Economic impact of foot disorders in dairy cattle

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Content

1.1 Abstract

Foot disorders have a great impact on the economics in dairy farming. It is assumed to be the third largest in terms of health costs in dairy farming, after mastitis and fertility problems. However, most farmers do not have a good overview of the economic losses caused by foot disorders, because most costs are not directly visible. The objective of this study was to calculate the farm specific costs caused by foot disorders using an specifically designed calculation tool. In the model underlying this tool, the prevalence of both clinical and subclinical cases is used as basic input and used to estimate the treatment costs, milk production losses, increased calving interval and culling associated with foot disorders. Combing these negative effects of foot disorders with market prices, enables the calculation of the economic consequences of foot disorders. All variables (prevalence, production effects and monetary values) can be changed by the user, enabling the calculation of the farm-specific losses of foot disorders. The result of the model shows a mean costs of €45 per cow per year due to foot disorder for a default Dutch dairy farm. The largest part of the costs are caused by the decreased milk production. However, when using data from individual dairy farms, a large variation in costs caused by foot disorders can be seen. The mean costs on dairy farms are comparable with the standard results of the model, but these costs varying from €23 to €60 per cow per year. These findings support the idea that to support farmers with decisions on foot disorders, costs should not be based on a normative estimation but on farm-specific calculations.

1.2 Samenvatting

Klauwaandoeningen hebben in de melkveehouderij een grote economische impact. Het is de op 2 na grootste kostenpost qua gezondheid in de melkveehouderij, op uiergezondheid en fertiliteit na. Dit terwijl de meeste melkveehouders geen goed zicht hebben op de kosten veroorzaakt door klauwproblemen, omdat deze gegevens meestal niet aanwezig zijn. Het doel van deze studie was het berekenen van de bedrijfsspecifieke kosten veroorzaakt door klauwproblemen door gebruik te maken van een specifiek ontworpen model. In dit model wordt de prevalentie van de klinische klauwaandoeningen en de subklinische klauwaandoeningen gebruikt als input om de kosten te berekenen voor de behandelkosten, de melkproductiedaling, de verlengde tussenkalftijd en de vroegtijdige afvoer van koeien ten gevolge van klauwaandoeningen. Door deze negatieve effecten te combineren met de marktprijs, is het mogelijk om de kosten te berekenen van de klauwaandoeningen op een bedrijf. Alle variabelen die worden gebruikt in het model (prevalentie, productie-effecten en geldvariabelen) om de totale kosten te berekenen kunnen door de gebruiker worden veranderd. De resultaten van het model laten zien dat de gemiddelde kosten €45 zijn per koe per jaar op een standaard Nederlandse melkveebedrijf als gevolg van klauwaandoeningen. Het grootste gedeelte wordt veroorzaakt door de melkproductiedaling. Wanneer de data van de individuele melkveebedrijven wordt vergeleken dan zie we echter een grote spreiding in de kosten. De gemiddelde kosten van een standaard bedrijf zijn vergelen met de individuele resultaten, welke variëren van €23 tot €60 per koe per jaar. Dit resultaat versterkt het idee dat bij het gegeven van bedrijfsadvies met betrekking tot klauwaandoeningen, er geen gebruik moet worden gemaakt van de gemiddelde kosten op een Nederlands melkveebedrijf, maar dat er gekeken moet worden naar de bedrijfsspecifieke kosten als gevolg van klauwaandoeningen.

2. Introduction

Animal diseases play an important role in the economic performance of dairy farms. Economic consequences of animal diseases can be distinguished in: (i) output losses following disease occurrence; (ii) expenditures made to treat disease or prevent its occurrence (McInerney, et al.,

1992). A farmer can optimize his/her efforts with regard to treatment and prevention in such a way that the additional costs of an improved control are outweighed by reduced losses.

Besides mastitis and fertility problems, foot disorders are one of the most important health problems in dairy cattle, because of the high incidence, severity and duration of foot disorder (Clarkson, et al., 1996; Enting, et al., 1997). Moreover, foot disorder are a serious welfare problem in dairy cattle (Whay, et al., 2003; Dyer, et al., 2007), and is one of the most important causes of impaired welfare in dairy cattle.

The economic effects of foot disorders are mainly caused by a decrease in milk yield (Green, et al., 2002), increase of advanced culling (Booth, et al., 2004), prolonged calving interval, extra veterinary costs and additional labor and treatment carried out by the farmer (Enting, et al., 1997). A considerable proportion of these economic losses are caused by subclinical foot disorders and not of clinical foot disorders (Manson and Leaver, 1988).

There are different types of foot disorders, comprised of several conditions which can be classified as: (i) infectious foot disorder (e.g. interdigital dermatitis, digital dermatitis and interdigital phlegmon) and (ii) non infectious foot disorders (e.g. sole ulcer and interdigital hyperplasia). All of these types of foot disorder have a specific effect on the welfare of the cow and economic consequences for the farmer. Existing studies gave estimates of the average costs per cow.(Enting, et al., 1997; Bruijnis, et al., 2010). But in reality, these values are an average of several farms. Each individual farm has not only a different prevalence of foot disorders, but the effects of foot disorders and the market circumstances might also differ from farm to farm. For a farmer to make decisions with regard to the prevention of foot disorders, it is important to have a good estimate of the economic consequences of foot disorders, and therefore of the potential benefits of improved management, for his or her own farm, as is demonstrated for mastitis by Huijps et al (2008). Recently a stochastic dynamic simulation model to calculate the economic consequences of clinical and subclinical foot disorders, distinguishing between the different types of foot disorders has been described (Bruijnis et al., 2010). This simulation model, however, uses specific software and needs too much specific input to be used to estimate the economic consequences of individual farms in a quick and efficient way. Moreover, no distinction was made in production losses due to different foot disorders. Recent work showed that there are differences in foot production effects due to different subclinical foot disorders (Sietsma, 2011).

The objective of this study was to develop a practical tool to estimate the economic losses of foot disorders for individual dairy farms.

3. Materials and Methods

We developed a calculation tool in Microsoft Office Excel 2007 to calculate the costs due to foot disorders on an individual farm. The tool model has a user friendly interface and is easily applicable for the farmer and his or her advisors to enable them to use specific farm input. Default values are based on scientific literature, relevant for the Dutch dairy situation. When there is no scientific literature available, expertise of the authors is used.

3.1 Input of the model

The total number of cows and the mean 305 days production of the herd are the first input data. Next the prevalence of each different type of foot disorder can be entered. When this data is unavailable on the farm of interest, default values will be taken. In this model we differentiate between the following types of foot disorders: sole ulcer (SU), dermatitis digitalis (DD), dermatitis interdigitalis (DI), interdigital hyperplasia (HYP), white line disease (WLD), sole haemorrhage (SH) and

interdigital phlegmonia (IP). A distinction was made between clinical and subclinical cases of each type of foot disorder. A cow with a clinical foot disorder is visibly lame (locomotion score 4 and 5) and a cow with a subclinical foot disorder is not visibly lame (locomotion score 2 and 3). The default prevalence of each for the different foot disorders is shown in table 1. The user of the model can change this values compared with the farm specific values.

Table 1: Default prevalence (%) per disorder group by clinical and subclinical.

	Abbreviation	**Clinical**[1]	**Subclinical**[2]
Sole ulcer	SU	9	6
Digital dermatitis	DD	20	20
Dermatitis interdigital	DI	7	26
Interdigital hyperplasia	HYP	2	5
White line disease	WLD	3	12
Sole Heamorrhage	SH	7	38
Interdigital Phlegmonia	IP	6	0

[1] source: Bruijnis, et al. 2010
[2] source: Sietsema. 2011

Input on culling is asked by asking the number of culled cows due to claw problems and the average value of a culled cow. Furthermore, input can be given on the treatment, such as veterinary costs, medicines and other treatment costs. Lastly the value of production losses can be entered. The default values of these variables are shown in table 2.

Table 2: default input value for calculating the losses and costs

Parameter	**Abbreviation**	**Value**	**Source**
Losses of decreased milk production, € / kg	L_{dmp}	0.12	Huijps and Hogeveen, 2007
Losses of discarded milk, € / kg	L_{disc}	0.17	Huijps and Hogeveen, 2007
Losses of prolonged calving interval, € / day	L_{pci}	0.70	C. Inchaisri, et al., 2010
Losses of advanced culled cows, € / cow	L_{cul}	480	Van der Walle, 2004
Veterinary cost, € / visit	C_v	100	Authors expertise
Veterinarian visits, # / year	V_v	2	Authors expertise
Treatment time dairy farmer, min / case	T_{tm}	20	Authors expertise
Hourly rate dairy farmer, € / hour	Hr	20	Authors expertise
Costs of treatment, € / case	C_{tm}	3	Authors expertise

In figure 1 the prevalence is shown for each type of foot disorder distinguish between clinical cases and subclinical cases and differentiate by parity.

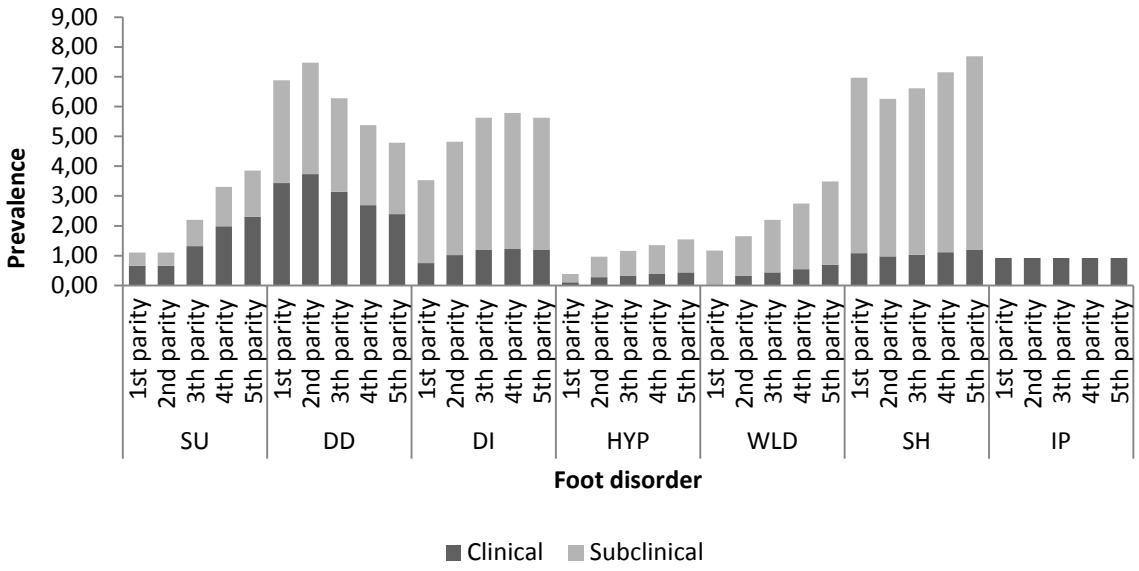

Figure 1: Prevalence for each type of foot disorder distinguish between clinical and subclinical and differentiate by parity. Source: Linde, et al. 2010

3.2 Calculation of costs

The total costs (TC) due to foot disorders comprised losses of decreased milk production (*Ldmp*), discarded milk (*Ldisc*), losses of prolonged calving interval (*Lpci*), losses of advanced culled cows (*Lcul*) and the costs of treatment (*Ctm*).

TC = Ldmp + Ldisc + Lpci + Lcul + Ctm

The losses of decreased milk production due to foot disorder are calculated based on the mean 305 days production (MP_{305}) corrected by parity (table 3), The prevalence of clinical cases (*cFD*) and the prevalence of subclinical cases (*sFD*) for each type of foot disorder per parity (figure 1), the percentage of decrease for each type of foot disorder differentiate by clinical cases (cc) and subclinical cases (sc) and the cost of decreased milk production (table 4).

$$Ldmp = \left(\sum_{k=1}^{cc} cFD\mathrm{k} \cdot dmpC \cdot tC \cdot MP305 \cdot \frac{PF}{100} + \sum_{k=1}^{sc} sFD\mathrm{k} \cdot dmpS \cdot tS \cdot MP305 \cdot \frac{PF}{100}\right) \cdot \mathrm{C}dmp$$

Table 3: 305 days milk production per parity.

	MP_{305}, kg	**Percentage of Mean** (*PF*)
Mean	8218	100
1st parity	7299	89
2nd parity	8371	102
3rd parity	8897	108
4th parity	8961	109
5th parity +	8697	106

source: CRV 2011

Table 4: percentage of milk losses and duration (in months) per claw disorder.

Foot disorder (*FD*)	**Clinical** (*dmpC*)[1]	**Duration clinical** (*tC*)[2]	**Subclinical** (*dmpS*)[3]	**Duration subclinical** (*tS*)[3]
Sole ulcer	8.00	2.50	1.50	12.0
Digital dermatitis	8.00	3.54	0.25	12.0
Dermatitis interdigital	8.00	3.40	0.00	12.0
Interdigital hyperplasia	8.00	4.01	3.90	12.0
White line disease	8.00	2.90	0.00	12.0
Sole haemorrhage	8.00	3.38	0.00	12.0
Interdigital Phlegmonia	8.00	1.02	0.00	12.0

[1] source: Amory, et al. 2008, Bicalho, et al. 2008, Green, et al. 2002
[2] source: Bruijnis, et al. 2010
[3] source: Sietsema. 2011

Optimally, interdigital phlegmonia has to be treated using antibiotics for 3 days which have a withdrawal time of 4 days, which result in discarded milk for 7 days. Some antibiotics have no withdrawal time which doesn't results in discarded milk. The losses are calculated based on the prevalence of clinical cases of interdigital phegmonia (ccIP), the milk production for the days the milk is discarded, the wait time (*wt*) due to antibiotic use and the costs of discarded milk, which is higher than decreased milk production, because of the higher cost for feet.

$$Ldisc = ccIP \cdot \frac{MP305}{305} \cdot wt \cdot Cdisc$$

The prolonged calving interval due to foot disorders is calculated based on the days the calving interval is prolonged and the costs for each day (L_{pci}). An average dairy cow with a clinical foot disorder has a prolonged calving interval of 12 days (*pciC*). An average subclinical cow has a prolonged calving interval of 6 days (*pciSC*). (Fourichon, et al.; 2000).

$$Lpci = (cc \cdot pciC + sc \cdot pciSC) \cdot Cpci$$

The losses of an advanced culled cow are based on calculations of the total number of culled cows (*nCul*) and the retention pay-off (*vCul*) which vary between € 240 and € 913 depended on the parity, fertility status and milk production.

$$Lcul = nCul \cdot vCul$$

The cost of treatment of foot disorders is calculated based on the costs of the veterinarian per visit (*Cv*), the amount of veterinarian visits (*Vv*), the costs of treatment per clinical case (*Ctm*), the treatment time of the dairy farmer per clinical case (*Ttm*) and the hourly rate of the farmer (*Hr*).

$$Ctm = Cv \cdot Vv + Ctm \cdot cc + Ttm \cdot cc \cdot Hr$$

3.3 Output of the model

Output of the tool consists of an overview of the total economic consequences of foot disorders on a specific farm. Besides the total economic consequences of foot disorders, distinction is made in the costs of decreased milk production, discarded milk, culled cows, the prolonged calving interval and the treatment. The economic consequences are expressed as total costs for the farm, per average cow on the farm and the costs associated with clinical foot disorders are expressed as costs per clinical case. .

3.4. Farm specific calculations

The model is used by 12 farms in the province Utrecht lying in the middle of The Netherlands to collect data to compare the farm specific calculations with the standard output. These farms are selected by a veterinary practice near Utrecht and asked to participate with this project. The model was filled by the farmer himself along with the first author between April and May 2011.

4. Results

The standard output of the model gives an overview of the total costs due to foot disorders of a default farm. The total costs due to foot disorders were estimated to be €3,392 for a farm with 77 cows and a 305 day production of 8,218kg milk. This means an average costs of €44 per cow on the farm per year. The losses of decreased milk production are €1,122, which is the greatest proportion (%) of the total costs. Most of the losses, such as the losses due to a decreased milk production are hidden losses, i.e., the farmer does not see them directly. The costs of treatment are relatively low, €582. These costs are directly visible for the farmer together with the losses of discarded milk and culled cows.

Table 5: Output based on default input is given as well as the summarized output and variation of 12 individual dairy farms.

Parameter	Abbreviation	Costs (€)	Costs per cow (€)	Mean costs per cow of 12 farmers (€)
Losses of decreased milk production	L_{dmp}	1,121.64	14.57	19.70 (10.25 – 24.26)
Clinical		854.79	11.10	14.04 (7.94 – 19.05)
Subclinical		266.85	3.47	5.66 (2.32 – 12.43)
Losses of discarded milk	L_{disc}	148.13	1.92	0.27 (0.00 – 1.69)
Losses of prolonged calving interval	L_{pci}	579.99	7.53	7.24 (3.71 – 9.57)
Clinical		349.27	4.53	4.55 (2.73 – 6.34)
Subclinical		230.71	3.00	2.68 (0.98 – 4.01)
Losses of advanced culled cows	L_{cul}	960.00	12.47	8.38 (0.00 – 27.83)
Cost of treatment	C_{tm}	581.94	7.56	9.21 (0.98 – 18.16)
Total costs	TC	3,391.69	44.05	44.79 (23.09 – 60.43)

The average estimated prevalence of the different foot disorders did not differ largely between the dairy farms that were visited (table 6). Only the prevalence of sole haemorrhage is much lower than the default prevalence shown in table 2. However, there was a large variation between farms. The average costs of €45 per cow were almost the same as the default (table 5). The underlying factors are different however. The losses due to a lower milk production were much higher than the default, on average €20 per cow per year. On the other hand, the losses of discarded milk and losses of advanced culled cows were lower than the standard, €0.27 and €8.38 per cow respectively. Moreover, there were large differences between farms. The total economic losses due to foot disorders varied from €23 to €60 per cow per year.

Table 6: average prevalence and variation of 12 farmers.

Foot disorder	Clinical	Subclinical
Sole ulcer	10.7 (4.6 – 15.4)	7.3 (3.1 – 10.3)
Digital dermatitis	19.7 (0.0 – 41.7)	19.7 (0.0 – 41.7)
Dermatitis interdigital	5.8 (0.0 – 13.8)	24.4 (0.0 – 50.8)
Interdigital hyperplasia	2.8 (0.0 – 8.7)	7.4 (0.0 – 22.9)
White line disease	4.4 (0.0 – 11.4)	17.7 (0.0 – 45.7)
Sole haemorrhage	3.6 (0.0 – 7.7)	19.7 (0.0 – 38.5)
Interdigital Phlegmonia	7.3 (0.0 – 19.6)	0.0

Table 7 shows the mean input values of the model. These costs are also relatively the same as the standard input values of the model. Only the costs of treatment per cow is greater than the standard .

Table 7: average input values and variation of 12 farmers.

Input	Abbreviation	Value
Veterinary cost, € / visit	C_v	90.00 (30 – 150)
Veterinarian visits, # / year / cow	V_v	0.029 (0.00 – 0.05)
Treatment time dairy farmer, min / case	T_{tm}	20.2 (10 – 30)
Hourly rate dairy farmer, € / hour	Hr	16.50 (0 – 30)
Costs of treatment, € / case	C_{tm}	4.78 (0 - 10)
Losses of culled cows, € / cow	L_{cul}	8.38 (0 – 27.83)
Costs of decreased milk production, € / kg	L_{dmp}	0.13 (0.12 – 0.22)
Costs of discarded milk, € / kg	L_{disc}	0.18 (0.17 – 0.27)

5. Discussion

We developed a model to calculate the total costs due to foot disorder by dairy cows. The default values used in the model are based on data from the literature. It gives an overview of the total costs and how these costs are made up. The model uses the farm specific input to calculate the total costs. Both clinical and subclinical data will be used. Most of the farms have the data of only the clinical cases of foot disorder present, The subclinical data will be calculated based on the clinical results of the farm and the standard prevalence. The model is practical applicable for the farmers and their advisors.

The model uses the most recent data of decrease milk production for clinical and subclinical foot disorder (Sietsema, 2011). These data could not be totally reliable, because the results are based on the percentage of milk production decrease from the milk product registration (MPR). But the percentage of decrease is not corrected for the lactation curve and there is no account that high producing cows more likely to have foot disorders , which results in a underestimation of the decrease of milk production. The model is built that when new data and/of farm specific data are available, it could be easily change by the user.

There is no account in de model of the costs of hoof trimmers and other preventively costs to avoid foot disorders. The costs are omitted in the model, because it was not predictable what the influence is of the preventively trimming on the prevalence of foot disorders in cattle on the individual farms.

The result of the model is farm specific and for the farmer a good overview of the total costs due to foot disorder. With this result it is possible to make a economic optimal decision by considerate between the costs of foot disorder and the costs of preventive measures.

12 Farmers run the model for their farm. They are selected via a veterinary practice near Utrecht. The farmers are asked to run the model for their farm and their opinion of it. It proved to be necessary to run the model together with the developer. In future it is intended that the model could be run together with the veterinarian of the farmer. The farmers where enthusiast about the model and they liked to know how many foot disorders cost on their farm and how these costs are made up.

6. Conclusion

The standard costs per cow per year are €45. These costs are less than the costs which Bruijnis (2010) calculated. These difference mainly caused of the lower losses of milk production decrease due to the subclinical cases. The decrease of milk production due to foot disorder is the greatest cost factor. It is varying between one third to almost 50 percent of the total costs.

The mean costs of the farmers are the same as the standard costs calculated by the model. But the variation between these farms is large. This implies that the total costs of a specific farm cannot be set by a default value. Therefore this model is useful to calculate the farm specific costs, which the farmer could use to make an optimal decision of treating foot disorder.

7. References

Amory, J.R., Z.E. Barker, J.L. Wright, S.A. Mason, R.W. Blowey, en L.E. Green. „Associations between sole ulcer, white line disease and digital dermatitis and milk yield of 1824 dairy cows on 30 dairy farms in England and Wales from February 2003-November 2004." *Preventive Veterinary Medicine*, 2008: 83:381-391.

Bicalho, R.C., L.D. Warnick, en C.L. Guard. „Strategies to analyze milk losses caused by diseases with potential incidence throughout the lactation: A lameness example." *Journal of dairy science*, 2008: 91:2653-2661.

Booth, C.J., L.D. Warnick, Y.T. Gröhn, D.O. Maizon, C.L. Guard, en D. Janssen. „Effect of Lameness on Culling in Dairy Cows." *American Dairy Science Association*, 2004: 87:4115–4122.

Bruijnis, M.R.N., H. Hogeveen, en E.N. Stassen. „Asessing economic consequences of foot disorders in dairy cattle using a dynamic stochastic simulation model." *American Dairy Science Association*, 2010: 93:2419-2432.

Clarkson, M.J., et al. „Incidence and prevalence of lameness in dairy cattle." *The Veterinary Record*, 1996: 138:563-567.

CRV. 2011. www.cr-delta.nl.

Dyer, R. M., N.K. Neerchal, U. Tasch, Y. Wu, P. Dyer, en P.G. Rajkondawar. „Objective determination of claw pain and its relationship to limb locomotion score in dairy cattle ." *American Dairy Science Association*, 2007: 90:4592–4602.

Enting, H., D. Kooij, A.A. Dijkhuizen, R.B.M. Huirne, en E.N. Noordhuizen-Stassen. „Economic losses due to clinical lameness in dairy cattle." *Livestock Production Science*, 1997: 49:259-267.

Fourichon, C., H.Seegers, en X. Malher. „Effect of disease on reproduction in the dairy cow: a meta-analysisi." *Theriogenology*, 2000: 53:1729-1759.

Green, L.E., V.J. Hedges, en Y.H. Schukken. „The Impact of Clinical Lameness on the Milk Yield of Dairy Cows." *American Dairy Science Association*, 2002: 85:2250–2256.

Huijps, K., en H Hogeveen. Stochastic Modeling to Determine the Economic Effects of Blanket, selective, and no dry therapy." *Journal of dairy science*, 2007: 90:1225–1234.

Huijps, K., T.J.G.M. Lam, en H. Hogeveen. „Costs of mastitis: facts and perception. " *Journal of Dairy Research*, 2008: 75: 113-120.

Inchaisri, C., R. Jorritsma, P.L.A.M. Vos, G.C. van der Weijden en H. Hogeveen. „Economic consequences of reproductive performance in dairy cattle. " *Theriogenology*, 2010: 74: 835-846.

Linde, C. van der, G. de Jong, E.P.C. Koenen, en H. Eding. „Claw health index for Dutch cattle based on claw trimming and conformation data." *American Dairy Science Association*, 2010: 93:4883-4891.

Manson, F.J., en J.D. Leaver. „The influence of concentrate amount on locomotion and clinical lameness in dairy cattle." *Animal Production*, 1988: 47: 185-190.

McInerney, J.P., K.S. Howe, en J.A. Schepers. „A Framework for the economic anaylysis of disease in farm livestock." *Preventive Veterinary medicine*, 1992: 13:137-154.

Sietsema, D.J. „Milk Losses due to claw disorders in Dutch dairy farms." 2011.

Van der Walle, K. „Gebruikswaarde van Melkvee (Values in use of dairy cattle)." Animal Sciences Group Wageningen UR, Lelystad, The Netherlands, 2004.

Whay, H.R., D.C.J. Main, L.E. Green, en A.J.F. Webster. „Assessment of the welfare of dairy cattle using animal-based measurements: direct observations and investigation of farm records ." *Veterinary Record*, 2003: 153:197-202.