Associations between housing- and management factors and cow mortality in Swedish dairy farms

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Abstract

On-farm mortality, meaning cows being euthanised or dying unassisted, is increasing in Sweden. Cows which die in this manner are not eligible to enter the food system, causing an estimated 17% of all cows that die in Sweden every year to be sent for destruction, a notably unsustainable practice. Numerous studies have been made on potential variables effecting mortality, but research specifically regarding the effects of housing-and management practices on mortality are scarce. Mortality rates of Swedish farms vary, and in this study, housing and management practices of 19 Swedish farms, 10 with low mortality and 9 with high, were evaluated through a combination of questionnaires and on-farm welfare evaluations. By investigating overcrowding, routines, practices and general information from the farmers in combination with welfare evaluations, the aim was to examine if any of the factors differed between farms with contrasting mortality rates. Overall, the low mortality farms had a larger number of welfare violations, but the severity of the violations were higher on the high mortality farms. High mortality farms were more overcrowded and suffered from inadequate routines and monitoring of calving, sick and lame cows. The high mortality farms additionally had less strict biosecurity measures. Potential bias is a risk with small study populations and questionnaire-based studies. To further validate the findings of this study and reduce the risks of potential bias, future research should feature larger study populations combined with refined methods.

Keywords: Housing, management, welfare, mortality, dairy cow, cattle, questionnaire study, epidemiology, animal science

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Abbreviations

Abbreviation	Description
LM	Low mortality
HM	High mortality
SCC	Somatic Cell Count
SOP	Standard Operating Procedure
SOMRS	Swedish Official Milk Recording Scheme

1. Introduction

1.1 Background

On-farm dairy cow mortality, meaning euthanasia and unassisted death, is on the rise in several countries, including Sweden (Alvåsen et al. 2014c; Compton et al. 2017). Euthanasia being the practice of purposefully ending a life to prevent further suffering, whereas unassisted death is when an animal dies on its own without intervention. While dairy cow mortality increases in Sweden, studies on the topic are not prevalent. Factors that influence cow mortality including herd size, breed, parity, yield and production type have been investigated (Alvåsen et al. 2014a; Alvåsen et al. 2014b) but research on the effect of housing and management factors on cow mortality is scarce. Previous studies have mentioned housing and management and their effect on *welfare* (Nielsen et al. 2023; Pilarczyk et al. 2025). Although not a direct measure of mortality, connections between welfare and mortality have been found (Thomsen & Houe 2018). Studies on the effects of housing and management on *mortality* are largely focused on housing system (Dechow et al. 2011) or based on countries other than Sweden (Sarjokari et al. 2018).

Sustainability is a growing concern within companies and organisations all over the world. In the United Nations Sustainable Development Goals, reducing food waste is listed under goal 12 – Responsible consumption and production (The Global Goals 2025). The aim is for global food waste to be halved by 2030, to keep food systems sustainable and reverse the harm inflicted on the planet (The Global Goals 2025). In the Swedish livestock industry, 17% of all cows that die each year are either euthanised or die unassisted without entering the food system (Växa 2025). Swedish legislation requires farmers to report cullings, euthanasia and unassisted deaths to the central register of bovine animals, CDB (Jordbruksverket 2021). Farmers enrolled in the Swedish Official Milk Recording Scheme (SOMRS) can also register culling reasons. Despite this, the cause of unassisted death or euthanasia is often unknown or unreported. Cattle that are euthanised or die unassisted are sent to destruction plants and are not consumed. Cattle sent to slaughter are inspected by official veterinarians who perform ante- and postmortem inspections and report any remarks (Livsmedelsverket 2018).

Culling implies the active decision to remove animals from the herd and can mean selling, euthanising or slaughtering animals. Within the context of this thesis, culling was used to express the act of choosing to end a cow's life, be that by slaughter or euthanasia.

Compared with international statistics, the lifespan of Swedish cows is short (Växa 2025). In 2025, the average age of culling of Swedish dairy cows was 60.8 months (Växa 2026). In the Netherlands, the average age of culling in 2018 was 70.8 months (Kulkarni et al. 2023). Danish cows had an average culling age of 61.5 months (Thomsen & Houe 2023) and Australian cows 80.88 (Wondatir Workie et al. 2021). In the UK, KPI results for 2022 displayed a median culling age to be 72 months (Hanks & Kossaibati 2023). Increasing the productive lifespan of dairy cows and reducing the influx of replacement heifers could lower emissions, increase production and be of financial gain for the farmers (Alvåsen et al. 2018; DeVries & Marcondes 2020). This as the rearing of replacement heifers is detrimental to environmental impact compared to lengthening the productive life of cows (Bell et al. 2014; Grandl et al. 2019), as well as most farm rearing costs only being recovered by the second lactation (Boulton et al. 2017). Cows dying or being euthanised and sent for destruction rather than slaughter is a waste of resources. Both because of meat going to waste which could otherwise be utilised, and the life of a cow being cut short, essentially wasting the emissions and efforts from raising the cow. It also raises concerns for both the sustainability for future generations, as well as the ethical implications for the cow concerning lacking welfare. If the underlying reasons for the unnecessary death of cows can be deciphered, measures can be taken to lower this number, which would be in line with the sustainable development goals, benefit farmers and improve the welfare of dairy cows. The aim of this study was to investigate and compare the housing- and management factors of farms with high on-farm mortality and farms with low on-farm mortality to gain insight into potential causes of the differing mortality rates.

1.2 Causes of mortality

According to statistics from Växa (2025), the most common specified reasons for culling cows in Sweden are reproduction, udder health and low yield (figure 1). The figure includes all expired cows - euthanised and unassisted deaths, as well as slaughtered animals.

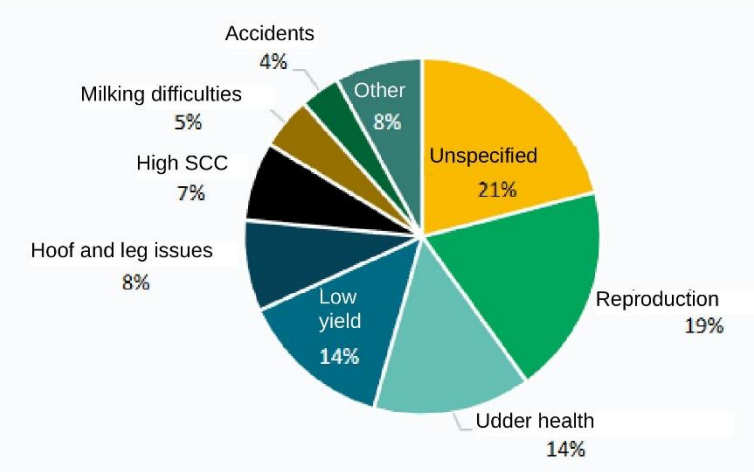

Figure 1: Proportion of culling causes for cows enrolled in the Swedish Official Milk Recording Scheme 2024-2025. Translated version of figure from Djurhälsostatistik 2024-2025 by Växa (2025).

1.2.1 Welfare

Disproportionate numbers of a farm's animals dying unassisted or being euthanized implies welfare issues within the farm (Thomsen & Houe 2018; Saxmose Nielsen et al. 2023). While it is evident that animal welfare is of value to farmers (Hansson & Lagerkvist 2015), differences in the definition of welfare may occur, making some aspects such as behavioural needs overlooked (Hötzel et al. 2025). There is no one true definition of Animal welfare, but several theories and frameworks which have been coined throughout the years. Despite different principles and implications, all the top definitions agree that animal welfare entails the physical but also mental and behavioural needs of the animals (Dwyer et al. 2026). The animal welfare rules of the European Union are based on the 'Five Freedoms' approach which entails freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury and disease; freedom from fear and distress and freedom to express normal behaviour (European Commission 2023). As the farms' choices of housing-and management impacts many aspects of the cows' life and health, there are many factors which could potentially affect the welfare of dairy cows by infringing on the five freedoms.

1.2.2 Infectious diseases

Diseases or disorders of the udder are common globally (Morales-Ubaldo et al. 2023; Thomsen & Houe 2023; Växa 2025; Hagner 2025). Udder health is the second most common cause for culling in Swedish cows (figure 1), many of the cases being due to mastitis (Växa 2025). Bacterial infections are the most common cause of mastitis and the types of bacteria involved can be environmental and/or contagious (Morales-Ubaldo et al. 2023). Several

environmental bacteria are common in mastitis cases, the most prevalent being *Streptococcus uberis*, *Staphylococcus aureus,* as well as *Escherichia coli & Trueperella pyogenes* (Klaas & Zadoks 2017; Växa 2025), all which are found in Swedish mastitis cases (Växa 2025).

Signs of pneumonia or other respiratory diseases are more commonly being noted in Swedish slaughterhouses (Växa 2025). Although the focus of this study is on on-farm deaths, not cows sent to slaughter, it can be assumed that expired cows suffer from these disorders as well, and that cases of them are represented within 'other' and/or 'unspecified' presented in figure 1. This is further substantiated with findings from studies of Danish and Finnish cows, as pneumonia has been listed as culling reason (Thomsen & Houe 2023) and found during necropsies of euthanised/unassisted dead cows (Wilson et al. 2022; Hagner et al. 2023; Hagner 2025).

The proportion of Swedish cows experiencing digital dermatitis, a contagious disease which can affect large proportions of herds, remains high (SVA 2024; Växa 2025). Amongst the methods to prevent infection and spread it is recommended to have frequent hoof care to catch early signs (SVA 2024). Keeping hoof care regular, having cows out to pasture, as well as following routines and treatment plans can also provide farmers with financial aid from the Swedish Board of Agriculture (Jordbruksverket 2026).

The high incidence of digital dermatitis and prevalence of environmental bacteria in mastitis cases, the suspected occurrence of pneumonia, as well as potential other infection risks makes evaluating the biosecurity factors on farms of differing mortality rates of interest.

1.2.3 Reproduction

Reproduction issues are the most common named culling reasons in Sweden (figure 1) and includes decreased fertility, calving complications and spontaneous abortion. Calving complications which could lead to euthanasia or unassisted death could be dystocia, puerperal paresis, prolapse and metritis to name a few (Hagner et al. 2023). The transition period three weeks before and three weeks post calving is also critical for cow health and longevity as the cow is at higher risk of developing disease (van Dixhoorn et al. 2018; Redfern et al. 2021)
The high incidence of cows culled for reproductive reasons indicates a need to inspect the routines and monitoring around calving on farms with differing mortality rates.

1.2.4 Overcrowding

Overcrowding or overstocking is a common welfare issue which affects many aspects of a cow's life. Besides restricting access to basic needs such as food and water, as well as the potential for increased waiting times between milkings, too high stocking density upsets natural behaviours such as hierarchy and forming of groups. This can lead to aggression, agonistic behaviours, stress and injuries (Pilarczyk et al. 2025). Overcrowding can also reduce lying time and behaviour, which has health implications such as hoof injury, disease and lameness (Fregonesi et al. 2007; Winckler et al. 2015). The European Food Safety Authority has deemed overstocking at the cubicle and low total space allowance as two of the main risks to cow welfare in cubicle systems (Saxmose Nielsen et al. 2018). For cows to be able to establish social groups and hierarchy, and express natural resting behaviour, at least one cubicle per cow, preferably more, is needed (Fregonesi et al. 2007; Winckler et al. 2015). Swedish legislation deems it necessary for at least one resting space per cow (Jordbruksverket 2018) and loose housed dairy cows to have a total area of 8.5 m^2/cow (Jordbruksverket 2024). Because of the detrimental effects on cow health and welfare due to overcrowding, a connection between overcrowding and mortality can be expected.

1.2.5 Symptoms and action

There are psychological factors which can affect the way farmers act in the event of illness or lameness in their herd. Farmers who perceive their herds to have low udder health and who feel a of lack of control may delay action or avoid treatment (Ekman et al. 2025). Further, Hansen & Østerås (2019), found that optimism positively affects willingness to improve on animal welfare and disease prevention, while pessimism had a negative effect on the welfare and perceived control. This could present in differences between farms with high and low mortality in their perceived importance of symptoms and their tendency to act in the event of symptoms.

1.3 Research questions

To investigate the effects of housing and management on dairy cow mortality, and with previous research in mind, data was analysed in the context of five research questions based on the literature overview;

1. *Do high mortality farms have a higher number of violations in welfare evaluations than low mortality farms?*
2. *Do high mortality farms have less strict biosecurity measures than low mortality farms?*
3. *Do high mortality farms have fewer routines and less monitoring surrounding calving?*

4. *Are high mortality farms associated with overcrowding factors?*
5. *Do high mortality farms value symptoms of lame and sick cows lower than low mortality farms and are they less likely to act in the event of symptoms?*

2. Materials and methods

2.1 Study population

There were certain inclusion criteria which had to be fulfilled by the farms to be eligible for the study. The first requirement was that the farms had to be enrolled in the Swedish Official Milk Recording Scheme (SOMRS) a digital tool by Växa which stores, processes and summarises data on Swedish dairy farms. Other criteria were that they had to have loose housing and a minimum herd size of 100 cows. Prior to the start of this thesis, farms were assigned to either the high mortality (HM) or low mortality (LM) class. To classify which farms had high and low mortality, all farms registered in SOMRS were divided into quartiles based on the cumulative incidence (CI) of mortality for year 2021 and 2022. To be classified as low mortality, farms had to have a CI below 3.88% in 2021 and below 3.63% in 2022. High mortality farms had to have a CI of above 7.895% in 2021 and over 7.58% in 2022. To avoid temporary low or high mortality rates, farms had to fit the criteria for both years to classify. Farms that fulfilled the criteria were contacted and asked to participate in the study. The study was funded by SLF (Stiftelsen Lantbruksforskning) and as an incentive for the farmers to participate, compensation in the form of a Djuröga® evaluation, as well as necropsies for expired cows were provided free of charge.

2.2 Questionnaire

The first draft of the questionnaire was made by Karin Alvåsen and the revised version sent out to farmers was developed by Annica Hansson at Växa. It was not deemed necessary to test the questionnaire as the first draft had been used in a previous study by Alvåsen et al. (2014b). The final version of the questionnaire had 72 questions and sub-questions included in nine sections (table 1.)

Table 1: Contents of questionnaire. Modified from Alvåsen et al. 2014b

Section	Questions regarding
Management	Farmer, number of cows, labour, interest in different tasks, education
Housing	Stall type, milking system, floor characteristics, bedding, cubicles, measurements, groupings
Feeding	Feeding plans, time and intervals, access to roughage, pasture type and access, measurements, feed spaces and types
Routines	Standard operating procedures, monitoring, dry cow management, hoof care, advisory services, groupings, biosecurity
Calving Cows	Calving spaces, monitoring, bedding, colostrum routines, groupings, post-partum care
Milking cows	Bedding, cleaning, dry cow management, groupings
Breeding	Use of natural service, opinion on genetic selection & mortality
General inquiries	Mortality follow-up, factors that affect mortality, effect of access to emergency slaughter
Lame and sick cows	Lame cows; detection and action; sick cows; symptoms and action

The questionnaire was sent out in Swedish. Question types varied and included multiple choice, free text, scales, and place for comments. A version of the questionnaire was created in Netigate, a web-based digital questionnaire tool. This made it possible to compile answers into a standardised format for processing. When translating the answers from the farmers, it was attempted to keep answers as verbatim as possible. Any doubts surrounding the translations, interpretations or terminology were discussed with the supervisors to present the contents as correctly as possible.

2.3 Djuröga®

The on-farm animal welfare evaluations were performed according to, and registered in the digital tool Djuröga®, owned and operated by Växa. Welfare evaluations took place during the indoor seasons of 2024 and 2025 and were performed by trained veterinarians employed by Växa. Evaluations were made in accordance with the Djuröga® guidelines; In groups of <35 animals, ≥90% should have individual evaluations (Hovelius 2026). For a level of randomisation, Hovelius (2026) recommended that all cows are chosen for evaluations in herds of 60 or less, every other cow in herds of 61-120 and every third cow in herds of 120

or more. The factors evaluated and the method and/or definitions are presented in table 2.

Table 2: Djuröga® evaluation factors. Summarised and translated from workshop presentation by Eleonor Hovelius, veterinarian (Växa) 2026-02-24

Factor	**Evaluation**
Cubicle utilization	How many cows are standing up in cubicles.
Lying behaviour	If cows are lying down in alley or if body part is hanging out of the cubicle.
Water access	Number of cows per drinking space. One drinking space = a functional water cup or 0.75 m water trough.
Body condition score	Combined scoring of visual examinations of spinous processes, transverse processes, pins, hooks & tail heads. Divided into *thin, normal & overweight*.
Rumen fill	Visual inspection of the filling of the paralumbar fossa, below transverse processes on left side. Divided into *filled* & *not filled*.
Cleanliness	*Clean* meaning completely free of dirt, alternatively small amounts of manure splatter. *Not clean* meaning at least *three* 10 cm in diameter areas of dirt.
Injuries	Areas with swelling, wound or scab, redness. *No injuries*= one injury <5x5 cm or combined injuries <10x10 cm. *Injuries*= one injury ≥5x5 cm or several injuries ≥10x10 cm. *Large injuries*= one injury ≥10x10 cm or combined injury size of ≥20x20 cm.
Movement	Combined evaluation of effort, stiffness, speed, willingness, gait and posture.

Evaluations of the animal welfare measures were registered in the programme, and the software presented the results with colour coded warnings of areas of improvement, as well as commendations where the farm fulfilled or exceeded expectations. The comparison between LM and HM farms was made by comparing applying the colour coding criteria from the Djuröga® programme to the group mean of LM and HM farms. Variables where the group mean was given warnings, i.e. the colour yellow or red, were deemed as violations in the analysis.

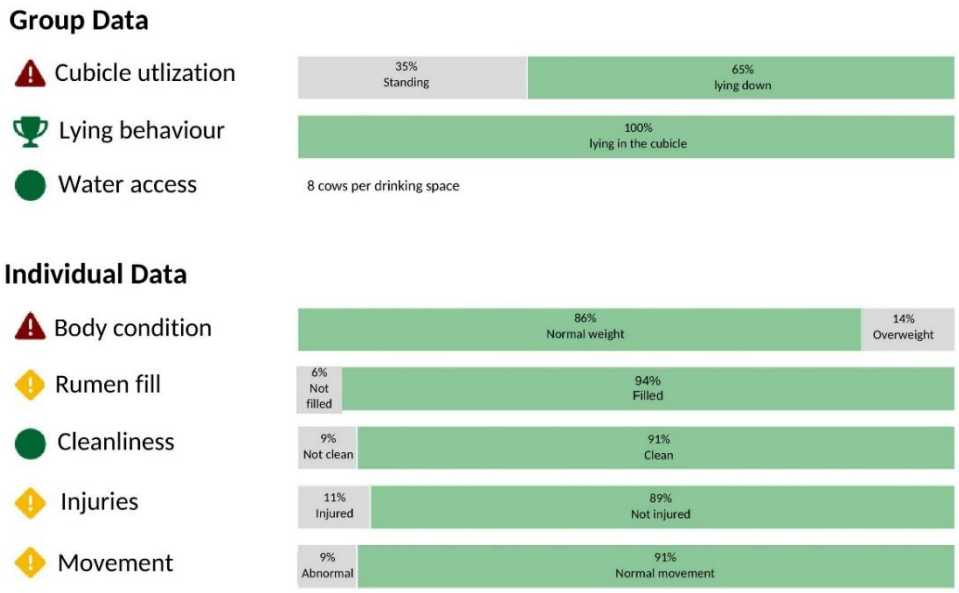

Figure 2: Herd data as presented in Djuröga®. Translated into English. Green icon represents sufficiency, yellow meaning subpar and red meaning poor results.

Colour coding was based on threshold values predetermined by the programme. It should be mentioned that the guidelines provided by Växa on the number of cows per water access differs from Swedish regulations. According to section 3 § 11 in the Swedish Board of Agriculture's Code of Statutes (SJVFS 2019:18), farms with automatic water supply are to have one drinking space per 10 milking cows and one drinking space per 25 other cattle. Växa's guidelines within Djuröga® signals yellow when there are 9-10 cows/water access and red when over 10 cows/water access. The Djuröga® evaluation colour coding does not take into consideration whether the cow is in milk or not.

2.4 Ethical considerations

As no animals were recruited, nor being used in any manner for the express purpose of the study, ethical approval for animal research was not deemed necessary. Farmers were well informed about the storage and usage of the data provided and sensitive data was not collected. Consent forms and non-disclosure agreements were signed by parties involved and all data was anonymised before being presented.

2.5 Data processing

Questions were processed as categorial variables. For multiple choice questions, affirmative answers were given the number 1 and negative answers were assigned as 'missing'. In cases where the multiple-choice questions also had alternatives, the resulting data set presented the data as 1, 2, or 3, respective of the different

alternatives. Questions with visual scales were processed as 1-10. Due to some not having a corresponding question format in Netigate, many questions had to be divided into sub-questions. This led to an increased number of variables in the resulting data sets. The total number of variables in all data sets added up to over 600. Free-text answers were included in the data sets but not in statistical analyses, nonetheless they provided useful information for general analyses and reflection.

In the cases where respondents had written a span of days, measurements, cows or other variables, it was decided to put the mean value as the answer. This method was chosen due to the large number of variables in the dataset. It was not feasible within the time frame to have different methods of deciding the input for every variable. When possible, the spans were made into separate columns, e.g. minimum and maximum cow numbers.

For the Djuröga® evaluations, since the participating farms had numbers of groupings varying from two to eight groups per farm, the results used for analysis were based on the largest dairy cow group and dry cow group from each farm. This was chosen as the method as all farms had at least one dairy cow group and one dry cow group. When multiple dairy or dry cow groups from the same farm had the same number of cows, the group chosen for inclusion was randomised.

2.6 Analysis

Statistical analyses were performed using the statistical software Minitab® version 22.4.0 (Minitab 2026) as well as Minitab® Web App. Due to the large number of variables exported from the questionnaire, not all were chosen for analysis in this thesis. Instead, the five research questions were formed and the questions related to them were used in analysis. The study design and the small number of participating farms did not make it possible to evaluate causation and correlation; rather, descriptive statistics were exported in table format.

2.7 Literature

Literature was found by utilising the SLU library service “Primo”, Google Scholar and Scopus. Only peer reviewed articles in English were used. References from within the resulting articles were scrutinised for relevancy and accuracy. Other references, such as Swedish legislation and Swedish agricultural data were collected from the source of publication. Previous publications within the cow mortality project were provided by the supervisor.

3. Results

3.1 Demographic

Twenty farmers agreed to participate in the study, half of them HM and half LM. It was later discovered that one of the HM farms did not have loose housing, which disqualified it from participation. This resulted in ten participating farms with low mortality and nine with high. The response rate of the questionnaire was 100% (n=19). The gender and age distribution is presented in table 2. All but two of the respondents were in a leadership position at the farm and all claimed to have responsibility for the cows.

Table 3: Study demographic: gender and age distribution

Variable	Gender	N	Mean (SD)	Min.	Q1	Median	Q3	Max.
Age	Female	7	50.71 (11.24)	37	39	48	59	67
	Male	12	45.42 (11.45)	23	38	45	56.25	64
Age	All	19	47.37 (11.36)	23	39	46	57	67

One farm, despite having one of the lowest mortality rates of the study, declined further involvement. Meaning that the questionnaire was filled in but no on-farm visit was performed. Due to the low number of total farms in the study, it was decided that the questionnaire would still be included in the analysis, without the information from Djuröga®. Another farm, from the HM group, had an on-farm visit but the data from it could not be ascertained as it could not be found in the system by the contacts at Växa. In total, 19 farms were included in the study and all but one had on farm-visits. Out of the farms included, 17 farms corresponding to 1653 cows were evaluated with Djuröga. For the resulting analysis, 867 cows were included.

3.2 Djuröga®

Descriptive statistics are presented in table 4 and 5. Most variables have similar means in both LM and HM farms. Variables where the mortalities deviate are the number of cows per water access, body condition scores, cleanliness, injuries and the utilisation of cubicles. There is also variation when comparing the dairy cow groups to the dry cow groups. Table 4 shows a higher mean of 14.38 cows/water access in the HM group, compared to the LM groups' 9.89. Contrastingly, in the dry cows, the LM group has a higher number of cows/water access (8.67) than the HM group (7.29) (table 5). The mean number of unclean and injured cows are similar within the HM and LM groups for the dairy cows (table 5) however, the maximum values are higher in the HM groups. More injured animals are seen in

the LM dry cows. The HM farms have a higher proportion of unclean dry cows (table 5).

*Table 4: Descriptive statistics of Djuröga evaluations on **dairy cows***

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Cows in group	Low	9	120.44	36.066	80	99.5	110	132	205
	High	8	113.63	25.845	65	102	116	125.75	155
Cows examined	Low	9	35.22	0.441	35	35	35	35.5	36
	High	8	36.75	2.315	35	35	35.5	38.75	41
Cows/water access	Low	9	9.89	1.900	7	8.5	10	11.5	13
	High	8	14.38	6.523	9	10	12.5	16	29
Thin	Low	9	0.022	0.039	0	0	0	0.05	0.11
	High	8	0.004	0.011	0	0	0	0	0.03
Normal	Low	9	0.91	0.084	0.74	0.86	0.94	0.99	1
	High	8	0.95	0.069	0.8	0.92	0.97	1	1
Overweight	Low	9	0.07	0.087	0	0	0.06	0.12	0.26
	High	8	0.05	0.071	0	0	0.02	0.08	0.2
Rumen fill	Low	9	0.97	0.032	0.91	0.96	0.97	1	1
	High	8	0.98	0.038	0.89	0.97	1	1	1
Not clean	Low	9	0.31	0.267	0.06	0.09	0.14	0.57	0.77
	High	8	0.38	0.330	0.12	0.16	0.26	0.67	1
Injured	Low	9	0.17	0.102	0.03	0.09	0.17	0.29	0.29
	High	8	0.12	0.138	0	0.01	0.1	0.2	0.4
Normal movement	Low	9	0.9	0.073	0.74	0.88	0.91	0.94	1
	High	8	0.94	0.053	0.86	0.89	0.94	0.99	1
Standing in cubicles	Low	9	0.22	0.069	0.11	0.17	0.21	0.25	0.35
	High	8	0.21	0.132	0.08	0.11	0.15	0.36	0.41
Outside of cubicles	Low	9	0.09	0.061	0	0.03	0.09	0.16	0.16
	High	8	0.11	0.126	0	0.03	0.08	0.12	0.4

* Missing data

*Table 5: Descriptive statistics of Djuröga evaluations on **dry cows**.*

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Cows in group	Low	9	19.11	12.272	5	9	18	26	45
	High	7*	16.86	9.045	6	9	15	23	32
Cows examined	Low	9	15.67	7.382	5	9	14	22.5	27
	High	8	14.38	8.210	6	7.5	11.5	21.75	29
Cows/water access	Low	9	8.67	5.895	3	4.5	7	13.5	19
	High	7*	7.29	6.184	2	3	6	10	20
Thin	Low	9	0.02	0.040	0	0	0	0.03	0.11
	High	8	0.04	0.099	0	0	0	0	0.28
Normal	Low	9	0.78	0.165	0.56	0.58	0.83	0.9	1
	High	8	0.86	0.098	0.72	0.79	0.85	0.97	1
Overweight	Low	9	0.2	0.181	0	0.03	0.14	0.42	0.44
	High	8	0.11	0.091	0	0	0.14	0.18	0.22
Rumen fill	Low	9	0.98	0.070	0.79	1	1	1	1
	High	8	0.94	0.170	0.52	1	1	1	1
Not clean	Low	9	0.08	0.140	0	0	0	0.18	0.39
	High	8	0.23	0.370	0	0	0.04	0.64	0.83
Injured	Low	9	0.21	0.134	0.07	0.11	0.17	0.33	0.44
	High	8	0.08	0.119	0	0	0.02	0.15	0.33
Normal movement	Low	9	0.95	0.079	0.78	0.91	1	1	1
	High	8	0.97	0.042	0.91	0.92	1	1	1
Standing in cubicles	Low	9	0.31	0.280	0	0.06	0.3	0.55	0.79
	High	8	0.49	0.396	0	0.13	0.43	0.88	1
Outside of cubicles	Low	9	0.04	0.075	0	0	0	0.07	0.2
	High	7*	0.14	0.333	0	0	0	0.07	0.89

*Missing data

3.3 Overcrowding

Overstocking or overcrowding was based on the number of cows per cubicle and square meters per cow and only included the milking cows. The utilisation of cubicles was also an aspect of the research question about overcrowding and can be visualized in tables 4 and 5. HM farms present with overcrowding on a larger scale than LM farms (figure 3).

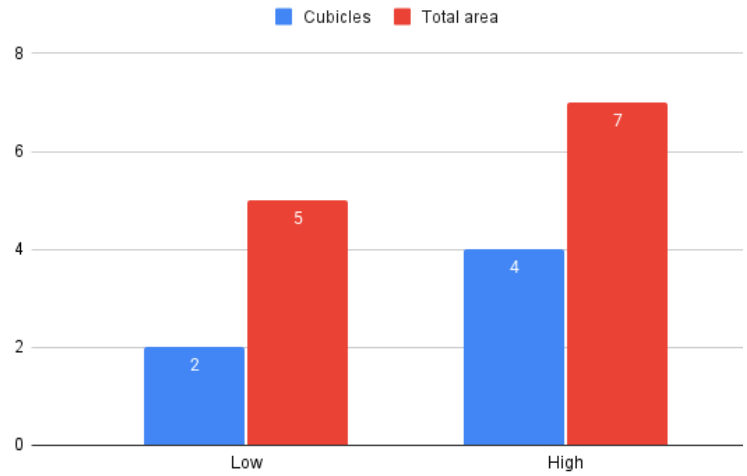

Figure 3: Bar chart of overcrowding of cubicles (LM n=10, HM n=9) and total area (LM n=9, HM n=9).

The mean, median and maximum area per cow was also lower in the HM herds. The lowest area can be observed in the LM group (table 6).

Table 6: Descriptive statistics of area per cow in low mortality (n=9) and high mortality (n=9) farms.

Variable	Mortality	Mean	StDev	Min.	Q1	Median	Q3	Max.
M²/cow	Low	8.34	2.111	4.77	6.61	8.44	10.34	10.86
	High	7.55	0.745	6.47	7.14	7.31	8.23	8.72

The average slaughter weight was higher in the HM farms according to data from SOMRS. Indicating a larger average cow size compared to LM farms.

Table 7: Slaughter weights of LM (n=8) and HM (n=10) farms

Variable	Mortality	Mean	StDev	Min.	Q1	Median	Q3	Max.
Slaughter weight	Low	310.58	19.11	276.95	295.06	321.13	325.02	329.41
	High	326.8	17.621	303.22	315.27	323.63	339.81	359.21

3.4 Calving

Only one farm from each group separated heifers from other cows during calving. Cows with poor or abnormal udder health were separated from healthy cows in some cases, more frequently in the LM group (table 10). More than 50% (LM n=6, HM n=4) of respondents claimed to not have disease prevention strategies in place, meaning that the calving occurred in an available calving space which could include both cows and heifers and animals with poor udder health.

Table 8: Distribution of disease prevention methods for calving in low mortality (n=10) and high mortality (n=9) farms.

Variable	Mortality rate	Yes	No
Heifers have own calving spaces	Low	1	9
	High	1	8
Poor udder health separated from "healthy"	Low	4	6
	High	2	7
Calving space without disease prevention strategies in place	Low	6	4
	High	4	5

The respondents were asked which signals they noted to be worthy of observation in the post-calving period of the cows (table 8). Seven out of the ten listed signals were more commonly observed in the LM group. The remaining three signals were equally observed in both groups. None were more commonly observed in the HM group.

Table 9: Distribution of signals deemed important for observation post-calving in LM (n=10) and HM (n=9) farms.

Variable	Mortality rate	Yes	No
General condition	Low	9	1
	High	7	2
Eyes	Low	6	4
	High	5	4
Coat	Low	4	6
	High	2	7
Ears	Low	6	4
	High	5	4
Standing	Low	3	7
	High	3	6

Variable	Mortality rate	Yes	No
Locomotion	Low	8	2
	High	8	1
Appetite	Low	9	1
	High	8	1
Rumination	Low	7	3
	High	7	2
Rumen fill	Low	8	2
	High	6	3
Temperature	Low	7	3
	High	5	4

All farms had monitoring of calving cows consisting of rounds. Routines for the prevention of parturient paresis were in place for all farms.

The testing of udder health and milk quality varied throughout the groups (table 10). None of the HM groups tested 'immediately after calving'. The highest numbers can be seen in testing 'at first milking' (LM n=9, HM n=6).

Table 10: Distribution of when udder health and milk quality was tested post-calving in low mortality (n=10) and high mortality (n=9) farms.

Variable	Mortality rate	Yes	No
Immediately after calving	Low	3	7
	High	0	9
At first milking	Low	9	1
	High	6	3
Before milk is sent to tank	Low	1	9
	High	3	6
Extra control if symptoms	Low	5	5
	High	3	6
If SCC is high at test milk	Low	2	8
	High	2	7

3.5 Biosecurity

Out of ten LM farms, seven of them declared to be involved in preventative infection programmes, compared to only four out of nine HM farms. The feed tables for dry cows were swept or cleaned more often in the HM farms than the LM farms (table 11). The resting areas of the cows, however, were scraped and replenished more often in LM farms which corresponds with the higher

percentage of unclean cows in the HM dairy and dry cows (table 4 & 5). Eight of the LM farms (n=10) and seven of the HM farms (n=9) used antimicrobial agents in the bedding, with mineral blends and slaked lime being the most common agents.

Table 11: Descriptive statistics on cleaning routines in low mortality (n=10) and high mortality (n=9) farms.

Variable	Mortality rate	Mean	StDev	Min.	Q1	Median	Q3	Max.
Cleanings of feed table/week	Low	3.48	2.647	0.25	1	3	7	7
	High	4.94	3.124	0.25	1.13	7	7	7
Cubicle scrapings/day	Low	2.5	0.471	2	2	2.5	3	3
	High	2.44	0.583	2	2	2	3	4
Litter replenished/week	Low	3.5	4.14	1	1	2	4	14
	High	2.28	1.856	1	1	2	2.25	7

Hoof care was provided more often in LM farms compared to HM farms. It was more common for LM farms to provide hoof trimming at the same occasion, but emergency hoof care in-between was more frequent in LM as well. Most farms, both HM and LM, did not follow a hoof care Standard Operating Procedure (table 13).

Table 12: Hoof care routines in low mortality (n=10) and high mortality (n=9) farms.

Variable	Mortality rate	Yes	No
Hoof care: 1/year	Low	0	10
	High	1	8
Hoof care: 2/year	Low	5	5
	High	3	6
Hoof care: 3 or more/year	Low	5	5
	High	5	4
All at the same occasion	Low	8	2
	High	7	2
Same occasion: ≤50%	Low	2	8
	High	2	7
Emergency hoof care in between	Low	7	3
	High	5	4
Hoof care SOP	Low	4	6
	High	3	6

The respondents were asked to state how they followed up on cow mortality through a multiple-choice question. Alternatives and responses are displayed in table 14. 'Signaler Djurvälfärd™' is a tool which is accessible to all members of SOMRS and displays areas of improvement within animal health. 'MinGård®' is a management tool also connected to SOMRS and Växa. All respondents were enrolled in SOMRS, meaning they had access to both tools. Cadaver journals include the date and cause of death/cause for euthanasia of expired cows. The most common reporting methods amongst the LM farms were 'Signaler Djurvälfärd™' and annual counselling visits. Amongst HM farms, frequent counselling visits and internal staff meetings were the most common follow-up methods. All farms but one HM farm had some manner of following up on mortality.

Table 13: Mortality follow-up methods in low mortality (n=10) and high mortality (n=9) farms.

Variable	Mortality rate	Yes	No
Signaler Djurvälfärd™	Low	6	4
	High	2	7
MinGård®	Low	1	9
	High	3	6
Report cause and follow up in management programme	Low	2	8
	High	2	7
Cadaver journal	Low	3	7
	High	3	6
Annual counselling visits	Low	6	4
	High	2	7
Frequent counselling visits	Low	2	8
	High	4	5
Annual internal staff meetings	Low	2	8
	High	2	7
Frequent internal staff meetings	Low	2	8
	High	4	5
Not at all	Low	0	10
	High	1	8

3.6 Symptoms and action

When asked to place symptoms of lame cows on a scale from 1-10, LM farms classed all symptoms higher than HM farms. HM farms were more likely to call a hoof trimmer, while LM farms opted to more often use their own hoof trimming chute. The same pattern could be seen with HM farms being more likely to call a veterinarian while LM farms were more likely to start own treatment. HM farms were more likely to place lame cows on monitoring lists and in hospital pens than LM farms (table 15).

Table 14: Lame cows; descriptive statistics of the perceived gravity of symptoms and the actions taken in low and high mortality farms.

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Lifting foot when standing	Low	10	8.9	0.876	7	8.75	9	9.25	10
	High	9	7.11	2.088	4	5	8	8.50	10
Avoiding foot/leg when walking	Low	10	9.1	0.876	7	9	9	10	10
	High	9	8.44	1.81	4	8	9	9.50	10
Curved back when standing	Low	10	8.1	1.197	6	7	9	9	9
	High	9	7.89	1.9	4	7	8	9.50	10
Curved back when walking	Low	10	8.9	0.738	7	9	9	9	10
	High	9	8	1.871	4	7	8	9.5	10
Increased time spent lying down	Low	10	7.8	1.814	5	6	8	9.25	10
	High	9	7.67	2.236	3	7	7	10	10
Trouble getting up/down	Low	10	9.2	0.919	7	9	9	10	10
	High	9	8.22	1.986	4	7	9	10	10
Will not come for milking	Low	10	8.9	1.197	6	8.75	9	10	10
	High	8*	8.5	1.852	6	6.25	9.5	10	10
Wait and see	Low	9*	1.89	2.892	0	0	1	2.5	9
	High	9	2.33	1.871	0	1	2	3.5	6
Call a hoof trimmer	Low	10	3.3	4.165	0	0	1	7	10
	High	9	5	2.828	2	2.5	5	7.5	10
Call a veterinarian	Low	9*	3.22	3.598	0	0	2	6	10

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
	High	9	4.78	3.032	0	2	5	7.5	9
Place on monitoring list	Low	9*	7.33	3.536	1	4	9	10	10
	High	9	8.22	3.232	0	8	10	10	10
Place in hospital pen	Low	9*	6.11	3.219	0	4	7	9	10
	High	9	7.89	1.364	6	6.5	8	9	10
Take to own hoof trim chute	Low	10	8.7	3.093	0	9	10	10	10
	High	9	6.89	2.667	2	4.5	8	9	9
Start own treatment	Low	9*	8.11	2.571	3	6	9	10	10
	High	9	7.67	2.398	2	7	8	9	10

* Missing data

An equal number of symptoms for sick cows were graded higher by HM and LM farms (table 16). HM farms were more likely to contact a veterinarian and LM more likely to start own treatment. In both lame and sick cows, LM farms were less likely to 'wait and see' in the instance of symptoms present. LM farms were also more likely to place sick cows on monitoring lists and in hospital pens, as well as start own treatment (table 16).

Table 15: Sick cows; descriptive statistics of the perceived gravity of symptoms and the actions taken in low and high mortality farms.

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Lying down excessively	Low	10	6.9	2.331	3	5	6.5	9.25	10
	High	9	8.33	1.323	6	7.5	8	9.5	10
Decreased production	Low	10	9.33	0.675	8	9	9	10	10
	High	9	9	1	7	8.5	9	10	10
Swollen udder, no milk let-down	Low	10	9.6	0.516	9	9	10	10	10
	High	9	9.33	0.707	8	9	9	10	10

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Diarrhoea	Low	10	7.8	2.573	4	4.75	9	10	10
	High	9	8.33	1.581	5	7.5	9	9.5	10
Nasal discharge	Low	10	6.5	1.9	4	4.75	6.5	8	10
	High	8*	6.75	1.488	5	5.25	6.5	8	9
Stopped eating	Low	10	9.7	0.483	9	9	10	10	10
	High	9	9.44	0.726	8	9	10	10	10
Ugly discharge	Low	10	5.6	2.119	2	4.75	5	7	10
	High	9	7.67	2.236	4	5.5	8	10	10
Fever, warm to the touch	Low	10	9.7	0.483	9	9	10	10	10
	High	9	9.22	0.833	8	8.5	9	10	10
Does not want to/does not come to milking	Low	10	8.9	1.287	6	8	9	10	10
	High	9	7.56	2.128	4	6	7	10	10
Lost weight	Low	10	9	1.414	7	7	10	10	10
	High	9	9.11	0.782	8	8.5	9	10	10
Wait and see	Low	9*	1.11	1.616	0	0	1	1.5	5
	High	8*	2	1.309	0	0.5	2.5	3	3
Take temperature	Low	9*	9.11	1.269	7	8	10	10	10
	High	9	9.11	0.928	8	8	9	10	10
Call a veterinarian	Low	9*	6.67	2.121	4	5	6	8.5	10
	High	9	7.89	1.833	5	6.5	8	10	10

Variable	Mortality rate	N	Mean	StDev	Min.	Q1	Median	Q3	Max.
Place on a monitoring list	Low	9*	8.78	2.048	4	8	10	10	10
	High	9	8	2.5	3	6.5	8	10	10
Place in a hospital pen	Low	10	8.3	1.636	5	7	8.5	10	10
	High	9	7.67	1.658	5	6	8	9	10
Start own treatment	Low	9*	8.56	2.297	3	8	9	10	10
	High	9	7.78	1.394	5	7	8	9	9

* Missing data

Twelve out of the seventeen listed symptoms of lame and sick cows were ranked of higher mean importance by the LM farms than by the HM farms. In total, five out of eleven proposed actions were more commonly taken by the LM farms.

4. Discussion

4.1 Djuröga®

HM farms had a lower number of violations (n=8) than LM farms(n=12), providing a negative answer to the question about HM farms having a higher number of violations. Out of the violations, however, a few of them are worth mentioning due to their potential effect on mortality rate.

4.1.1 Water access

The high number of dairy cows/water access in the HM group is troublesome but can provide context for seemingly unrelated issues within the herd. With a mean number above the legal limit of 10 cows/automatic water access (Statens Jordbruksverk 2019), and a max of almost triple that (29 cows/water access) improvements are overdue. Not having adequate access to water can be a major stressor for the cow, both in terms of physical and mental stress. Inadequate water sources is a risk factor for dominance issues, conflict and agonistic behaviours within the herd (Nizzi et al. 2024; Burkhardt et al. 2025). When water access is restricted, non-dominant or subordinate cows drink smaller amounts more frequently, disrupting the time budget for rest (Nizzi et al. 2024). This, in turn can lead to lameness and leg injuries with repeated rubbing of hocks and knees when getting up (Cramer & Solano 2024), as well as an increased risk of hoof lesions from prolonged standing (Charlton et al. 2016; Eriksson et al. 2021). Another problem with an increased number of cows per drinking space is the potential for increased bacterial load introduced with a higher number of individuals utilising the same access.

4.1.2 Cleanliness

HM cows were dirtier than LM cows, with a mean of 38% (HM) vs 31% (LM) of dairy cows and 23% (HM) vs 8% (LM) of the dry cows being classified as not clean. Unclean cows present a biosecurity risk as the incidence of diseases such as mastitis, foot issues, skin infections and SCC increases (Hauge et al. 2012; Lundmark Hedman et al. 2021). All which could lead to culling or unassisted death.

4.1.3 Injuries

An unexpected result from the Djuröga® evaluations was that more animals were classified as injured in the LM groups. A reason for this could be that life sustaining efforts are more prevalent in the LM group. As can be seen by the results of 'Symptoms and action', LM farms were more likely to treat cows themselves, rather than calling a veterinarian. Having a veterinarian come out to the farm for treatment of injuries can be expensive which may lead to the farmer weighing cost and benefit of keeping the cow with treatment or culling it. The high percentage of injuries in LM farms could be that the cows are actively being treated for the wounds, potential lack of skill in the treatment, or that they simply had more injured cows than HM farms. Another reason could be due to the randomisation of the farms, as many had more than one group of each, the groups chosen for analysis could potentially have an overrepresentation of injured cows. Positioning and types of neck rails can also affect the injury rate, as lesions can occur due to friction on the neck from ill-fitted neck rails and displacements during feeding (Kielland et al. 2010; Jewell et al. 2019). There could also be issues with dominance in the injured herds, as dominant cows tend to displace subordinate cows which can lead to injuries (Veissier et al. 2004). To further elaborate on these theories, it would have been beneficial to have notes for all farms taken during the evaluations for more information on the type and level of injuries, as well as to have more knowledge of barn factors such as layout or sharp edges which could give rise to injuries.

4.1.4 Cubicle utilisation & overstocking

Animals standing in cubicles or lying with partially or wholly outside of the cubicles can be indicative of issues on herd level. According to statistics provided on the farms from SOMRS, HM farms had higher mean slaughter weights than their LM counterparts. This indicates larger animals in HM herds. Considering that overweight cows were not more prevalent in HM farms than LM ones (table 4 & 5), it can be assumed that the higher slaughter weight is due to larger cows, not fatter ones. This could explain the higher number of cows not being able to use the lying areas correctly. If the cubicles or barn layout is not optimal for the sizes, adaptations will be made by the animals to more properly fit. Such as lying diagonally or resting the hocks on the cubicle edge to fit. Another reason for cows to place themselves in these positions could be from a dominant cow being in the cubicle in front in double row housing systems, the subordinate cow positioning herself to avoid the dominant cow. These factors, as well as uncomfortable or too little bedding can all affect the lying time and subsequent welfare of dairy cows (Saxmose Nielsen et al. 2023).

The questions about barn and cubicle layout and sizes could not be deciphered with the Djuröga® protocol, nor be complemented by the answers provided in the questionnaire as the forementioned factors were not included in questioning.

4.1.5 Bias

There are risks of potential observation bias because of the different on-farm evaluators. Partially because of personal motivations and morals, giving way to different focuses when evaluating, but also due to the varying sizes of groups, time allocations and experience levels. At least one evaluator was new at the job, while others were senior. Errors or issues can occur both on a novice and experienced level. Lacking the knowledge of or being uncertain of the methods, as well as complacency can all lead to errors. Staff responsible for the evaluations had all been trained and calibrated in performing the evaluations for consistency and continuity. While no errors were discovered in the on-farm reports, it is nevertheless necessary to state the potential risk of unconscious faults and bias.

It is also important to note that the welfare evaluations represent the status of the farms at the specific time and day of the evaluation. Changes may have been made since the evaluation, or the animals chosen for examination could have been randomised in a way which represented poorer or better welfare. As mentioned, in herds of 120 and more the examiner should look at every second or third cow, the order the person started in could influence the overall grade of the farm. One snapshot in time does not justly reflect the whole status of the farms and their animals.

4.1.6 Definition of welfare

As stated in the introduction, there are several definitions and theories of what defines animal welfare. While many are based on the absence of negative experiences such as the ‘Five Freedoms’ approach, newer definitions of animal welfare also highlight the effects and benefits of positive experiences (Reimert et al. 2023; Rault et al. 2025). The method used to evaluate animal welfare in this study focussed on the absence of negatives rather than the presence of positives. Meaning that the welfare measurements, depending on definition, did not include all aspects of animal welfare. If it had, the same results might not have been attained.

4.2 Biosecurity

In the questionnaire, the respondents were asked about hoof care; intervals and if they employed a standard operating procedure for hoof care. A 'hoof care SOP' or 'hoof care Standard Operating Procedure' entails that hoof care is done at strategical intervals of the lactation, such as 30-90 days before calving, 30-90 days post calving and 120 days after second trimming (Växa 2022). This as opposed to a set schedule of trimming all cows at set times without taking consideration of lactation stages. Most of the farms claimed to provide hoof care at the same occasion, which is not in agreement with claiming to follow a hoof care SOP, as 4/10 LM farms and 3/9 HM stated doing. In addition, one farm had commented that they did not understand what 'SOP' meant. Although uncertainty about terminology can be cleared up by looking them up online, this requires initiative from the respondent, which can be difficult to gain due to an already lengthy questionnaire. For future reference, specialized terms or wordings may need to be explained in the questionnaire for better compliance from respondents.

Despite all farms in the study having access to online mortality follow-up tools, only five out of nine HM farms utilised them. In contrast, all but one LM farm had digital follow-up of mortality. 'Signaler Djurvälfärd™' was the most common tool for LM farms, while internal staff meetings dominated in the HM group. Following up on and discussing mortalities in the herd internally can be a great compliment, but having digital records with statistics and advice may be more efficient as a follow-up method and as a preventative measure for the management of the herd (Sandgren et al. 2009; Santman-Berends et al. 2021).

To further answer the research question of HM farms having less strict biosecurity measures, more specific questions could have been asked. As the recruitment of new livestock presents many biosecurity threats, details about routines surrounding recruitment such as quarantine practices, number and frequency of animals purchased, source herds and more could have been of interest (Mee et al. 2012). In-depth questions on cleaning methods and routines would also have been beneficial for more robust analysis. Overall, LM farms were cleaner, less overcrowded, monitored, valued and acted on more symptoms. More of LM farms than HM farms were in preventative infection programmes. LM farms had more robust mortality follow-up and hoof care than HM farms.

4.3 Calving

Although more than half of both LM and HM farms did not have disease prevention strategies when it came to calving spaces, LM farms observed more

signals post-calving. This points to a more encompassing strategy for preventing complications and disease in the calving cows. Both mortality groups had rounds and routines for parturient paresis, but udder health and milk quality was tested quicker post-calving in LM farms.

4.4 Overcrowding

Overcrowding was seen more in the HM farms, both on the cubicle level and the total area. Factors investigated in other parts can be connected to overcrowding in some way or the other. Djuröga® factors such as cubicle utilisation and lying behaviour, biosecurity risks such as higher risk of disease spreading in close quarters and cleanliness to name a few. The lower mean area per cow in the HM group is further exacerbated by the average higher slaughter weight in the HM farms, potentially increasing the effects of overcrowding. More cows in inadequate space also means more bacterial pressure, more filth accumulation and risk factors which could lead to illness and disease. All the forementioned factors together are likely to influence the mortality rate of a farm. Signifying the need for additional studies with more in-depth focus on overcrowding factors and parameters and the potential validation of them.

The most important question for the question about overcrowding, (appendix, question 11), appeared to not have been worded clearly enough. Several missing, misleading and misunderstood answers were given. One potential flaw with the wording was that the respondents were not clearly instructed which measurements to give. It was not expressed whether they were supposed to put the entire living area or only the measurements of the lying area. This could mean that answers used in analysis were incorrect and not given in the same manner for all farms. Bigger or smaller measurements than intended could have been accounted for, skewing the results. This was suspected to be the case with the LM farm with the lowest area (4.77 m^2). Due to a generational shift and extensive renovations during the time of the study, the measurements and the number of cows did not correlate between questionnaire and welfare evaluations. This makes for uncertainty of the factuality of the overcrowding variables. If the provided measurements are true, the theory that overcrowding affects mortality is put into question.

4.5 Symptoms and action

More than half of the listed symptoms were ranked of higher mean importance by the LM farms than by the HM farms. The LM farms were also less likely to 'wait and see' in cases of symptoms present and were more likely to provide seven out of thirteen actions. As mentioned in the introduction, farmers who perceive their herd's health as low and who feel a lack of control and optimism can delay or omit treatment. From this, it can be theorized that LM farms, due to their potentially lower incidence rate of illness and higher optimism and control, are more able to act and treat sick and lame animals. The higher perceived importance of symptoms could signify a higher level of care, education or perceived control, or be a sign of higher optimism. Being more prone to act on their own in instances of acute illness or lameness, leading to quicker treatment could also be explained by the perceived control in the LM farms. Being confident and competent enough to successfully start treatment on farm when suitable could save precious time for the sick or lame animal and may improve her chance of survival. There are preventative health programs such as "Villkorad Läkemedelsanvändning" (ViLA) which translates to "conditional use of medicine" and allows affiliated farmers to keep and administer certain medications and treat specified illnesses and conditions (Jordbruksverket 2026b). Being allowed to treat your own animals could provide much needed confidence and feeling of control, potentially improving the level of care and rate of treatment. It takes effort, however, to commit to a health programme such as ViLA, which could be difficult for farmers with low optimism and perceived control. Some prerequisites also make it impossible for farms with high mortality rates to improve via this method, as farms are only eligible if their annual mortality is below 10% (Jordbruksverket 2026b). Relying on professionals for hoof care and veterinary treatments they are not legally allowed to perform themselves could prove expensive. This could further affect the confidence and feeling of control for the farmers. This, in turn, could decrease willingness and might lead to choices being made to cull instead of keeping the animal alive, increasing the mortality rate which in turn makes it more difficult to change as access to some preventative health programmes are unattainable. There are methods outside of official programmes which could improve the health and welfare of sick and lame cows such as more frequent milkings and increased monitoring, perhaps in a hospital pen. But with lack of optimism, confidence and control, actions may seem unnecessary or unachievable (Hansen & Østerås 2019; Ekman et al. 2025).

4.6 Study design

There are risks of multiple bias types in questionnaire studies. As the questionnaires in this study were filled out individually by the farmers, without access to clarification if needed, there was potential for misunderstanding. The questionnaire used in this study was lengthy and some of the questions or answer alternatives could be hard to interpret despite the pre-testing done by Alvåsen et al. (2014b). This led to certain questions having generally lower response rate than others, and some had higher numbers of misinterpretations. To avoid interpretation errors, many answers were kept as they had been filled in. It was decided that only obvious misinterpretations which would skew analysis be changed or removed so as not to disturb the integrity of the answers and present potential areas of bias.

The goal with the project this thesis was done within was to gather as much information about housing and management of the farms as possible, not to answer the particular research questions stated in the introduction of this thesis. Had the study been designed for the research questions, the questionnaire might have been designed differently. Since many of the questions had been tested before in the study by Alvåsen et al. (2014b), the questionnaire was not tested again before this study. But as some practices and standards have changed since 2014, a test version might have benefitted the overall quality of the study.

To add further depth, it would have been beneficial analyse the proportion of unassisted deaths versus euthanasia on the farms. This data was provided, but outside of the timeframe of this thesis. According to Thomsen & Houe (2018), farms where a high percentage of the expired cows have died *unassisted* are more prone to have lacking management factors. The opposite is true for farms where a high number of cows are *euthanized*, as this could indicate active management choices such as cost efficiency or change of direction within the farm (Thomsen & Houe 2018). For future studies, comparing farms with high and low numbers of unassisted deaths instead of only mortality rate, a possible confounder could be removed. Alternatively, adding questions about culling reasons and motivations could prove to more accurately differentiate the farms with welfare issues and farms with active management choices which includes euthanasia.

Having 20 farms included in the study was deemed sufficient, although one not fulfilling the inclusion criteria, resulted in 19. For future studies, including more farms would be beneficial for obtaining more robust statistical analysis and results. More participants would also lessen the effect of potential observational bias. Reworking the questionnaire or making structured interviews instead of or as a complement would also lessen the bias.

5. Conclusion

Overall, the low mortality farms had more strict biosecurity measures, more routines and monitoring around calving, less overcrowding and were more likely to act and value symptoms higher in sick and lame animals. High mortality farms had fewer welfare violations, but the violations observed are of note due to their detrimental effect on welfare and mortality. The results of this study should not be interpreted as the definitive causes behind the differing mortality rates. Rather, they should be looked at as potential clues which need further investigation. There could be a connection between the differing factors looked at in this study and mortality rate, but there could also not be. Within the limitations of this study, we cannot say for sure. Future studies on the housing and management of Swedish farms with low and high mortality should look to include more farms with varying mortality rates for validation purposes and statistical analysis. If there are significant differences, tools for advisory services could be developed to reduce Swedish dairy cow mortality, improve sustainability and benefit farmers and cows.

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Popular science summary

Mortality rates of Swedish dairy cows are increasing, meaning that a growing number of animals are not entering the food chain, but being sent for destruction. This is a waste of resources, not sustainable and needs to change. There is a lack of research on what could be causing the increasing mortality rates in Sweden. To remedy this, it was decided to compare the housing and management factors on Swedish farms with low and farms with high mortality, to see if any differences between the two categories could be found.

Farmers included in the study were given a questionnaire to fill in about themselves, housing, management, routines and their opinions on certain statements. In addition to the questionnaire, the farms were also evaluated by veterinarians by using a welfare evaluation protocol.

The results of both questionnaires and welfare evaluations were compared between the low and high mortality groups and it could be seen that high mortality farms had more overcrowding, less strict infection prevention, less routines and monitoring of calving cows and were less likely to act if a cow displayed symptoms of being sick than low mortality farms.

The areas where high mortality farms were found lacking can be assumed to be contributing factors to their status as high mortality farms. The findings from this study can be used for educational purposes, as the shortcomings can be seen as examples of what not to do to lower mortality rates at dairy farms.

Appendix 1

Draft of English version of the questionnaire. Some changes to questions were done.

Questionnaire about longevity in dairy cows

QUESTIONS ABOUT THE FARM

Number of milking dairy cows: _____

1. About me:

☐ Female

☐ Male

Age: _____years

Role on the farm: _____

Are you the person in charge of the milking cows?

☐ Yes ☐ No

Proportion of the household's disposable income from milk production:

_____%

Work experience in milk production: _____years

What level of education do you have?

☐ Secondary school or equivalent

☐ Agricultural college

☐ Other college

☐ Further education courses (within agriculture)

☐ Agricultural technologist education

☐ Agronomist education

☐ Other university education

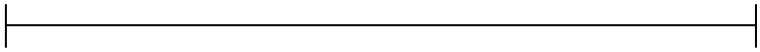
☐ Other What? -

_____

2. How much do you appreciate doing the following work? *Cross <u>on</u> the line*

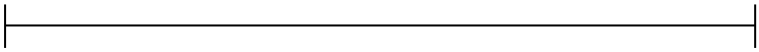
Machinery maintenance

less fun fun



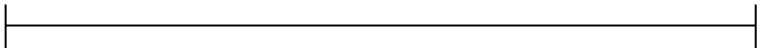
Crop production

less fun fun



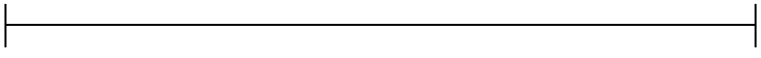
Animal care

less fun fun



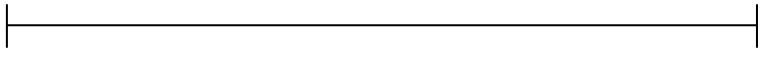
Feeding of animals

less fun fun



Milking

less fun fun



3. **Are you considering changing the number of cows in your herd over the next two or three years?**

☐ Yes, I want to have ☐ more cows ☐ fewer cows

☐ No

Comment:

4. **Is there anyone else taking care of the cows in your herd?**

☐ No, **pass on to question 6**

☐ Yes, only family member **pass on to question 6**

☐ Yes, only employees

☐ Yes, family member and employees

5. **How many employees (excluding family members) are caring for animals in the herd?**

☐ 1

☐ 2

☐ 3 or more

6. **Which milking system is used?**

☐ Tie-stall pipeline

☐ Parlor

☐ Automatic milking system Brand:_____

☐ Rotary

Comment:

7. In what housing system are the majority of the milking cows kept?

☐ Tie stall

☐ Free stall with cubicles

☐ Free stall with deep litter

☐ Combination of tie stall and free stall

8. Have you used any advisory services during the last 12 months?

Feed ☐ 1-6 times ☐ 7 times or more

☐ No

Preventive animal herd health ☐ 1-6 times ☐ 7 times or more

☐ No

Breeding ☐ 1-6 times ☐ 7 times or more

☐ No

9. To your knowledge, will the farm still be running in five years? *Cross on the line*

No Maybe Yes, for sure

|---|

☐ Do not know

Comment:

QUESTIONS ABOUT HOUSING

10. What type of floor is in the majority of the cubicles or cow places?

Concrete: _____ % of the cubicles

Rubber: _____ % of the cubicles

Mattress: _____ % of the cubicles

Deep litter: _____ % of the cow places

Comment:

11. How many cubicles/cow places are there in the shed for the milking cows?

Cubicles: _____ Cows: _____ Titled

_____ m^2

Cubicles: _____ Cows: _____ Titled

_____ m^2

Cubicles: _____ Cows: _____ Titled

_____ m^2

Cubicles: _____ Cows: _____ Titled

_____ m^2

Cubicles: _____ Cows: _____ Titled

_____ m^2

Cubicles: _____ Cows: _____ Titled

_____ m^2

Alternatively deep litter bed _____$m^{2.}$ Cows: _____ Titled

Comments:

12. How is the feeding limited for the milking cows in the herd?

☐ Feed yokes (lockable or not) number of feed yokes:

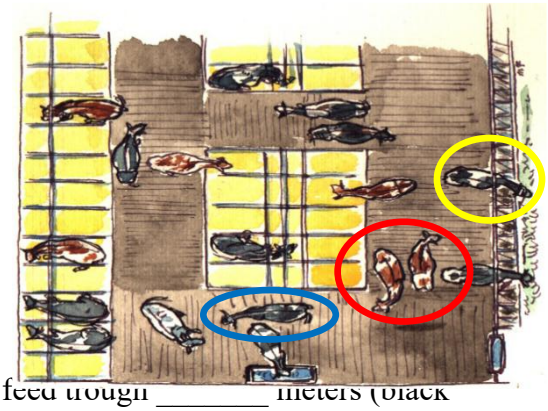
_____

☐ No limitation (e.g. head rail) _____ meters of feed trough

Comment:

If you have a tie stall: move on to question 16

13. How wide are the walkways behind an eating cow at the feed trough (yellow circle)?



☐ No cow can pass

☐ 1 cow can pass (blue circle)

☐ 2 cows can pass abreast (red circle)

☐ More than 2 cows can pass abreast

Total width of the walkways behind the feed trough _____ meters (black arrow)

14. What type of flooring is the majority of the walkways for the milking cows?

☐ Concrete

☐ Slats

☐ Rubber rugs - proportion of the shed: ≤ 25% ☐ 25-75% ☐ ≥75% ☐

Comment:

15. How do you group your cows? *Indicate all that apply*

☐ Lactation stage

☐ New-calved cows separately Number of days in this group _____

☐ First parity cows separately

☐ Pregnant/non pregnant

☐ Somatic cell count/udder health

☐ Lame cows

☐ Fattening/slaughter cows

☐ Treated cows with waiting period

☐ Dry cows

☐ Other grouping: _____

Comment:

QUESTIONS ABOUT FEED

16. How many hours per day do the cows have access to feed (roughage or mixed feed) on the feed trough?

_____hours/day

Comment:

17. How many times per day are the cows fed with roughage or mixed feed?

_____times/day

Comment:

18. Do you check the troughs for remaining feed that is out of reach of the cows?

☐ Yes ☐ 1 time/day ☐ 2 times/day ☐ >2 times/day

☐ No

☐ Irrelevant, the cows can always reach the feed

Comment:

19. How large a grazing area is used for the milking cows?

☐ Production pasture _____ hectares

☐ Exercise pasture _____ hectares

Comment:

20. How many hours per day do the milking cows have access to pasture (during the most intensive pasture period)?

_____hours/day

Comment:

21. When during the day are the milking cows out on pasture?

☐ Only daytime

☐ Only nighttime

☐ Daytime and nighttime

☐ It varies

Comment:

22. Do the cows have the opportunity to go back into the shed whenever they want when out on pasture?

☐ Yes

☐ Yes, sometimes When?_____

☐ No, the gates are shut

Comment:

23. Are special feed rations calculated for cows in the transition period (the month before calving to the time soon after calving)?

☐ Yes, at least once a year

☐ Yes, but not every year

☐ No

24. Are feed rations calculated for the heifers?

☐ Yes, at least once a year

☐ Yes, but not every year

☐ No

☐ Do not raise heifers

25. Do you analyze your roughage?

☐ Yes, for every harvest

☐ Yes, at least once a year

☐ Yes, but less than every year

☐ No

Comment:

QUESTIONS ABOUT ROUTINES

26. Are written herd health plans and daily routines used at the farm?

☐ Yes In which areas?

_____

☐ No

Comment:

27. How many minutes per day are used for surveillance? Estimate the total amount of time for all persons among the milking cows (as well as heifers and calves) including milking, feeding, heat rounds, finding unhealthy/suspect animals, improving bedding, removing manure, etc.

Cows _____min/day

Heifers _____min/day

Calves _____min/day

☐ We use an activity meter system for ☐ heifers ☐ milking cows

☐ We use alarm lists

Comment:

28. Do you assess body condition score for heifers (6 months to 1st calving) and cows?

Heifers: ☐ Yes, regularly ☐ Yes, sometimes ☐ No

Cows: ☐ Yes, regularly ☐ Yes, sometimes ☐ No

Comment:

29. How many times each year is a cow's hoof trimmed on average?

☐ 1 ☐ 2 ☐ 3 or more

Comment:

30. Is the whole herd trimmed at the same occasion?

☐ Yes (≥ 90%) ☐ and some cows when needed

☐ No What proportion are trimmed at the same occasion? ☐ ≤50% ☐ 50-90%

Comment:

31. Do you have access to a chute on the farm?

☐ Yes ☐ No

Comment:

32. How do the calves get their first colostrum?

☐ Manually Proportion of calves:_____%

☐ Suckles themselves Proportion of calves:_____%

Sum: 100 %

Comment:

33. Within how many hours after calving do the calves get colostrum, and how much colostrum do they get on average?

_____ hours after calving

_____ liters

34. How many times do the young stock change system (e.g. individual pen, group pen on deep litter, group pen on slats, free stall with cubicles, tie stall) until first calving?

☐ 2 times

☐ 3 times

☐ 4 times

☐ 5 times or more

Comment:

35. Where do the calvings occur?

☐ Group maternity pen with place for _____cows/pen _____ pens

☐ Individual maternity pen

_____ pens

☐ Not separated from the other cows

☐ Outside

36. For how long are the <u>cow and calf</u> together in the maternity pen (hours or days after calving)?

_____hours *<u>or</u>*

_____days

☐ Not relevant

Comment:

37. Which type of bedding has been used for the milking cows during the last year?

Indicate all that apply.

☐ Sawdust

☐ Cutter shavings

☐ Peat

☐ Whole straw

☐ Chopped straw

☐ Mix of _____

☐ Have changed bedding during the period

Comment:

38. How often do you improve the bedding for the milking cows?

_____times per ☐ day ☐ week ☐ month

Comment:

39. Are pregnant heifers kept with milking cows?

☐ Yes For how long? _____days before calving

☐ No

Comment:

40. When do you start to dry-off a cow?

_____ days before scheduled calving

Comment:

41. How long does it usually take to dry-off a cow in your herd?

_____days

Comment:

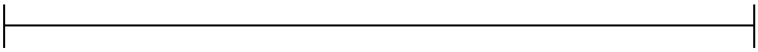
42. Are cows with high yield (at time of drying off) dried off later than the other cows?

☐ Yes ☐ No

Comment:

43. What do you think of breeding (i.e. genetic selection)? *Cross on the line*

not so important very important



44. Do you use a bull (natural service) in your herd?

☐ Yes To which groups of animals? Heifers ☐ Cows ☐

☐ No

Comment:

45. Which one of the following interventions is most important for reducing the proportion of cows that die unassisted or are euthanized in the herd?

Choose one alternative

☐ Building technology

☐ Higher carcass prices

☐ Better disease control/biosecurity

☐ Better genetic material

☐ No special intervention, it mostly depends on good or bad luck

☐ Not relevant

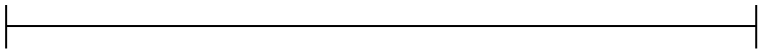
Comment:

QUESTIONS ABOUT LAME AND SICK COWS

46. How do you recognize that a cow is lame? *Cross on the lines*

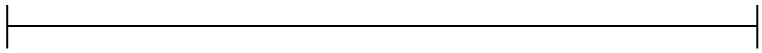
Does not put pressure on the leg when standing

not so important very important



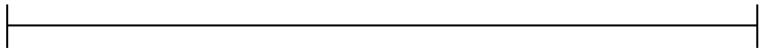
Does not put pressure on the leg when walking

not so important very important



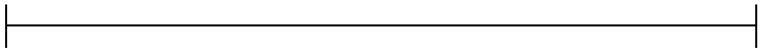
Hunching when standing

not so important very important



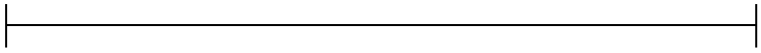
Hunching when walking

not so important very important



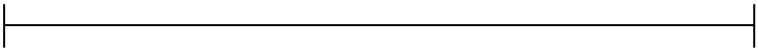
Increased lying time

not so important very important



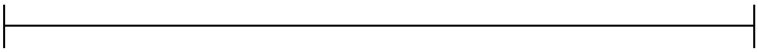
Difficulties when standing up or lying down

not so important very important



Does not come to milking

not so important very important

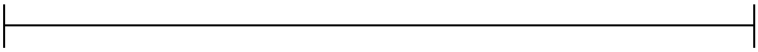


Comment:

47. What is the first thing you do when you recognize a lame cow? *Cross on the lines*

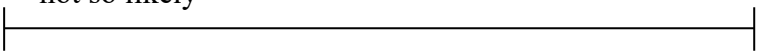
Wait

not so likely very likely



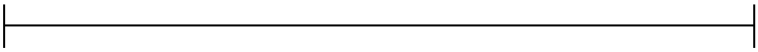
Call the veterinarian

not so likely very likely



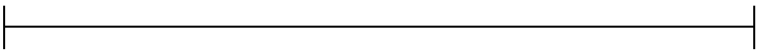
Call the hoof trimmer

not so likely very likely



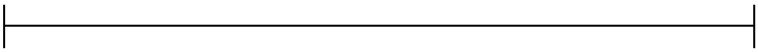
Put the cow on a surveillance list

not so likely very likely



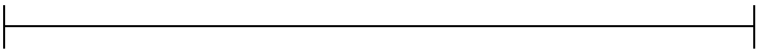
Move the cow to an isolation pen

not so likely very likely



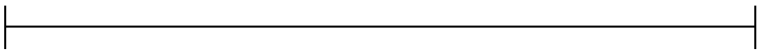
Take her to the chute for hoof trimming

not so likely very likely



Start a treatment on my own

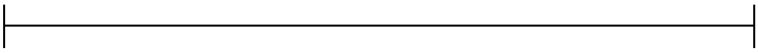
not so likely very likely



48. How do you recognize an unhealthy cow? *Cross <u>on</u> the lines*

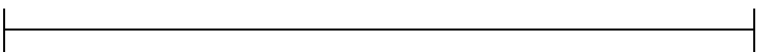
Lying a lot

not so important very important



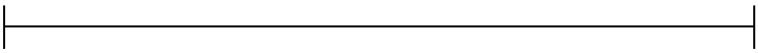
Changes in the milk

not so important very important



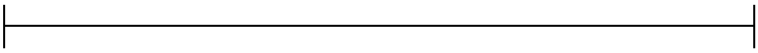
Swollen udder

not so important very important



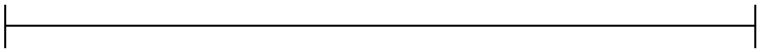
Diarrhea

not so important very important



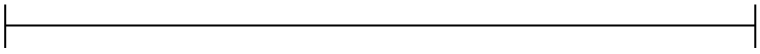
Nasal discharge

not so important very important



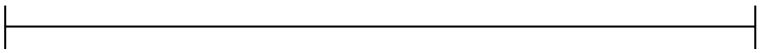
Stopped eating

not so important very important



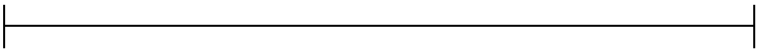
Vaginal discharge

not so important very important



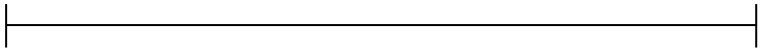
Fever, warm

not so important very important



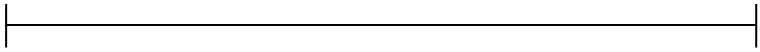
Does not come for milking

not so important very important



Reduced general condition

not so important very important

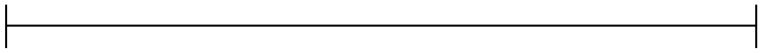


Comment:

49. What is the first thing you do when you recognize an unhealthy cow (excluding accidents, e.g. fracture of a leg)? *Cross on the lines*

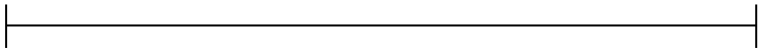
Wait

not so likely very likely



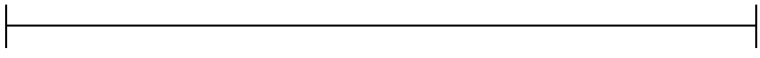
Measure her temperature

not so likely very likely



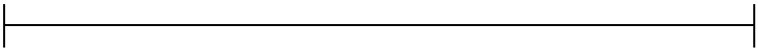
Call the veterinarian

not so likely very likely



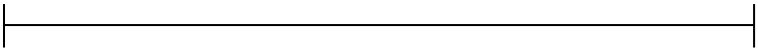
Add her to a surveillance list

not so likely very likely



Move the cow to an isolation pen

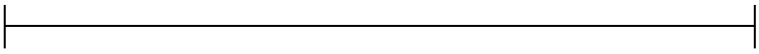
not so likely very likely



Start a treatment on my own

not so likely

very likely



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