Reasons and risk factors for culling of Holstein dairy cows in Morocco

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Abstract   This study was carried out in a commercial herd from 2008 to 2012 in order to determine the most prevalent reasons for culling Holstein cows and to assess the effects of risk factors. Overall, 519 (28.2%) cows were culled for involuntary (98.8%) and voluntary (1.2%) reasons. The involuntary causes of culling were diseases (38.7%), reproduction problems (36.0%), udder disorders (7.7%), lameness (3.7%) and death (12.7%). Mean age of cows at culling was 70.5±15.6 months and the time interval from last calving to culling averaged 263±196 days. Logistic binary regression was used to model the hazard of culling. The analysis of risk factors showed that parity, calving season, and age at first calving had significant effects on the hazard of culling (P < 0.05 to P <0.001). Thus, cows at parity 3 and 4 or greater had a 116.5% and 253.8% risk of culling, respectively than cows at parity 1 (reference class) (P < 0.001). Cows that calved from May to August and from September to December had a 19.7% and 45.5% risk of culling, respectively, higher than those that calved from January to April. The risk of culling increased with increasing age at first calving. Thus, cows having an age at first calving of 25-30 and 31-38 months had a 130.8% and 90.4% risk of culling, respectively, higher than cows having an age at first calving less or equal than 24 months. It was concluded that identifying reasons for culling can be helpful in determining management problems in dairy herds.

Keywords: Holstein dairy cows, culling, udder disorders, logistic regression, risk factor

Introduction

Culling is defined as the removal of cows from the herd due to sale or death. It has been typically classified as voluntary and involuntary, and both are essentially motivated by economic considerations. Voluntary culling is defined as the departure of healthy cows from the herd for production related reasons, such as low milk yield, old age or excessive number of cows in the herd. In this case, farmer has complete freedom of choice over which cows are removed from the herd. Involuntary (or forced) culling is defined as the removal of cows for reasons considered those that reduce a dairy cow's main function, which is to produce milk, such as severe disease, reproductive problems or death. However, because many cows leave the herd for more than one reason, the distinction between voluntary and involuntary reasons is not always clear or useful.

Culling is a complex, expensive and challenging issue that involved both biological and managerial factors. Its purpose is to improve the profitability of herd by culling of sick, infertile and low producing dairy cows, and replacing them with high quality heifers. The optimum dairy herd profitability is reached by increasing the number of cows culled for voluntary reasons and minimizing the number of involuntary cow culls (Mohammadi and Sedighi, 2009). According to numerous studies (Seegers et al., 1998; Pinedo et al., 2010; Stojić et al., 2012), total culling, including deaths, averaged 32-36%. Moreover, several authors (Seegers et al., 1998; Stevenson et al., 1998; Kuczaj et al., 2008; Azizzadeh, 2011) have shown that infertility followed by udder disorders, low milk production and lameness are the main reasons for cows leaving the herd.

To my knowledge, no studies have been conducted examining the culling in Moroccan dairy herds. Therefore, the objective of the present study was to investigate reasons for culling as diagnosed by veterinarians in one of the biggest commercial dairy herds in Morocco, and to analyse effects of some risk factors. Identifying reas-

ons for culling can be helpful in determining manage-ment problems in dairy herds.

Material and methods

Herd management

Data were collected in a commercial dairy herd in northern Morocco. This herd was used because of the completeness of its records. All cows in the herd were Holstein. Data were recorded between July 2008 and December 2012. Average age at calving was 45.2 months, ranging from 23 to 83 months, average lactation number was 2.29, ranging from 1 to 4 or greater, and age at first calving between 21 and 38 months.

All cows were housed in free-stall barns and fed the same diet, which was formulated to meet the nutrient requirements of a lactating Holstein cow weighing 650 kg and producing 25-35 kg of milk daily. The farm milked cows in fully automated milking parlors (Boumatic, USA) equipped with automatic milking machine. Cows were milked two to three times daily according to their lactation stage. At each milking, cows were examined for symptoms of clinical mastitis by the milking personnel. During the period of study, the mean 305-day milk yield was 8066 kg.

Studied variables and statistical analyses

The data available on studied cows were identification of cow, parity, birth date, calving date, culling date and primary reason for culling. The culling rate was calculated as number of culled cows during the studied period divided by total number of cows present at that period. The proportion of culls for each culling reason was calculated as number of cows culled due to that culling reason divided by total number of culled cows. The age at culling was calculated using birth and culling dates, and the interval from last calving to culling was calculated using last calving date and culling date. The culled cows were sorted according to culling reason, number of lactations at time of culling, season of calving and age at first calving.

The initial data file included 1937 records. After editing, we excluded cows with an unknown birth, calving or culling date, cows without a lactation number and culled cows for unknown reason. Discarded records represented 9.49% of the initial data. Finally, 1839 records were analyzed. To assess the effects of risk factors, culling was defined as a binary trait (0 = no culling, 1= culling), based on whether a cow was removed from the herd or not. Logistic binary regression was used to model the hazard of culling. The logistic model, fitted with culling as the outcome variable (present: 1, absent: 0), included fixed effects of the risk factors of parity (4 levels: 1, 2, 3, and 4 or greater), season of calving (3 levels: January – April, May – August and September – December) and age at first calving (3 levels: ≤24, 25-30 and 31-38 months). Odds ratios and 95% confidence intervals were obtained from PROC Logistic (SAS, 2002). The odds ratio is a measure of the likelihood of an outcome occurring in observations with a given risk factor compared with observations without the risk factor. An odds ratio of 1.0 implies that observations with a risk factor are equally likely to have the same outcome as observations without the risk factor. Reference classes consisted of parity 1, the calving season January - April, and the age at first calving ≤24 month classes.

Results

Although the goal of each farmer is to keep milking cows as long as possible, culling of unprofitable cows is necessary. Overall, 519 cows were culled during the study period, i.e. an overall culling rate of 28.2% and an annual culling rate of 5-6%. High percent of cows left the herd due to involuntary culling (98.8%), with a very small proportion for voluntary culling (1.20%). Table 1 shows reasons for cows leaving the herd and their frequencies. The involuntary reasons for culling were diseases (38.7%), reproduction problems (36.0%), udder disorders (7.7%), lameness (3.7%) and death (12.7%) which was due to mastitis and unknown causes (Figure 1). The most important reason for voluntary culling was low milk yield.

Mean age at culling and interval from last calving to culling of all culled cows and for each culling reason are presented in Table 1. Mean age of cows at culling was 70.5±15.6 months. Age at culling of cows culled for low milk yield was higher than those of cows culled for any other reason. The age at culling averaged 66.7, 75.1, 68.2, 76.8 and 81.2 months for cows culled for diseases, reproduction problems, udder disorders, lameness and low milk yield, respectively. For cows that died during the study period, the average age at death was 73.5 months. The average length of time that a cow remained in the herd after last calving (interval from last calving to culling) was 263±196 days. It was relatively lower in cows culled for lameness (205 days), higher in those culled for reproduction problems (381 days) and intermediate in cows culled for diseases, udder disorders and low milk yield. The interval from last calving to death averaged 249 days.

Distributions of reasons for culling of Holstein cows according to parity, calving season and age at first calv-
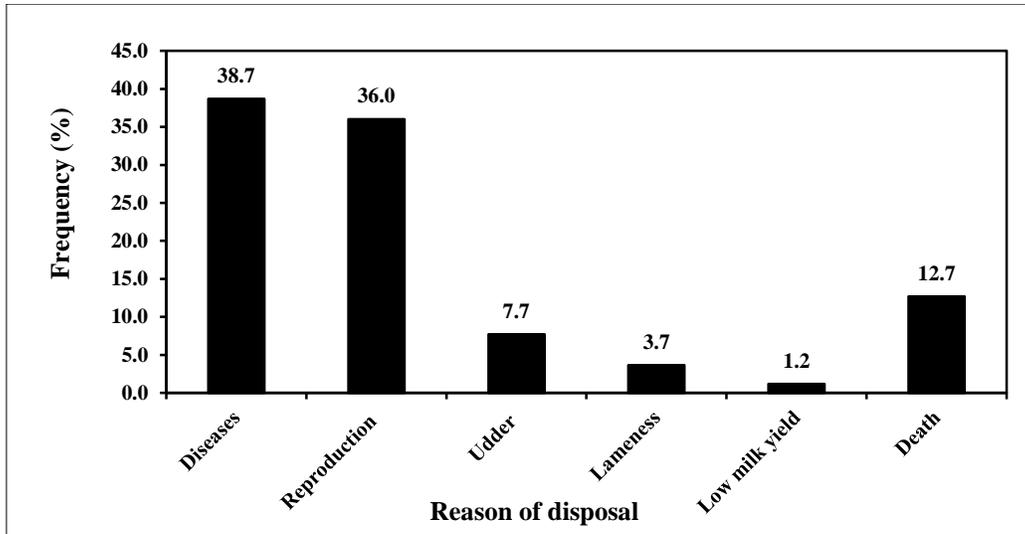
Figure 1. The distribution of reasons for culling of Holstein cows
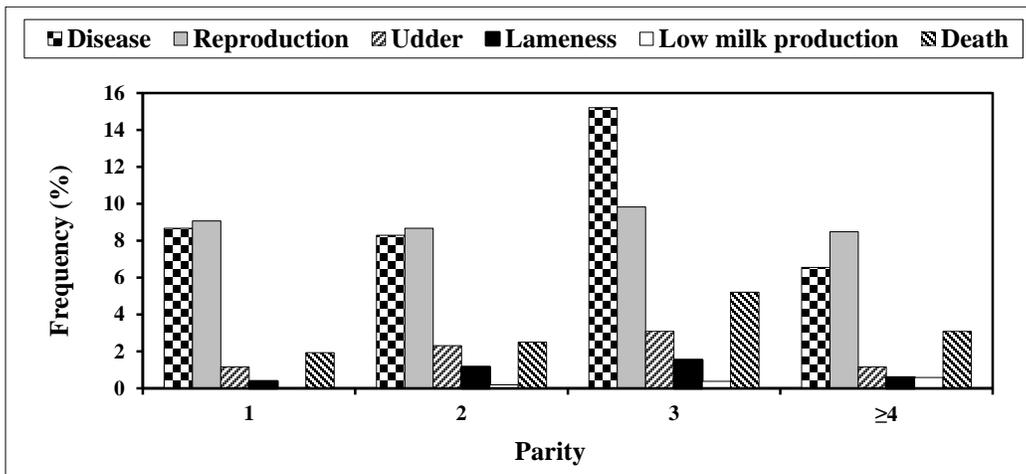
**Figure 2.** The distribution of reasons for culling of Holstein cows according to parity
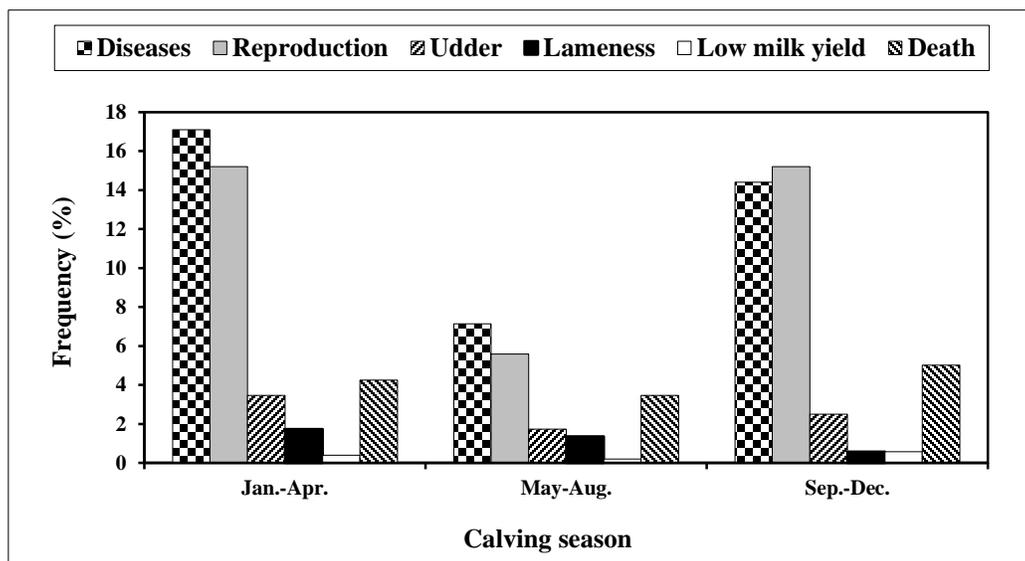
Figure 3. The distribution of reasons for culling of Holstein cows according to last calving season
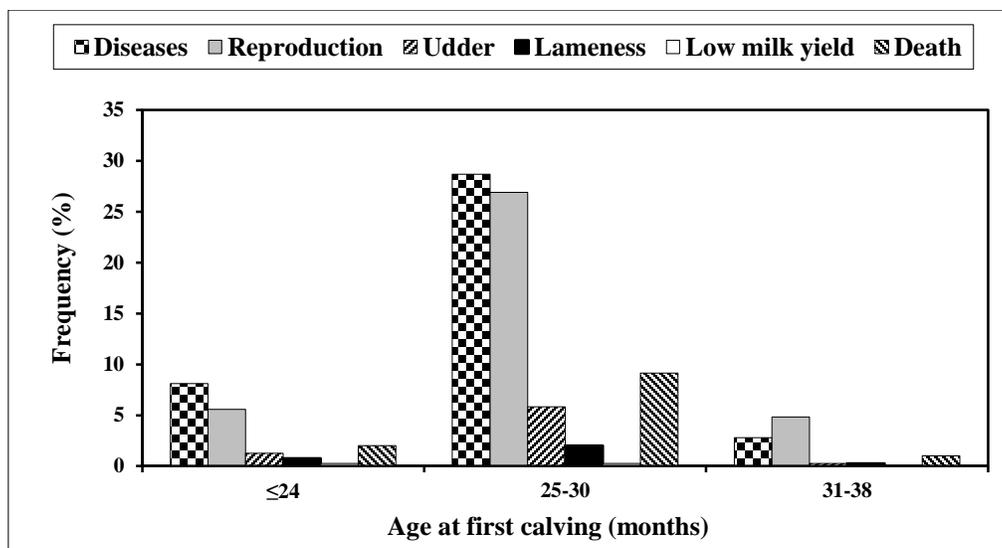
Figure 4. The distribution of reasons for culling of Holstein cows according to age at first calving

ing are showed in Figures 2, 3 and 4. Culled cows for diseases and death were higher at parity 3 compared to other parities. The proportions of culled cows for diseases and reproduction problems were lower in May - August calving season than in January - April and September - December. The proportions of culled cows due to diseases, reproduction problems and death were higher when cows calved for the first time at 25-30 months compared to those that calved for the first time at ≤24 and 31-38 months.

The analysis of risk factors showed that parity, calving season, and age at first calving had significant effects on the hazard of culling ($P < 0.05$ to $P < 0.001$). Thus, cows at parity 3 and 4 or greater had a 116.5% and 253.8% risk of culling, respectively than cows at parity 1 (reference class) ($P < 0.001$). However, the results of the Wald chi-square test showed non significant differences between parity 2 and the reference class ($P > 0.05$).

Culling hazard was also influenced by calving season ($P < 0.05$). Cows that calved from May to August and from September to December had a 19.7% and 45.5%

risk of culling, respectively, higher than those that calved from January to April. The difference between September-December calving season and the reference class was significant ($P < 0.01$), whereas that between May-August calving season and the reference class was not significant ($P > 0.05$).

The hazard of culling differed among age at first calving classes ($P < 0.001$). The risk of culling increased with increasing age at first calving. Thus, cows having an age at first calving of 25-30 and 31-38 months had a 130.8% and 90.4% risk of culling, respectively, higher than cows having an age at first calving ≤24 months. Differences between the reference class (≤24 months) and the two other age at first calving classes were significant ($P < 0.05$ to $P < 0.001$).

Discussion

The annual culling rate obtained in the current study (5-6%) was lower than rates varying from 20.9 to 35% reported in the previous studies (Esslemont and Kossaibati, 1997; Stevenson and Lean, 1998; Azizzad-

Table 1. Means and standard deviations of age at culling and interval from last calving to culling (removed or dead) according to reason of culling

Cull reason	Number	Age at culling (months)		Interval from last calving to culling (days)	
		Mean	Standard deviation	Mean	Standard deviation
Diseases	201	66.7	16.2	248	195
Reproduction problems	187	75.1	13.4	381	258
Udder disorders	40	68.2	13.6	234	168
Lameness	19	76.8	6.40	205	135
Low milk yield	6	81.2	16.5	234	241
Death	66	73.5	15.1	249	164
Total	519	70.5	15.6	263	196

eh, 2011; Ansari-Lari et al., 2012). This low culling rate per year is not in agreement with the conclusion of Raguz et al. (2011) who stated that animals from bigger herds (as the one of the present study) were at relatively higher risks of culling than the animals from smaller herds, especially herds with less than 5 cows. The high cost of replacement heifers (about $ 2000) and the low sale price of culled cows seem to be the most important reasons for the low culling rate, and especially voluntary culling. Furthermore, proportions of involuntary and voluntary culling correspond to those reported by Mohammadi and Sedighi (2009) (98.5% and 1.5%, respectively) and Azizzadeh (2011) (96% and 4%, respectively).

The main reasons for culling cows in the present study were diseases, reproduction problems followed by udder disorders. This is in agreement with Beaudeau et al. (1993) who estimated that more than half of all cullings were associated with health disorders. Thus, to decrease culling rate, it is crucial to improve management techniques in order to minimize the effects of diseases. Moreover, many previous studies (Mohammadi and Sedighi, 2009; Azizzadeh, 2011; Ansari-Lari et al., 2012; Didarkhah et al., 2013) reported that infertility or reproductive problems remained the most prevalent reason for involuntary culling (from 23.6% to 47% of all culls). Also, Gröhn et al. (1998) reported that after a cow has conceived, her risk of culling decreases. Moreover, for Mohammadi and Sedighi (2009), Azizzadeh (2011) and Ansari-Lari et al. (2012), mastitis or udder disorders were the second frequent reason for culling (9.6%, 6.5% and 17.5% of all culls, respectively). Results from the current study indicated that among the involuntary causes, lameness was responsible for 3.6% of all cullin-

gs, which are in agreement with the results of Ansari-Lari et al. (2012) and Didarkhah et al. (2013) who showed that 3.5% and 3%, respectively of dairy cows were culled for foot disorders, but lower than results of Mohammadi and Sedighi (2009) who found that lameness accounted for 8.3% of disposals. The proportion of culled cows for low milk yield was small since cows are not selected on their potential for milk production. Thus, it appears clearly that reasons for culling are numerous, but the decision to cull a cow from a herd is usually based upon several reasons of varying importance, and sometimes the reason that gets recorded is only one of many possibilities.

The average age of cows at culling was 70.5±15.6 month. This is in agreement with the result of Ansari-Lari et al. (2012) who reported that mean age of cows at culling was 6 years and the oldest culled animal was 15 years old. In the present study, the age at culling indicates that cows were culled after they realized 3 to 5 lactations. The average parity at time of disposal, reported by other researchers, varied from 2.94 to 4 (Nieuwhof et al., 1989; Stevenson and Lean, 1998; Hare et al., 2006; Azizzadeh, 2011). Age of cows at culling for diseases, reproduction problems, udder disorders, lameness and low milk yield averaged 66.7, 75.1, 68.2, 76.8 and 81.2 months, respectively. Seegers et al. (1998) reported similar results pointing that culled cows for these reasons were more frequent at 4th-6th parities; but culled cows from infertility or reproductive disorder were younger, and most of them culled before 3rd parity. After calving, average length of time that a cow remained in the herd was 263 days. Therefore, it seems that the end of lactation appeared to be an interesting period for dairy farmers to decide if a cow was to remain in the

Table 2. Number, estimated odds ratio, 95% Wald confidence interval (CI) and P-value from logistic binary regression model for risk of culling

Factor	Number	Odds ratio	95% Wald CI		P-value
			Lower	Upper	
Parity		***			
1	536	1.000	-	-	-
2	494	1.036	0.739	1.454	0.8360
3	544	2.165	1.577	2.972	0.0001
4 or greater	265	3.538	2.377	5.266	0.0001
Season of calving		*			
January - April	802	1.000	-	-	-
May - August	311	1.197	0.837	1.711	0.3254
September - December	726	1.455	1.113	1.902	0.0060
Age at first calving (months)		***			
≤24	441	1.000	-	-	-
25-30	1190	2.308	1.672	3.186	0.0001
31-38	208	1.904	1.122	3.231	0.0170

* P < 0.05
*** P < 0.001

herd. This calving to culling interval is in the range of those reported by Seegers et al. (1998), Stevenson and Lean (1998) and Azizzadeh (2011) (212, 284 and 194 days). Moreover, Ansari-Lari et al. (2012) found that the distribution of calving to culling interval is bimodal with two peaks, up to 100 days after calving and then 290 to 360 days after calving. In the present study, cows culled due to diseases, udder disorders and lameness were removed earlier, whereas those culled for reproduction problems were discarded later. This indicates that the latter group of cows was removed later in lactation than cows culled for some other reasons. Also, Azizzadeh (2011) reported that cows culled for digestive tract disorders, injuries, udder disorders, calving difficulties and voluntary reasons were removed earlier in lactation than those culled for reproductive disorders, infectious diseases and lameness. In fact, the time that a cow remained in the herd depends on whether a replacement animal is immediately available or not. If no replacement animal is available, then the culled cow is kept as long as she keeps paying for herself. However, when a replacement animal is available, keeping a culled cow in herd will delay another more profitable cow from coming into the herd. In this case, she is removed very quickly.

Cows in 3rd and 4th lactation or greater had a much higher risk of being culled than did cows in 1st lactation, which was assigned as a reference class. This result is in agreement with results of Bahonar et al. (2009) and Bahrampour et al. (2016) who concluded that the odds of culling increased noticeably with parity and higher parity cows had a higher risk of culling because age and parity were associated with an increase in risk of health disorders. However, Raguz et al. (2011) reported that the risk of culling decreased with parity, since cows in first parity were most exposed to risk of culling about 21 times (Holstein) and about 14 times (Simmental) more than the animals in fourth parity (reference class). Moreover, the probability of a cow being culled differs depending on the age of the animal, which is similar to what we have reported in this study for parity. Thus, Dohoo and Martin (1984) reported that the risk of removal was highest in cows between 3 and 5 years of age and also in cows over 7 years of age.

The odds of culling cows were higher in May - August and September - December calving seasons than in January - April calving season. This result is not in concordance with the finding of Bahonar et al. (2009) who did not find any evidence for a significant effect of calving season on culling. However, it is in agreement with that of Ansari-Lari et al. (2012) and Bahrampour et al. (2016) who found that hazard of culling was significant-

ly lower for cows which calved in winter and summer compared with spring months. This was explained by farmers' attitude toward culling in different seasons which is based on predictable climatic changes, since farmers tend to cull diseased cow in spring and autumn to avoid worsening conditions in summer and winter.

Cows that calved the first time between 25-30 months and between 31-38 months had risk of culling higher than those that calved before 24 months. This finding shows the importance of reducing age at first calving. Our result is consistent with that of Bahrampour et al. (2016) who reported that higher ages at first calving increased the risk of culling. Moreover, Nilforooshan and Edriss (2004) and Zavadilová and Štípková (2013) who found that length of productive life was on average slightly shorter for cows with higher age at first calving. In contrary, Raguz et al. (2011) concluded that the age at first calving is considered as an effect of minor importance on the length of productive life.

Conclusion

The culling of unbeneficial cows is a necessary management practice. Results of the present study showed that cows were mainly culled for diseases, reproductive problems and udder disorders. The hazard of culling was significantly higher for cows which are in 3rd lactation or greater, have calved in May – December season and have calved the first time at later ages. Therefore, the key for reducing culling is to keep cows comfortable and healthy by minimizing management factors with a high impact on health and production.

Acknowledgments

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