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Clinical mastitis in Spanish dairy cows: incidence and costs

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Abstract

Clinical mastitis in Spanish dairy herds has been studied. Since April 2005 up to December 2006, in 25 Spanish herds 1,054 cases registered were available. Aims were to determine mastitis incidence and factors of risk, to analyze whether yield production has been affected, and to quantify mastitis costs along 2006. The 25% lactations were infected at least once with average recurrence of 1.64. Descriptive analysis showed that 29% of cases occurred within the first month after calving. Primiparous showed higher mastitis frequency at early and late lactation while in multiparous cases number was progressively decreasing since the first month. Multiparous were statistically more liable to mastitis than primiparous. Mastitis did not show effect on yield production. Mastitis costs included treatment products and discarded milk. Individual daily production at each case onset was estimated by using monthly official milking records. An average mastitis case cost was 73.93 €, cheaper in primiparous than in multiparous because of lower milk production. Average discarded milk represented 74% of total cost per case. Mastitis costs were 117 € per infected cow and lactation. Then, annual economic losses due to mastitis were 3,190 € per average herd, showing the concern of producers on selecting resistant animals as well as the importance of the implementation of systematic recording for clinical mastitis in Spanish dairy farms.

Additional key words: genetic selection, udder health.

Resumen

Mamitis clínica en el vacuno lechero español: incidencia y costes

Se ha estudiado la mamitis clínica en 25 explotaciones utilizando 1.054 casos registrados desde abril de 2005 a diciembre de 2006. Los objetivos del trabajo fueron determinar la incidencia, analizar si la producción se vio afectada y calcular los costes generados en el año 2006. El 25% de las lactaciones presentaron algún episodio de mamitis, siendo la recurrencia media de 1,64. El 29% de los primeros casos se diagnosticaron en el primer mes tras el parto. Las primíparas fueron más susceptibles al principio y al final de la lactación, mientras que las multíparas presentaron menos casos según avanzaba la lactación. Sólo resultaron estadísticamente significativos el rebaño y el número de lactación, siendo las vacas con más de un parto más propensas a la mamitis. La producción de leche no se vio afectada. Los costes de mamitis incluyeron los correspondientes a medicamentos y a la leche retirada no comercializada. La producción individual diaria en el momento de la infección fue estimada utilizando el control lechero mensual oficial. El coste medio de mamitis fue de 73,93 €, siendo más caro en las multíparas debido a una mayor producción. El coste medio por media de leche retirada representó el 74% del coste por caso. El coste por vaca infectada fue de 117 € por lactación, lo que supone unas pérdidas económicas anuales por rebaño medio de 3.190 €, justificando la preocupación de los productores por seleccionar animales resistentes y la necesidad de sistematizar la recogida de mamitis clínicas en las explotaciones lechera españolas.

Palabras clave adicionales: salud de la ubre, selección genética.

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Abbreviations used: AFRIGI (Asociación de Frisona de Girona), A.R. (autonomous region), DISC (discarded milk costs), EFRIFE (Federación Frisona de Euskadi), TREAT (treatment administration costs), UPM (Universidad Politécnica de Madrid).

Introduction

Breeding goal in dairy cattle is maximizing profitability by selecting animals with high production that remain as much time as possible in herd avoiding problems (i.e. functional animals). However, functionality has been endangered through years because of exhaustive selection on increasing production level and antagonistic genetic correlations between production and resistance to some diseases (Rauw *et al.*, 1998). Then, nowadays profitability depends on reducing costs more than increasing income (by improving production) and selection is focusing on functional traits, such as fertility, diseases and calving ease (Philipsson and Lindhe, 2003; Stott *et al.*, 2005).

The National Monitoring Health System (2007) reported clinical mastitis, lameness, and infertility as the most prevalent diseases. Moreover, mastitis has been described as the most common and costly disease in dairy production causing over 38% economic losses due to health problems (Seegers *et al.*, 2003). Mastitis frequency increased dramatically in the last decades. Heringstad *et al.* (1999) found that mastitis incidence in 1994 (28%) was two-times the frequency in 1978. In the last ten years, depending on populations and lactation number, averages ranged from 12% to 40% (i.e. Zwald *et al.*, 2004a; Wolfová *et al.*, 2006). Risk factors associated to clinical mastitis are milking routine, type of housing, feeding, and season, as environmental effects (Rupp, 1999). But also older cows, later first calving, first stages of lactation, and cows with deep udders, week attachments, and high production, are more liable to mastitis (Carlén *et al.*, 2004).

Health problems have negative consequences not only on animal welfare (Collard *et al.*, 2000) but also in economics of herds because of additional costs in veterinary, medicines, reduction of production, discarded milk, and involuntary culling. Thus, economic losses due to mastitis are an important concern for dairy producers though some costs are not obvious (Østeras, 2000). Mastitis losses can be classified as direct or indirect. Direct costs are due to treatment (drugs), discarded milk (unmarketable milk due to antibiotic residues), veterinary assistance, and extra labor. Indirect costs are "hidden costs": reduction of production (milk unproduced regarding to a healthy cow), involuntary culling, and even, worsening of milk quality because of changes in milk composition (Rajala-Schultz *et al.*, 1999; Østeras, 2000). Costs reported in literature range from 43 € to 189 € (equivalent to 145 € to 325 € per cow and year) depending on monetary unit and country (i.e. prices), severity level, age of cow, and on concepts considered on calculations.

Because of all mentioned above, mastitis is considered in breeding programs since long time. It has low heritability, from 0.01 to 0.11 (Rupp and Boichard, 1999; Carlén *et al.*, 2004; Zwald *et al.*, 2006). However, mastitis is not routinely recorded at commercial farms, and then, it has been mostly dealt indirectly by using indicator traits such as udder conformation, somatic cell count, and milking ease. Those traits are more heritable than mastitis and show high genetic correlations with the disease (Lund *et al.*, 1994). Progressively, most countries included some of them in their selection indexes with the aim of selecting mastitis resistant animals (Miglior *et al.*, 2005; Shook, 2006).

The aim of this study was to deal with mastitis in Spanish dairy cows using on farm records in order to reconsider clinical mastitis in the breeding goal. Then, specific objectives were to determine mastitis incidence and factors of risk, to analyze whether yield production has been affected, and to quantify mastitis costs, along 2006.

Material and methods

Since April 2005, clinical mastitis incidence are being recorded at some Spanish herds from Basque Autonomous Region (A.R.) and Gerona. Special sheets have been designed jointly between farmers associations (EFRIFE and AFRIGI) and researchers from Animal Production Department of Polytechnic University of Madrid (UPM). Farmers (or corresponding veterinary) fill those sheets and associations send them periodically to UPM, where herd, cow identification, quarter affected, dates of beginning (diagnosis) and end of treatment, treatment applied, and any observation are digitalized. Clinical mastitis was diagnosed when a cow had visually abnormal milk secretion from one or more quarters or by signs of inflammation of the udder tissue. For a same cow, two cases were considered as independent when dates of diagnosis did not match and did not overlap treatment period, regardless how many quarters were affected.

Data were edited according to different analysis in order to use as much reliable information as possible. Data from 25 herds (2,593 total cows) with continuous mastitis recording were used. Clinical cases of cows with complete and 305 days standardized lactation from the beginning of data recollection to December 2006 were used to study mastitis dynamic throughout lactation (307 cases of 184 infected lactations). Mastitis incidence and cost per case were determined using all the infections available in 2006 (1,054 cases from 643 infected cows), while cost per cow, effects of factors on udder health, and influence on total production were studied from lactations with calving from October 2005 and completed along 2006, using both healthy and mastitic cows (587 lactations).

Mastitis incidence was calculated, per year and per three-month periods, as follows:

$$\text{Incidence (\%)} = \frac{\text{Cows with one case at least}}{\text{Total cows (healthy and mastitic)}}$$

Recurrence was the ratio from number of cases and total infected cows.

Statistical analyses

Descriptive analyses were done to study mastitis distribution along the lactation. Management factors with potential effects on the incidence of mastitis were analyzed using GLM procedure of statistical package SAS (2001) for the sample under study. Fixed models were analyzed including always herd (25 classes) plus the following effects: calving month (7 classes: October to December 2005 and from January to April 2006), season of year of calving (2 classes: 2005 and 2006), lactation number (3 classes: first, second, and third or more lactation), 305 days milk production (as covariate). Interactions between calving month (and season) and parity were also studied. Mastitis occurrence within lactation (yes/no) was considered as dependant variable. Differences among least square means within effects were analyzed using Tukey's multiple means comparison test at 5% significance level. Odds ratios between levels for significant effects using models from GLM results were performed by LOGISTIC procedure.

Mastitis costs

Cost per case. Only costs due to treatment of each case were calculated, including treatment administration (TREAT) and discarded milk costs (DISC). Other costs such veterinary honoraries and production loss, were not included because of incomplete information (there is a survey in process of veterinary costs) and the need of more extensive timeframe to estimate loss in milk production. Individual treatment cost was obtained as follows:

$$\text{TREAT} = \textit{unit cost} \times \textit{daily units} \times \textit{treatdays}$$

Where *unit cost* is the cost of each applied unit of each product (milliliters or intramammary syringes); *daily units* is the quantity needed per day; *treatdays* is administration period (in days) for each medicine. Average prices of different medicines and dosage recommendations provided by veterinary services and enterprises were used to estimate product unit costs.

Along treatment period and withdrawal time (following indications of pharmaceutical laboratories for each product) milk was considered unmarketable to avoid antibiotic residuals in milk for human consumption. If more than one product was used as treatment, the longer withdrawal time was used. Discarded milk costs were individually estimated as follows:

$$\text{DISC} = \textit{daymilk} \times \textit{pmilk} \times (\textit{treatdays}+\textit{withdrawal})$$

Where *daymilk* is daily milk production (in kg); *pmilk* is average price of milk in 2006 (0.31 € kg^{-1}); *treatdays* is administration period (in days) for each medicine; *withdrawal* is days after the last administration.

Individual daily milk production at the onset of each mastitis case was estimated using updated to January 2007 monthly milking records, provided by associations, following some rules:

- If onset occurred between calving and first monthly control, average daily production was assumed the same as the first control.
- If onset occurred between two monthly controls, two intervals were considered (before and after midpoint). Daily production was estimated as the production at corresponding midpoint interval.
- If onset occurred after the last control record, one of the following situations was considered:
  - If lactation was completed (dry date was known). If onset was before dry day, daily production was assumed the same as the last control (zero otherwise).
  - If lactation was uncompleted (unknown dry day). If onset was previous to control nine (270 days in lactation), cow was considered still in lactation and daily production was assumed the same as the last control (zero otherwise).

- If two following cases occurred, overlapped milk discarded was taking into account to avoid double counting.

Cost per cow. Only one lactation per cow was available because of the short timeframe of this study. Then, cost per cow can be considered as cost per lactation as well. It was calculated as the sum of costs of all cases of the cow.

Results

Mastitis incidence and recurrence

Summary of data by parity and mastitis status (healthy/mastitic), average 305 days milk, fat, and protein yields are shown in Table 1, as well as average days in milk. Average cow from population produced 9,603 kg of milk in 328 days of lactation. Average production of healthy cows was 8,931 kg and 9,838 kg of milk, 323 kg and 354 kg of fat, and 278 kg and 314 kg of protein, for Gerona and Basque A.R., respectively. For mastitis cows, 9,320 kg and 9,929 kg of milk, 328 kg and 357 kg of fat, and 292 kg and 325 kg of protein, for Gerona and Basque A.R., were found.

Average mastitis incidence in 2006 was 24.76%. Incidence at average herds from Gerona was higher than in Basque A.R. (31% and 19%, respectively). In the period of study, 1,054 cases (477 in Basque A.R. and 577 in Gerona) corresponding to 643 cows were recorded. Then, an average recurrence of 1.64 cases per cow was obtained. A 38% of cows presented more than one mastitis episode. Moreover, almost 13% of infected cows had at least three cases in 2006. Figure 1 presents mastitis incidence by lactation number and zone over all population. In general, first lactation cows had lower mastitis frequency (6%) than multiparous (8% and 10% for second and third plus lactations, respectively). Increasing trends by lactation number were more pronounced in Basque A.R. Frequencies for primiparous in Gerona were almost two-fold than in Basque A.R. (8% and 5%, respectively).

Clinical mastitis distribution

Along 2006, the first three-month period (winter) showed 32% of infections, followed by summer (26%), spring, and autumn, with 22% and 20%, respectively. Three-monthly distribution of clinical mastitis cases is presented in Figure 2. By regions, in Gerona, winter and summer were the most prevalent periods, whereas in Basque A.R. was the first three months of 2006. Probably reasons are weather and labor time. Farmers justified that spring is the busiest period of the year and they usually spent less time on recording data, as well as in autumn. Then, maybe the information in late 2006 could not be complete.

The 49% of all mastitis cases occurred within 90 days after calving (not shown). Distribution of first

Table 1. Data considered in this study: number of cows, production yield and lactation length

	Population of 25 herds	Complete lactations in 2006			
		Gerona		Basque A.R.	
		Healthy	Mastitic	Healthy	Mastitic
Cows	2,593	161	104	242	80
- First lactation	1,436	77	35	122	16
- Second lactation	608	46	27	57	26
- Rest of lactations	549	38	42	63	38
305 days kg milk	9,603 ± 1,939	8,931 ± 1,781	9,320 ± 1,521	9,838 ± 2,190	9,929 ± 1,986
305 days kg fat	344 ± 74	323 ± 71	328 ± 66	354 ± 83	357 ± 75
305 days kg protein	302 ± 58	278 ± 55	292 ± 49	314 ± 56	325 ± 52
Days in lactation	328 ± 111	315 ± 41	313 ± 37	309 ± 43	315 ± 49

A.R.: autonomous region

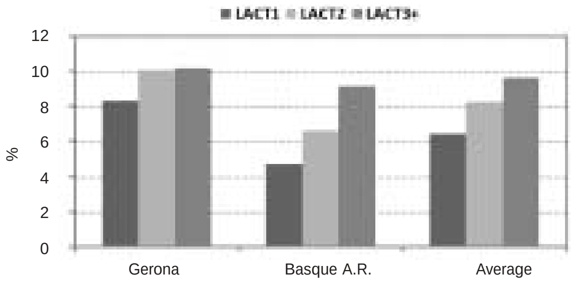

Figure 1. Mastitis incidence (%) in first (LACT1), second (LACT2), and rest of lactations (LACT3+) for Gerona, Basque Autonomous Region, and average population.

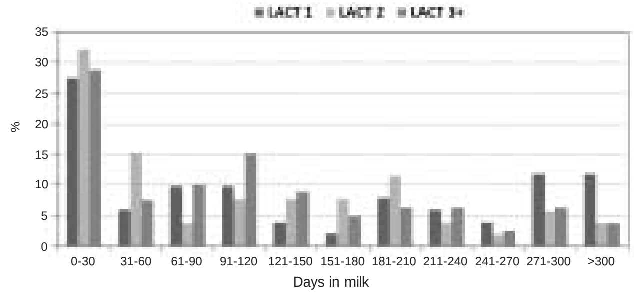

Figure 3. First-case mastitis occurrence throughout lactation by parity.

infections throughout lactation is presented in Figure 3, for first, second and third or more lactations. First case was mostly diagnosed in the first month (29%). After this period, behavior of primiparous and multiparous was slightly different. Cows with more than one calving showed first infection mostly at early lactation whereas in primiparous 12% of first cases also occurred over 270 days in milk. In Figure 4, weekly distribution over the first four months of lactation is shown. Cows in first lactation were most prone to mastitis within the first 7 days after calving, whereas for multiparous liability remained until fourth week.

Management factors and mastitis effect on production

Calving month (and season), production level, and age of cow (by parity) were analyzed as factors of risk using completed lactations in 2006. No statistically significant effects (at 5% level) on mastitis other than herd and lactation number were found. Nor were interactions neither 305 days production as covariate. Regarding to lactation number, multiparous cows were more liable to suffer mastitis (coefficient of determination of 0.1438). Odds ratios for first and second lactation regarding to third and more lactations were 28% and 69%, respectively. There were not differences in milk, fat, and protein yield per lactation between healthy and mastitic cows. Stage of lactation did not result statistically significant on mastitis incidence.

Mastitis costs

Average mastitis case cost was 73.93 € (Table 2). Discarded milk costs represented 74% of total cost per case. Regarding to lactation number, average mastitis case in primiparous was slightly cheaper than a case in multiparous. Costs were higher for cows with at least three calvings than for cows in second lactation in Gerona whereas in Basque A.R. costs were similar. Taking

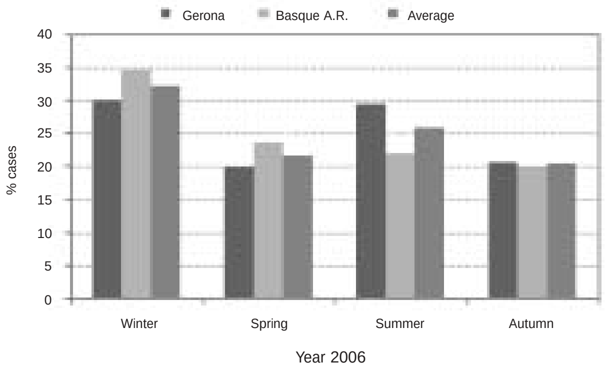

Figure 2. Distribution of clinical mastitis cases by three-month periods of 2006**.**

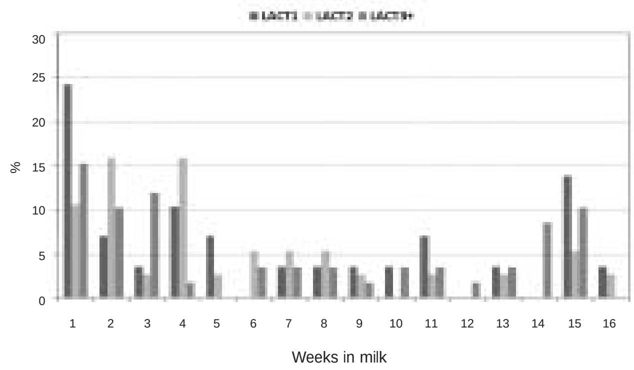

Figure 4. Distribution of first mastitis cases within the first four months of lactation by parity.

Table 2. Average mastitis costs (€) and case costs (€) for first (LACT1), second (LACT2), and later lactations (LACT3+) by regions

	Gerona	Basque A.R.	Average
Cost/case	80.50 ± 31.94	66.28 ± 30.96	73.93 ± 32.26
Treatment	23.32 ± 16.95	19.55 ± 14.79	21.57 ± 16.07
Discarded milk	59.24 ± 20.85	49.06 ± 24.65	54.57 ± 23.22
LACT1	72.50 ± 27.38	56.75 ± 25.64	66.64 ± 27.74
LACT2	82.19 ± 32.30	68.61 ± 28.80	76.05 ± 31.46
LACT3+	85.54 ± 33.96	68.79 ± 33.90	76.67 ± 34.90
Cost/cow	116.09 ± 58.63	117.74 ± 77.44	116.85 ± 67.71
LACT1	100.49 ± 53.93	104.21 ± 81.34	101.81 ± 63.66
LACT2	135.33 ± 72.73	99.21 ± 57.96	117.73 ± 67.61
LACT3+	113.75 ± 49.13	133.89 ± 84.96	123.82 ± 69.57

into account all cases throughout a lactation, mastitis cost per infected cow and lactation was 117 €, what represents 29 € per present cow at herd.

Discussion

Average mastitis incidence in our population agreed with other studies. Literature reports mastitis incidences from 11% to 40% in different dairy populations (Heringstad *et al.*, 2000; Kadarmideen and Pryce, 2001; Valde *et al.*, 2005). Results obtained by lactation number are in accordance too with those populations, with statistically significant higher frequency in multiparous than in first-lactation cows (Hagnestam *et al.*, 2007). Cows with more than one calving were more prone to mastitis due to physical alterations of udder. Along the productive life, teat canal loses its elasticity and udder attachments become relaxed, increasing the risk of mastitis (Zwald *et al.*, 2004b). Regarding to recurrence, our results (1.64) were slightly higher than, for instance, 1.4 reported by Wilson *et al.* (2004), and should be remarked that 38% of cows were recurrent.

Descriptive analyses regarding to mastitis distribution throughout lactation and risky seasons were consistent with larger populations. However, the small data set could have conditioned statistical analyses and unexpected results were found. For instance, the effect of production level could have been hidden by herd, which absorbed almost all variability. Further, consequences of mastitis on lactation yielding could also be biased due to conditions imposed such as using 305 days standardized lactations, because there was no difference between a cow culled by mastitis before a minimum milking period and another with lactation in course. However, despite no significant differences were found by stage of lactation our results were similar to other studies. The most liable period was the first month of lactation, as also found Carlén *et al.* (2004), Zwald *et al.* (2004a, 2006), and Harder *et al.* (2006). First cases of primiparous occurred mostly during the first week (Rajala-Schultz *et al.*, 1999; Wilson *et al.*, 2004). Some differences in mastitis distribution were found in first and second-plus lactations with other works. Wilson *et al.* (2004) reported that in primiparous fewer cases were detected from the second week onward while in our study mastitis increased in last stages, close to next calving. Regarding to calving season (or calving month), there is no consensus in literature. Rupp (1999) found statistically significant more incidences in heifers (but not in multiparous) with calvings from November to April. Other studies showed summer as the most influencing period because of heat stress. Riekerink *et al.* (2007) pointed out that influence of calving season is different depending on pathogens involved.

Average costs in Gerona and Basque A.R. were 80.50 € and 66.28 € per case, respectively. Differences were due to treatment protocols applied in both zones. Economic losses due to mastitis were estimated at 117 € per infected cow and lactation (29 € per cow present in herd). Literature reports a wide range of mastitis costs depending on concepts included on calculations. Wolfová *et al.* (2006) estimated losses from 43.63 € to 84.84 € in Czech Republic, including costs from discarded milk, drugs, veterinary service, extra labor time, antibiotic for drying of cows, and an extra milking machine. For a population from United States, Shim *et al.* (2004) reported 134 € as losses from milk (unproduced and unmarketable) and treatment. Mastitis was more expensive in multiparous than first-lactation cows because of higher milk yield. Taking into account the results obtained, in an average herd of our population with 110 cows, mastitis costs were 3,190 € per year, only counting for treatment and discarded milk, and it would be higher if milk price increases.

Then, this study dealing with clinical mastitis in Spain from on farm data reported a way to estimate mastitis costs due to treatment and discarded milk. Future works should consider veterinary, milk yield reduction, and replacement costs in order to take into account mastitis in a profit function to obtain economic importance of mastitis regarding to other production traits. Moreover, with the final aim of including resistance to clinical mastitis in the breeding goal on selection scheme by developing an udder health index, as much information as possible it is necessary to obtain reliable genetic evaluations and parameters of clinical mastitis because of the low heritability showed in other studies. Thus, because of the concern of dairy farmers in animals without health problems to avoid extra-costs, it would be recommended to implement a routinely recording system of clinical mastitis throughout the Spanish dairy population.

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