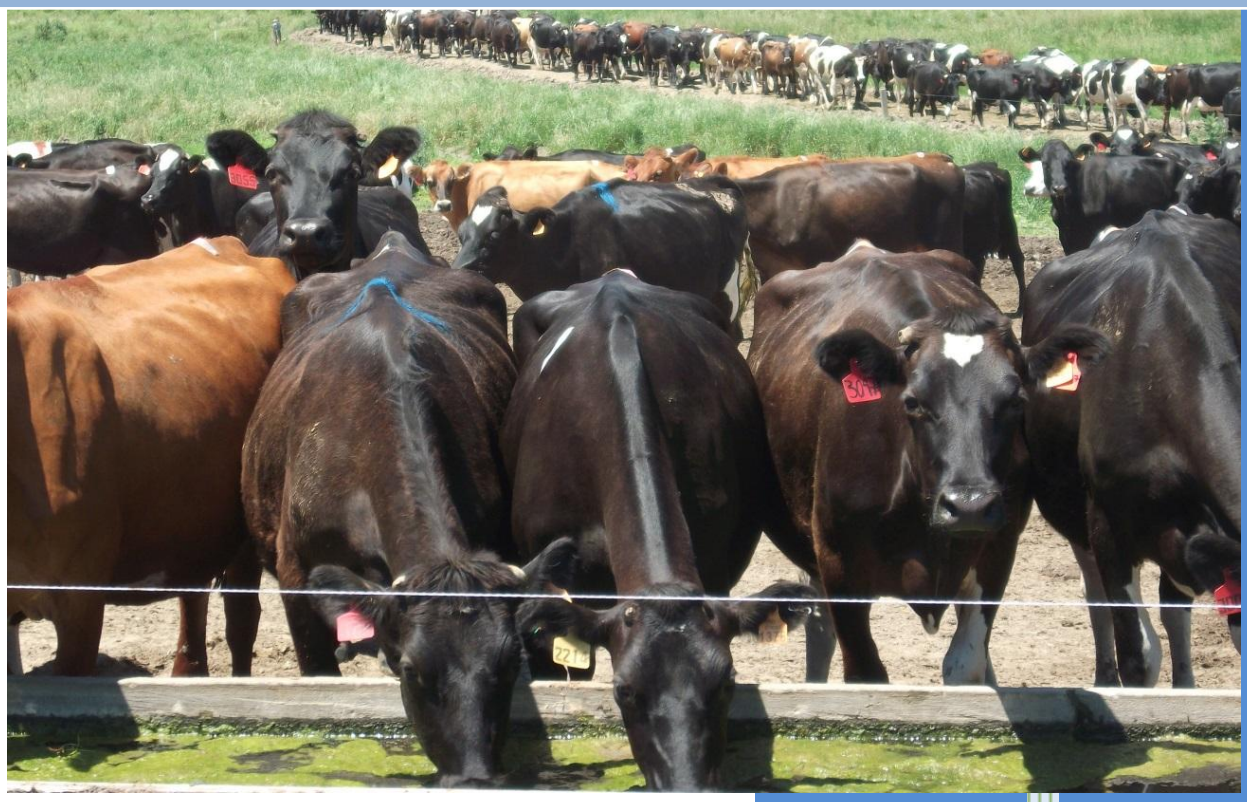
Cow comfort in relation to milk yield on pasture based dairy herds in Uruguay



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Master thesis Farm Animal Health and Veterinary Public Health

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2. Abstract

Nowadays, animal welfare is an increasingly important topic in political discussions. Farmers need to maintain high producing dairy herds without compromising on animal welfare. The aim of this study is to describe the positive correlation between animal welfare ("cow comfort") and milk yield. In a 5 week survey, 40 pasture-based dairy farms in Uruguay were visited in October 2012 in order to compare a set of milk production parameters to a cow comfort score. In Uruguay cows are kept on pasture so to score cow comfort a pasture based cow comfort scoring system was used. This scoring system was derived from the barn based cow comfort scoring system developed by Van Eerdenburg. Information about the milk yield was obtained by either digitally stored information or by milking parlour notes. A significant correlation ($r=0.405$, $p=0.01$) is found between fat corrected milk production of October 2012 and the cow comfort result. Further analysis indicated that 16% of the variation in milk production could be explained for by the cow comfort score. This correlation is similar to the one reported for dairy cows kept in barns.

3. Introduction

Due to scale enlargement, specialization and mechanization of production, management of dairy herds has experienced radical changes in the last few decades. This has led to the current high producing cow. But to what extend have these changes impacted animal welfare? Nowadays animal welfare is an increasingly important topic in political discussions. Especially in countries like The Netherlands, where there's no shortage of feed or food, this subject is gaining interest. But what is animal welfare? Brambell et al. stated in 1965 that animals should be free to "stand up, lie down, turn around, groom themselves and stretch their limbs" codified as the five freedoms of Brambell and folded into the following format:

- Freedom from hunger and thirst;
  - By ready access to fresh water and a diet to maintain full health and vigour.
- Freedom from discomfort;
  - By providing an appropriate environment including shelter and comfortable resting area.
- Freedom from pain, injury or disease;
  - By prevention or rapid diagnosis and treatment.
- Freedom to express normal behavior;
  - By providing sufficient space, proper facilities and appropriate company of the animals' own kind.
- Freedom from fear and distress;
  - By ensuring conditions and treatment that avoid mental suffering.

Animal welfare was defined as: "a wide term that embraces both the physical and mental well-being of animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behavior. (Brambell et al., 1965)

Deprivation of only one of the five freedoms can already lead to reduced milk production.(Bicalho et al, 2008; Warnick et al, 2001) Since reduced welfare impacts production negatively, it can be debated if this concept could also be applied the other way around. It would be of great value to be able to determine animal welfare at dairy farms and relate these findings to milk production. If such a scoring system would be available, the importance of increased welfare could for example be indicated by production rates and thereby financial gains.

But how can one measure animal welfare? Currently three systems are available. The European Animal Welfare Quality®, Cow compass (koe Kompas 2012) and the barn-based cow comfort score. (Van Eerdenburg et al, 2013). The goal of Welfare Quality® is to integrate animal welfare into the food quality chain by being transparent about product quality and the efforts made to improve animal welfare. (Welfare Quality®) Cow compass is a practical management tool that can be used by veterinarians to make a risk assessment on a dairy herd. Cow compass consist of seven chapters and animal welfare is one of them. (koe Kompas 2012). This management tool can be used to give an indication that there might be a problem with animal welfare but not to give it a proper value.

A difference between the barn-based cow comfort score and Welfare Quality® is the minimum score that must be reached for each chapter in the cow comfort score. If in this system the minimum score is not reached, the difference will be subtracted from the total score of that particular chapter. For this reason it is possible for a chapter to stand out and influence the total score. For example, if an animal has mastitis the discomfort experienced therefrom is overruling the availability of a big pasture. The

system yields a score ranging from -500 to 500 points, with higher scores indicating better welfare. Despite above mentioned, the biggest difference rests in the execution time of the barn-based cow comfort score which will consume far less time than the Welfare Quality®. This is because the barn-based system takes more environmental factors into account and the Welfare Quality® is mainly animal based. (Van Eerdenburg et al, 2013)

The aim of this study was to determine the relation between cow comfort and milk production on pasture based dairy herds in Uruguay. The above mentioned scoring systems are designed for cows held in cubicles. To score cow comfort on the dairy farms in Uruguay, a scoring system for cow comfort on pasture-based dairy farms was used, as previously described by Verschuuren (2010) and Wolf (2010). This scoring system was based on the barn-based cow comfort scoring system of van Eerdenburg et al. (2013) and adapted to a pasture based system in Uruguay. This resulted in a scoring system for pasture-based dairy farms which is comparable with the barn-based cow comfort scoring system. (van Eerdenburg et al., 2013)

The scoring system for cow comfort on pasture-based dairy farms consists of 13 categories: general, milking parlour and waiting area, waiting area, milking parlour, exit milking parlour, water, feeding sites, walkways, loading site, pastures, farmer and staff, environmental management and animal health. Total scores can range from -500 up to 500 points. The cow comfort score was supposed to be correlated to several parameters of milk production namely the 305 day rolling herd average, the milk fat percentage and the milk protein percentage. But, not all included farms were able to provide equally reliable production data so it was decided to collect data from the month October 2012 which was available on all the dairy herds.

4. Material and methods

This study was conducted by two investigators. From October 30 until the 2nd of December 2012, 40 pasture-based dairy farms in Uruguay were visited. The farms were located mainly in the southern part of Uruguay and the size varied from 39 to 1100 cows per farm. The farms were visited under supervision of DVM Mette Bouwman, who works as a mastitis expert in Uruguay.

The aim of the study was to investigate the correlation between cow comfort and several parameters of milk production namely the 305 day rolling herd average, the milk fat percentage and the milk protein percentage. Unfortunately, not all included farms were able to provide equally reliable production data. Larger dairy farms could hand over perfectly reliable digitally stored 305 day rolling herd averages. This in contrast to the smaller dairy herds where there were no 305 day rolling herd averages available. Prevailingly small dairy herds that lacked the 305 day rolling herd data were visited in the first weeks of the study. In consultation with the supervisor was decided to collect data from the month October 2012 which was available on all the dairy herds. In the end, 7 of the 40 dairy herds could not hand over reliable protein and fat percentages of the produced milk.

In order to collect all the data, farmers were asked to fill out a questionnaire (appendix 1) and an additional checklist (appendix 2) was filled out by the two investigators.

Results of the cow comfort scoring were analyzed using IBM SPSS 19. Spearman and Pearson correlations were calculated between the different scoring items and the three variables of interest, milk production, milkfat percentage and milk protein percentage. The two-tailed Pearson correlation was used to compare the cow comfort to the milk production because it was normally divided. The Spearman correlation was used to compare the cow comfort score to the protein and fat percentages because these weren't normally divided.

5. Results

The scores of the 40 pasture-based dairy farms are presented in table 5.1. For fat and protein percentage, 7 of the 40 farms lacked reliable information. Therefore, the mean and standard deviation of fat and protein percentage were based on only 33 pasture-based dairy farms. An average fat concentration has been used to calculate the fat corrected milk production for the remaining 7 pasture-based dairy farms.

Parameter	Mean	Standard Deviation
Milk production (liters)	21.90	3.35
Fat corrected milk production	21.07	3.22
Fat %	3.79	0.28
Protein %	3.33	0.13
Total score (cow comfort score)	263.30	68.14
General	1.33	9.54
Milking parlour and waiting area	3.20	1.57
Waiting area	-3.55	6.13
Milking parlour	15.68	1.83
Exit milking parlour	2.60	4.56
Water	25.38	9.28
Feeding sites	10.56	9.45
Walkways	7.23	8.58
Loading site	2.68	2.98
Pastures	55.08	29.03
Farmer and staff	1.25	40.56
Environmental management	0.88	7.06
Animal health	141.43	25.21

Table 5.1: The mean values and the stand deviations of all the parameters measured in the research

5.1 Milk production

A significant correlation (r=0.401, p=0.01) existed between the fat corrected milk production and the cow comfort score, using the two-tailed Pearson correlation. The relevance of the correlation can estimated by the r^2, being 0.16. This indicates 16% of the variation in milk production can be explained for by the cow comfort score. The scatter plot is displayed in figure 5.1.1.

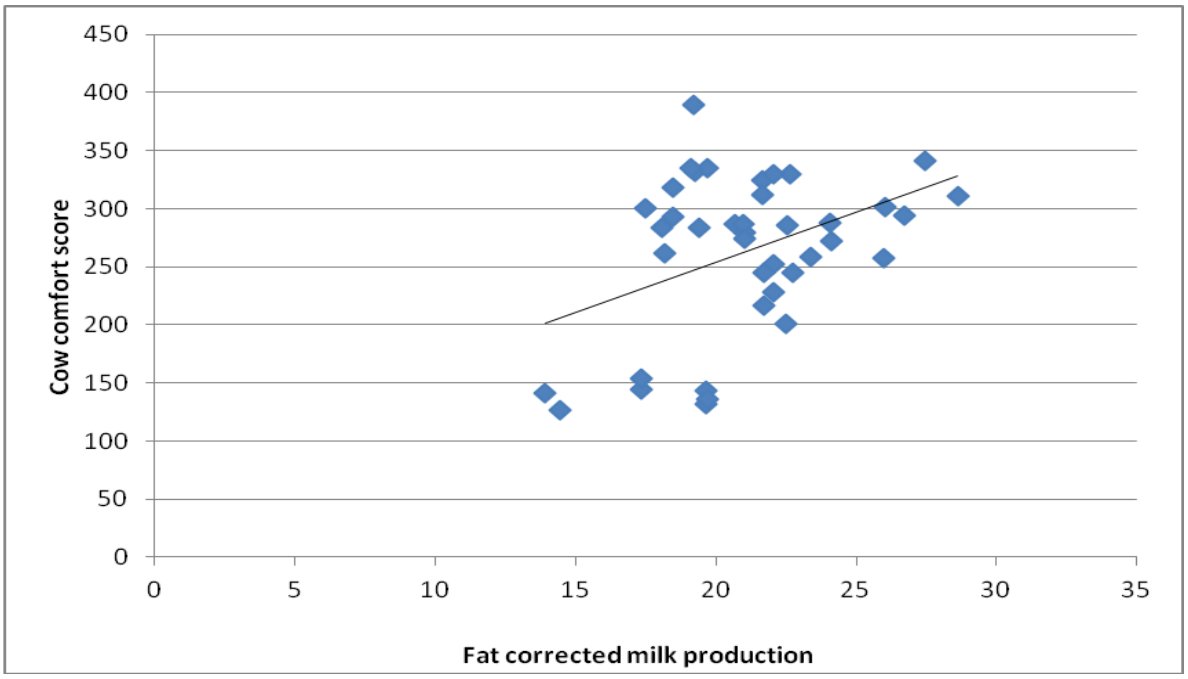

Figure 5.1.1: Fat corrected milk production (kg per day) versus the Cow comfort score (Pearson, r = 0.405 p = 0.01)

The fat corrected milk production is also plotted against all the categories of the cow comfort score by using the two-tailed non parametric Spearman correlation. The correlations are displayed in the table below, table 5.1

Cow comfort score categories	Significance p	Correlation coefficient r
General	0.121	0.249
Milking parlour and waiting area	0.127	0.245
Waiting area	0.279	0.175
Milking parlour	0.542	-0.099
Exit milking parlour	0.177	0.218
Water	0.552	0.097
Feeding sites	0.580	-0.090
Walkways	0.125	0.246
Loading site	0.940	0.012
Pastures	0.292	0.171
Farmer and staff	0.062	0.298
Environmental management	0.067	-0.293
Animal health	0.064	-0.296

Table 5.1: Fat corrected milk production versus each category of the Cow comfort score.

5.2 Milk fat percentage

No significant correlation between the milk fat percentage and the cow comfort score could be found (Spearman correlation=0.181, n=, p=0.313) .The scatter plot is displayed in figure 5.2.1.

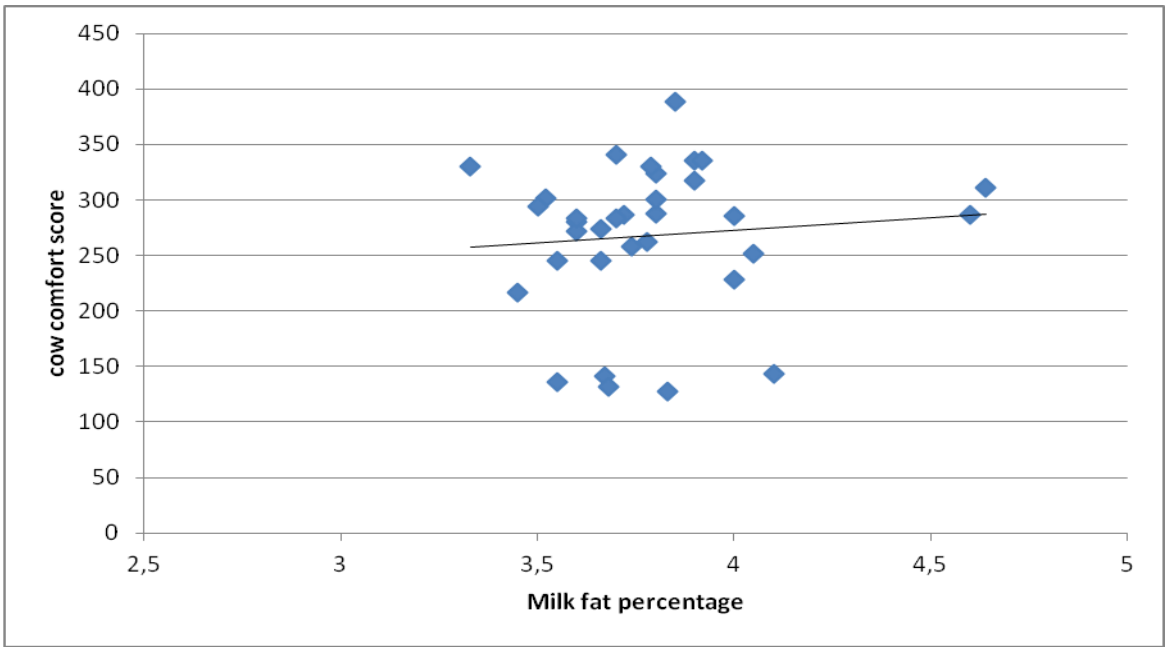

Figure 5.2.1.: Milk fat percentage versus the Cow comfort score (Spearmann, P = 0,313 R = 0,181)

The milk fat percentage is also plotted against all the categories of the cow comfort score by using the two tailed non parametric spearman correlation has been investigated. The correlations are displayed in the table below, table 5.2

Cow comfort score categories	Significance P	Correlation coefficient R
Total score	0.313	0.181
General	0.257	0.203
Milking parlour and waiting area	0.629	0.087
Waiting area	0.957	0.010
Milking parlour	0.157	-0.252
Exit milking parlour	0.877	-0.028
Water	0.099	-0.292
Feeding sites	0.977	-0.005
Walkways	0.754	0.057
Loading site	0.032*	0.373
Pastures	0.471	0.130
Farmer and staff	0.302	0.185
Environmental management	0.859	0.032
Animal health	0.993	0.002

Table 5.2.: Milk fat percentage versus each category of the Cow comfort score.

5.3 Milk protein percentage

The correlation found between the milk protein percentage and the cow comfort score by using the non-parametric Spearman correlation P = 0,091 and R = -0,299. Although not significant, the p-value shows a trend towards significance and might therefore not be excluded as possibility. The scatter plot is displayed in figure 5.3.1.

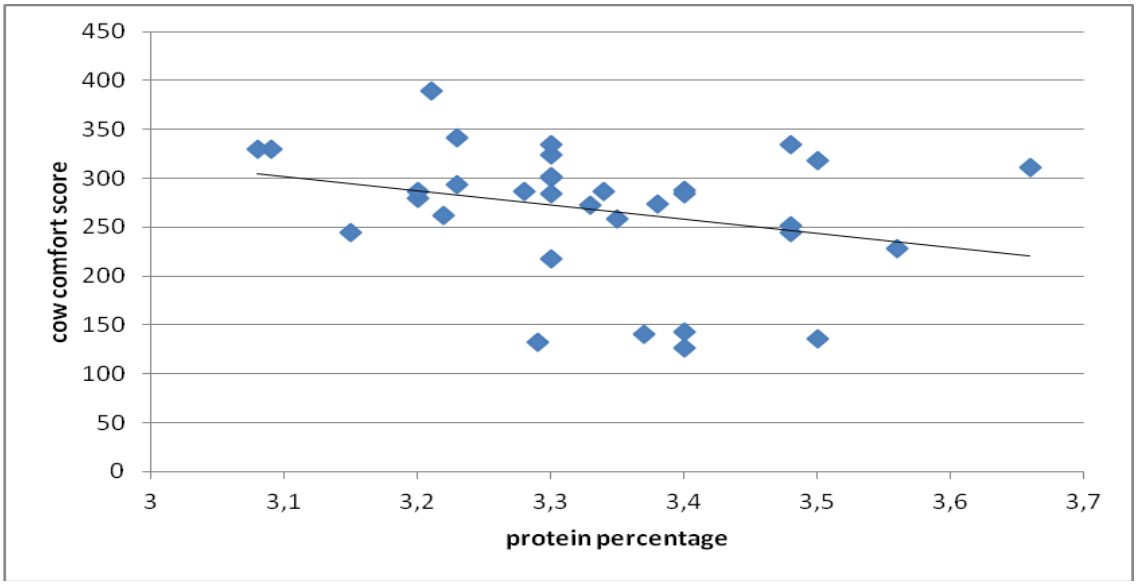

Figure 5.3.1.: Milk protein percentage versus the Cow comfort score (Spearmann, P = 0,091 r=-0.299)

The milk protein percentage is also plotted against all the categories of the cow comfort score using the two tailed non parametric spearman correlation.The correlations are displayed in table 5.3.

Cow comfort score categories	Significance P	Correlation coefficient R
Total score	0.091	-0.299
General	0.137	-0.265
Milking parlour and waiting area	0.982	0.004
Waiting area	0.376	0.159
Milking parlour	0.198	-0.230
Exit milking parlour	0.557	0.106
Water	0.970	0.007
Feeding sites	0.453	-0.135
Walkways	0.760	0.055
Loading site	0.563	0.104
Pastures	0.346	-0.169
Farmer and staff	0.061	-0.330
Environmental management	0.402	-0.151
Animal health	0.606	-0.093

Table 5.3.: Milk protein percentage versus each category of the Cow comfort score.

6. Discussion

6.1 The pasture-based cow comfort scoring system (validation)

As mentioned in the material and methods of this study two investigators collected the data to fill out the pasture based cow comfort scoring system (Wolf 2010, Verschuuren 2010) which has been derived from the barn based cow comfort scoring system (van Eerdenburg, 2013). The problem is that the pasture based scoring system had not been validated yet. The validation of the pasture based scoring system of Wolf and Verschuuren was the aim of the study of Chantal Duijn (Duijn, 2014). The result of the study by Duijn is *"a new system containing the chapters: general, milking parlour and pre milking yard, exit milking parlour, water, feeding sites, walkways, loading site, pastures, farmers and staff, environmental management, animal health and youngstock. With the suggested changes it is probably possible to achieve a useful and effective scoring system. This new system needs to be validated in the future."* (Duijn, 2014). In the present study it was tried to use the new adapted pasture based scoring system of Duijn (2014). But too much information was lacking, especially from the chapter youngstock which was added by Duijn so it couldn't be filled out properly. This means that it must be taken into account that by interpretation the results of this study a non-validated pasture based cow comfort scoring system has been used and that a new and improved, but still not validated, pasture based cow comfort scoring system is available for future studies. (Duijn, 2014)

As mentioned above the pasture-based scoring system that was used in this study wasn't validated. But the significant correlation ($r=0.405$, $p=0.01$) that has been found corresponds with earlier barn-based studies in The Netherland, Greece and Mexico. The Dutch farms had a correlation of 0.34 ($p < 0.02$) between the number of points scored and the 305 day milk yield. A similar trend was observed for the Greek farms in the correlation between milk yield and total score ($r = 0.31$; $p < 0.08$). The Mexican farms had a larger variation and a lower correlation ($r = 0.13$; $p = 0.35$). (van Eerdenburg, 2013)

6.2 Milk production, milk fat and protein percentage

As mentioned in the material and methods. The number of dairy cows on the 40 dairy herds visited varied from 39 to 1100 per farm. The variation in herd size in the study is of much importance. Although several studies have shown an impact of herd size on welfare, the variation in herd size in this study might be a benefit because it includes farms of all sizes. (Abdelfattah, 2013; De Vries, 2015; Fregonesi 2007) Not all included farms, however, were able to provide equally reliable production data. Most larger dairy farms could hand over perfectly reliable digitally stored 305 day rolling herd averages. This in contrast to the smaller dairy herds where there were no 305 day rolling herd averages available. Prevailingly small dairy herds that lacked the 305 day rolling herd data were visited in the first weeks of the study. In consultation with the supervisor was decided to collect data from the month October 2012 which was available on all the dairy herds. In the end, 7 of the 40 dairy herds could not hand over reliable protein and fat percentages of the produced milk. This was due to ignored communication by mail or the fact that the dairy herds produced cheese at their own facilities and had these data not available.

6.3 Language barrier

The official language of Uruguay is Spanish. Both investigators were not familiar with this language. The investigators tried to minimize the influence of the language barrier by using supervisor Mette Bouwman as interpreter and by using a translated questionnaire.

6.4 Mastitis and weather influences

The dairy herds, included in this study, were visited under supervision of Mette Bouwman. This supervision was needed for transportation and Spanish translation. Because Mette Bouwman works as a mastitis expert most of the dairy herds visited had mastitis problems during the visit. Only the production in the month October 2012 instead of a 305 day rolling herd average was plotted against the cow comfort score. This could have influenced the results. Both the welfare score, although the scoring system includes diseases, as the milk production results can be negatively influenced by mastitis problems. (Fogsaard 2015, Bareille 2003, Fourichon 1999) In the last two weeks the language barrier decreased and the students were able to visit some dairy herds without supervision. These cfarms differed substantially in mastitis problems and could have leveled the overall effect.

Even more important is that in the first weeks of this study climate issues with heavily rainfalls and periods of drought might have influenced the production data. During the study the students as well as some of the dairy herds had to cope with some severe rain showers. Not only rain showers but also periods of heat stress. Because, as mentioned above, just milk production of the month October 2012 instead the 305 day rolling herd average was taken in to account. These severe rain showers and periods of heat stress and thus severe climate differences between the days that a dairy herd was examined could have had a short time effect on the milk production. (Jones 1999, Lambertz 2014

7. Conclusion

A significant correlation (r=0.405, p=0.01) is found between the fat corrected milk production of October 2012 and the cow comfort score. The relevance of the correlation can be estimated by the r^2, being 0,16. This indicates 16% of the variation in milk production can be explained by the cow comfort score. Although this study shows promising results and corresponds with earlier barn-based cow comfort studies, more research is required to answer the same question for a 305 day rolling herd average. In order to answer this question, the new validated pasture-based cow comfort system can be used to score the cow comfort. (Duijn, 2014)

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9. Appendix

9.1 Questionnaire

General information / *Información general*	
Date of visit: *Fecha visita:*	
Number farm: *Matrícula:*	
Number of dairy cows: *Número de vacas lecheras:*	
Number of cows in lactation: *Número de vacas en lactancia*	
Race: *Raza:*	
Average age dairy cows: *Edad promedia de las vacas lecheras:*	
How many employees are there? *¿Cuántos empleados hay?*	
Are you educated? *¿Está educado?*	
Are the employees educated? *¿Se educa a los empleados?*	
Is there any further training and retraining? *¿Hay más Top formación y el reciclaje?*	
Size area (ha): *Tamaño en hectárea:*	
Size area (ha) for the cows: *Tamaño en hectárea de las vacas:*	

(Animal)health / *Sanidad*	
How many cows are crippled at the moment? *Cuántas vacas rengas hay hoy?*	
What is the percentage cows that were suffering from lameness this year? (Don't count repeated cases twice) *¿Qué porcentaje de las vacas estuvieron rengas durante el año pasado? (no contar vacas repetidoras)*	
How many cows are you treating today for mastitis? *¿Cuántas vacas reciben tratamiento por mastitis clínica hoy?*	

How many cases (%) of mastitis did you have this year? (in case of 14 days healthy and then again mastitis counts as a new case) *¿Cuántos casos de mastitis clínica hubo durante el año pasado? (la definición de un caso nuevo es: luego de 14 días sin problemas)*	
Wat is the percentage of cows with abomasal dislocations per year? *¿Cuál es el porcentaje de vacas con dislocaciones abomasales por año?*	
What is the percentage of cows with milk fever per year? *¿Anualmente, cuál es el porcentaje de hipocalcemia?*	
What is the percentage of cows with acetonaemia per year? *¿Cuál es el porcentaje de vacas con acetonemia por año?*	
What is the percentage of cows with rumen acidosis at the moment? *¿Qué porcentaje de las vacas ha sufrido acidosis en este momento?*	
What is the percentage of cows that is directly pregnant after the first insemination? *¿Cuál es el porcentaje de preñez a la primera inseminación?*	
What is the average time between calving? *¿Cuál es el intervalo entre partos?*	
What is the percentage of cows that get pregnant after insemination? *Cuál es el porcentaje de preñez final?*	
How many cases (%) needed assistance at calving? *¿Cuántas vacas necesitaron asistencia durante el parto durante el año pasado?*	
How many cases (%) needed assistance of a veterinarian at calving? *¿Cuántas vacas necesitaron asistencia veterinaria durante el parto durante el año pasado?*	
How many cows (%) died in the last year with an explanation? *¿Cuántas vacas (%) fallecieron en el último año con una explicación?*	
How many cows (%) died in the last year without an explanation? *¿Cuántas vacas (%) fallecieron en el último año sin una explicación?*	

Miscellaneous / *Misceláneo*	
How many times per day are the cows fed? *¿Con qué frecuencia se suministra el alimento (1 o 2 veces/día)?*	
How do you estimate the quality of the nutrition? *Cuál es su evaluación de la calidad del alimento? (bien / mal)*	
Are there differences in diets between the cows or the cows in different stadia of lactation? *¿Hay diferencias en las dietas entre las vacas o las vacas en diferentes etapas de la lactancia?*	
Are the cows resting during the hot hours of the day? *¿Las vacas pueden descansar durante las horas de mayor calor?*	
Is there ad libitum water available for the cows? *¿Las vacas tienen acceso a agua fresca y limpia todo el día?*	
What are the milking hours? *¿Cuáles son los horarios de ordeño?*	
How long are the cows maximal waiting in the waiting area? *¿Cuál es la duración máximaque el lote (la vaca)permanece en el corral de espera?*	

9.2 Scoring system sheet points

Scoring system for cow comfort on pasture-based dairy farm			
	Minimum	**Maximum**	**Points**
General	**10**	**20**	
Fear behavior		5	
Stretching when raising from the pasture		3	
Tails are hanging straight and relaxed		3	
Broken tails		0 (-100)	
Bellowing		4	
Environmental noise		0 (-5)	
Flies		0 (-5)	
Tail docking		0 (-5)	
Cleanliness score		5 (-5)	
Milking parlour and waiting area	2	5	
Behavior		3 (-3)	
Max. time waiting before entering the milking parlour		2	

Waiting area	8	17	
Shade		5 (-5)	
Presence of a ventilation system		1	
Presence of sprinklers		5	
Slipperiness floor		2	
Cleanliness floor		2	
Flatness floor		2	
Milking parlour	8	18	
Placing of feeding troughs		3	
Space		3	
Slipperiness floor		1	
Cleanliness floor		1 (-1)	
Flatness floor		1 (-1)	
Stairs and slopes		1	
Walking related to placement of the shafts		2	
Light		2	
It smells nice		1 (-2)	
% kicking cows		3 (-3)	
Exit milking parlour	3	6	
Floor		1 (-1)	
Mud		2 (-2)	
Surface		2	
Rubbish and obstacles		0 (-2)	
Slopes		1	
Water	16	33	
Ad libitum water available		10	
Type of place to drink		3	
Cleanliness		5	
Temperature		5	
Distance from the pasture with cows to the place to drink		3	
Sufficient amount and size of drinking troughs		5	
Safety of the drinking trough		2	
Feeding sites	13	27	
Additional feeding sites in the pasture		10	
Surface		3	
Cleanliness of the surface		3	
Feeding place per cow		3	
Contamination of the feeding site		0 (-3)	
Distance from the pasture to the feeding site		3	
Quality		5	
Walkways	9	18	

Floor		3	
Mud		5 (-5)	
Surface		3	
Rubbish and obstacles		0 (-5)	
Walking distance		3	
Slopes		2	
Speed of cows walking		2	
Loading site	3	6	
Steepness		1	
Safety		2	
Flatness floor		2	
Straight end		1	
Pastures	35	70	
Shade during hot hours of the day		20 (-20)	
Food availability		20 (-20)	
Mud		10 (-10)	
Rubbish and obstacles		10 (-10)	
Presence extra pasture		5	
Mud extra pasture		5	
Farmer and staff	34	68	
Relevant education farmer		5	
Relevant education staff		5	
Way of herding		10 (-10)	
Way of treating the cows during herding		20 (-15)	
Way of treating the cows around the milking parlour		20 (-15)	
Use of automatic driving aids		10 (-10)	
Environmental management	5	10	
Rest during hot hours of the day		5	
Milking hours aligned to the climate		5	
Animal health	100	202	
Hair		5 (-10)	
% lameness / year and locomotion		25 (-25)	
Hocks		20 (-60)	
Carpus		20 (-60)	
Claws		20	
% mastitis / year		15 (-15)	
Abomasal dislocation		10 (-15)	
Filling of the rumen		5 (-10)	
% milk fever / year		5 (-10)	
Acetonaemia		5 (-15)	
Body condition score		17	

% rumen acidosis / year		15	
Fertility		25 (-10)	
Calving		15	
Cow mortality		0 (-500)	
Total		500	