Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

RESEARCH ARTICLE

Dairy Herd Mastitis Program in Argentina: Farm Clusters and Effects on Bulk Milk Somatic Cell Counts

C Vissio[1]*, SA Dieser[2], CG Raspanti[2], JA Giraudo[1], CI Bogni[2], LM Odierno[2] and AJ Larriestra[1]

[1]Departamento de Patología Animal, Facultad de Agronomía y Veterinaria, Universidad Nacional de Río Cuarto, Ruta 36 km 601 Código Postal X5804BYA, Río Cuarto, Córdoba, Argentina; [2]Departamento de Microbiología e Inmunología, Facultad de Ciencias Exactas, Físico-Química y Naturales, Universidad Nacional de Río Cuarto, Ruta 36 km 601 Código Postal X5804BYA, Río Cuarto, Córdoba, Argentina
*Corresponding author: cvissio@ayv.unrc.edu.ar

ARTICLE HISTORY

Received: March 15, 2012
Revised: May 11, 2012
Accepted: July 16, 2012

Key words:
Cluster analysis
Dry cow therapy
Mastitis control
Mastitis management
Post-dipping

ABSTRACT

This research has been conducted to characterize dairy farm clusters according to mastitis control program practiced among small and medium dairy producer from Argentina, and also to evaluate the effect of such farm cluster patterns on bulk milk somatic cell count (BMSCC). Two samples of 51 (cross-sectional) and 38 (longitudinal) herds were selected to identify farm clusters and study the influence of management on monthly BMSCC, respectively. The cross-sectional sample involved the milking routine and facilities assessment of each herd visited. Hierarchical cluster analysis was used to find the most discriminating farm attributes in the cross sectional sample. Afterward, the herd cluster typologies were identified in the longitudinal sample. Herd monthly BMSCC average was evaluated during 12 months fitting a linear mixed model. Two clusters were identified, the farms in the Cluster I applied a comprehensive mastitis program in opposite to Cluster II. Post-dipping, dry cow therapy and milking machine test were routinely applied in Cluster I. In the longitudinal study, 14 out of 38 dairy herds were labeled as Cluster I and the rest were assigned to Cluster II. Significant difference in BMSCC was found between cluster I and II (60,000 cells/mL). The present study showed the relevance and potential impact of promoting mastitis control practices among small and medium sized dairy producers in Argentina.

To Cite This Article: Vissio C, SA Dieser, CG Raspanti, JA Giraudo, CI Bogni, LM Odierno and AJ Larriestra, 2013. Dairy herd mastitis program in Argentina: farm clusters and effects on bulk milk somatic cell counts. Pak Vet J, 33(1): 80-84.

INTRODUCTION

In the last decade, the Argentina dairy sector has undergone a deep transformation. The country's milk production is growing steadily, with a decrease in number of herds of smaller size. In spite of that, the dairy industry is dominated by small-scale dairy farmers, those dairy farms producing less than 2,000 liters/day. This herd stratum represents 80% of the dairy operations in the Córdoba province and 70% of Argentina's dairies. Among these producers, no systematic description of health standards for mastitis status and management is available. Therefore, studies to assess the implementation of good practices in small and medium size dairy farmers in Argentina for mastitis control are needed. The basis of the mastitis control consists of a few therapeutic and preventive measures of well known efficacy (Hogeveen *et al.,* 2011). The tools for the control of mastitis, such as dry cow therapy and post-dipping, are interventions included in the checklist known as 'Five Point Plan' (post-milking teat dipping, dry cow therapy, pre-milking hygiene, proper function and operation of milking equipment, and appropriate treatment of clinical case). The implementation of the 'Five Point Plan' helped to dramatically reduce the incidence of contagious mastitis and BMSCC (Bradley, 2002). The level of implementation of the 'Five Point Plan' among producers is important in order to assess the quantification and the effectiveness of the interventions used among small and medium sized dairy herds in Argentina. No previous study has been conducted in Argentina to describe the effects of management styles on mastitis control among small and medium sized dairy farmers. An understanding of the variation of the management profile can help devise outreach programs targeted to specific groups of farmers (Sraïri and Lyoubi, 2003; Østerås and Sølverød, 2009; Brightling *et al.*, 2009; Avilez *et al.*, 2010). The objectives of this research were to 1) identify dairy farm clusters based on udder health management style of small and medium size producers from Argentina and 2) study the influence of herd management styles on monthly BMSCC.

MATERIALS AND METHODS

The target population was dairy farms located in Córdoba province, Argentina. The producers' association of the region provided the roster and records of herd size. The farms involved in the cross-sectional study constituted a sample of 51 dairies, randomly selected from the roster. The herds studied (n=51) represented a sampling fraction of 15.1%. Forty-five out of 51 (87%) producers agreed to participate upon the first call, whereas those who declined (n=6) were randomly replaced by a second round of invitations. The sample size was set to 51 herds for practical and economic reasons.

All selected farmers received a letter describing the study, and then the herds were contacted by phone. The herds (n=51) were visited once between March and September 2007. Each herd visit involved the following systematic procedure (1) Visual assessment of routine and parlor characteristics during milking using a checklist (2) Collection of bulk tank milk sample. BMSCC was determined using Somacount 300 (Bentley, USA 1997) within the collection day. (3) Administration of a questionnaire to the farmer. The questionnaires were developed following detailed discussion with specialists working in the milk quality area and examination of the main factors known to affect BMSCC, such as milking parlor, milking practices, and diagnosis and control of mastitis. The first author was the only interviewer in all farms. The questionnaire topics were divided into five items and to reduce collinear variables, each item was subjected to Multiple Correspondence Analysis (MCA). Variables selected by MCA were those with high relative weight considering Axes 1.

All variables selected within each item, were subjected to Hierarchical cluster analysis to typify the herds. The measure of distance applied was Gower [sqrt(1-S)]. Descriptor variables statistics were calculated for each farm clusters. Logistic regression was used to model BMSCC as binary dependent variable (lower or higher than the population median). The cluster category was the predictor and herd size was included in the model to control for confounding. A $P<0.05$ was considered statistically significant. A prospective evaluation of BMSCC including 38 dairy farms (longitudinal sample) located in the same region was performed. These farms were members of a cooperative association, which carried out monthly BMSCC throughout the study period, since July 2007 to June 2008. Each farm was visited once and the dairymen interviewed using checklist. Using the descriptor variables of the cluster analysis output, each farm was labeled as either Cluster I or II. Association between cluster and in BMSCC was examined using a linear mixed model with herd random effects. The ln BMSCC was analyzed using a MIXED model with repeated measures in R (http://www.r-project.org/ version 2.2.0) to evaluate the effect of cluster. First order autoregressive correlation was used as covariate structure for repeated measures analysis. The model included the fixed effect of cluster (I and II) and the random effect of herd. The data are discussed if an overall time effect was with $P<0.05$. The model was as follows: ln BMSCC = intercept + β1cluster + random effect "herd" + ε. Normality and homocedasticity were evaluated by means of residual analysis.

RESULTS AND DISCUSSION

The herd size distribution of the cross sectional sample and farms involved in the prospective study showed a similar pattern as the target population (Table 1). The consistency of herd size distribution observed between studied farms and the target population suggests a good sampling performance. As a result, we had confidence on regarding the inferences derived from this study for small and medium size dairy herds from Argentina. The quality of survey statistics is also influenced by the non-response rate (Groves *et al*., 2004). Issues such as the failure to deliver the survey request, the refusal and inability to participate, are critical aspects to monitor and reduce the survey bias (Dunn *et al*., 2004). The response rate achieved in this survey was 87%, which is considered appropriate for interview-based studies (Singleton and Straits, 2009). This may be related to the multiple ways participants were contacted (letter and phone calls), which has been described as a critical aspect to keep a high level of participant compliance (Groves *et al*., 2004). The 38 herd descriptors collected in the questionnaire were grouped in 5 items: level technology, parlor characteristics (Table 2), milking routine and mastitis control (Table 3), herd structure (Table 4), and socio-demographic characteristics of dairymen (Tables 2 and 4). In overall, during the milking routine, the udder washing was done by almost all dairymen, but neither of them dried. In addition, the pre-dipping was used at only one farm. The diagnosis of subclinical mastitis was not a routine procedure among the producers. Furthermore, treatment with antibiotics of clinical mastitis (cases) was performed at 96.4% of the farms and the most of them applied intramammary therapy. The herd BMSCC median (n=51) from the samples collected was 329,000 cells/mL (1st quartile: 269,000 cells/mL, 3rd quartile: 537,000 cells/mL). In similar way, previous research conducted in Argentina reported 51.7% dairies with BMSCC lower than 350,000 cells/mL (Acuña *et al*., 2001). The herd descriptors to discriminate clusters were milk production (liters/day/cow), interval between veterinary visits, post-dipping, dry cow therapy, age of the dairymen and interval between milking machine tests. These farm attributes were able to identify two clusters, with a cophenetic correlation coefficient of 0.81, which suggests a high relation between distances in the reduced space and distances in the original space. The dairies included in the Cluster I practiced post-dipping and dry cow therapy on a regular basis. In contrast, such interventions were poorly applied at farms included in the Cluster II. Other distinctive

Table 1: Herd size distribution (total cows/herds) for target population and study samples

Target population and study samples	Size distribution (total cows / herds)				
	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Target population (n=338)	43	146.5	187	283.5	495
Cross-sectional sample (n=51)	95	135	160	200	284
Longitudinal sample (n=38)	102	154	187	233	277

Table 2: Herd descriptors about level technology, parlor characteristics and socio-demographic characteristics of dairymen for the cross-sectional sample of small and medium dairy farms (n=51) from Córdoba, Argentina (2007)

Item	Variables	Classes	Number of farms	Frequency (%)
Level technology	Milk production records	Yes	20	39.2
		No	31	60.8
	Artificial insemination	Yes	21	41.2
		No	30	58.8
	Computerized record keeping	Yes	28	54.9
		No	23	45.1
	Interval between vet visit	≤ 60 days	38	74.5
		> 60days	13	25.5
Parlor characteristics	Milking parlor type	Tandem	41	80.4
		Parallel	10	19.6
	Interval between milking machine test	≤4 months	24	47.1
		>4 months	27	52.9
	Bulk tanks	Yes	44	86.3
		No	7	13.7
Socio-demographic characteristics of dairymen	Educational level	None	13	25.5
		Primary school	31	60.8
		Secondary school	7	13.7
	Educational course in dairy-health management	Yes	7	13.7
		No	44	86.3
	Use gloves during milking	Yes	5	9.8
		No	46	90.2

features between clusters were the milk production (liters/cow/day), the intervals of veterinary visits and milking machine tests. In this sense, the Cluster I showed the best performance (Table 5). The cluster category had no effect on the BMSCC even after the adjustment for herd size in the logistic regression model. Although, the cluster analysis was able to identify two groups of farms, however, when such category was included as predictor in the logistic model, no differences were found in BMSCC. Previous research found a high concordance between health profile and farm types (Faye, 1991). Considering management, structure and production record data, these authors described three different clusters, which showed association with health farm profile. Using a longitudinal approach, Faye *et al.* (1994) found association between six herd clusters with different levels of "udder infection complex" and dipping practices, covering of the milking parlor, disinfection practices, housing cleanliness and milk production. The reason of the lack of association in our study could be due to the use of the cross-sectional sample, where the BMSCC assessment and the herd descriptors were evaluated at the same time. A longitudinal design would be more appropriate to evaluate the association of herd management styles on udder health performance (Schukken *et al.*, 2003; Dufour *et al.*, 2011). In respect to prospective evaluation of BMSCC, the herds belonging to the longitudinal sample that were assigned to Cluster I (n=14) applied dry cow therapy, post-dipping and regular milking machine tests. In the case of the

Table 3: Herd descriptors about milking routine and mastitis control for the cross-sectional sample of small and medium dairy farms (n=51) from Córdoba, Argentina (2007)

Variables	Classes		Number of farms	Frequency (%)
Treatment of clinical cases	Yes		49	96.1
	No		2	3.9
Type of therapy of clinical case	Intra-mammary		42	82.4
	Systemic		7	13.7
Microbiology analysis of milk sample from clinical mastitis	Yes		6	11.8
	No		45	88.2
Cows with clinical mastitis milked last	Yes		7	13.7
	No		44	86.3
Diagnosis of subclinical mastitis	Yes		1	2
	No		50	98
Drying-off management	Suddenly plus food restriction		21	41.2
	Milking every two days with food restriction		20	39.2
	Milking every two days without food restriction		10	19.6
Years of dry cow therapy	None		13	25.5
	Less than a year		8	15.7
	At least 1 year		30	58.8
Milking practices	Udder washing	Yes	48	94.1
		No	3	5.9
	Use paper towels	Yes	0	0
		No	51	100
	Teat pre-dipping	Yes	1	2
		No	50	98
	Milk stripping	Yes	35	68.6
		No	16	31.4
	Teat post-dipping	Yes	20	39.2
		No	31	60.8

Table 4: Herd descriptors about herd structure and socio-demographic characteristics of dairymen for the cross-sectional sample of small and medium dairy farms (n=51) from Córdoba, Argentina (2007)

Items	Variables	Mean (Standard deviation)	Range
Herd structure	Total hectares	203.3 (91.4)	80-543
	Hectares cattle	155.8 (43.6)	70-273
	Liters/cow/day	16.96 (3.7)	9-27
	Liters/day	2231.4 (863)	600-4300
	Total cows	165 (43.9)	100-284
Socio-demographic characteristics of dairymen	Age (years)	40.9 (11.2)	21–65
	Peoples working in milking parlor	2.39 (0.63)	1-4

Table 5: Characteristics of the farms cluster identified among small and medium herd size dairies (n=51) from Córdoba, Argentina (2007)

		Cluster I (n=18)	Cluster II (n=33)
		% of farms	% of farms
Categorical variables			
Interval between vet visit	Often (≤ 60 days)	83.3	69.7
Interval between milking machine test	Often (≤ 4 months)	44.4	36.4
Teat post-dipping		100.0	6.1
Years of dry cow therapy	At least 1 year	83.3	45.5
	Less than a year	11.1	18.2
Continuous variables			
Dairymen age (mean±SD)		40.0±11.5	41.4±11.2
Milk in Liters/cow/day (mean±SD)		18.8±3.5	16.0±3.6

SD: standard deviation

dairies assigned to Cluster II (n=24), 75% of the farmers applied two of the aforementioned interventions, while the rest applied only one or none. The repeated measures analysis revealed significant differences between clusters (P=0.03). The ln BMSCC average was slightly higher for Cluster II in comparison to Cluster I. The ln BMSCC averages were 5.62 (SE=0.07) and 5.81 (SE=0.06) for Cluster I and II, respectively. The monthly ln BMSCC gap between Cluster I and II was relatively constant overtime with an average of 60,000 cells/mL (Fig. 1).

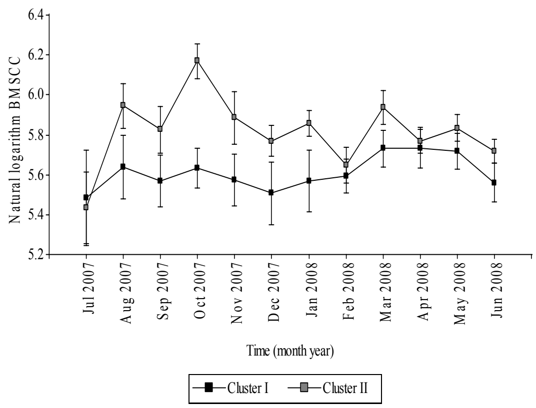

Fig. 1: Monthly bulk milk somatic cell count (BMSCC) averages and standard deviation for herds belong to Cluster I (n=14) and Cluster II (n=24).

The BMSCC gap detected between clusters provides some evidence about the effectiveness of the udder health program implemented in those diaries included within the Cluster I. Previous research (Barkema *et al.*, 1998; Wenz *et al.*, 2007; Kelly *et al.*, 2009; Hussain *et al.*, 2012a, 2012b) showed the association between management styles and changes in BMSCC overtime, sustaining the use of good practices against mastitis. In this sense, Fenlon *et al.* (1995), Barkema *et al.* (1998), and Wenz *et al.* (2007), classified herds as "low", "borderline" and "high" based on BMSCC, and evaluated herd management profiles for each BMSCC farm strata. Fenlon *et al.* (1995) found that post-dipping and the regular program of milking machine test were common practices within the farms classified as "low". Barkema *et al.* (1998) found that 93.2 and 75.3% producers that applied dry cow therapy and post-dipping, respectively, belonged to the "low" group (low BMSCC). Wenz *et al.* (2007), within the "low" group, identified a high frequency of farms applying the same procedures. In addition, Kelly *et al.* (2009), using linear models, found that dairies in which post-dipping was applied the BMSCC was 30,000 cells/mL lower than herds that did not practice such intervention. The same authors also found that dry cow therapy reduced the BMSCC average to a value of 77,000 cells/mL. The BMSCC patterns showed by Kelly *et al.* (2009) are consistent with our results, although they reported the decrease of the BMSCC for each particular intervention. Both were observational studies where herd was the unit of concern, because of that is not possible to control the confounding effect due to intra-herd variability of management. Therefore, the associations found must be interpreted with caution. In addition, it is also possible to make false inferences, wrongly assuming that associations observed at herd level do not represent association that could exist at individual level (Diez Roux, 2004). The implementation of a mastitis control program was the main difference found between farm clusters. Farmers' attitude and understanding udder health is critical to implement a control program (van Asseldonk *et al.*, 2010; Hogeveen *et al.*, 2011; Kristensen and Jakobsen, 2011). In the present research, the only human factor included in the cluster analysis was dairymen age which showed similar distribution in both clusters. However, other authors have found associations between management style and udder health status (Barkema *et al.*, 1999; Jansen *et al.*, 2009; Atasever, 2012).

Conclusion: This study highlighted management patterns of mastitis control schemes among small and medium size dairy farms in Argentina. Herd characteristics and mastitis control program described two well differentiated farm clusters regarding the 'Five Point Plan' An additional herd sample studied longitudinally, showed lower BMSCC average for herds assigned to Cluster I (good practices) in comparison to farms labeled as Cluster II. The present study showed the relevance and potential impact of promoting good practices in mastitis control.

Acknowledgement: This work was supported by grants from SECyT (Secretaría de Ciencia y Técnica, Universidad Nacional de Río Cuarto) and FONCyT (Agencia Nacional de Promoción Científica y Tecnológica).

REFERENCES

Acuña CN, RE Chertcoff and APM Margariños Pinat, 2001. Somatic cell count and bacteriological status of bulk tank milk samples from Argentine dairy farms. Proc 40th Ann Meet Natl Mastitis Council, Reno, Nevada, USA, 11-14 Feb, pp: 175-176.

Atasever S, 2012. Estimation of correlation between somatic cell count and coagulation score of bovine milk. Int J Agric Biol, 14: 315–317.

Avilez JP, P Escobar, G von Fabeck, K Villagran, F Garcia, R Matamoros and AG Martínez, 2010. Productive characterization of milk farms using multivariate analysis. Rev Cient (Maracaibo), 20: 74-80.

Barkema HW, JD van der Ploeg, YH Schukken, TJGM Lam, G Benedictus and A Brand, 1999. Management style and its association with bulk milk somatic cell count and incidence rate of clinical mastitis. J Dairy Sci, 82: 1655-1663.

Barkema HW, YH Schukken, TJ Lam, ML Beiboer, G Benedictus and A Brand, 1998. Management practices associated with low, medium and high somatic cell counts in bulk milk. J Dairy Sci, 81: 1917-1927.

Bradley AJ, 2002. Bovine mastitis: an evolving disease. Vet J, 164: 116-128.

Brightling PB, RD Dyson, AF Hope and JA Penry, 2009. A national programme for mastitis control in Australia: Countdown downunder. Ir Vet J, 62: 52-58.

Diez Roux AV, 2004. The study of group-level factors in epidemiology: rethinking variables, study designs, and analytical approaches. Epidemiol Rev, 26: 104-111.

Dufour S, A Fréchette, HW Barkema, A Mussell and DT Scholl, 2011. Invited review: Effect of udder health management practices on herd somatic cell count. J Dairy Sci, 94: 563–579.

Dunn KM, K Jordan, RJ Lacey, M Shapley and C Jinks, 2004. Patterns of consent in epidemiologic research: evidence from over 25000 responders. Am J Epidemiol, 159: 1087-1094.

Faye B, 1991. Interrelationship between health status and farm management system in French dairy herds. Prev Vet Med, 12: 133-152.

Faye B, N Dorr, F Lescourret, J Bamouin and M Chassagne, 1994. Farming practices associated with the udder infection complex. Vet Res, 25: 213-218.

Fenlon DR, DN Logue, J Gunn and J Wilson, 1995. A study on mastitis bacteria and herd management practices to identify their relationship to high somatic cell counts in bulk tank milk. Br Vet J, 151: 17-25.

Groves RM, FJ Fowler, MP Couper, JM Lepkowski, E Singer and R Tourangeau, 2004. Survey Methodology: Wiley series in Survey Methodology, New York, USA, pp: 43-198.

Hogeveen H, K Huijps and TJGM Lam, 2011. Economic aspects of mastitis: New developments. N Z Vet J, 59: 16-23.

Hussain R, MT Javed, A Khan, F Mahmood and R Kausar, 2012a. Mastitis and associated histo-pathological consequences in the context of udder morphology. Int J Agric Biol, 14: 947 952.

Hussain R, A. Khan, MT Javed and F. Rizvi, 2012b. Possible risk factors associated with mastitis in indigenous cattle in Punjab, Pakistan. Pak Vet J, 32: 605-608.

Jansen J, BHP van den Borne, RJ Renes, G van Schaik, TJGM Lam and C Leeuwis, 2009. Explaining mastitis incidence in Dutch dairy farming: The influence of farmers' attitudes and behaviour. Prev Vet Med, 92: 210-223.

Kelly PT, K O'Sullivan, DP Berry, SJ More, WJ Meaney, EJ O'Callaghan and B O'Brien, 2009. Farm management factors associated with bulk tank somatic cell count in Irish dairy herds. Ir Vet J, 62: 45-51.

Kristensen E and EB Jakobsen, 2011. Challenging the myth of the irrational dairy farmer; understanding decision making related to herd health. N Z Vet J, 59: 1-7.

Østerås O and L Sølverød, 2009. Norwegian mastitis control programme. Ir Vet J, 62: 26-33.

Schukken YH, DJ Wilson, F Welcome, L Garrison-Tikofsky and RN Gonzalez, 2003. Monitoring udder health and milk quality using somatic cell counts. Vet Res, 34: 579-596.

Singleton RA and B Straits, 2009. Approaches to Social Research. 5 Ed, Oxford University Press, New York, USA, pp: 654.

Sraïri MT and R Lyoubi, 2003. Typology of dairy farming systems in Rabat Suburban región, Morocco. Arch De Zoot, 52: 47-58.

van Asseldonk MAPM, RJ Renes, TJGM Lam and H Hogeveen, 2010. Awareness and perceived value of economic information in controlling somatic cell count. Vet Rec, 166: 263-267.

Wenz JR, SM Jensen, JE Lombard, BA Wagner and RP Dinsmore, 2007. Herd management practices and their association with bulk milk somatic cell count on United States dairy operations. J Dairy Sci, 90: 3652-3659.