, if compared to the healthy ones (Group 1). Due to those figures, both Group 2 and 3 were presumed to have a potential subclinical inflammation of the mammary gland. In Group 4 (>250,000 SCC/mL) the average daily loss in milk production compared to Group 1 was 6.41 kg and made up the rest of the population (23.08%).

The results of a previous study in Hungary, performed by Ózsvári et al. (2003) were similar. In their survey the cows in group of 101,000-250,000 SCC/mL showed a daily milk yield decrease of 4.25 kg compared to a group under 100,000 SCC/mL, while this group had an average SCC of 51,140 cells/mL. This is quite a correlative result, as the lower threshold chosen for this study could be the major reason for the difference. The two SCC groups with the cut-off lines of 251,000-400,000 cells/mL and 401,000-1,000,000 cells/mL in the previous study showed a milk yield depression of 5.93 kg and 7.76 kg, respectively. In this study, Group 4 (≥250,001 SCC/mL) basically includes the aforementioned two groups of the previous study and the 6.41 kg decrease in daily milk production is also quite a similar result, as it lies within the two Hungarian daily milk reductions.

Herd managers and staff on the surveyed farms often argued that their average SCC always stays underneath the local German dairy factories restriction of 300,000 cells/mL and therefore receive the premium payment. Additionally, their bulk tank somatic cell counts (BTSCC) is as low as practically possible (<100,000 SCC/mL) and they claimed that this study is a rather theoretical view on the problem of udder health. It might be true that a research like this is not fully applicable in the daily practical life of a dairy farm, however, it provides us with potential targets we can aim at, in order to improve animal health and farm profitability. Prophylactic treatments and health control plans of dairy cattle often appear rather costly to farm managers, but researches done so far have shown that preventive measures and mastitis control plans have a relatively low input compared to the high savings they can achieve (Cook and Sharp, 2005; Huijps et al., 2010).

Conclusions

The results of this study show that subclinical mastitis has a large impact on milk yield. Even cows with higher than 50,000 SCC/mL, but below 100,000 SCC/mL showed a remarkable milk production loss during the lactation which really underlines that inflammatory changes must be present in cows producing milk with more than 50,000 SCC/mL. Our findings revealed that the reduced milk receipts due to lower milk production of cows with higher than 50,000 SCC/mL had the largest economic consequences, even larger than the generally accepted cut-off value of 100,000 SCC/mL for subclinical mastitis.

Reduction in clinically manifested diseases, such as clinical mastitis, is often used to show a possible financial return to farmers, as it is the easiest for them to see their direct economic results (e.g. medication cost, culling expenses). The subclinical forms of udder diseases and their obscured production impacts are often hard to distinguish for herd managers and accordingly fall into the responsibility of the veterinarian. Nevertheless, the findings of this study demonstrate that subclinical mastitis has a large impact on the revenue of a dairy farm and a reduction of its incidence comes with considerable financial returns.

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