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RESEARCH ARTICLE

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ECONOMIC IMPACT OF BOVINE MASTITIS IN ESPÍRITO SANTO, BRAZIL

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ABSTRACT

The objective was to calculate the economic losses of clinical and subclinical mastitis in dairy cows. Eighteen farms and 175 lactating cows were evaluated from February to December 2015. A black black-ground mug test was performed to assess the presence of clinical mastitis and milk was collected from the tank to verify economic losses through somatic cell count (TSCC) for each property. The economic losses generated by clinical mastitis were calculated considering the cost of treatment and the grace period with milk disposal. The calculation of the loss of production of the property was stipulated through the reduction of production caused by the high TSCC. The economic impact of clinical mastitis was an average of US \$ 53.67 for each positive case, with the disposal of milk being the main factor to increase economic losses. Estimates of losses about TSCC were US \$ 2.58 per day and the US \$ 77.40 monthly, due to reduced milk production about the high somatic cell count found in the tank. It is necessary to inform producers about the high costs caused by losses of clinical mastitis and the high somatic cell count in milk.

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INTRODUCTION

Dairy farming is an important activity from an economic point of view, mainly for small producers, generating income in a relatively small area when compared to beef cattle, being, therefore, a relevant activity in the country. It stands out for its participation in the formation of income in the agricultural sector and the supply of food of high nutritional value to the population (ACOSTA *et al.*, 2016). Despite the growing expansion of dairy cattle in recent years, the activity lacks improvements in the quality of the milk produced, which is being demanded more by the current legislation, industry, and consumer (BRASIL, 2018a, b). Bovine mastitis stands out among the diseases that affect dairy herds, it occurs worldwide, being considered one of the biggest obstacles to its exploitation (FERRIANI BRANCO, 2010; PEREIRA NETO, 2010).

The occurrence of mastitis is the main source of damage in the dairy herd, having a direct impact on production costs and losses in milk quality. It is also a problem for the industry, in this context, the use of low-quality milk impairs the yield in the manufacture of dairy products, decreased shelf life of such products, and changes the original characteristics of the milk and its derivatives, as the inflammatory response of the mammary gland causes casein to suffer a significant reduction due to the action of leukocyte and blood proteases (BUENO *et al.*, 2006). The objective of the present study was to quantify the economic losses resulting from clinical and subclinical mastitis in crossbred cows with milk ability in the southern region of Espírito Santo.

MATERIALS AND METHODS

The study was approved by the ethics committee for the use of animals at the Federal University of Espírito Santo, under protocol number 003/2015. A total of 175 crossbred dairy cows (*Bos taurus taurus* x *Bos taurus indicus*) were used, in different lactation stages, from four municipalities (Bom Jesus do Norte, Ibatiba, Irupi and São José do Calçado) in the Caparaó region (20 ° 26 ' 5 " S and 41 ° 47 ' 2" 'W), south of the state of Espírito Santo, Brazil, from February to December 2015. The 18 properties were randomly selected, with four properties in São José do Calçado and Ibatiba, and five in Irupi and Bom Jesus do Norte. All lactating cows on each farm were evaluated. The detection of clinical mastitis was determined by identifying the clinical signs of inflammation of the mammary gland and by testing the black black-ground mug test. Subclinical mastitis was diagnosed using the California Mastite Test (CMT), and later collection of milk from the tank to determine the somatic cell count of the tank (SCCT), performed by the Somaticell[®] kit (Idexx; Maine, USA), according to manufacturer's recommendations. The milk samples were collected in sterile tubes, with identification of each property and municipality, packed in thermal boxes containing ice and transported to the Animal Products Inspection Laboratory of the Veterinary Hospital of the Center for Agricultural Sciences and Engineering of the Federal University of Espírito Santo. The owners of the herds answered a questionnaire, in order to find out the characteristics of the property, the number of milked animals, dairy production and the value of individual production. For calculation purposes, the average dollar value in 2015 was US \$ 3.33, and the average value of a liter of milk was US \$ 0.30 / liter, according to the Center for Advanced Studies in Applied Economics (CEPEA, 2015). To assess the amount spent on treatment, an intramammary antibiotic value of US \$ 1.47 per tube was considered. Three day antibiotic treatment was also considered for animals affected with clinical mastitis and a four day grace period after the last application of the antibiotic, totaling seven days of disposal of all milk produced by the treated animal. Economic losses related to clinical mastitis (CM) were estimated considering seven days of total disposal of milk produced by the animal with CM (three days of treatment and four days of grace period after the last application of the antibiotic), plus the cost of the antibiotic used for the treatment, considering the use of one tube per ceiling with MC and three days of treatment, totaling three tubes per affected ceiling. Therefore, the economic impact on production due to clinical mastitis (EICM) was estimated according to the formula:

$$\text{EICM} = \text{milk disposal (US \$)} + \text{treatment cost (US \$)}$$

Where, disposal of milk is the product of the individual production of the animal, treatment period (comprised of seven days) and the value of the liter of milk. The cost of the treatment is equal to the product of the number of ceilings affected by the value of the treatment. Losses for subclinical mastitis (SM) were estimated in relation to SCCT, according to the methodology of Schepers *et al.* (1997) and Hortet; Seegers (1998), where there is a percentage decrease in production in relation to the increase in the number of somatic cell count (SCC; Table 1). The value of the economic impact of subclinical mastitis (EISM) was measured from the average value of the liter of milk paid to producers in 2015 (US \$ 0.30 / liter), multiplying the total decrease in the production of each property by the value of the liter of milk, resulting in the daily and monthly economic loss resulting from the increase of SCCT in the analyzed dairy properties. The economic impact on production due to subclinical mastitis (EISM) was estimated according to the formula:

$$\text{EISM} = \text{Daily production of the property} * \text{reduction of production by SCCT.}$$

RESULTS

Four properties presented cases of clinical mastitis, and one property in Irupi presented two cases. In four of the five cases found, the animals had only one affected roof, with the exception of one animal

that had clinical mastitis on the four roofs (Table 2). In the municipality of Bom Jesus do Norte there were no cases of clinical mastitis.

Table 1. Somatic cell count (SCC) and respective decrease in production (%). Adapted from Shepers et al. (1997); Hortet and Seegers (1998)

SCC	Estimated production decrease (%)
≤ 50.000	0.0
50.000 a 100.000	0.5
100.000 a 150.00	1.5
150.000 a 200.000	2.0
200.000 a 250.000	2.4
250.000 a 300.000	2.7
300.000 a 350.000	3.0
350.000 a 400.000	3.5
≥ 400.000	8.0

Economic losses related to subclinical mastitis are shown in tables 3 and 4 according to properties (P) and municipalities. In the municipality of São José do Calçado, collections were made in four properties, with a total of 43 animals and an average daily production of 135.5 liters. Among the four properties studied, three (P1, P2 and P4) presented SCCT values between 457,000 and 700,000 cells/mL of milk, with an estimated daily loss of 8% (Table 1). The P3 property presented a SCCT value of 186,000 cells/mL of milk, with an estimated loss of 2%. The average loss in production in the municipality of São José do Calçado was 6.5% (Table 5). In the municipality of Ibatiba, collections were made in 49 animals from four farms, with an average production of 178.25 liters / day, with three farms (P5, P6 and P8) showing SCCT values above 400,000 cells / mL, with estimated loss in the production of 8%. The P7 property presented a SCCT value of 379,000 cells / mL of milk, thus having an estimated loss in production of 3.7%. The average value of estimated losses in production in the municipality of Ibatiba was 6.9% (Table 5).

In the municipality of Irupi, where collections were made in five properties, 39 animals were evaluated, with an average production of 167.8 liters / day, with estimated losses in production ranging from 8% (P9 and P11) to 1.5% (P10). The property (P9) stands out with a SCCT value of 1,120,000 cells / mL and P10 with 118,000 cells / mL for SCCT. The average loss of production in the municipality was 4.6% (Table 5). The municipality of Bom Jesus do Norte, where collections were made on five properties, a total of 44 animals were evaluated, with an average production of 64.08 liters daily. Great variation of SCCT was found (Table 4), properties with SCCT value of 165,000 cells / mL (P16) and an estimated 2% reduction in milk production and properties with SCCT value above 400,000 cells / mL (P14 and P17) with an estimated 8% reduction in production. The average value of losses due to the prevalence of subclinical mastitis was 4.7% (Table 5). Considering the average production of the five municipalities and the average value of production losses, a production reduction value of approximately 8.5 liters / day, 255 liters / month and 2550 liters of milk is obtained if we consider the lactation period of a cow in 10 months. Therefore, the producer with cases of subclinical mastitis in the herd has losses of approximately US \$ 2.58 per day and monthly losses of US \$ 77.40 (Table 5), if we extrapolate the losses during the lactation period of the cow, we have an average loss of US \$ 774.00 cow / year.

DISCUSSION

The prevalence of clinical mastitis for the studied region was 2.85% (5/175). Other studies have reported a prevalence of clinical mastitis of 2.89% to 8.57% for municipalities in the same region, with acceptable levels of clinical mastitis ranging from 2 to 5% in dairy herds (ALMEIDA *et al.*, 2021; PHILPOT; NICKERSON, 2002), therefore, the results found in the present study meet these specificities.

Table 2. Economic losses due to clinical bovine mastitis in municipalities in the Caparaó region, Espírito Santo, 2015

Municipalities	Ibatiba	Irupi	Irupi	São José do Calçado	
Production of the affected animal (L)	8	30	40	16	17
Number of ceilings affected	1	4	1	1	1
Disposal of milk ¹ (days)	7	7	7	7	7
Treatment cost ² (US\$)	4.41	17.64	4.41	4.41	4.41
Economic loss due to milk disposal (US\$)	16.80	63.00	84.00	33.60	35.70
Total loss (treatment + disposal; US\$)	21.21	80.64	88.41	38.01	40.11

¹ Discard the milk considering the treatment period and lack of antibiotics (days);

² Considering the price of the antibiotic with the use of a tube per affected ceiling and the duration of the treatment for three days.

Table 3. Values of decreased production due to subclinical mastitis in the municipalities of São José do Calçado and Ibatiba, Caparaó region, Espírito Santo, 2015

Municipalities	São José do Calçado				Ibatiba			
Property	P1	P2	P3	P4	P5	P6	P7	P8
Number of lactating animals	5	9	10	19	6	5	28	10
Production (liters / day)	50	130	125	237	63	80	400	170
SCCT average value ¹	700	457	186	470	1.970	700	379	600
Decrease in production ² (%)	8	8	2	8	8	8	3,5	8
Daily production loss (L)	4	10.4	2.5	18.96	5.04	6.4	14	13.60
Monthly production losses (L)	120	312	75	568.80	151.20	192	420	408

¹ Count of somatic cells in the tank (x 1000 cells / mL of milk);

² Adapted from Schepers et al. (1997); Hortet and Seegers (1998; table 1).

Table 4. Values of decreased production due to subclinical mastitis in the municipalities of Irupi e Bom Jesus do Norte, Caparaó region, Espírito Santo, 2015

Municipalities	Irupi					Bom Jesus do Norte				
Property	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Number of lactating animals	13	8	4	9	5	6	12	12	7	7
Production (liters / day)	405	139	66	184	45	20	129	74	39	58
SCCT average value ¹	1.120	118	760	340	224	630	205	165	418	340
Decrease in production ² (%)	8	1,5	8	3	2,4	8	2,4	2	8	3
Daily production loss (L)	32.40	2.08	5.28	5.52	1.18	1.60	3.09	1.48	3.12	1.74
Monthly production losses (L)	972	62.40	158.40	165.60	32.40	48.00	92.88	44.40	93.60	52.20

¹ Count of somatic cells in the tank (x 1000 cells / mL of milk);

² Adapted from Schepers et al. (1997); Hortet and Seegers (1998; table 1).

Table 5. Average production and average reduction estimated by the prevalence of subclinical mastitis according to the somatic cell count of the tank (SCCT), in the municipalities studied in the Caparaó region, Espírito Santo, 2015

Municipality	Average production (Liters / day)	Average percentage of loss (%)	Average losses in liters of milk	Daily economic loss (US \$)	Monthly economic loss (US \$)
São José do Calçado	135.50	6.50	8.80	2.66	79.80
Bom Jesus do Norte	64.00	4.68	2.99	0.90	27.00
Irupi	167.80	4.58	7.68	2.32	69.60
Ibatiba	178.20	6.87	12.24	3.71	111.30
Average	168.30	5.06	8.51	2.58	77.40

The economic losses related to the presence of clinical mastitis in the herd are mainly the disposal of milk, expenses with medications, functional loss of the mammary gland and the death of the animal (FONSECA; SANTOS, 2001). The economic impact of clinical mastitis varied between properties, the cost of curative treatment was US \$ 4.41 per treated ceiling (Table 2), these values are considered lower when compared to US \$ 7.34 found by other authors (COSTA *et al.*, 2008), however, in the present study, the value of labor and charges with a veterinarian was not taken into account. In addition to the high costs of treatment, the presence of antibiotic residues in milk is a public health and technological problem throughout the dairy chain, since the residues have an inhibitory effect on the development of dairy yeasts used in the manufacture of dairy products (SILVA, 2011; GARGOURI *et al.*, 2013). Thus, the milk of these animals must be totally discarded, since the sending of this milk with antibiotic residues generates punishments for the producer since the dairy products regularly perform analyzes in order to avoid the capture of milk with medicated residues. The disposal of milk was the main factor to increase the economic impact of clinical mastitis, other authors reported that the economic impact related to mastitis must estimate the costs of milk discarded during and after treatment (PETROVSKI *et al.* 2006).

For the calculation of mastitis costs, it does not matter if the discarded milk will be reused in another sector of the rural property, since this milk invariably fails to generate revenue. Therefore, the item that had the greatest economic impact was the disposal of milk from animals undergoing treatment for clinical mastitis (Table 2), depending on the number of days of milk disposal, considering the treatment period and the antibiotic deficiency period. The total economic impact, accounting for milk disposal and treatment costs, was US \$ 268.38 on properties evaluated in the municipalities of the Caparaó region, south of Espírito Santo. The municipality of Irupi stands out, which presented three cases of clinical mastitis in two properties, with a total cost of US \$ 207.06. The property with the lowest cost was located in the municipality of Ibatiba US \$ 21.21, in contrast, the affected animal was the one with the lowest milk production among the animals positive for clinical mastitis (Table 2). The average economic impact in relation to clinical mastitis in the region studied was US \$ 86.46, it is worth mentioning that in the present study, only the cost of treatment plus the disposal of milk was evaluated, thus justifying a lower value when compared to other authors with US losses. \$ 100.43 per cow / year, excluding the expenses with prevention (CARNEIRO *et al.*, 2004), and \$ 95.69 (LOPES, 2012), higher than the present work.

Losses due to mastitis reported by other authors were approximately US \$ 200.00 per cow / year, ranging from US \$ 35.00 to US \$ 295.00 (DEGRAVES; FETROW, 1993). There are cost estimates of US \$ 226.00 for each case of mastitis (BERRY *et al.*, 2004), and there are values of US \$ 163.00 per cow / year, without considering the cost of prophylaxis, veterinary fees and additional labor (KIRK; BARTLETT, 1988). The cost of treatment for clinical mastitis represented on average 13.14% of the total economic impact caused. There is a direct relationship between the cost of treatment and the production of the affected animal, the lower the production of the sick animal, the greater the percentage with expenditure of medicines of the total cost of treatment, the opposite is also true. Thus, the values may change according to the average cost of a liter of milk, the cost of the medicine used and the period of grace of the medicine. The estimate of the reduction in milk production generated by bovine mastitis is permanently under debate and it is known that it is influenced by the birth order, age of the animal, lactation stage, reproductive status, breed, milk production before infection, degree of gland inflammation, duration of mastitis, season, nutritional composition of the cow's diet and the pathogens involved (HORTET; SEEGERS, 1998; SEEGERS *et al.*, 2003; HUIJPS *et al.*, 2008). Losses can be even greater when considering the decrease in milk production, depreciation in nutritional quality, cost of veterinary and laboratory care and losses in genetic potential (HOGEVEEN *et al.*, 2019). These losses highlight the importance of the disease in the profitability of milk production systems and justify efforts to keep the disease under control.

In the present study, samples were collected from 18 properties in four municipalities, adding up to a total of 175 animals. On average, the properties have approximately 9 lactating animals (9.72 animals per property). The average production per property is 134.11 liters / day, ceasing to produce approximately 5.54% of milk due to the prevalence of subclinical mastitis and respective SCCT (SHEPERS *et al.*, 1997; HORTET; SEEGERS, 1998). In the present study, average monthly losses of US \$ 77.40 and up to US \$ 568.80 per lactating cow were found. There are reports of losses of US \$ 317.38 per cow (COSTA *et al.*, 1998). It is observed that the economic impact per animal is high, even without the presence of clinical signs. Subclinical mastitis has been drawing attention by reducing the productivity of the herd and increasing the count of somatic cells, causing the producer to have discounts on the amount paid per liter of milk. When it comes to dairy farming, productivity and adequacy in terms of quality are the biggest challenges of the activity. Therefore, attention should be paid to cases of mastitis in the herd, since the disease can be considered one of the main causes of economic impact and damage to property.

CONCLUSION

It is concluded that clinical mastitis is a disease present in dairy cattle in the municipalities of the Caparaó region, south of Espírito Santo, resulting in direct economic losses for producers, both due to the cost of treatment and the disposal of milk from the affected animals, demonstrating the importance of taking all precautions to avoid the presence of the disease in the herd. Subclinical mastitis, although inapparent, is present in all the properties studied, causing indirect economic losses, due to the estimated reduction in milk production.

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