Mastitis costs money: What's new?

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Abstract

A first step in mastitis management is to describe the udder health situation on a farm. From an economic point of view, parameters such as incidence of clinical mastitis, bulk milk somatic cell count and percentage of cows with increased somatic cell count should be combined with an estimation of the impact of the disease on farm profitability. To estimate the costs of mastitis, the following cost factors should be taken into account: decreased (milk) production, veterinary services, diagnostics, drugs, discarded milk, labour, decreased product quality, increased risk of other diseases and increased risk of culling. Reviewing existing estimates of the costs of mastitis, revealed estimates of € 28 (for only clinical mastitis) to more than € 97 per average cow on the farm per year. In a recent Dutch study, the costs for mastitis (clinical and subclinical), was estimated at € 78 per average cow present on a farm per year. Data from commercial Dutch dairy farms showed that these costs could differ largely between farms (€ 17 - € 198 per average cow on the farm per year).Farmers tended to underestimate these costs. This underlines the importance of specifying the costs of mastitis for individual farms instead of using generic estimations.

The next step is the selection of management factors to reduce the level of mastitis. Based on scientific literature and expertise, the effect of 19 mastitis prevention measures for different mastitis situations has been estimated and the costs and benefits of these measures were estimated accordingly. The net benefits of mastitis prevention measures do differ between farms and is not always positive. Although economic calculations to support decisions of dairy farmers are important, farmers' attitude and economic behaviour should also be looked at.

Keywords: clinical mastitis, subclinical mastitis, economics, management

Introduction

Mastitis is a production disease and is implicitly associated with dairy production. Production diseases are the most expensive diseases on dairy farms. Due to the chronic nature of mastitis, economic damage is spread out over the year. The economic damage of the most important cost factors, such as milk production decreases and risk of culling, are not directly visible as costs. Thererfore, the costs of mastitis might be underestimated.

Economic calculations are meant to support decision making, which can take place at various levels. In order to use economics in decision support at the herd level, the knowledge of the decision maker or advisor should go beyond the average costs of mastitis.

The costs of mastitis have been quantified in several occasions for several countries, and at the 4th IDF International Mastitis Conference, a generic framework for mastitis management has been given (Hogeveen and Osteras, 2005). Since that conference, much new information on the economics of mastitis and mastitis prevention has been developed. The goal of this contribution is to describe the costs of mastitis and of mastitis management. The following topics will be given: a description of mastitis from an economic perspective, the most recent cost calculations including the variation in costs between farms, the cost-effectiveness of improved mastitis management and finally the economics of mastitis will be shortly discussed with regard to behavioural change.

Mastitis from an economic perspective

A framework

Basically, animal health economics is dedicated to support decisions. Although we often focus on the dairy farm when discussing mastitis, mastitis should be looked upon from a broader perspective. A good background of this perspective is given by McInerney (1996). In a livestock production system, resources (input) are processed on a farm into several products. The main product of a dairy farm is obviously milk. The dairy processing industry processes the raw milk and makes products that are bought by consumers. Milk and milk products are useless when they do not improve the welfare of the society by increasing human satisfaction. Because they give satisfaction, consumers are willing to pay a price for the dairy products. Diseases may affect this process in different ways (Figure 1):

1. Lower the efficiency of the production process, leading to lower efficacy of the use of resources, either by a lower level of output or by a higher need of resources to maintain the same level of output. This is an important mechanism for mastitis and the cost estimates presented in this report are all on this pathway.The cost estimates given in this contribution are all on this pathway.
2. Lower the suitability of products for processing, either by a lower quality of the product, or by more complicated processing of the product. Very high levels of somatic cell count are known to affect, for instance, the cheese yield and shelf life of dairy products (see for instance Santos *et al* 2003). This mechanism is, however, not very important in most dairy producing countries.
3. Affect the human well-being directly, for instance through zoonotic diseases. This mechanism is of limited importance for mastitis, because only very few intramammary infections are potentially zoonotic. Antibiotic residues may be an indirect effect of effect of mastitis on human well-being.

4. Reduce the total value a society gains from livestock. This is an indirect economic effect, which may occur due to mastitis problems, when people lose trust in milk. The image of the dairy industry and its products is an important issue in this mechanism. This pathway might become more and more important for mastitis in relation to animal welfare and image of dairy production. Unfortunately, there are no data available on this subject.

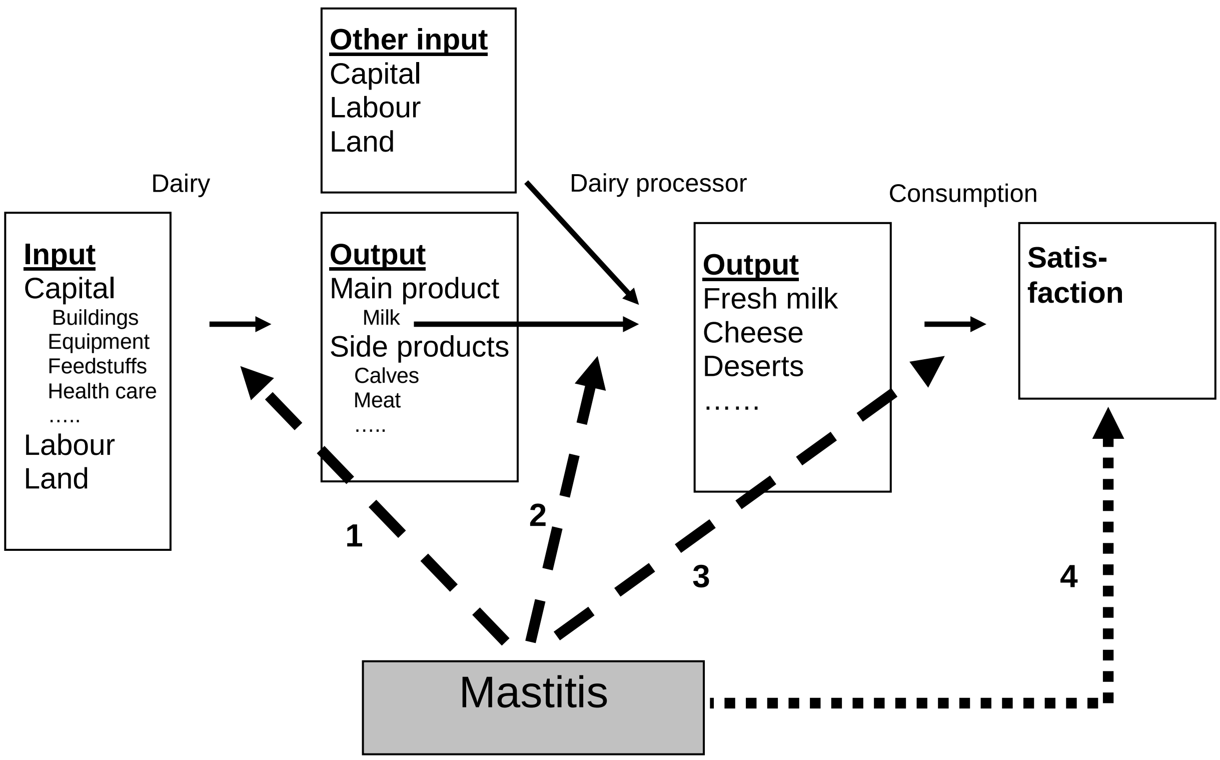

Figure 1. Pathways through which mastitis affects the dairy production system (adapted after McInerney 1996).

These 4 pathways affect the dairy farmer directly through a lower production or a lower price for lower quality products, or indirectly through a lower demand for dairy products, which affects the price. It also implies that decisions with regard to diseases can be taken at different levels. Decisions can be taken at the farm level, either with regard to individual animals (do I treat this animal?), the herd (do I improve the level of prevention?), the dairy processor (do we want our dairy farmers to improve the bulk milk somatic cell count?) or at society level (do we make more strict laws to prevent antibiotic resistance?).

Effects of mastitis on farm profitability

When evaluating the economic effects of mastitis, it is necessary to know the basic resource-using process of the dairy farm (McInerney 1996). This resource-using process can be presented as a production function (Figure 2). The production function represents the efficiency of deriving output (milk, calves and meat) from variable resources such as feedstuffs and health care (input), within the constraints of the farm structure (for instance the available land, buildings, labour and management capacity of the farmer). This process is more efficient (in terms of resources needed for a certain amount of output) for a farm with a low level of mastitis (the top curve in Figure 2) than for a farm with a high level of mastitis (the bottom curve in Figure 2). With more mastitis, more resources are needed for the same amount of produced milk. The optimum level of production is given by the ratio between P_R, the price of the resources and P_Q, the price of production (milk price). If for instance, the milk price increases, the slope of the ratio line will become lower and the optimal level of milk production will be higher. Because of the difference in production curves, we do not have to think only in terms of less production (from A to B) or in more resources needed, but we have a different optimum (moving A to F). This means that the damage of mastitis is a combination of decreased output (Q_L – Q_H) and decreased input (R_L – R_H). In a quota situation, this becomes even more complex, because farmers produce a fixed amount of milk (the output is constant).

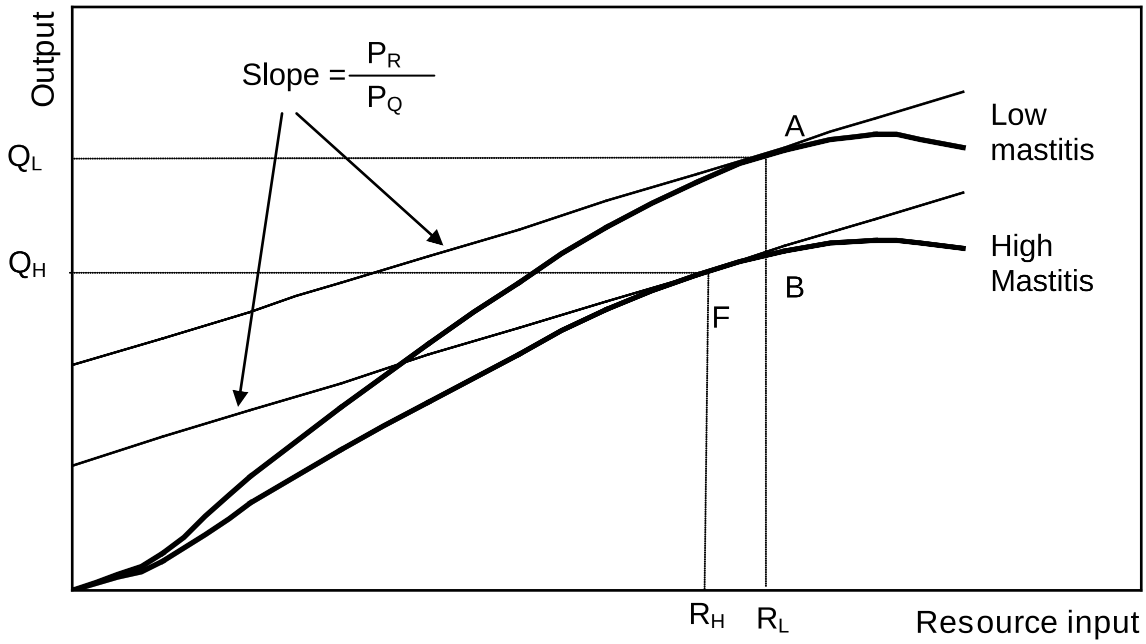

Figure 2. Effect of mastitis under optimal economic management.

Factors that determine the cost of mastitis

Production functions differ from farm to farm, and it is difficult to get insight in the costs of mastitis (and of other production diseases) based on real data. There are very few publications on this subject that are of practical value, due to either a lack of power (number of farms in the study) or to lack of detail in the data (e.g., Rougoor *et al* 1999). Most calculations therefore are carried out as model studies. The factors that determine the cost of mastitis are:

- Decreased (milk) production
- Veterinary services
- Diagnostics
- Drugs
- Discarded milk
- Labour

- Decreased product quality
- Increased risk of new cases of the same disease or of other diseases
- Increased risk of culling
- Materials and investments for prevention

Although the relative cost of the factors might differ between countries and between regions, the economic principles behind them are the same. A more detailed description of these factors can be found elsewhere (Halasa *et al* 2007; Hogeveen and Østerås 2005; Petrovski *et al* 2006).

Costs of mastitis

Recent calculations

A review on the costs of mastitis has recently been published by Halasa *et al* (2007). Those papers described in that review that were published between 1993 and 2006 and that calculated the costs of clinical mastitis, either per case or per average cow on the farm, are presented in Table 1. In addition to the papers reviewed by Halasa *et al* (2007), Table 1 also presents four more recent calculations. First, using a herd simulation model, the estimated avoidable losses in the Swedish situation were estimated to be € 97 per cow year (Hagnestam-Nielen and Østergaard 2009). The maximum level of avoidable losses is assumed to be a situation where the risk of mastitis is 0.1 of the default risk of mastitis. Thus, the total costs of mastitis in that study, were more than € 100 per cow year. Secondly, a dynamic bio-economic simulation model was developed (Halasa *et al* 2009b), aiming at modelling transmission of pathogens between cows in a herd. In that study, losses due to lower milk production were calculated by taking the marginal costs for having additional heifers that have to be milked to compensate lower milk yields. Consequently, the milk production losses in that study were low. Thirdly, in a study of Bar et al. (2008) a dynamic programming model to optimize culling in relation to mastitis was used. This potentially is a valuable approach, because culling is an important cost factor, which is very difficult to model because large differences exist between farmers in their approach of culling.

Table 1. Overview of cost calculations for clinical mastitis, either per case of clinical mastitis, or per cow in the herd.

Category	Miller[1] 1993	Kossaibati[2] 1997	Huijps 2008	Hagnestam-Nielsen[3] 2009	Halasa 2009b	Bar[4] 2008
Level	Cow	Case	Cow	Cow-year	Cow	Cow
Milk production losses	12	52-70	36	78	11	-[5]
Labour	3	1	4	-	11	-
Treatment	0-4	1-12	15[6]	-	14	-
Culling	11	67	22	-	46	-
Death	2	20	0	-	0	-
Veterinarian	2	2-27	1	-	2	-
Milk quality	-	-	0	-	0	-
Materials	6	-	0	-	0	-
Diagnostics	-	-	0	-	0	-
Total	30	286	78[7]	97	84	61

[1] Costs of treatment were calculated per pathogen. Calculations included costs for prevention
[2] Costs of mastitis were categorised as mild, severe, or fatal.In the table, however, the minimum and maximum costs are calculated, taking into account the prevalence of mastitis in each category.
[3] Costs were calculated as the difference between the default risk and the lowest possible risk, being 0.1 of default risk
[4] Costs were calculated under optimized culling
[5] Unknown or not calculated
[6] Including costs for discarded milk
[7] In the original paper, the total costs of mastitis were € 140 per cow per year. The figure given here (€ 78 per cow/year) is derived by using recent Dutch calculations of milk production losses due to increased somatic cell count (Halasa *et al* 2009a).

Finally, a recent study of Huijps *et al* (2008) describes a tool, meant for farmers and their advisors, to calculate farm specific costs of mastitis. For average Dutch circumstances, the costs of a case of clinical mastitis were estimated to be € 210, varying from € 235 for clinical mastitis in the first month post partum to € 164 for clinical mastitis in the last part of lactation. The costs for subclinical mastitis were dependent on the number of cows with an increased somatic cell count and were due to milk production losses. For a farm with an average production of 8,500 kg per 305 days and a bulk milk somatic cell count of 200,000 cells/ml, these costs were € 20 per average cow on the farm per year. Using an average incidence for clinical mastitis (30 cases per 100 cows per year) the total costs of mastitis for a Dutch dairy farm with 65 cows were calculated at € 78 per average cow on the farm per year. Costs for production losses are the largest part of these costs, as is presented in Table 2.

Table 2. Costs of mastitis calculated for the average Dutch situation (Basic) and according to data collected on 64 Dutch dairy farms. The mean, minimum and maximum values are given.

		Farmers data		
	Default	Min	Mean	Max
Input				
Farm size (nr cows)	65	28	83	160
Farm size (kg quota)	650,000	195,000	702,621	1,500,000
Yearly mastitis incidence (%)	30	6	29	100
Bulk milk somatic cell count (cells/ml)	200,000	60,000	178,484	300,000
Costs milk production losses (€/kg)	0.12	0	7.47	12
Costs visit of veterinarian (€/visit)	20	0	23.50	100
Costs of drugs (€/treatment)	20	5	33.18	110
Value of farmers labour (€/hour)	18	0	18.83	200
Costs of culling (€/culled cow)	480	0	382.50	750
Total costs for mastitis (€/cow present)	78	17	78	198

Diffferences between farms

As stated above, the economic consequences of disease may differ between farms. Additionally, the incidence and severity of disease may also differ. Farmer reported data on mastitis and farmers' estimation of cost factors from 64 dairy farms are summarized in Table 2. The incidence of clinical mastitis differed largely between farms, as did bulk milk somatic cell count and the number of cows with an increased somatic cell count. From an economic point of view, the variation in costs of, for instance, milk production losses, labour and culling is much more interesting than the average costs. The costs associated with a decreased milk production due to disease differed from 0 to € 0.12 per kg milk. Estimation of these costs under the Dutch quota circumstances is difficult. Based on marginal costs and benefits of having additional cows to fill a milk quota, the authors estimated a default value of € 0.12 per kg milk. This means that either the author's estimation was too high, or that farmers underestimate the costs associated with milk production losses. Also a large variation could be seen in costs for culling. Finally the costs for additional labour differed largely between farms

(0 – 200 € per hour). In these costs for labour, some farmers did not look at opportunity costs per se, but took also the willingness to pay to prevent the labour associated with clinical mastitis into account. Under practical circumstances, the costs per cow present on a farm for mastitis varied between € 17 and € 198 (Table 2). In the same study, before calculating the farm specific costs of mastitis, farmers were asked to estimate the total costs of mastitis for their farm. Of the 64 dairy farmers, 18 (28 %) had a good or a slight overestimation of the costs of mastitis on their farm. In total 46 (72 %) farmers underestimated the costs of mastitis on their farm. The maximum difference between calculated and expected costs was € 122 per cow per year. These results emphasize the need for farm-specific calculations on the costs of mastitis.

Cost-efficiency of management

Effects of preventive measures

Costs of mastitis, as such, are not interesting. Costs that cannot be avoided do not give much room for improvement. A first indication about avoidable costs is to compare the costs for mastitis between farms. Part of that difference can be due to structural differences between farms (for instance, the age of the buildings and milking equipment) or to economic valuation of production differences. Culling for instance, can be more expensive for one farm than for another due to differences in cost of heifer raising. In all situations, however, part of the differences between farms can be attributed to management. For decision support this is the most interesting part. We often see room for improvement, but what is the most efficient management measure to advise? A first step to systematically work on that is to evaluate the effect of different management measures on the mastitis situation of a farm.

In a recent study (Huijps *et al* 2009b), two kinds of inputs were used to determine the efficacy of 18 different management measures, literature and expertise. Management measures were based on NMC (www.nmconline.org) and UGCN (www.ugcn.nl) recommendations. Because literature was incomplete, expert opinions were additionally included. The experts were asked to indicate a minimum, most likely and maximum effect for every management measure, specified for a 100% environmental mastitis problem and a 100% contagious mastitis problem. The results of the expert sessions and the literature search were combined to determine the efficacy of the management measures in one overall distribution, consisting of a minimum, mean, and maximum value (Table 3).

Table 3. Most likely effects (ML, with ranking between brackets) and minimum (Min) and maximum (Max) effects for the different management measures given as a percentage decrease in incidence of clinical mastitis for a 100% environmental and a 100% contagious situation.

	Environmental		Contagious	
Management measure	ML (ranking)	Min ; Max	ML (ranking)	Min ; Max
Milking clinical cases last	4.75 (15)	3.11 ; 6.58	9.56 (7)	6.98 ; 12.50
Milking subclinical cases last	2.63 (17)	1.52 ; 4.25	12.08 (5)	8.17 ; 16.58
Separate cloth	6.08 (10)	3.21 ; 8.96	9.61 (6)	5.59 ; 13.84
Wash dirty udders	6.68 (9)	4.50 ; 9.03	4.60 (15)	3.11 ; 5.93
Prestripping	2.99 (16)	1.68 ; 4.35	2.94 (17)	1.61 ; 4.38
Milkers' gloves	0.26 (18)	1.68 ; 4.35	1.81 (18)	-8.59 ; 8.66
Post milking teat disinfection	36.51 (1)	31.97 ; 39.23	37.15 (1)	32.44 ; 40.08
Flushing clusters clinical	5.03 (12)	1.05 ; 8.72	8.55 (9)	1.90 ; 14.25
Flushing clusters subclinical	5.03 (12)	1.05 ; 8.72	8.55 (9)	1.90 ; 14.25
Replace teat cup liners	6.03 (11)	3.69 ; 8.44	7.82 (11)	5.68 ; 9.68
Treatment protocol	5.03 (12)	2.56 ; 7.81	6.02 (12)	3.53 ; 8.77
Drying off	11.75 (5)	7.41 ; 16.28	14.02 (4)	8.94 ; 19.72
Keep cows standing	9.47 (7)	5.94 ; 13.19	5.18 (14)	2.94 ; 7.47
Dry cow minerals	14.98 (3)	11.19 ; 18.90	14.27 (3)	10.87 ; 17.98
Prevent overcrowding	12.06 (4)	7.98 ; 16.25	8.75 (8)	5.59 ; 12.10
Clean stalls	11.57 (6)	7.94 ; 15.42	5.55 (13)	3.04 ; 8.40
Clean yards	8.17 (8)	4.84 ; 11.76	4.28 (16)	2.25 ; 6.58
Optimize feed	17.00 (2)	12.44 ; 21.73	16.48 (2)	12.27 ; 20.82

Net benefit of preventive measures

When the effects of the management measures are known, costs of the management measures and benefits as the decreased costs of mastitis can be calculated. These calculations have been carried out for three different (theoretical) farms: the default dairy farm described before to determine the most likely costs of mastitis, a problem farm and a good farm with respect to udder health (Table 4). For each management measure, the costs (including labour) to implement the management measure were calculated per cow per year. The net benefits of a management measure represent the difference between the current costs of mastitis and the new costs of mastitis plus the costs of the management measure. In these calculations it was assumed that the preventive measure was not carried out yet and would be carried out completely.

Two preventive measures, keeping cows standing after milking (‘keep cows standing’) and rinsing the milk cluster after milking a cow with clinical mastitis (‘rinse clusters clinical’) had a positive net benefit in all three situations (Table 4). The preventive measures washing dirty udders (‘Wash dirty udders’), wearing milkers’gloves (‘wear milkers’ gloves’), and blanket use of dry cow antibiotics (‘drying off’) have positive net benefits for all situations except for the ‘good’ farm. The preventive measures using post milking teat disinfection (‘Post milking teat disinfection’) and supplementation of dry cow minerals (‘dry cow minerals’) vary between negative net benefits (for the ‘good’ farm), zero net benefits, and positive net benefits.

In many situations the application of preventive measures is not cost effective and, from an economic point of view, should not be applied. However, in the calculations a stable, endemic, mastitis situation was assumed. The effect of a preventive measure is an improvement of the mastitis situation towards a new, stable, level. Additional preventive measures do also play a role in preventing sudden downturn of the mastitis situation. This can be regarded as a mastitis outbreak. This effect has not been taken into account. Moreover, it might be that estimated effect of management measures is sometimes under estimated. For instance, it is known from specific studies under the same economic circumstances that the use of blanket dry cow therapy over no dry cow therapy at all is cost-effective (Huijps *et al* 2007).

Table 4. Characteristics of three farms (average, mastitis problem farm and good mastitis situation farm) and the net benefits (€/cow/year) of 18 mastitis prevention measures for the three types of farms.

	Farm type		
	Average	Problem	Good
Farm characteristic			
Nr cows	65	65	65
Production (kg/cow/year)	8,500	8,500	8,500
% environmental mastitis	65	50	50
% contagious mastitis	35	50	50
BTSCC	200	350	100
Incidence of clinical mastitis (%)	30	40	10
Milking places in milking parlour	12	12	12
Costs of mastitis (€/farm/year)	4,743	7,199	1,405
Costs of mastitis (€/cow/year	73	111	22
Net benefits (€/cow/year) of management measure			
Milking clinical last	-29,21	-38,86	-9,16
Milking subclinical last	-27,64	-35,95	-10,03
Separate cloth	-16,95	-11,94	-21,48
Wash dirty udder	2,18	5,35	-2,47
Prestripping	-28,34	-23,35	-32,12
Milkers' gloves	2,05	7,31	-2,72
Dipping	0,33	15,69	-21,44
Rinse clusters clinical	6,07	13,82	0,92
Rinse clusters subclinical	-116,40	-169,94	-46,25
Replace teat cup liners	-6,76	-2,98	-10,05
Treatment protocol	-3,74	1,25	-9,12
Drying off	3,77	14,50	-5,39
Keep cows standing	3,71	9,08	0,77
Dry cow minerals	-0,26	9,13	-8,82
Overcrowding	-14,16	-7,21	-20,15
Clean boxes	-47,03	-40,92	-50,81
Clean yards	-45,04	-41,75	-50,05
Optimize feed	-10,88	-2,82	-20,79

Concluding remarks

Economic behaviour

Because farming is an economic activity, the economic effects of mastitis and mastitis management should be known to the farmers. However, farmers' economic behaviour is not always as expected using neo-classical economic theory. For instance, although from an economic point of view different types of cost factors can be regarded as exchangeable when they are equal in monetary terms, Dutch farmers do value different types cost factors differently (Huijps *et al* 2009a). Long term investments were considered preferable over changing routines.

The attitude of farmers towards mastitis is another important aspect in explaining the mastitis situation on a farm (Jansen *et al* 2009). Therefore, calculating costs does not guarantee a change of behaviour. For instance, in a pilot study on the value of economic information associated with milk production recording information, farmers thought that the cost calculations of high somatic cell counts specifically made for their farm, were not relevant for them (Hogeveen *et al* 2010). Finally, from the field of behavioural economics, it is known that people have a loss aversion, which indicates that losses loom larger than gains. This is also manifested in mastitis management. It has been shown that bulk milk somatic cell count penalties seem to be a higher motivation for changes in mastitis management than bonuses (Valeeva *et al* 2007). Another example is that farmers who already had implemented a specific management measure were more likely to continue doing this than farmers who applied a different management regime, regardless of the availability of more effective or lower-cost alternatives (Huijps *et al* 2010).

What's new?

In this contribution, the costs of mastitis and the net benefits of preventive measures have been described. It was already known that mastitis costs money. The high costs of mastitis are recently confirmed by studies from Sweden, the USA and the Netherlands. Data on the variation of costs of mastitis are new as well as is the fact that farmers do underestimate the costs of mastitis largely and that it is, therefore, important to be able to calculate farm specific costs of mastitis. New is also the attempt to estimate the effects of preventive measures on the incidence of mastitis and the bulk milk somatic cell count. Effects of preventive measures do differ from farm to farm and estimation of these effects is difficult. Therefore, both costs of mastitis and net benefits of mastitis prevention should be calculated for each dairy farm specifically. These calculations should be supported by computer tools. Besides an optimisation of preventive measures at the farm level, cow level decisions, such as treatment decisions can also be optimised (e.g., Steeneveld *et al* 2007; Steeneveld *et al* 2010). These are not worked out in this contribution. An interesting item for the future is the relation between mastitis, animal welfare and image of dairy production (pathway 4 in Figure 1). The possible effect of a change in image of milk on the demand for dairy products and consequentially, the effect on milk price should be studied. These effects might be more important for the income of dairy farmers than the costs of mastitis due to an inefficient production (pathway 1 in Figure 1) as described in this contribution.

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