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The Management Practices Associated With Prevalence and Risk Factors of Mastitis in Large Scale Dairy Farms in Thuringia, Germany (ii-Management and Hygienic)

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Abstract: The current study was conducted to investigate the management and hygienic factors that found to be associated with prevalence of mastitis in dairy herds in Thuringia, Germany. For the purposes of the field research eighty four dairy farms were involved in the study. Milk samples (64542) from 10741 dairy cows were randomly collected and subjected to a bacteriological investigation. The relevant recorded performance data were obtained from the national data center (VIT), Verden. Suitable statistical analysis models were selected to test the effect of some management and hygienic factors on prevalence of mastitis. The results found that the probability of encountering mastitis was higher, in tie-stall housed cows, and with the use of pipe milking unit ($p<0.001$; OR, 3.23 and 2.66 respectively). Meanwhile it was found that ignorance of inter-milking sanitation (IMS) and the moist means of udder cleaning in addition to the non use of post-milking teat disinfection were associated with increased risk of mastitis ($p<0.001$; OR, 4.49, 3.10 and 3.68 respectively).

Key words: Odds ratio, mastitis, risk factors, prevalence, dairy cows, inter-milking sanitation, post-milking teat disinfection

INTRODUCTION

In most countries of the world, dairy cattle breeding programs are directed toward milk production traits. Although these traits are of primary economic importance, functional traits such as longevity, fertility and udder health are of increased interest to producers to improve herd profitability. Mastitis is defined as an infection of the udder, caused by bacteria entering the quarter through the teat end (Rodenburg, 1990). According to the US national mastitis council (1996); mastitis is an inflammation of the mammary gland in response to injury for the purpose of destroying and neutralizing the infectious agents and to prepare the way for healing and return to normal function. Mastitis is one of the most common dairy diseases (Rajala-Schultz *et al.*, 1999) because of its high incidence (Seegers *et al.,* 1997a and Seegers *et al.,* 1997b). A group of researchers (Weller *et al.,* 1992; Lund *et al.,* 1994; Pösö and Mäntysaari, 1996 and Emanuelson and Oltenacu, 1998) reported that direct selection against clinical mastitis is difficult because in most countries other than the Nordic ones clinical mastitis event is not widely recorded. And because the corresponding heritability of the trait is very low close to 0.02, while Heringstad *et al.* (1999) estimated heritability of clinical mastitis in Norwegian cattle to be 0.035. Straw yard compared to cubicle housing as well as practicing post-milking teat disinfection was found to increase the incidence rate of clinical mastitis (Peeler *et al.,* 2000). Bray and Shearer (2003) claimed that milking machine has little effect on mastitis if properly operated

Barkema *et al.* (1999) attributed the increase in the incidence rate of clinical mastitis in herds practicing post-milking teat disinfection to *E. coli* infections. Natzke (1981); Pankey (1989); Boddie *et al.* (1993) and Malinowski (2000), concluded that pre-milking udder hygiene and teat dipping are aimed at reducing infections mainly caused by contagious pathogens and preventing new infections and to a lesser extent at preventing infections that might be caused by environmental pathogens. Biffa *et al.* (2005) recently in Ethiopia found that Prevalence of mastitis was significantly influenced by inadequate sanitation of dairy environment. ($\chi^2= 28.7$, $p < 0.001$).

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The objective of the study was to survey and investigate the management and hygienic factors most likely influencing the prevalence and risk factors associated with mastitis in large scale dairy farms.

MATERIALS AND METHODS

The study period was June 1998 to April 2000. Farms included in the study (48 large scale dairy farms) are among 572 dairy farms in the state of Thuringia, Germany. The study included a total of 64542 milk samples, of which 56950 were udder quarter samples and 7592 were whole milk samples from 10742 cows. Herd size, herd management, housing, feeding regime and husbandry system data were obtained using a questionnaire. Milk performance data was supplied by the national data center (VIT) at Verden. Regularly collected milk samples were subjected to bacteriological investigations at the Animal Health Service, Mastitis Laboratory at Bad Langensalza (Thuringia). The three sources of the data were merged into one data set (SAS, 1996). Mastitis pathogens isolated were categorized into two groups (contagious and environmental). Table 1 summarizes the factors distribution of the data.

Table 1: Distribution of the data

Factor	No. of classes	Definition
Housing system	3	Loose housing (slat or plan floor) and tie-stall system
Milking equipment	3	Pipe system, carrousel and milking parlor
IMS	2	Used, not used
Type of udder Cleaning	2	Moist, dry
Teat disinfection	2	Used, not used

IMS= Inter-milking sanitation

The procedure freq. was employed to compute the frequencies of contagious and environmental groups of bacteria (SAS, 1996). χ^2-test was achieved to test the significance of pathogens encountered in the udder quarters and the udder samples in accordance with the factors studied.

For the investigation of the relationship between the probabilities of occurrence of mastitis in response to management and hygienic factors, logistic regression analysis was performed in which logistic regression model was used. Maximum Likelihood was used to estimate the unknown parameter β with the aid of the procedure logistic (SAS, 1996). χ^2-test was used to examine the statistical significance. The following model was chosen after many trials:

$$\text{Logit}(\rho_i) = b_o + \Sigma b_{(1)} a_i + \Sigma pa_i + \text{Anim}_o$$

Where:

- ρ_i = Probability of occurrence of mastitis,
- b_o = Intercept,
- $b_{(1)}$ = Regression coefficient of the i^{th} risk factor,
- Σpa_i =fixed effect of the i^{th} risk factor,
- Anim_o =Random effect of the o^{th} animal,

(i = housing system, milking equipment, IMS, type of udder cleaning and teat disinfection).

RESULT AND DISCUSSIONS

In order to over-come the obstacle of complex interrelationship of quarters and the effect of one pathogen on the risk of infection with another, analysis was carried out on both quarter and cow levels. Table 2 summarizes the management and hygienic risk factors associated with prevalence of mastitis. Results in Table 3 showed that housing systems were found to influence the prevalence of mastitis significantly; tie system was at far high risk of developing mastitis ($p<0.001$; 30.70%; OR, 3.23; Cl. 2.43-2.72) than loose housing (27.23%-29.80%; OR, 1.00) as shown in Table 2. Similar findings were reported by Rodenburg (1990), Valde *et al.* (1997) and Kalmus *et al.* (2006). In tie-stall farms, the main risk factors for mastitis are teat injuries, short stalls and shortage of bedding material. Occurrence of mastitis was significantly influenced by milking system ($p < 0.001$), cows managed to be milked using pipe system was revealed to develop mastitis with a higher risk ($p< 0.001$; 35.45%; OR, 2.66; Cl. 2.51-2.62) than using other milking system as shown in Table

4. If pipelines are not correctly and regularly cleaned and rinsed with a plenty of water this will lead to the bacterial lodgment and raise the problem of inter-pipe pathogen transmission. Barkema *et al.* (1999) and Barnouin *et al.* (2005) reported that milking units are among the risk factors for intra-mammary infection. Table 5 indicated that the prevalence of mastitis pathogens, contagious ones in particular (71.39%) was significantly higher ($p < 0.001$; 49.09%) in farms ignoring IMS.

Table 2: Management and hygienic risk factors associated with mastitis, estimated coefficient (b), standard error (S.E.), χ^2, Odds ratio (OR) and 95% confidence interval (95% CI)

Risk factor	b	S.E.	χ^2	OR	95% CI
Intercept	-3.23	0.21			
Loose housing system				1	
Tie-stall system	0.01	0.024	43.86*	3.23	2.43-2.72
Carrousel and milking parlor				1	
Pipe system	-0.23	0.03	47.92*	2.66	2.51-2.62
IMS (used)				1	
IMS (not used)	-0.60	0.04	144.71*	4.49	4.18-4.83
Dry udder cleaning				1	
Moist udder cleaning	0.47	0.04	123.59*	3.10	3.03-3.18
Teat dipping (used)				1	
Teat dipping (not used)	0.732	0.057	55.98*	3.68	3.36-3.73

IMS= Inter-milking sanitation
*p<0.001 (highly significant)

Table 3: Influence of housing system on the prevalence and risk factors of mastitis causing pathogens

Housing system	OR (95% CI)	positive samples	Contagious		Environmental	
			Relative	Absolute	Relative	Absolute
Loose housing with slat floor (n=20597)	1	6138 (29.80)	4093 (66.68)	(19.87)	2045 (33.32)	(09.93)
Loose housing with plan floor (n=20524)	1	5589 (27.23)	3824 (68.42)	(18.63)	1765 (31.58)	(08.60)
Tie-stall system (n=5022)	3.23 (2.43-2.72)	1542 (30.70)	1140 (73.93)	(22.70)	402 (26.07)	(08.00)
χ^2	43.86*	291.12*				

OR= Odds ratio CI= Confidence Interval
*p < 0.001 (highly significant)
Numbers in parentheses indicate percentage

Table 4: Influence of milking system on the prevalence and risk factors of mastitis causing pathogens

Milking system	OR (95% CI)	positive samples	Contagious		Environmental	
			Relative	Absolute	Relative	Absolute
Pipe system (n=959)	2.66 (2.51-2.62)	339 (35.45)	232 (68.44)	(24.26)	107 (31.56)	(11.88)
Carrousel (n=22687)	1	7336 (32.34)	5509 (75.10)	(24.29)	1827 (24.90)	(08.05)
Milking parlor (n=32180)	1	9438 (29.33)	6477 (68.63)	(20.13)	2961 (31.37)	(09.20)
χ^2	47.92*	103.69*				

OR= Odds ratio CI= Confidence Interval
*p < 0.001 (highly significant)
Numbers in parentheses indicate percentage

Table 5: Influence of IMS on the prevalence and risk factors of mastitis causing pathogens

IMS	OR (95% CI)	positive samples	Contagious		Environmental	
			Relative	Absolute	Relative	Absolute
Used (n=54669)	1	16545 (30.26)	11812 (71.39)	(21.61)	4733 (28.60)	(08.66)
Not used (n=1157)	4.49 (4.18-4.83)	568 (49.09)	400 (70.42)	(34.57)	168 (29.56)	(14.52)
χ^2	144.71*	286.92*				

OR= Odds ratio IMS=Inter-milking sanitation CI= Confidence Interval
*p < 0.001 (highly significant)
Numbers in parentheses indicate percentage

The probability of occurrence of mastitis in those farms was more than four times ($p < 0.001$; OR, 4.49) than farms actively practicing IMS*;* indicating that IMS of the milking units prevent the intra-mammary infection between one milking and the other. Similar is the finding of Barnouin *et al.* (2005). To achieve an optimum quality production, it is of paramount importance to clean the udder of the cow before commencing the milking process. Results in Table 6 showed that even though the prevalence of mastitis causing pathogens was significantly higher with the use of dry udder cleaning ($p < 0.001$; 32.05%; OR, 1.00), the risk of encountering mastitis due to the use of moist udder cleaning was significantly higher ($p < 0.001$; 28.46%; OR, 3.10).

This outcome is supported by Yalcin *et al.* (1999). The study found that post milking teat dipping which aimed at reducing infection mainly caused by contagious pathogens and prevents new infection is a risky factor (Table 7). The non use of post-milking teat disinfection was significantly affecting the prevalence of mastitis; it was more than three times risky (35.98%; p<0.001; OR, 3.68) than practicing post milking teat disinfection (29.38%; OR, 1.00). Teat-dipping was also a risk factor in the study of Barkema *et al.* (1998); Malinowski (2000); Peeler *et al.* (2000) and Maiti *et al.* (2004).

Table 6: Influence of method of udder cleaning on the prevalence and risk factors of mastitis causing pathogens

Method of udder cleaning	OR (95% CI)	positive samples	Contagious		Environmental	
			Relative	Absolute	Relative	Absolute
Dry	1	9170 (32.05)	6746 (73.57)	(23.58)	2424 (26.43)	(08.47)
Moist	3.10 (3.03-3.18)	7648 (28.46)	5309 (69.42)	(19.76)	2339 (30.58)	(08.70)
χ^2	123.59*	229.51*				

OR= Odds ratio CI= Confidence Interval
*p < 0.001 (highly significant)
Numbers in parentheses indicate percentage

Table 7: Influence of post milking teat disinfection on the prevalence and risk factors of mastitis causing pathogens

Teat disinfection	OR (95% CI)	positive samples	Contagious		Environmental	
			Relative	Absolute	Relative	Absolute
Teat dipping (n=45038)	1	13232 (29.38)	9104 (68.80)	20.21	4128 (31.20)	(09.17)
Not used(n=10788)	3.68 (3.36-3.73)	3881 (35.98)	3108 (80.08)	28.81	773 (19.92)	(07.17)
χ^2	55.98*	54.38*				

OR= Odds ratio CI= Confidence Interval
*p < 0.001 (highly significant)
Numbers in parentheses indicate percentage

Conclusion:

The study concluded that the udder health as well as the welfare of the cow and dairy enterprise profitability can best be optimized by following customary mastitis management plans. The use of hygienic procedures, hygienic teat management and regular machine maintenance and testing are of utmost importance in reducing the effect of mastitis causing pathogens and consequently reducing the mean incidence rate.

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