Improving the recording of culling reasons for Danish dairy cattle by exploring the different systems used in Europe

by

Laure-Marie Pirès

3IEDA Livestock production & Dairy management

January 2023 - Nantes, France

Supervised by Mr Jan Van Beekhuizen

Preface

This report marks the end of my education journey. It has been written in order to fulfil the requirements for obtaining the diploma of the Livestock production program of AERES hogeschool of Dronten. Hence, I will present this report in order to obtain my Bachelor in Dairy management.

The report, “Improving the recording of culling reasons for Danish dairy cattle by exploring the different systems used in Europe”, will be presented to you in accordance with the knowledge accumulated during my university training and personal experience. Researching and writing this dissertation began in September 2022 and ended in December 2022. The Animal and Veterinary Sciences department of Aarhus University in Denmark carried it. It will be used as a basis to spread awareness about the importance of recording culling reasons to Danish farmers and students at agriculture schools.

First, I want to thank Jan Tind Sørensen and the ANIVET team for welcoming me to Denmark. I particularly want to thank my company coach Peter T. Thomsen for his support and valuable advice. I also want to thank Jan van Beekhuizen, my thesis coach, for his help through the writing process and his pertinent feedback. Moreover, I am grateful for all the people who took some time to share some information and data about their country: Guðmundur Jóhannesson (Iceland), Jenny Gibbons, Darren Todd, and James Hanks (England), Benoit Rubin (France), Josef Hambrusch (Austria), Vőneki Éva (Hungary). Finally, I am very grateful for the daily support I get from my family and my boyfriend.

EDIT FOR ASSESSORS

The following parts have been modified since the Research Proposal and need to be re-evaluated:

- Preface
- 5. Recording the culling reasons give indicators of longevity
- 6. The situation of Denmark

Summary

In the European Union, cattle registration has been harmonised, and every farmer has to report cattle deaths to a national computer database. However, there is no obligation to mention the reason for culling, death or slaughter. In dairy farming, the herd is constantly renewed by letting in some young cows, and to keep the same number of heads, some other cows have to exit the production. From an economic and environmental point of view, it is paramount to increase the longevity of dairy cows. In Denmark in 2021, only approximately 66,8% of all culled cows had a reason for departure registered. Therefore, there is a lack of detailed understanding of why a third of the Danish dairy cattle are culled. A literature study and e-mail interviews were carried out in order to answer the following question:

How to identify ways to improve the recording of culling reasons for Danish dairy cattle by exploring European systems?

Austria, Hungary, and Germany might keep track of departure reasons, but private companies or other small organisations do it in a very fragmented way. Estonia and Poland have an ongoing program to register culling reasons nationally; the Czech Republic, Romania, the United Kingdom, France, and Iceland keep track of culling reasons through on-farm software, surveys, and private companies. Despite each country's own classification, categories used to describe deaths have been relatively uniform and resemble the Danish classification. They usually included low milk yield, accidents/injury, reproduction problems, locomotor disorders, metabolic disorders, udder/teat disorders, infections, and unknown reasons.

Denmark, the United Kingdom, Iceland, Poland, and Estonia have "reproduction problem" as their first or second most frequent culling reason. The proportion of culling for hooves/legs problems is similar in Denmark (13%), Poland (10,4%), and the United Kingdom (10,2%), whereas it is higher in Estonia (26,4%). Concerning culling for udder problems, only Poland (15,5%) has a similar rate to Denmark.

Hence, this study highlighted the importance of creating a national database for culling records and for them to be accessible throughout Europe. The quality of the collected data is highly impacted by choosing the proper categories for recording culling and making the recording process understandable for farmers. Further studies need to be conducted to gather more data about culling reasons in European dairy cattle.

Table of contents

Table of Figures

Table of tables

I. Introduction

In dairy farming, the herd is constantly renewed by letting some young cows, called heifers, enter the production. In order to keep the same number of heads, some other cows have to exit the production. This action is called culling, meaning removing an animal from the herd due to sale, slaughter, or death. Culling of cows is also influenced by the market conditions and the farmer's desire to improve herd genetic potential.

1. The different culling reasons for dairy cows

The primary reasons for culling reported by farmers are reproduction (i.e., failure to conceive), mastitis, and low milk production (Bascom & Young, 1998). Besides, there are other reasons a cow may have to exit the herd: leg and foot problems, metabolic diseases or disorders, infectious, injury, bad temper, and accidents (Adamczyk *et al.*, 2017).

1.1. Reproduction problems

Low fertility, difficulties at calving and poor health postpartum are considered reproduction problems. They negatively impact the lactation period, reducing the farmer's annual revenue (Inchaisri *et al.*, 2010).

1.2. Mastitis

Mastitis is an inflammation of the mammary gland and the most common disease in dairy cattle (Cheng & Han, 2020). It causes economic losses due to reduced yield, treatment costs, and poor milk quality (Cheng & Han, 2020).

1.3. Foot or leg problems

The most common foot problems encountered are white line disease, laminitis, sole ulcer and digital dermatitis. They all induce lameness and pain, resulting in a drop in milk production (Warnick *et al.*, 2001).

1.4. Metabolic disorders

Concerning metabolic disorders, acidosis, ketosis and milk fever are common among dairy cows (Herdt, 2013). The economic loss of one cow with subclinical ketosis is estimated to be 78$ (Geishauser *et al.*, 2001).

The reduction of milk yield of cows affected by milk fever ranged from 1,1 kg/day to 2,9 kg/day, depending on parity and the time taken for diagnosis (Rajala-Schultz *et al.*, 1999).

1.5. Infectious diseases

Adding to these, infectious diseases like BVD (Bovine Viral Diarrhea) and IBR (Infectious Bovine Rhinotracheitis) can cause the death of animals. Overall, all factors mentioned affect the longevity of dairy cattle, thus, the farm's economy.

2. The economic importance of age at culling

The economic advantage of longevity lies primarily in retaining productive cows for as long as possible while ensuring that less productive cows are replaced as soon as it is economical to do so (Stott, 1994). Indeed, during the first two years of life, a dairy cow does not produce any milk but still requires feeding, shelter and care. The average cost of raising a dairy heifer from weaning to freshening is estimated to be between 1736$ and 2294$ per heifer, depending on the countries and systems (Overton *et al.*, 2013 ; Akins & Hagedorn, 2015 ; Tranel, 2019). 54% of that amount is allocated to feeding, with the rest equally distributed between labour, fixed costs and other variable costs (Akins & Hagedorn, 2015). The first calving marks the beginning of her milk production, thus her productive life. By spreading the costs of the first two years over her entire lifetime, the longer the productive period, the better the turnover is (Dentine *et al.*, 1987).

It is important to note that the high-producing dairy cow requires a diet that supplies the nutrient needs for high milk production (Erickson & Kalscheur, 2020). Moreover, with the current inflation trends, the rapid increase in prices of fertilisers, feed, energy, wages, and construction materials is putting pressure on the profit margins of dairy farms (Wegrzynowski, 2022). Thus it is in the farmers' best interest to increase the longevity of their cattle.

3. The relation between culling age and environmental impact

Delaying the culling of a cow also means lowering its environmental impact. At the beginning of her productive life, the methane emitted by a cow per kg of milk is very high due to the first two years of rearing without milk production. However, the longer the cow lives and produces milk, the more this ratio will decrease. Consequently, improving longevity means that the amount of methane emitted per kg of milk produced will drop, resulting in a lower environmental impact per kg of milk.

4. The future of dairy farming

According to the FAO, the global demand for food is expected to double by 2050. As a result, agricultural systems worldwide will have to provide extra food to feed this growing population (FAO & Global Dairy Platform, 2019). With agriculture being one of the most polluting sectors (Heatable, 2022), these trends challenge the evolution of farming. Nevertheless, emission intensities of greenhouse gases per kilogram of milk declined by almost 11% from 2005 to 2015. These declines are recorded in all regions, reflecting continued improvements to on-farm efficiency, achieved via improved animal productivity and better management (FAO & Global Dairy Platform, 2019). However, this efficiency needs to be improved even more in the years to come.

5. Recording the culling reasons give indicators of longevity

Hence, from an economic and environmental point of view, it is paramount to focus on increasing the lifespan of a dairy cow in the years to come (Kerslake *et al.*, 2018). Currently, the average lifespan of a dairy cow in industrialised countries is between 4,5 and 6,5 years (Vredenberg *et al.*, 2021), despite the maximum annual milk production occurring in the fifth lactation period (Horn *et al.*, 2012). Therefore, to increase the longevity of cows, it is essential to understand why the cow was disposed of in the first place. This information can be registered by farmers when the cow exits production. It is also important to note that achieving greater longevity through improved cow health will improve cow welfare.

Precise knowledge of reasons for culling will be valuable in increasing longevity in the long term. In the European Union, cattle registration has been harmonised, and every farmer has to report cattle deaths to a national computer database. However, there is no obligation to mention the reason for culling, death or slaughter. Nevertheless, two European countries, Estonia (Mõtus & Niine, 2022) and Poland (Adamczyk *et al.*, 2017), have developed a public system for recording longevity and reasons for culling dairy cows. In addition, the European breeding companies Masterrind (Germany), ABS (Italy, Germany, Poland and Spain) and Viking Genetics (Denmark, Sweden, Finland) have also started to include longevity and productive life in their selection of breeding animals.

6. The situation of Denmark

Denmark is a European country with a milk production of 5,6 billion kg of milk per year (Jagdish, 2022). The national herd counted 559 000 lactating cows in 2021 (EUROSTAT, 2021), with the main breeds being Danish Red, Holstein, and Jersey. An average farm holds 210 cows, which is one of the largest in Europe (Jagdish, 2022). At the moment, an average Danish dairy cow is culled before she is five years old and before the end of the third lactation (Børsting *et al*., 2021), which is relatively low. For almost 20 years now, Danish farmers have had the option to register a cause of culling on the software DMS Animal Registration. They can register one or two reasons for departure for their cattle, choosing from an established list of reasons: "age", "other diseases", "diarrhoea", "low milk yield", "increased cell count", "claw/leg disorder", "pneumonia", "milking time", "reproduction problems", "calving difficulty", "sanitation for specific disease", "metabolic or digestive disorder", "temperament", "accident/injury", "mastitis", "udder health", "unknown".

From 2020 to 2021, almost 281 700 cows were registered as culled, with 83,3% slaughtered, 10,2% dead and 6,5% euthanised (Aarhus University, 2022). In 2021, the main reasons for culling were low milk production (33%), reproduction problems (25%), udder health (16%), and claw/legs problems (13%) (Aarhus University, 2022). Unfortunately, the proportion of cows with culling reasons recorded in Denmark is low. For example, in 2021, only approximately 66,8% of all culled cows had a reason for departure registered (Aarhus University, 2022). Therefore, there is a lack of detailed understanding of the reasons behind a third of all the Danish dairy cows culled.

In that spirit, the Danish government launched a project named *Cows with good longevity – to benefit welfare and the climate*. The purpose of the project is to obtain new knowledge that can help to increase the longevity of dairy cows, thereby optimising the economy of farmers, the welfare of the cows and reducing the climate impact per kg of milk. One of its goals is to understand how other European countries keep track of the cows' longevity and culling reasons in order to inspire changes in the Danish system. The final objective would be to get as close as possible to 100% of cows with a culling reason registered. The government contacted the Animal Sciences and Veterinary department of Aarhus University to help research the question.

7. The need to collect data about culling reasons in Europe

To my knowledge, no systematic review has been published on dairy cow culling records in European countries. Consequently, there are no points of comparison available to improve a system, thus the need to explore the different methods used in Europe. Furthermore, many cows are culled for unknown reasons, preventing the understanding of their longevity. With access to that knowledge, it would be easier to target the levers to pull to better the cow's lifespan on the farm.

Therefore, this thesis aims to focus on the following question:

How to identify ways to improve the recording of culling reasons for Danish dairy cattle by exploring European systems?

To answer it, some sub-questions will be addressed:

- *What are the different methods currently used in European countries to record culling reasons in dairy herds?*
- *What are the main culling reasons according to these culling records?*
- *Which method gives the most useful data?*

II. Material and Methods

1. What are the different methods currently used in European countries to record culling reasons in dairy herds?

In order to collect information about methods used to record culling on dairy farms in European countries, a systematic review was performed. Only studies written in English or French and extracted from CAB Abstracts, PubMed, Science Direct and Web of Science from 2000 to 2022 were included. Dairy cows were the participant of interest. Articles published before 2000 were considered outdated as legislation might have changed since. Only articles about European countries were considered. The other inclusion criteria were the mention of a recording system, report or database about dairy cow culling, the presence of numeral data from culling or longevity records, and the explanation of the method to report culling on dairy farms.

Two reviewers performed the selection of the articles, data extraction and assessment of the risk of bias. To ensure accuracy and consistency, the same set of keywords was used on every database and appeared in the title (Appendix I). A PRISMA flow diagram presented the articles' identification, screening, eligibility and inclusion. A Cohen's Kappa was calculated (SPSS) to report the level of agreement for article inclusion during screening among reviewers.

With the final selection of articles, methods and organisations responsible for recording culling for each country were listed. For countries without a detailed description of the recording method, extensive internet research was performed based on the information extracted from the articles. Finally, a description of the method of recording the culling of dairy cattle for each country was made.

2. What are the main culling reasons according to these culling records?

For the purpose of collecting data about the reasons for culling in each country, some e-mail interviews were performed by contacting relevant companies, institutions and organisations. As many countries as possible were contacted to ensure sufficient data was obtained. The following European countries were considered: Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Lithuania, Luxembourg, Macedonia, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom.

Countries like Andorra, Cyprus, Liechtenstein, Malta, Monaco and San Marino were not included as their size is irrelevant to the study. The same e-mail template was sent to the contact person of each organisation (Appendix II). To find a contact person for each country, the IFCN (International Farm Comparison Network) was used as a starting point. In addition, the EDF association (European Dairy Farmers) and ministries of agriculture were contacted.

The intent was to gather the most up-to-date data about the ratio of culled cows recorded compared to the total number of cows and the main reasons for culling reported. These interviews also helped to collect additional information about the methods to record culling on dairy farms.

3. Data obtained after the literature review and interviews

After the literature study and interviews were performed, there is, unless data is not available, for each country:

- A qualitative description of the procedure to record culling on dairy farms
- Proportion (in percentage) of culled cows with reasons for culling recorded compared to the total of culled cows in that period
- A list of culling reasons with the percentage % of cows concerned for that period

4. Which method gives the most useful data?

To assess which method(s) of recording gives the most useful data, the obtained data were analysed through descriptive statistics with a classification of the proportion of culled cows with a reason reported for each country, ranking from the lowest to the highest. The lowest was considered the least effective method, and the highest the most effective.

In order to see if there is a significant difference between the main reasons for culling between countries, a Chi-squared test was performed for each culling reason in SPSS. The independent variable was the name of the country, a categorical variable with multiple unpaired groups. The dependent variable was the percentage of cows registered under the culling reason chosen, a continuous variable. The null hypothesis H0 was "*There is no significant difference between countries for the amount of culled cows for [culling reason]*". The alternative hypothesis H1 was "*There is a significant difference between countries for the amount of culled cows for [culling reason]*". The null hypothesis was rejected if the p-value was lower than 0,05. All results were combined in tables and displayed as graphics for a better understanding.

III. Results

The literature study and the e-mail interviews allowed us to collect qualitative and quantitative data about culling records in eight European countries. The method of recording departure reasons was explained for eight countries, and the main culling reasons were analysed through descriptive statistics for four countries. Unfortunately, no information about the ratio of culled cows recorded compared to the total number of cows was retrieved for any country, so the third sub-question cannot be answered.

1. The different methods currently used in European countries to record culling reasons in dairy herds

The identification process and screening resulted in 9 studies included in the review (Figure 1). Cohen's Kappa showed that the two reviewers had an agreement of 92,08%, meaning there was a substantial agreement. The data extracted from these studies gave information about culling records for five countries: Czech Republic, Estonia, Poland, Romania, and Switzerland.

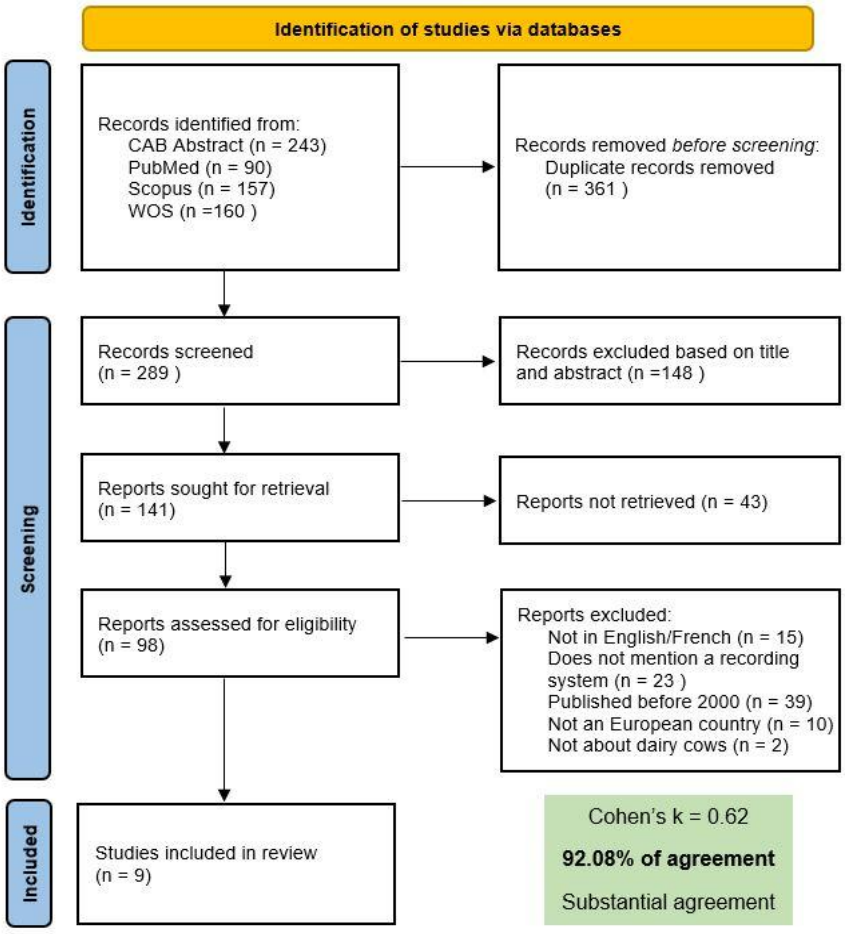

Figure 1: PRISMA flow diagram with Cohen's Kappa

Concerning the e-mail interviews, of the 39 European countries selected for the study, 30 were contacted (Appendix III). Despite the many reminders sent, only nine responded and data were obtained for 3 of them: France, Iceland, and the United Kingdom. Unfortunately, the data obtained from France was too sparse and outdated. Other countries like Germany, Hungary and Austria answered by saying they did not have a specific system to record culling reasons. It was also impossible to find information about the ratio of culled cows recorded compared to the total number of cows for any country. The interviews helped to give an overview of each country's recording system.

1.1. Czech Republic (Frelich *et al.*, 2010)

Czech Republic does not have any national database for reporting culling reasons. However, the Czech-Moravian Breeders Corporation published yearbooks on reasons for culling and milk performance of Czech dairy cattle based on surveys. Therefore, farmers can choose between two categories: zootechnical and health reasons. The options available are: "(low) milk production", "high age", "other zootechnical reasons", "mastitis", "fertility", "heavy birth", and "other health reasons".

1.2. Estonia (Rilanto *et al.*, 2020 ; Mõtus & Niine, 2022)

In Estonia, dairy farmers can report one culling reason for each cow that leaves the herd in the Estonian Livestock Performance Recording. There are 24 culling reasons to choose from: "selling", "age", "low milk yield", "udder flaws", "udder and teat traumas", "mastitis", "fertility problems", "gynaecological diseases", "abortion", "dystocia", "undesirable leg conformation", "leg traumas", "leg disorders", "metabolic diseases", "milk fever", "gastrointestinal disorders", "respiratory diseases", "infectious diseases", "other traumas", "animal lost", "accident", "bad temperament", "bad milking", and "other reasons". However, this system does not discriminate whether the cow is slaughtered, dead or euthanised. This information can be registered in the Estonian Agricultural Registers and Information Board (EARIB) database.

1.3. Iceland

Iceland does not have any national database for reporting culling reasons. However, companies like RML, consulting in agriculture and related industries, collect data about these culling reasons. Farmers can choose between these options: "metabolic diseases", "mastitis", "infertility", "teat accidents", "calving problems", "low yield", "age", "sudden death",

"accidental", "teat defects", "udder defects", "low milking speed", "bad temperament", "adjusting to milk quota", and "unknown".

1.4. Poland (Adamczyk *et al.*, 2017 ; Adamczyk *et al.*, 2021 ; Kalińska & Słósarz, 2016)

Poland has a national recording system held by SYMLEK, the Polish National Milk Recording System, and managed by the Polish Federation of Cattle Breeders and Dairy Farmers. While farmers send their production results, they can also register the reasons for departure of their cows with the following options: "infectious diseases", "respiratory system diseases", "low milk yield", "nutritive and metabolic diseases", "legs diseases", "udder diseases", "infertility and reproduction problems", "old age", "accidents", and "other".

1.5. Romania (Gavrilă *et al.*, 2015)

Romania does not have a recording system for culling reasons, but the agency ANARZ, also called National Agency for Animal Husbandry "Prof. dr. GK Constantinescu" gathers some on-farms data. They record departure reasons according to the following criteria: "agalactia", "pericarditis", "reticulum and foreign bodies", "endometritis", "womb disorders", "ovarian disease", "diseases of the udder", "limb disorders", "repeated abortions", "dystocia", "accidents", and "nutrition and metabolism diseases".

1.6. Switzerland (Struchen *et al.*, 2016)

In Switzerland, there is no national record for culling reasons. However, the "Tierverkehrsdatenbank" (TVD), the system for the identification and registration of cattle, can get farmers some bonuses if the farmers send complete data, so the animal movement history is complete.

1.7. United Kingdom

The United Kingdom has no legal obligation to record culling reasons. Therefore, the only data that exists comes from the on-farm management software of the three major milk recording companies: NMR, CIS and QMMS. Interherd is one on-farm management software owned by NMR that publishes data on a random sample of 500 herds annually. The culling reasons recorded are "mastitis/high cell count", "out of calving pattern", "lameness/legs & feet", "abortion", "accident/trauma/injury", "metabolic disorder", "calving injury/downer cow", and "infectious disease".

1.8. Comparison of the different culling records

Looking at the big picture, Czech Republic and the United Kingdom have the most straightforward culling records with an average of 7 possible reasons. In contrast, Estonia has the most complex, with 24 possible options. In addition, Czech Republic, Iceland and Poland only have one or two options for reproduction issues, whereas Estonia, Romania and the United Kingdom have more extensive and precise criteria (Table 1)

Table 1 : Presence or absence of culling reasons regarding reproduction for different countries culling records

	INFERTILITY	CALVING PROBLEM	ABORTION	DYSTOCIA	GYNECOLOGICAL DISEASE
CZECH REPUBLIC	x	x			
ESTONIA	x		x	x	x
ICELAND	x	x			
POLAND	x				
ROMANIA			x	x	x
UNITED KINGDOM	x	x	x		

Regarding reproduction problems, the option "infertility" is present in almost every country. Estonia proposes the most detailed options by making a difference with "abortion", "dystocia", and "gynaecological disease". Concerning health reasons, Czech Republic's record is minimal by only proposing a "mastitis" option. Iceland is also relatively concise, with three options available. However, Estonia, Poland and Romania propose various options to choose from (Table 2). It has to be noted that only Estonia mentions "milk fever" and "gastrointestinal disorders", and only Romania mentions "heart problems" and "foreign bodies reticulum".

Table 2: Presence or absence of culling reasons regarding health for different countries culling records

	MASTITIS	METABOLIC DISEASE	UDDER/ TEAT INJURY	MILK FEVER	GASTRO-INTESTINAL DISORDERS	RESPIRATORY DISEASES	INFECTIOUS DISEASES	TRAUMA	LEG TRAUMA/ DISORDER	HEART PROBLEM	FOREIGN BODIES RETICULUM
CZECH REPUBLIC	x										
ESTONIA	x	x	x	x	x	x	x	x	x		
ICELAND	x	x	x								
POLAND		x	x			x	x		x		
ROMANIA		x	x						x	x	x
UNITED KINGDOM	x	x					x		x		

For the rest of the options, "low milk production", "old age", and "accident" can be found in almost all culling records (Table 3). However, Iceland is the only one mentioning "milk quota" and "death". Estonia is the only one using "selling", "leg conformation", and "animal lost". This section is more diverse and changes from one country to another.

Table 3: Presence or absence of diverse culling reasons for different countries culling records

	LOW MILK PRODUCTION	OLD AGE	SELLING	LEG CONFORMATION	DEATH	ACCIDENT	UDDER/TEAT DEFECT	TEMPERAMENT	BAD MILKING	ANIMAL LOST	MILK QUOTA
CZECH REPUBLIC	X	X									
ESTONIA	X	X	X	X		X	X	X	X	X	
ICELAND	X	X			X	X	X	X	X		X
POLAND	X	X				X					
ROMANIA	X					X					
UNITED KINGDOM						X					

2. The main culling reasons in European dairy herds, according to the records

The data from Estonia is based on 154 057 cows with culling reasons registered between 2013 and 2015 collected for the study of Rilanto *et al.*, 2020. The main reasons for departure were feet and claw disorders (26,4%), udder disorders (22,6%), digestive and metabolic disorders (18,1%), and infertility (12,5%) (Figure 2). The other reasons range between 1 and 7%.

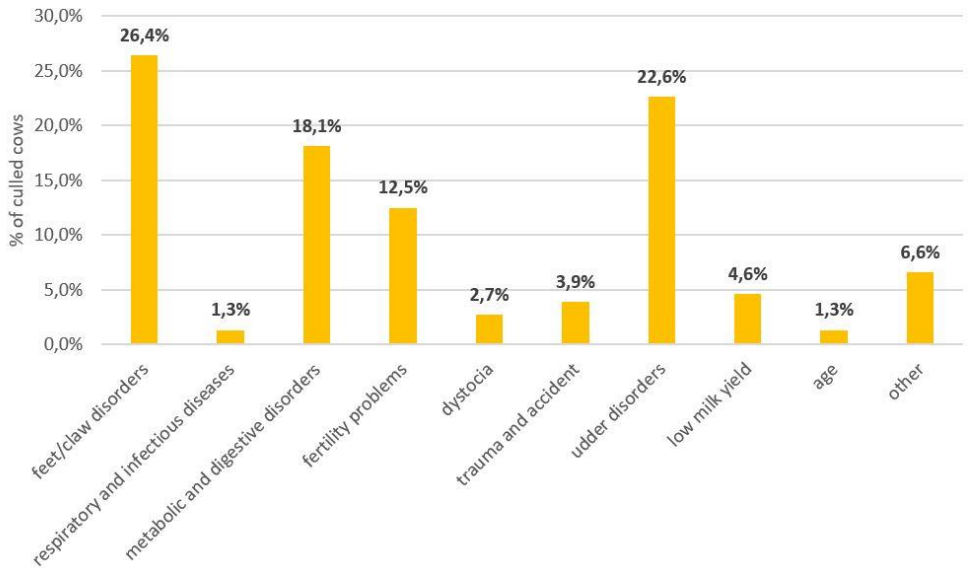

Figure 2: Reasons of culling registered for Estonian cows during the 2013-2015 period

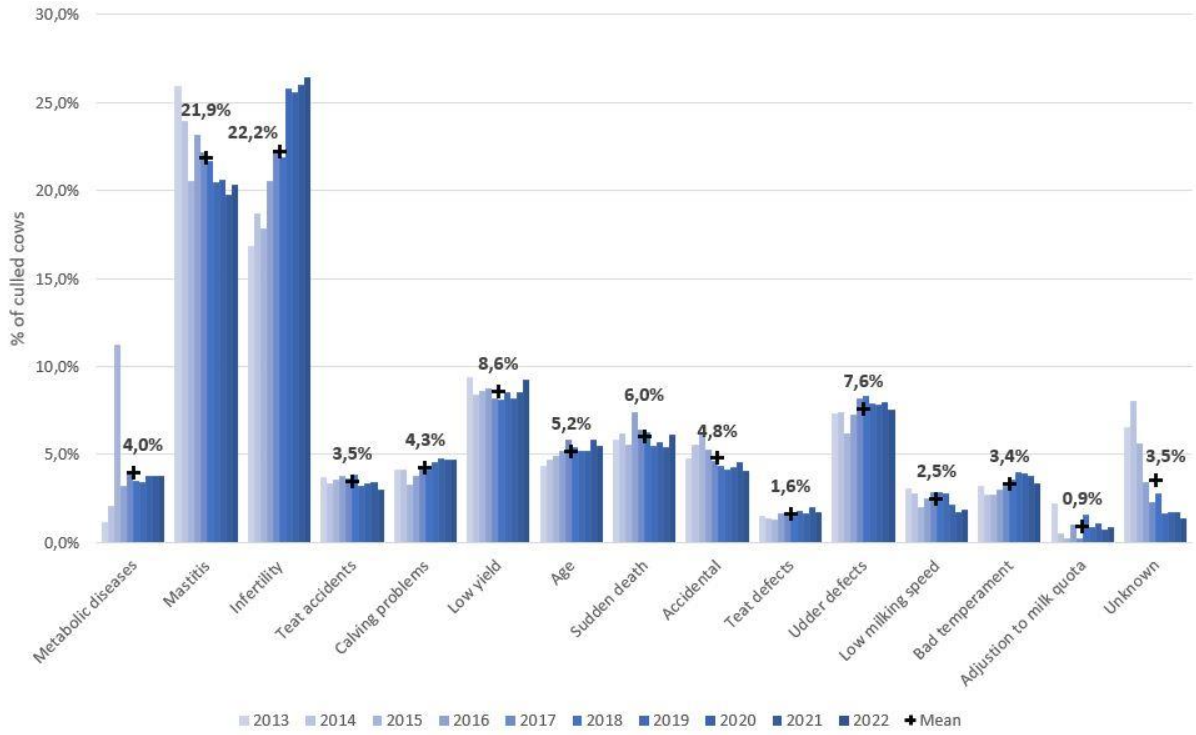

Figure 3: Reasons for culling registered for Icelandic cows from 2013 to 2022

Data from Iceland is based on a total of 80 417 cows registered during the last ten years. On average, the main reasons for culling are infertility (22,2 ± 3,65%), mastitis (21,9 ± 1,96%), low milk yield (8,6 ± 0,43%), and udder defects (7,6 ± 0,61%) (Figure 3). It is noticeable that the number of departures for mastitis has dropped since 2013, whereas the number of cows disposed of for infertility problems has increased. The number of unknown reasons also drastically dropped since 2013, going from 6,6% to 1,4%. There is a surprising spike at 11,2% of cows culled for metabolic diseases in 2015.

Concerning Poland, the data comes from 135 496 cows with a culling reason recorded in 2012, collected by Adamczyk *et al*., 2017 (Figure 4). The primary reasons for culling were fertility and reproduction problems (39,6%), udder diseases (15,5%), accidents (12,4%), and leg diseases (10,4%) (Figure 4).

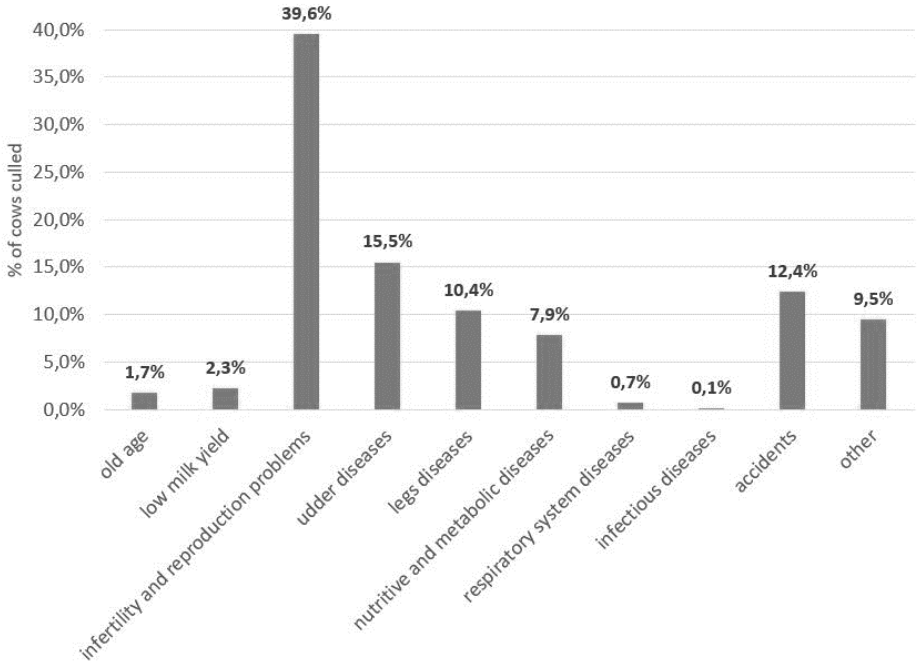

Figure 4: Reasons for culling registered for Polish cows in 2012

Regarding the United Kingdom, on average, the most common culling reasons were failure to get pregnant (26,1 ± 1,6%), mastitis/high cell count (12,6 ± 2%), lameness (10,2 ± 0,3%), and infectious diseases (9,3 ± 2%) (Figure 5). The number of cows was not mentioned (CHAWG, 2020).

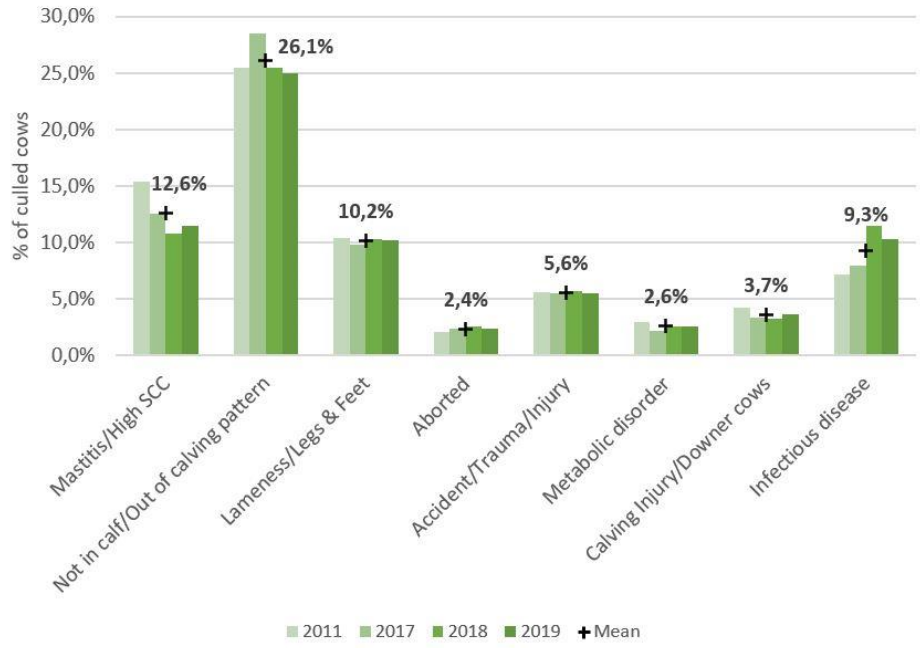

Figure 5: Reasons for culling registered for cows in the United Kingdom of 2011 and from 2017 to 2019

3. Comparison of main culling reasons between different countries

It is clear that these four countries share some main culling reasons: mastitis, also classified as udder disease, is the second most prevalent culling reason in all countries investigated. Infertility is also a big cause of departure for Iceland, the United Kingdom and Poland. Finally, Lameness and feet/claw disorders appear twice in the top three reasons for culling.

For statistical analysis, I decided to only compare data from the same years; hence Poland and Estonia data were not included. However, the United Kingdom and Iceland could be compared for 2017, 2018 and 2019 (Table 4). The variable compared were "mastitis", "infertility", and "metabolic disorder", as they were present in the records of both countries. The p-value was 0,007, so lower than 0,05: the null hypothesis H0 "There is no significant difference between countries for the amount of culled cows for metabolic disorder, mastitis and infertility" was rejected for the years 2017, 2018 and 2019.

Table 4:Frequencies of the culling reasons between 2017 and 2019 for the United Kingdom and Iceland

		United Kingdom	Iceland
2017	mastitis	12,6	22,2
	fertility	28,5	22,3
	metabolic disorder	2,2	4
2018	mastitis	10,8	21,7
	fertility	25,5	21,9
	metabolic disorder	2,6	3,5
2019	mastitis	11,5	25,8
	fertility	25	25,8
	metabolic disorder	2,6	3,5

IV. Discussion of results

The main goal of this report was to understand how other European countries keep track of the longevity and record the culling of dairy cows. A literature study and e-mail interviews were conducted to identify the recording method put in place and retrieve some recent data.

1. The different ways of recording culling reasons for dairy cows in Europe

Firstly, the results showed that not every country has a major way to keep track of the culling reasons, which is the case of Austria, Hungary, and Germany. These countries might keep track of departure reasons, but it is done in a very fragmented way by private companies or other small organisations. They might also do it by region, meaning each has its own structure and entity of recording, making it harder to gather. Only Estonia and Poland have an ongoing program to register culling reasons nationally, which resembles the current situation of Denmark (Aarhus University, 2022). Czech Republic, Romania, the United Kingdom, France, and Iceland keep track of culling reasons through on-farm software, surveys, and private companies. The case of Switzerland is quite particular: they do not seem to have a way to record culling reasons nationally, but their national cattle registration offers some bonuses for specifying a reason for departure for each cow. Unfortunately, no more information was found about it, so it cannot be explained more.

From the culling records, it was observed that the number of reasons for departure to choose from varied greatly from one country to another. Despite each country's own classification, categories used to describe deaths have been relatively uniform and resemble the Danish classification (Aarhus University, 2022). They usually included low milk yield, accidents/injury, reproduction problems, locomotor disorders, metabolic disorders, udder/teat disorders, infections, and unknown reasons. Some of these categories match with the “the dairy certificate of death” imagined by McConnel & Garry (2017) to be used to record the death reasons of cattle. This death certificate included categories like specific disease process as a stand-alone problem, traumatic injury, feed management, miscellaneous events not conducive to prevention, and undetermined (McConnel & Garry, 2017). The principal difference between recording the culling records and the certificate of death is that the latter does not consider production-related reasons, such as low milk yield, udder defect or reproductive problems. Also, each category's level of detail varies depending on countries.

For example, Estonia had a detailed record with 24 reasons to choose from, while the Czech Republic and the United Kingdom had minimalistic records with seven reasons on average. Denmark ranges in the middle, with 16 categories to choose from (Aarhus University, 2022).

2. The main culling reasons from different European countries

Observing the culling records, some culling reasons are recurring for several countries. As stated by Bascom and Young, reproduction problems are a major reason for getting rid of a cow: Denmark, The United Kingdom, Iceland, Poland, and Estonia have "reproduction problems" as their first or second most frequent culling reason (Bascom & Young, 1998). The United Kingdom (26,1 ± 1,6%) and Iceland (22,2 ± 3,65%) are similar to Denmark (25%), whereas it is pretty low for Estonia (12,5%) and very high for Poland (39,6%).

Bascom and Young (1998) believe mastitis is the second most important reason for culling. However, only the United Kingdom (12,6 ± 2%) and Iceland (21,9 ± 1,96%) have them in their top three reasons for departure. Lastly, Bascom and Young state that low milk production is also a primary reason for cattle culling. It is valid for Denmark but not other countries: only Iceland (8,6 ± 0,43%) has this reason in its top three, and it is still four times less than Denmark (33%).

The rate of culling for hoof/legs problems is similar in Denmark (13%), Poland (10,4%), and the United Kingdom (10,2 ± 0,3%), whereas it is higher in Estonia (26,4%). Concerning culling for udder problems, only Poland (15,5%) has a similar rate to Denmark (16%). It has to be noted that it is quite low for Iceland (7,6 ± 0,61%).

3. The effectiveness of each method of recording

Assessing the effectiveness of the culling record with quantitative data was not possible for this study. However, the effectiveness of a record system can be estimated by looking at two points: the culling categories available and the accessibility for farmers.

The quantity and quality of the culling categories directly impact the accuracy of the data registered by farmers. Reportable culling reasons are often combined into broad, poorly defined categories (e.g. metabolic diseases, foot diseases, and trauma) which do not provide much information (McConnel & Garry, 2017). The record must distinguish between the type of culling (slaughter, death, culling) and the reason for culling (reproduction problem, lameness…).

As seen before, too many poorly defined categories can confuse the farmer and give biased data. However, on the other hand, not enough categories can also be tricky for the farmer to choose from.

The second point is that if farmers are only allowed to register one reason for slaughter in the register, it does not consider any concurrent disorders that the cow might have. Therefore, asking for the primary cause of death without a whole cow health history could lead to biased responses. This means that farmers must be educated about selecting the primary reason for culling. On the other hand, many options available give more accurate data but require more time from the farmer, which can result in less reporting.

4. Discussion of the method

First, this study was conducted to avoid conflict of interest and bias. The author of this report and other participants did not have any financial or personal relationship with other people or organisations that could inappropriately influence the report's content. Two different assessors performed the literature study with 92,08% of agreement, which minimised the risk of bias in selecting papers. Also, papers were retrieved from multiple platforms, ensuring that a maximum of papers could be screened and retrieved. Concerning the statistical analysis, it was only performed on raw data obtained from interviews and not on data extracted from the literature review. Indeed, caution is needed when comparing culling rates across studies, as culling rate definitions and calculations can vary.

Secondly, the amount of data collected was relatively poor to answer the main question correctly. The data was deemed acceptable to answer the question submitted by the Danish government. However, it would be considered weak for a formal scientific publication. This is mainly due to the time allocated and the wingspan of the research. Furthermore, it was initially chosen that the data collection would be centred on European countries as Denmark is located in Europe. Comparing Denmark to countries from other continents would have increased the number of biases due to climate, economy, environment, laws and cultural differences. Still, finding a contact person for each of the 39 countries selected and then getting in touch with the company or organisation holding the culling information to obtain them was time-consuming. Despite sending e-mail reminders, it could take one week to a month to get an answer from someone. Considering that it would take between 1 and 5 persons to contact per country to retrieve data, the four-month span of the work behind this report was very limited.

The number of countries contacted might have also been too high. It would have been more efficient to focus only on European Union countries instead of European countries.

V. Conclusions

To increase the longevity of cows, it is essential to understand why the cow was disposed of in the first place. Unfortunately, in Denmark in 2021, only approximately 66,8% of all culled cows had a reason for departure registered. Therefore, there is a lack of detailed understanding of the reasons behind a third of culled Danish dairy cows. In order to improve the Danish registration system, a literature study and e-mail interviews were conducted to understand how other European countries record culling reasons.

Austria, Hungary, and Germany might keep track of departure reasons, but it is done in a very fragmented way by private companies or other small organisations. They might also do it by region, meaning each has its own structure and entity of recording, making it harder to gather. Estonia and Poland have an ongoing program to register culling reasons nationally; the Czech Republic, Romania, the United Kingdom, France, and Iceland keep track of culling reasons through on-farm software, surveys, and private companies.

Despite each country's own classification, categories used to describe culling have been relatively uniform and resemble the Danish classification. They usually included low milk yield, accidents/injury, reproduction problems, locomotor disorders, metabolic disorders, udder/teat disorders, infections, and unknown reasons.

Denmark, the United Kingdom, Iceland, Poland, and Estonia have “reproduction problem” as their first or second most popular culling reason. The rate of culling for hoof/legs problems is similar in Denmark (13%), Poland (10,4%), and the United Kingdom (10,2 ± 0,3%), whereas it is higher in Estonia (26,4%). Concerning culling for udder problems, only Poland (15,5%) has a similar rate to Denmark.

Hence, this study highlighted the importance of creating a national database for culling records and for them to be accessible throughout Europe. The quality of the collected data is highly impacted by choosing the proper categories for recording culling and making the recording process understandable for farmers. Further studies need to be carried out to gather more data about culling reasons in Europe dairy cattle.

VI. Recommendations

This study showed that the current recording system for culling reasons in Denmark has enough categories to choose from. However, it might be hard for farmers to choose the right reason, as a cow is not always culled for one thing only. Hence, educating and spreading awareness about the subject to improve cows' longevity is primordial. It could be done in agricultural schools, farmers' organisations and dairy companies.

There is also a need to record culling reasons nationally in Europe and share the data among countries.

VII. List of references

Aarhus University (2022). Culling records from 2020 to 2021 in Denmark. Unpublished internal company document.

Adamczyk, K., Grzesiak, W., & Zaborski, D. (2021). The Use of Artificial Neural Networks and a General Discriminant Analysis for Predicting Culling Reasons in Holstein-Friesian Cows Based on First-Lactation Performance Records [Article]. Animals, 11(3), 18, Article 721. https://doi.org/10.3390/ani11030721

Adamczyk, K., Makulska, J., Jagusiak, W. & Węglarz, A. (2017). Associations between strain, herd size, age at first calving, culling reason and lifetime performance characteristics in Holstein-Friesian cows. Animal, 11(2), 327-334. https://doi.org/10.1017/s1751731116001348

Akins, M. S. & Hagedorn, M. A. (2015). Heifer Management Blueprints : The cost of raising dairy replacement 2015 updates. https://fyi.extension.wisc.edu/. https://fyi.extension.wisc.edu/dairy/files/2015/10/2015-Cost-of-Raising-Replacements-Factsheet-Final.pdf

Bascom, S., & Young, A. (1998). A Summary of the Reasons Why Farmers Cull Cows. *Journal of Dairy Science*, *81*(8), 2299–2305. https://doi.org/10.3168/jds.s0022-0302(98)75810-2

Børsting, C. F., Landbrug & Fødevarer, & DCA - Nationalt Center for Fødevarer og Jordbrug. (2021). Normtal for husdyrgødning. DCA - Nationalt Center for Fødevarer og Jordbrug

CHAWG. (2020). Fifth Report GB Cattle Health & Welfare Group. In Cattle Health and Welfare Group of Great Britain. Cattle Health and Welfare Group of Great Britain. https://www.chawg.org.uk

Cheng, W. N., & Han, S. G. (2020). Bovine mastitis: risk factors, therapeutic strategies, and alternative treatments — A review. *Asian-Australasian Journal of Animal Sciences*, *33*(11), 1699–1713. https://doi.org/10.5713/ajas.20.0156

Dentine, M., McDaniel, B. & Norman, H. (1987). Comparison of Culling Rates, Reasons for Disposal, and Yields for Registered and Grade Holstein Cattle. *Journal of Dairy Science*, *70*(12), 2616-2622. https://doi.org/10.3168/jds.s0022-0302(87)80331-4

Erickson, P. S. & Kalscheur, K. F. (2020). Nutrition and feeding of dairy cattle. Animal Agriculture, 157-180. https://doi.org/10.1016/b978-0-12-817052-6.00009-4

FAO & Global dairy platform. (2019). The role of the dairy sector in a low-carbon future. FAO. https://www.fao.org/publications/card/en/c/CA2929EN

Frelich, J., Šlachta, M., & Kobes, M. (2010). Reasons for the culling of dairy cows on low-input mountain farms. Journal of Agrobiology, 27(1), 41-48. http://www.zf.jcu.cz/obecne/veda-a-vyzkum/journal-of-agrobiology

Gavrilă, M., Mărginean, G. E., & Kelemen, A. (2015). Research on longevity and cause of reduction of herd life in Holstein cows. Scientific Papers, Series D. Animal Science, 58, 284-289. http://animalsciencejournal.usamv.ro/pdf/2015/Art49.pdf

Geishauser T., K. Leslie and K. Kelton. (2001) Monitoring Subclinical Ketosis in Dairy Herds. Comp.Cont. Ed. 23; 65-71

Heatable. (2022, 30 septembre). Most Polluting Industries in 2022 Revealed. https://heatable.co.uk/boiler-advice/most-polluting-industries

Herdt, T. H. (2013). Metabolic Diseases of Dairy Cattle (Veterinary clinics of North America) (2nd ed., Vol. 29). Elsevier.

Horn, M., Knaus, W., Kirner, L., & Steinwidder, A. (2012). Economic evaluation of longevity in organic dairy cows. Organic Agriculture, 2(2), 127–143. https://doi.org/10.1007/s13165-012-0027-6

Inchaisri, C., Jorritsma, R., Vos, P., van der Weijden, G., & Hogeveen, H. (2010). Economic consequences of reproductive performance in dairy cattle. Theriogenology, 74(5), 835–846. https://doi.org/10.1016/j.theriogenology.2010.04.008

Jagdish, J. (2022, February 15). Dairy Farming in Denmark, Breeds, How to Start. Agri Farming. https://www.agrifarming.in/dairy-farming-in-denmark-breeds-how-to-start

Kalińska, A., & Slósarz, J. (2016). Influence of cow temperament and milking speed on herd life, lifetime milk yield and reasons of cow culling. Annals of Warsaw University of Life Sciences - SGGW, Animal Science(No.55(2)), 177-186. http://annals-wuls.sggw.pl/?q=node/384

Kerslake, J., Amer, P., O'Neill, P., Wong, S., Roche, J. & Phyn, C. (2018). Economic costs of recorded reasons for cow mortality and culling in a pasture-based dairy industry. Journal of Dairy Science, 101(2), 1795-1803. https://doi.org/10.3168/jds.2017-13124

McConnel, C. S., & Garry, F. B. (2017). Dairy cow mortality data management: the dairy certificate of death. *The Bovine Practitioner*, 64–72. https://doi.org/10.21423/bovine-vol51no1p64-72

Mõtus, K. & Niine, T. (2022). Cow culling patterns in eight commercial Estonian dairy herds and farmers' behaviour in reporting culling reasons. *Research in Veterinary Science*, *152*, 190-206. https://doi.org/10.1016/j.rvsc.2022.08.011

Overton, M., R. Corbett, and W. Boomer. (2013). An economic comparison of conventional vs intensive heifer rearing. Pages 122–130 in Proc. Western Dairy Management Conference, Reno, NV, March 6–8, 2013.

Pannwitz, G. (2015). Standardised analysis of German cattle mortality using national register data [Article]. Preventive Veterinary Medicine, 118(4), 260-270. https://doi.org/10.1016/j.prevetmed.2014.11.020

Rajala-Schultz P.J., Y.T. Grohn and C.E. McCulloch (1999) Effects of Milk Fever, Ketosis and Lameness on Milk Yield in Dairy Cows. Journal of Dairy Science. 82 (2) 288-294

Rilanto, T., Reimus, K., Orro, T., Emanuelson, U., Viltrop, A. & Mõtus, K. (2020). Culling reasons and risk factors in Estonian dairy cows. *BMC Veterinary Research*, *16*(1). https://doi.org/10.1186/s12917-020-02384-6

Stott, A.W. (1994), THE ECONOMIC ADVANTAGE OF LONGEVITY IN THE DAIRY COW. Journal of Agricultural Economics, 45: 113-122. https://doi.org/10.1111/j.1477-9552.1994.tb00382.x

Struchen, R., Reist, M., Zinsstag, J., & Vial, F. (2015). Investigating the potential of reported cattle mortality data in Switzerland for syndromic surveillance [Article]. Preventive Veterinary Medicine, 121(1-2), 1-7. https://doi.org/10.1016/j.prevetmed.2015.04.012

Tranel L. (2019) Heifer raising costs in 2019. ISU Publication LT-18–01. https://www.extension.iastate.edu/dairyteam/files/page/files/whats_it_cost_to_raise_heifers_2019_0.pdf

Vredenberg, I., Han, R., Mourits, M., Hogeveen, H., & Steeneveld, W. (2021). An Empirical Analysis on the Longevity of Dairy Cows in Relation to Economic Herd Performance. Frontiers in Veterinary Science, 8. https://doi.org/10.3389/fvets.2021.646672

Warnick, L., Janssen, D., Guard, C., & Gröhn, Y. (2001). The Effect of Lameness on Milk Production in Dairy Cows. *Journal of Dairy Science*, *84*(9), 1988–1997. https://doi.org/10.3168/jds.s0022-0302(01)74642-5

Wegrzynowski, M. (2022, 19 octobre). New article: Inflation and low supply growth dominate the dairy sector. IFCN Dairy Research Network. https://ifcndairy.org/inflation-and-low-supply-growth-dominate-the-dairy-sector/c

VIII. Appendices

Appendix I: Keywords for boolean search

Web of Science

((TI=(bull* or cow or cows or "dairy cow" or "dairy cows" or "lactating cows" or "lactating cow" or bovin* or steer* or "bos taurus" or cattle or heifer*)) AND TI=(cull* or kill* or euthani* or slaughter* or butcher* or longevit* or mortalit* or disposal*)) AND TI=(record* or database* or "data base*" or document* or regist* or archive* or annal* or "data file*" or "track record" or track* or reason* or cause* or report*)

Scopus

(TITLE (bull* OR cow OR cows OR "dairy cow" OR "dairy cows" OR "lactating cows" OR "lactating cow" OR bovin* OR steer* OR "bos taurus" OR cattle OR heifer*) AND TITLE (cull* OR kill* OR euthani* OR slaughter* OR butcher* OR longevit* OR mortalit* OR disposal*) AND TITLE (record* OR database* OR "data base*" OR document* OR regist* OR archive* OR annal* OR "data file*" OR "track record" OR track* OR reason* OR cause* OR report*))

Pubmed

((bull*[Title] OR cow[Title] OR cows[Title] OR "dairy cow"[Title] OR "dairy cows"[Title] OR "lactating cows"[Title] OR "lactating cow"[Title] OR bovin*[Title] OR steer*[Title] OR "bos taurus"[Title] OR cattle[Title] OR heifer*[Title]) AND (cull*[Title] OR kill*[Title] OR euthani*[Title] OR slaughter*[Title] OR butcher*[Title] OR longevit*[Title] OR mortalit*[Title] OR disposal*[Title])) AND (record*[Title] OR database*[Title] OR "data base*"[Title] OR document*[Title] OR regist*[Title] OR archive*[Title] OR annal*[Title] OR "data file*"[Title] OR "track record"[Title] OR track*[Title] OR reason*[Title] OR cause*[Title] OR report*[Title])

CAB abstracts

title:(bull* or cow or cows or "dairy cow" or "dairy cows" or "lactating cows" or "lactating cow" or bovin* or steer* or "bos taurus" or cattle or heifer*) AND title:(cull* or kill* or euthani* or slaughter* or butcher* or longevit* or mortalit* or disposal*) AND title:(record* or database* or "data base*" or document* or regist* or archive* or annal* or "data file*" or "track record" or track* or reason* or cause* or report*)

Appendix II: E-mail template

"Hello,

I'm a research intern at the Department of Animal and Veterinary Sciences of Aarhus University in Denmark. I'm currently working on a research project about culling records of dairy cattle in Europe, which aims to inspire changes in the Danish system. It consists of collecting information about procedures for recording culling reasons in other European countries, through existing literature and interviews (e-mails) with people representing relevant organisations, companies and authorities.

You may have some information we are looking for:

- Procedure to record culling on dairy farms
- Amount of culled cows recorded compared to the total amount of cows
- Main reasons for culling

Do you have access to any such information, and would you be willing to share it with us? We are also interested in incomplete or partial information. The data sources will be cited in any publication from this project.

Thank you,

Best regards"

Appendix III: Table summarising e-mail interviews answers

European countries selected	Countries contacted	Answered received	Data obtained
Albania	☑		
Austria	☑	☑	
Belarus			
Belgium	☑		
Bosnia and Herzegovina			
Bulgaria	☑	☑	
Croatia			
Czechia	☑		
Estonia	☑	☑	
Finland	☑		
France	☑	☑	☑
Georgia			
Germany	☑		
Greece	☑		
Hungary	☑	☑	
Iceland	☑	☑	☑
Ireland	☑		
Italy	☑		
Kosovo	☑		
Latvia	☑		
Lithuania	☑		
Luxembourg	☑		
Macedonia			
Moldova	☑		
Montenegro			
Netherlands	☑	☑	
Norway	☑		
Poland	☑	☑	
Portugal	☑		
Romania	☑		
Russia	☑		
Serbia	☑		
Slovakia			
Slovenia	☑		
Spain	☑		
Sweden			
Switzerland	☑		
Ukraine			
United Kingdom	☑	☑	☑