

## Recording of culling reasons in Danish dairy cows

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### HIGHLIGHTS

- Of 281,682 culled cows, 83.3 % were slaughtered, 10.2 % died, and 6.5 % were euthanized.
- In 66.8 % of culled cows, farmers had reported a culling reason.
- Culling reasons and culling modes differed with parity.
- Recording of culling reason was more likely in Jersey cows, and in older cows.
- Herds with high milk yield and low cell counts were better at reporting culling reasons.

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### ABSTRACT

Culling in dairy cows has major impacts on production economy and animal welfare, and has been described and evaluated in many studies. Information about why a cow is culled (culling reason) may be useful for many different purposes. Still, the present study is the first to evaluate explanatory factors for recording of culling reasons. Danish dairy farmers are required to report the culling mode (slaughter, unassisted death, or euthanasia) to the Danish Cattle Database. Further, the reporting of one or two culling reasons – from a list of options – is possible but not mandatory. Data from 281,682 cows culled in Danish dairy herds in 2020 and 2021 were analyzed. The mean age at culling was 1,845 days, 83.3 % of the culled cows were slaughtered, 10.2 % died unassisted and 6.5 % were euthanized. In 66.8 % of the culled cows, the farmer had reported at least one culling reason. The most frequent culling reasons for slaughtered cows were milk production (29 % of all culling reasons reported), followed by reproduction (25 %), and udder health (16 %). For unassisted dead cows, metabolic/digestive disorders were most frequently reported (25 %), followed by unknown reasons (18 %), and udder health (15 %). For euthanized cows, accidents were most frequent (29 %), followed by locomotor disorders (18 %), and metabolic/digestive disorders (17 %). Culling mode, as well as culling reasons, differed by parity and breed. Results from a logistic regression model showed that the odds of at least one culling reason being reported was significantly higher in Jersey cows compared to other breeds. Compared to Holstein cows, the odds of a reason being reported was 2.5 times higher in Jersey cows. The odds increased with increasing parity of the cow. In herds with a high mean milk yield and a low somatic cell count, the odds of reporting a culling reason was higher than in herds with lower milk yield and higher somatic cell counts, and the odds of reporting a culling reason increased with an increasing number of disease treatments recorded per cow per year.

### 1. Introduction

Throughout the world, a large number of dairy cows are culled each year, and culling of dairy cows has been described and evaluated in many studies (as reviewed by Compton et al. (2017)). Culling influences the production economy in a dairy herd, and culling due to diseases may be seen as an indicator of compromised animal welfare (Langford and

Stott, 2012; Kerslake et al., 2018).

Information about why a cow is culled (culling reason) may be useful for many different purposes: knowing why a cow left the herd, either for slaughter, or due to death or euthanasia, may be used to improve (health) management in the herd and avoid repeating mistakes leading to loss of cows. Breeding companies can utilize information about culling reasons in their breeding indices, with the overall aim to improve

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**Table 1**

Proportion of 281,682 culled dairy cows leaving the herd by slaughter, unassisted death or euthanasia, stratified by parity.

	All cows	Parity					
		1	2	3	4	5	6 or older
Slaughtered	83.3 %	86.1 %	85.8 %	83.1 %	81.0 %	80.2 %	79.6 %
Unassisted dead	10.2 %	8.0 %	8.6 %	10.5 %	12.0 %	12.2 %	12.5 %
Euthanized	6.5 %	5.9 %	5.6 %	6.4 %	7.0 %	7.7 %	7.9 %

**Table 2**

Distribution of culling reasons reported by farmers for 188,132 Danish dairy cows culled during 2020 and 2021.

Categories as originally stated by farmers	Proportion of culled cows with reason	Broader categories defined for this study	Proportion of culled cows with reason
Too low milk yield	17.9 %	Milk production	28.0 %
Milking time	0.7 %		
Lack of milk ejection	0.3 %		
Udder conformation	8.1 %		
Bad temper	1.0 %		
Reproduction	21.3 %	Reproduction	21.3 %
High somatic cell count	7.8 %	Udder health	15.5 %
Mastitis	7.7 %		
Hoof/leg disorder	12.4 %	Locomotor disorders	12.4 %
Metabolic/digestive disorders	5.9 %	Metabolic/digestive disorders	5.9 %
Diarrhea	0.5 %	Other diseases	5.7 %
Pneumonia	0.8 %		
Eradication of specific diseases	1.5 %		
Other diseases	2.9 %		
Accidents	5.0 %	Accidents	5.0 %
Unknown	2.3 %	Unknown	2.3 %
Age	2.0 %	Age	2.0 %
Calving related injuries	1.9 %	Calving related injuries	1.9 %
Sum	100 %	Sum	100 %

productivity, health and longevity of cows. Information about culling reasons may also be used in different inspection or quality assurance schemes developed to monitor, and potentially improve, animal welfare. Given the potential benefits of knowledge about culling reasons, it is surprising that - to our knowledge - the present study is the first to evaluate explanatory factors for recording of culling reasons.

Danish dairy farmers are required to report the culling mode (slaughter, unassisted death, or euthanasia) to the Danish Cattle Database. Further, the reporting of one or two culling reasons - from a list of options - is possible but not mandatory. The objectives of this study were to describe culling of Danish dairy cows and evaluate explanatory factors for recording of at least one culling reason.

## 2. Materials and methods

A dataset containing information about all Danish dairy cows culled during 2020 and 2021 was retrieved from the Danish Cattle Database. Culled cows were defined as cows slaughtered, cows dying unassisted, and cows euthanized. Cows sold for dairy purposes were not included in the dataset. Only cows (defined as animals having calved at least once) of dairy breeds - including crossbreds - and from dairy herds were included. At the cow level, the dataset included information about the identity of the cow, her breed, dates of birth, calving(s) and culling, culling mode (slaughter, unassisted death, or euthanasia), and culling reason(s) reported by the farmer. At the herd level, the dataset included information about the identity of the herd, herd size, mean milk yield, mean somatic cell count, mortality of cows and calves, proportion of stillborn calves, disease treatments, and whether the herd was organic or conventional.

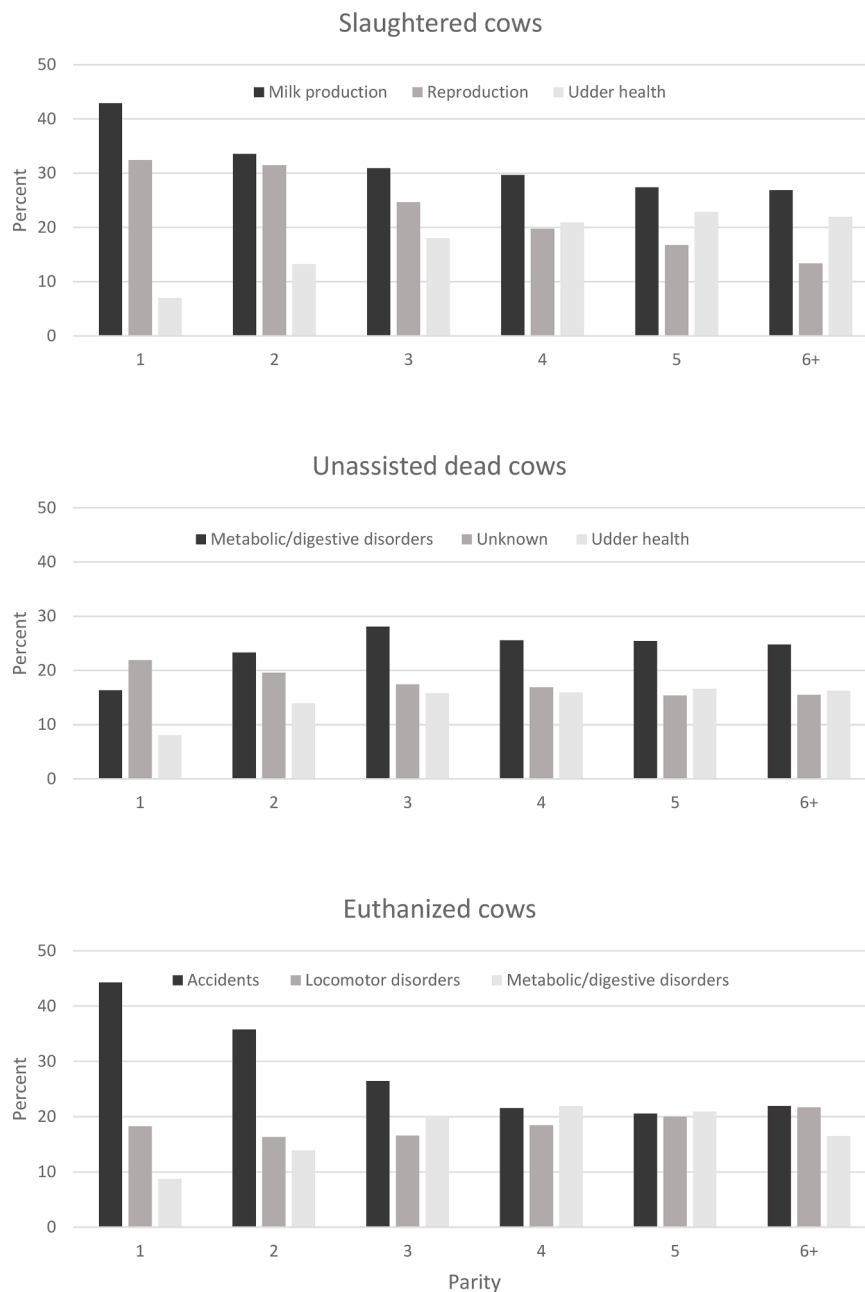
Information about culling modes and culling reasons is presented descriptively and the statistical significance of differences between breeds, parities, and culling modes was evaluated using chi-square tests (SAS, version 9.3). Explanatory factors for reporting a culling reason was evaluated using a logistic regression model (PROC GLIMMIX, SAS version 9.3) with reporting of at least one culling reason (yes/no) as the outcome, and parity, breed, mean herd level milk yield, mean bulk tank

somatic cell count, mean annual cow mortality rate, mean annual calf mortality rate, mean proportion of stillborn calves, mean number of recorded disease treatments per cow per year, herd size, and organic/conventional as explanatory variables. All herd level variables were calculated as the mean for the two years under study (2020 and 2021). For the analysis, all continuous herd level variables were grouped in four groups based on quartiles. Herd was included in the model as a random effect. Results are presented as odds ratios with 95 % confidence intervals and *P*-values, as well as the proportion of culled cows with a recorded culling reason for each category/level.

## 3. Results

During 2020 and 2021, 281,682 cows were culled from Danish dairy herds and included in the dataset. The mean age at culling was 1845 days (minimum: 428, median: 1772, maximum 7645) and the mean number of days from first calving to culling was 1082 days (minimum: 0, median: 1008, maximum: 6787). Of the culled cows, 19.5 % were in their first lactation, 21.9 % in their second lactation, 22.0 % in their third lactation, 17.2 % in their fourth lactation, 10.7 % in their fifth lactation, and 8.7 % in their sixth or later lactation. The highest parity of any culled cow was 14 (6 cows). Of the culled cows, 83.3 % were slaughtered, 10.2 % died unassisted, and 6.5 % were euthanized. These proportions differed between breeds ( $P < 0.0001$ ) with the highest proportion of slaughtered cows among Red Danish Dairy breed (89.1 %) and the lowest proportion among Jersey cows (79.8 %). Accordingly, Red Danish Dairy breed had the lowest proportion of unassisted dead (7.2 %) and euthanized cows (3.8 %). The proportions of slaughtered, unassisted dead and euthanized cows differed with parity ( $P < 0.0001$ ), with a lower proportion of slaughtered, and a higher proportion of dead and euthanized cows with increasing parity (Table 1).

In 66.8 % of the 281,682 culled cows, the farmer had reported at least one culling reason to the Danish Cattle Database, and in 10.2 % of cases, two culling reasons were reported. The proportion of culled cows with at least one reason reported was higher for cows euthanized (73.9 %) than for cows slaughtered (67.6 %) or dying unassisted (55.9 %) ( $P <$



**Fig. 1.** Proportion of the three most frequent culling reasons as reported by farmers for 188,132 Danish dairy cows culled during 2020 and 2021. Proportions are shown separately for slaughtered, unassisted dead and euthanized cows, and stratified by parity.

0.0001). The distribution of culling reasons (first reason only) for all cows where at least one reason was reported is presented in Table 2. Table 2 presents the culling reasons both as the original culling reasons selected by the farmers, and as a lower number of broader categories where some categories are merged to give a better overview. In cows where a second culling reason was reported, reasons relating to milk production (37.5 % of stated reasons) and reproduction (13.4 %) were most prevalent. Interestingly, reproduction was stated as the second culling reason in 32.1 % of cows with low milk yield as the first reason. This may suggest that farmers often do not insist on prolonging reproductive efforts for lower producing cows.

The first culling reasons reported by farmers differed for different culling modes ( $P < 0.0001$ ). The most frequent culling reasons for slaughtered cows were milk production (29 % of all culling reasons reported), followed by reproduction (25 %), and udder health (16 %). For unassisted dead cows, metabolic/digestive disorders were most

frequently reported (25 %), followed by unknown reasons (18 %), and udder health (15 %). For euthanized cows, accidents were most frequent (29 %), followed by locomotor disorders (18 %), and metabolic/digestive disorders (17 %). Fig. 1 shows the proportion of the three most frequent culling reasons for each culling mode, stratified by parity. For example, it can be seen that milk production becomes a less prevalent reason for slaughter with increasing parity, that accidents become a less prevalent reason for euthanasia with increasing parity, and that unknown reason is reported less frequently for unassisted death in older cows compared to younger cows.

Results from the logistic regression evaluating explanatory factors for the reporting of at least one culling reason are presented in Table 3. The odds of a culling reason being reported was significantly higher in Jersey cows compared to other breeds. Compared to Holstein cows, the odds of a reason being reported was more than twice as high in Jersey cows. The odds increased with increasing parity of the cow. In herds

**Table 3**

Results from a logistic regression evaluating explanatory factors for reporting of a culling reason when Danish dairy cows are culled. Higher odds ratios indicate a higher odds of a reason being reported.

Variable	Levels	Proportion of culled cows with a reason reported	Odds ratio	95 % confidence interval for odds ratio	P-value
Breed	Holstein	65.5 %	1		<0.0001
	Jersey	76.8 %	2.52	2.44–2.59	
	Crossbred	64.2 %	1.13	1.10–1.16	
	Red Danish Dairy	66.7 %	1.52	1.47–1.58	
Parity	1	64.8 %	1		<0.0001
	2	65.7 %	1.03	1.00–1.06	
	3	66.5 %	1.05	1.03–1.08	
	4	67.5 %	1.09	1.06–1.12	
	5	68.7 %	1.13	1.10–1.17	
	6 or older	71.1 %	1.23	1.19–1.27	
Milk yield (mean annual milk yield, kg energy corrected milk)	<10,334	57.8 %	1		<0.0001
	10,334–11,110	68.9 %	1.68	1.64–1.72	
	11,111–11,904	66.3 %	1.51	1.47–1.54	
	>11,904	74.3 %	2.18	2.11–2.24	
Somatic cell count (mean annual bulk tank somatic cell count, cells/ml)	<165,000	71.9 %	1.52	1.49–1.56	<0.0001
	165,000–193,000	70.3 %	1.40	1.36–1.43	
	194,000–227,000	66.8 %	1.29	1.26–1.32	
	>227,000	58.0 %	1		
Cow mortality (mean annual cow mortality rate)	<3.9 %	64.9 %	1.01	0.99–1.04	<0.0001
	3.9 %–5.1 %	68.7 %	1.08	1.05–1.10	
	5.2 %–6.7 %	69.8 %	1.24	1.21–1.27	
	>6.7 %	63.9 %	1		
Calf mortality (mean annual calf mortality rate)	<3.6 %	68.9 %	1.15	1.12–1.18	<0.0001
	3.6 %–5.6 %	70.1 %	1.18	1.16–1.21	
	5.7 %–9.1 %	65.3 %	1.00	0.98–1.03	
	>9.1 %	62.8 %	1		
Proportion of stillborn calves	<4.0 %	64.2 %	1		<0.0001
	4.0 %–5.0 %	68.1 %	1.16	1.13–1.18	
	5.1 %–6.3 %	68.9 %	1.25	1.22–1.28	
	>6.3 %	65.9 %	1.21	1.18–1.23	
Disease treatments (mean number of treatments per cow per year)	<0.44	56.5 %	1		<0.0001
	0.44–0.67	66.5 %	1.41	1.38–1.45	
	0.68–1.00	72.2 %	1.70	1.66–1.74	
	>1.00	71.8 %	1.72	1.67–1.76	
Herd size (number of cows)	<180	61.8 %	1.04	1.02–1.07	<0.0001
	180–288	67.9 %	1.14	1.11–1.16	
	289–469	69.1 %	1.07	1.05–1.10	
	>469	68.6 %	1		
Organic/conventional	Conventional	67.1 %	1		<0.0001
	Organic	64.7 %	1.45	1.41–1.49	

with a high mean milk yield and a low somatic cell count, the odds of reporting a culling reason was higher than in herds with lower milk yield and higher somatic cell counts. The odds of reporting a culling reason increased with an increasing number of disease treatments recorded per cow per year.

#### 4. Discussion

Almost 17 % of the culled cows were not slaughtered, but died unassisted or were euthanized on-farm. This is an increase compared to 2005 and 2006, where 14 % of culled Danish cows died or were euthanized (Houe et al., 2011). Pinedo et al. (2010) found that 20.6 % of culled cows in a large sample of cows from USA from 2001 to 2006 died or were euthanized, whereas Rilanto et al. (2020) found much lower proportions of 4.0 % among primiparous cows and 6.3 % among multiparous cows from Estonia during 2013–2015. A higher cow mortality (a higher proportion of death and euthanasia) in older cows has been found in many other studies worldwide (e.g., Thomsen et al., 2004; Alvåsen et al., 2014; Shahid et al., 2015; Reimus et al., 2018).

Overall, approximately two thirds of the culled cows had at least one culling reason reported by the farmer, more among euthanized cows, and less among unassisted dead cows. This is not surprising, as a cow is normally euthanized only after a diagnosis has been made and a negative prognosis for the recovery of the cow has been established. In some of the cases where a culling reason was not reported, the cause of death may have been unknown. Still, 2.3 % of all culled cows had the culling reason 'unknown' reported. In these cases, the farmer has actively indicated that the culling reason has been evaluated, but not determined.

Very often a cow is not culled due to a single reason, but rather due to an often complex chain of events eventually leading to death or slaughter (Fetrow et al., 2006; Thomsen, 2022). Allowing farmers to report only one or two culling reasons may therefore not accurately reflect the true reason for culling. On the other hand, the use of a large number of very detailed culling reasons may be less operational and more laborious, and in turn result in a lower proportion of culled cows with a culling reason reported by farmers.

We found a higher odds of reporting a culling reason in herds with high milk yields and low somatic cell counts. A high milk yield and a low somatic cell count may be seen as a proxy for 'good management' or 'good husbandry', and the association between milk yield, somatic cell count and odds of reporting culling reasons may be due to 'good farmers' also taking extra interest and care in reporting culling reasons. Higher odds of reporting in herds with more disease treatments recorded may be due to several mechanisms: Farmers keeping good treatment record may also be more likely to report culling reasons. Alternatively, in herds with major problems with diseases (=many treatment records), the farmer may be aware that culling records may be a useful 'tool' to monitor disease status, guide preventive measures, and in turn reduce morbidity in the herd. It could have been interesting to further explore the association between farmer characteristics and reporting of culling reasons. However, due to the origin of the data, this was not possible in the present study.

In some cases, odds ratios and the 'raw numbers' showing the proportion of culled cows with a culling reason reported for each variable and level in Table 3 are somewhat different. This is due to the fact that the logistic regression models the effect of each explanatory variable taking the effect of all other variables in the model into account. In other words, odds ratios compare levels of an explanatory variable 'all other things equal'; hereby sometimes being different from the 'raw numbers'. Due to the large dataset, most associations evaluated in this study had very low *P*-values. When assessing the implications of the findings, more emphasis has been given to the magnitude of the numerical differences found, putting lesser emphasis on statistically significant, but numerically smaller, differences.

#### 5. Conclusion

Overall, 83.3 % of culled Danish dairy cows were slaughtered, whereas 10.2 % died unassisted and 6.5 % were euthanized. Approximately two thirds of cows culled in Denmark in 2020 and 2021 had a culling reason reported by the farmer. These reasons differed between culling modes with milk production being the most frequent reason for slaughter, metabolic/digestive disorders for unassisted dead cows, and accidents for euthanized cows. Reporting of at least one culling reason was more likely in Jersey cows, in older cows, and in cows from herds with a high milk yield, a low somatic cell count, and a high number of recorded disease treatments.

#### Author statement

Not relevant in this study

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#### CRediT authorship contribution statement

**Peter T. Thomsen:** Conceptualization, Funding acquisition, Methodology, Investigation, Data curation, Formal analysis, Software, Writing – original draft, Visualization. **Hans Houe:** Conceptualization, Funding acquisition, Methodology, Investigation, Writing – review & editing.

#### Declaration of Competing Interest

None

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