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Research Article

Culling Strategies of Dairy Cows in Eastern Province of Saudi Arabia (2014-2019)

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ABSTRACT

A total of 48853 ± 1802 lactating Holstein cows were used from 2014 to 2019 to study the culling strategies in a high-producing dairy farm in Saudi Arabia. The culling decision was taken by two expert veterinarians. Ten culling causes (collected from the herd database) were grouped as abortions, age (old age, heifer excess number, fence shy, and under size for age), failure to conceive, general health (general health, congenital abnormalities, eye problems, and persistent bloat), injury/lame, low milk yield, mastitis, poor conformation, reproductive tract abnormalities, and udder conformation. Results revealed the average culling rate per year ranged from 16.07% to 23.68%. The culling proportions depending on number of lactations were 40%, 26%, 18%, and 16% for the first, second, third, and fourth lactation, respectively. The most frequent reason for culling was reproduction (failure to conceive and abortions). Failure to conceive, abortions, general health, injury/lame, and udder conformation were common reasons (6.51-28.59%) for culling across the majority of years. Age, low milk yield, mastitis, poor conformation, and reproductive tract abnormalities were the least likely reasons (1.64-12.11%) for culling. The common reasons for culling during four seasons across all years (4%-34%) were failure to conceive, abortions, udder conformation, general health, and injury/lame. The common reasons for culling across all months (5.10-25.30%) were failure to conceive, abortions, udder conformation, general health, injury/lame, and low milk yield. In conclusion, the common causes for culling cows in the high-producing dairy farm were abortions, failure to conceive, general health, and udder conformation.

Keywords: Dairy cows; Culling; Seasonal culling; Monthly culling

INTRODUCTION

In dairy farms production, culling is the inevitable removal of a live cow or cows from the farm for immediate slaughter or sale [1,2]. The definitions of elimination of cows are culling (removal of a live cow from the farm for immediate slaughter), sale (movement to another farm for future dairy purposes), and mortality (death of an animal on the farm, whether euthanized or unassisted) [2,3]. Culling of cows is a technique leads to herd improvement and increased profits or reduced costs by replacing diseased or non-pregnant cows [4,5]. However, culling is a major cost for dairy farms but also an essential part in managing herd productivity [1,6]. There is no single optimal culling rate that is applicable to all herds for all years due to a variety of economic factors, farm capacities, individual cow factors, mortality rates within the herd, availability of replacements, and biosecurity considerations [1]. Culling decision is complicated and made in a non-programmed fashion, so the decision maker who decides to cull a cow should take in his consideration factors related to the cow like general health, level of milk production, reproductive status, diseases, pregnancy status, stage of lactation, and age, and also external factors such as the availability of replacement heifers, parlour capacity, milk and beef prices, housing availability, or even country-specific quotas [7-10]. Optimal timing is important at culling as too early or too late culling results in economic loss [11]. The optimal culling in dairy farms was achieved to reach the maximum profit and avoid individual risk factors in the herd [1]. The reasons of culling in caw farms are related to reproductive situation, milk production,

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metabolic and post-partum diseases, lameness and mastitis [12,13]. There are many factors affecting the reproductive tract including the environmental condition, immunologic status of cows, the diffusion of digestive problems, contagious diseases and infection of mammary gland [14]. Milk production average in the farm is negatively correlated with increase turnover rate resulting in the decrease of milk production in replacement animals compared to substituted animals within short period [15]. Furthermore, a high turnover rate significantly raises the replacement costs at the farm level [15]. Another reason of culling associated with undesirable factors that have varied depending on age, parity and stage of lactation of the dairy cow [16-18]. In some countries, the culling percentage of dairy cows may change along the year based on outer factors like climate [19]. In addition, dairy cow farms have particularly culling policy and involuntary culling related to the percentage of dying on the farm. The studding causes of culling and replace cows in dairy farms may be identify some problems in the production system [19]. Furthermore, a comprehensive analysis of the reasons of culling in dairy cows is necessary in order to improve productivity. The aim of the present study was to evaluate the culling causes in a high-producing dairy farm at middle region in Saudi Arabia, during six years between 2014 and 2019. This will facilitate the establishment of benchmark indicators at different times of the year which may help to identify seasonal problems in the production system.

MATERIALS AND METHODS

This study was approved ethically by Al-Safi Dairy Company Committee, Saudi Arabia.

Study population

The study was carried out on a high production dairy farm with Holstein cows over a period of 6 years (1st January 2014 to 31st December 2019). The farm total area is 2900 Hectare (about 30 km^2) and located 24°12'11.0"N 47°26'17.0"E. The farm housed 48853 ± 1802 lactating Holstein cows (bovine females that had calved at least once) throughout the study in 8 units (6107 cows per unit). The number of milking is 3 to 4 time/cow (at 4 a.m., 12 p.m., and 8 p.m. or at 6 a.m., 12 p.m., 6 p.m., and 12 a.m., respectively) according to the cow productivity and individual milk yield was recorded daily. Cows were housed in sand-bedded free-stall barns, and were fed a total mixed ration consisting of corn silage, grass silage, and concentrates and cows were never grazed. The cooling system in the farm depends on big fans and showers. Breeding management was carried out by artificial insemination of cows observed in estrus with Holstein semen. Cows were not inseminated before 50 days postpartum. For the purpose of the present study, the year was divided into four periods as shown in Table 1.

Causes of culling

The culling of cows occurred through monthly auction that might be takes place once or twice/month. Almost all culled cows were intended for beef slaughter. The average annual herd turnover rate was estimated as the mean number of eliminated cows per year over the 6-year period divided by the mean number of cows present during the 6-year period [1]. The cause of culling was established consensually by two veterinarians, taking into account the veterinary diagnosis and the productive, genetic improvement and milk quality criteria. Data were collected from the herd database that revealed ten causes of culling *viz*., abortions, age (old age, heifer excess number, fence shy, and under size for age), failure to conceive, general health (general health+congenital abnormalities+eye problems+persistent bloat), injury/lame, low milk yield, mastitis, poor Conformation, Reproductive tract abnormalities, and udder conformation.

Statistical analysis

The associations between causes of culling were evaluated using linear mixed effect model with random effect for years, seasons, and months to account for repeated data on animals [20]. The results were presented as means ± SEMs and considered significant at $P<0.05$. Post-hoc pairwise comparisons of estimated marginal means for causes of culling at different years, seasons, and months were applied using Bonferroni adjustment. Statistical analysis was conducted using Stata Statistical Software version 13 (2013) [21].

RESULTS

The total number of cows in the farm ranged from 44015 to 52740 head (Table 2). The average culling rate per year ranged from 16.07% to 23.68% (Table 2). The culling proportions depending on number of lactations appeared in Figure 1. The highest proportion of culling occurred in the first lactation (40%). Culling value 26% registered in the second lactation. Culling proportion was similar in the third and fourth lactation or above with 18%, and 16%, respectively (Figure 1). A description of percentages of cows culled for all reasons during six years showed in Table 3 and Figure 2. The most frequent primary reason for culling was reproduction (failure to conceive and abortions). Failure to conceive (18.24-28.59%), abortions (18.19-22.32%), and general health (9.57-15.76%), udder conformation (11.48-16.31%), and injury/lame (6.51-8.70%) were common reasons for culling across the majority of years. Age (4.15-7.85%), low milk yield (2.65-12.11%), mastitis (2.43-5.89%), poor conformation (2.07-3.68%), and reproductive tract abnormalities (1.64-4.65%) were the least likely reasons for culling during all years (Figure 2). Displayed the percentage of culled cows removed for ten

Table 1. Description of the characteristics of the different periods of the year.

Season	Autumn			Winter			Spring			Summer		
Months	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug
High temp.	46	42	38	30	31	31	40	40	44	49	49	47
Low temp.	23	18	5	4	6	7	10	16	20	25	28	23
Humidity %	44.13	51.88	66.6	67.42	53.32	56	52.71	55.9	47.1	34.03	34.45	47.13
THI	93.39	89.87	79.34	72.84	69.58	72.44	76.77	83.4	91.36	93.77	93.46	93.89

Table 2. Percentages of total eliminations for cows during a period of six years (2014-2019).

Eliminations	2014		2015		2016		2017		2018		2019	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total culling	7099	16.13	7447	16.79	8446	18.17	8654	16.07	12242	23.68	11522	21.85
Total number of cows	44015	100	44343	100	46485	100	53847	100	51689	100	52740	100

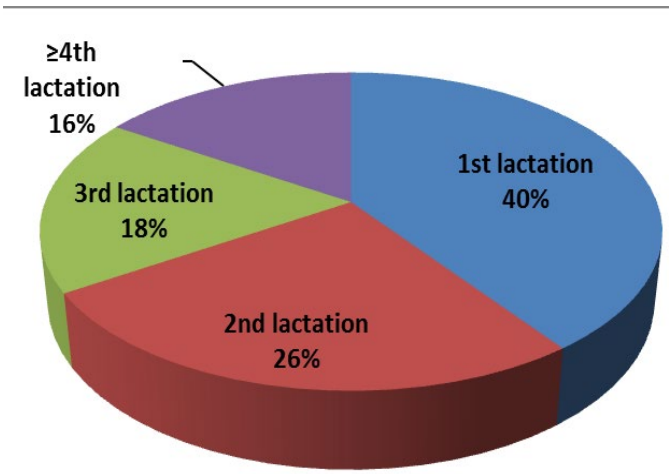

Figure 1: Culling proportions in relation to number of lactations.

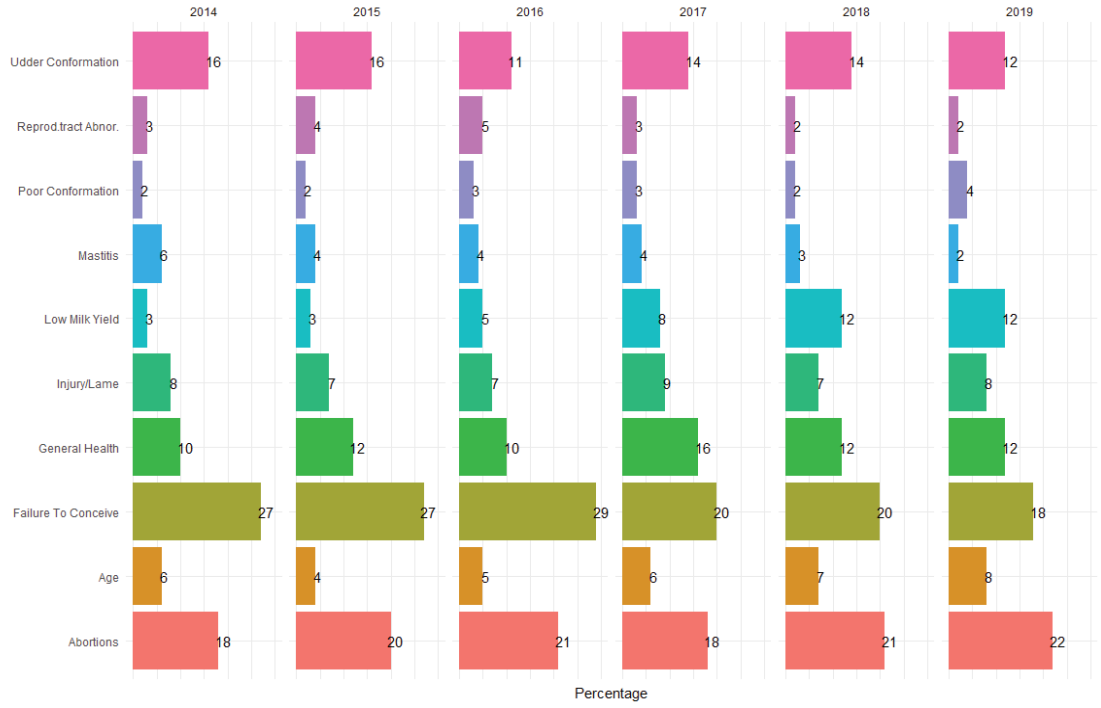

Figure 2: Percentages of culling reasons by years.

reasons by season (Table 4). The most common reasons for culling across all seasons were failure to conceive (22.53-23.25%), abortions (18.23-22.23%), udder conformation (13.35-14.65%), general health (11.24-13.03%), and injury/lame (6.25%–8.81%). The description of culling reasons during the year and season appeared in Figure 3. The common reasons for culling in the four seasons across all years were failure to conceive (17-34%), abortions (13%-25%), udder conformation (10%-18%), general health (8-17%), and injury/lame (4-13%). Displayed percentages of culled cows eliminated for ten reasons by year and month (Table 5). The common reasons for culling across all months were failure to conceive (19.82-25.30%), abortions (16.79-23.77%), udder conformation (11.46-15.92%), general health (9.71-15.84%), injury/lame (5.10-10.48%), and low milk yield (5.20-9.14%). Culling due to abortions was commonly

Table 3. Distribution of causes of culling of cows during a period of six years (2014-2019).

Causes	2014		2015		2016		2017		2018		2019	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Abortions	1305	18.38^{ac}	1515	20.34^{ac}	1765	20.9^{ab}	1574	18.19^{a}	2542	20.77^{a}	2572	22.32^{a}
Age	429	6.04^{bc}	309	4.15^{de}	391	4.63^{b}	535	6.18^{ac}	895	7.31^{ab}	905	7.85^{ab}
Failure to conceive	1940	27.33^{a}	2018	27.10^{bc}	2415	28.59^{a}	1730	19.99^{a}	2499	20.41^{a}	2102	18.24^{a}
General health	723	10.18^{ac}	868	11.66^{acd}	808	9.57^{ab}	1364	15.76^{ad}	1422	11.62^{ab}	1340	11.62^{ab}
Injury/Lame	536	7.55^{ac}	549	7.37^{ad}	631	7.47^{b}	753	8.70^{ac}	797	6.51^{ab}	931	8.08^{ab}
Low milk yield	188	2.65^{b}	202	2.71^{d}	401	4.75^{b}	669	7.73^{ac}	1448	11.83^{ab}	1395	12.11^{ab}
Mastitis	418	5.89^{bc}	309	4.15^{de}	380	4.50^{b}	307	3.55^{bcd}	395	3.23^{bc}	280	2.43^{b}
Poor Conformation	157	2.21^{b}	182	2.44^{d}	292	3.46^{b}	260	3.00^{bc}	254	2.07^{b}	424	3.68^{b}
ReprodTract Abnor	245	3.45^{b}	323	4.34^{de}	393	4.65^{b}	230	2.66^{bc}	271	2.21^{b}	189	1.64^{b}
Udder conformation	1158	16.31^{ac}	1172	15.74^{ace}	970	11.48^{ab}	1232	14.24^{ac}	1719	14.04^{ac}	1384	12.01^{ab}
Total culling	7099	16.13	7447	16.79	8446	18.17	8654	16.07	12242	23.68	11522	21.85
Total number of cows	44015	100	44343	100	46485	100	53847	100	51689	100	52740	100

Note: Percentages with dissimilar superscript in the same column are significantly different at P<0.05-0.01

Table 4. Description of seasonal culling of cows during a period of six years (2014-2019).

Causes	Autumn		Winter		Spring		Summer	
	No.	%	No.	%	No.	%	No.	%
Abortions	2742	21.64^{a}	2630	18.23^{a}	2731	19.43^{a}	3170	22.23^{a}
Age	634	5.00^{b}	980	6.79^{ab}	1095	7.79^{ab}	755	5.29^{b}
Failure to conceive	2856	22.53^{a}	3353	23.25^{a}	3228	22.97^{a}	3267	22.91^{a}
General health	1651	13.03^{ab}	1621	11.24^{ab}	1589	11.31^{ab}	1664	11.67^{ab}
Injury/Lame	1111	8.77^{ab}	1271	8.81^{ab}	924	6.58^{ab}	891	6.25^{ab}
Low milk yield	821	6.48^{ab}	1195	8.29^{ab}	1155	8.22^{ab}	1132	7.94^{ab}
Mastitis	374	2.95^{b}	615	4.26^{b}	592	4.21^{b}	508	3.56^{b}
Poor conformation	390	3.08^{b}	376	2.61^{b}	384	2.73^{b}	419	2.94^{b}
Reprod.Tract Abnor.	384	3.03^{b}	458	3.18^{b}	443	3.15^{b}	366	2.56^{b}
Udder conformation	1710	13.49^{ab}	1925	13.35^{ab}	1911	13.60^{ab}	2089	14.65^{ab}
Total culling	12673	100	14424	100	14052	100	14261	100

Note: Percentages with dissimilar superscript in the same column are significantly different at P<0.05-0.01

Table 5. Percentages of monthly culling of cows during a period of six years (2014-2019).

Causes	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Abortions	17.57^{ab}	16.79^{ab}	17.93^{a}	19.06^{ac}	20.97^{a}	22.38^{ab}	21.73^{a}	22.49^{a}	17.58^{a}	23.77^{a}	21.93^{a}	19.63^{ab}
Age	5.14^{bc}	7.55^{abc}	10.13^{ab}	7.48^{abc}	6.47^{ab}	5.54^{bc}	6.07^{ac}	4.45^{bcd}	5.00^{abc}	4.50^{b}	5.58^{ab}	5.98^{bc}
Failure to conceive	22.04^{a}	21.92^{a}	21.47^{a}	23.45^{c}	23.48^{a}	25.30^{a}	20.22^{a}	22.92^{a}	19.82^{a}	23.91^{a}	22.80^{a}	25.00^{a}
General health	12.03^{abd}	11.99^{abc}	13.62^{ab}	9.80a^{bc}	11.46^{ab}	9.71^{abc}	13.04^{ac}	12.32^{ac}	15.84^{ac}	12.52^{ab}	11.71^{ab}	10.16^{abc}
Injury/Lame	8.08^{abe}	10.48^{abc}	7.97^{ab}	5.1^{ad}	6.26^{ab}	6.20^{bc}	6.1^{aac}	5.70^{ac}	10.47^{abc}	8.09^{ab}	8.39^{ab}	8.39^{abc}
Low milk yield	8.33^{abe}	6.89^{abc}	6.74^{ab}	9.14^{abc}	8.18^{ab}	7.98^{abc}	7.82^{ac}	7.10^{ac}	5.2^{abc}	5.76^{b}	8.16^{ab}	9.10^{abc}
Mastitis	5.16^{bc}	4.55^{bc}	4.09^{b}	4.75^{ad}	3.65^{b}	3.85^{c}	3.78^{bc}	3.13^{bc}	2.67^{b}	2.87^{b}	3.23^{b}	3.38^{cd}
Poor conformation	2.35^{ce}	3.50^{c}	3.11^{b}	2.8b^{d}	2.38^{b}	2.67^{c}	3.54^{bc}	2.70^{bc}	3.82^{c}	2.72^{b}	2.99^{b}	2.27^{c}
Reprod.tract abnor.	3.32^{cde}	3.28^{c}	3.48^{b}	3.04^{bd}	3.05^{b}	2.77^{c}	2.58^{bc}	2.38^{bc}	3.59^{c}	2.91^{b}	2.79^{b}	3.00^{cd}
Udder conformation	13.87^{abd}	13.07^{abc}	11.46^{ab}	14.47^{acd}	14.11^{ab}	13.60^{abc}	14.22^{ac}	15.92^{ad}	16.00^{ac}	12.94^{ab}	12.42^{ab}	13.09^{abd}
Total culling	4764	3627	3474	5786	4792	4727	4233	5301	3037	5153	4483	6033

Note: Percentages with dissimilar superscript in the same column are significantly different at P<0.05-0.01

Figure 3. Percentages of culling reasons by the year and season.

recorded (21.73-23.77%) in June, July, August, and October across all years. Failure to conceive resulted in elimination of cows across all years (22.80-25.30%) in the months April, May, June, August, October, November, and December. Cows were culled because of general health across all year's most commonly (13.04-15.84%) during March, July, and September. Low milk yield resulted commonly in culling of cows all over the study in seven months (7.82-9.14%) named January, April, May, June, July, November, and December. Culling cows eliminated due to mastitis across all years were recorded commonly (4.55-5.16%) during months January, February, and April (Table 5).

DISCUSSION

The present study demonstrated overall culling rates per year ranged from 16.07% to 23.68%. These rates are higher than the culling rates (11.96-15.00%) reported in Sudan, and 13.8% in Spain, and nearly similar to rates (18.3-20.0%) recorded in United States, 13.1-22.1% in Iran, 21.3% in Ireland, and 22.6% in the UK [13,22-28]. However, high culling rates (25-36%) are recorded in United States, and Spain and 26.24% in Estonia [3,6,29-31]. The percentage of turnover rates ranges from 28.2 to 33.5% in Canada, United States, United Kingdom, and Netherlands [32-35]. Moreover, culling rates are 20–35% in Poland, and 29%-35% in Scotland [4,18]. Some studies suggested that profitable culling rates ranged from 25% to 40% [36]. These great variations in culling rates of previous studies might be attributed to the variation in dairy farms culling strategies, reasons of culling, climate and environmental factors, economic factors, and intuition of the culling decision maker. Pure Holstein breed cows are more susceptible to productive and reproductive disorders than crossbred cows, thus being more prone to culling [37,38]. In the present study, the highest proportion of culling occurred in the first lactation (40%). Similar rate (40.4%) has been recorded in the first parity in Spain [3]. Nevertheless, low culling rates in the first lactation are found (15.4%) in United States herds, 18.4% in Iranian dairy herds, 23.0% in Hungary, and 33.0% in United States [24,26,39,40]. In this study, culling value 26% was reported in the second lactation. Similarly, culling rates during the second lactation are reported (24.4%) in United States herds, and 26.6% in Iranian dairy herds [26,39]. However, low value is recorded (22.9%) in Spain, and high percent reported (32.0%) in Hungary for culling in the second lactation [3,40]. In the current study, culling proportion was similar in the third and fourth lactation or after fourth lactation with percentages of 18 and 16%, respectively. Culling trends in the third lactation are 21.7% in Spain, and 25.0% in Hungary [3,40]. In the fourth lactation, the culling rate is 16.2% in Spain like the rate in this study [3]. However, Low culling rates in the fourth lactation are recorded (7.0%) in Scotland, and (12.0%) in Hungary [34,40]. In after fourth parity cows, the culling rate is low 8.0% in Hungary, and high 18.8% in Spain [3,40]. The culling risk is higher in multiparous cows (19.2%) than in primiparous cows (14.0%) [24]. Simultaneously, in Estonia, high culling rates are recorded in older parity [6]. In the present study, the most-frequent primary reason for culling during six years was reproduction (failure to conceive and abortions; 22–29%). Failure

to conceive is the most prevalent cause of culling dairy cows [12,25,41-43]. Parallel to the current study, reproductive disorders constitute the most-frequent culling reason (20.0%) in the United States, 22.0% in Hungary, 24.7% in north-west Spain, 24.8% in Sweden, 28.5% in France, and 30.2% in Spain of total culled cows [3,13,16,40,44]. Nevertheless, the percentages of elimination due to reproductive causes are 17.7% and 9.2% in the United States, and 18.0% in Canada [30,32,45]. In the current study, the common reasons for culling across all the six years were failure to conceive, abortions, general health, udder conformation, and injury/lame. Reproductive disorders, mastitis, low milk production, lameness and mortality are the most common reasons for culling cows [3,18,40,46,47]. On the same direction of this study, the most-frequent culling reason is failure to conceive (infertility) which accounted for 17.7% in Sudan, 15.0-31.0% in Turkey, 22.7% in China, 26.1% in France, 27.4% in Scotland, 20.9-28.4% in Germany and Switzerland, and 32.6% in Iran of total culled cows [5,16,18,23,25,48-50]. However, the culling rate due to infertility was low (12.5%) in Estonian dairy cows [6]. Health problems lead to culling of cows in percentages of 23.9% in China, and more than 50% in a review [49,51]. These values are greater than the rate of culling due to general health (9.57-15.76%) reported in this study. Culling rates due to udder related disorders are 12.3% of total culls in France, and 12.9% in China [16,49]. These culling percentages are within the range of culling due to udder conformation (11.48-16.31%) recorded in the present study. However, udder disorders lead to high culling rates that reported (22.5%) in Estonia, 26.9% in Scotland, and 30.0% in Hungary [6,18,40]. In the present study, culling due to injury/lame was 7-9% of the total culls. Similar value (7.3%) is reported in China [49]. However, the value of the current study is lower than the reported rates (10.4-15.0%) in Germany and Switzerland, 14.3% in the United States, and 26.4% in Estonia, and higher than the recorded culling rates (2.0%) in Sudan, 2.4% in Spain, and 2.7% in France [3,6,16,23,30,49,50]. Injury/lame leads to low milk yield, infertility due to restricted movement required to achieve the normal cows' activities [23]. The present results clearly showed that the least likely reasons for culling during all the six years were age, low milk yield, mastitis, poor conformation, and reproductive tract abnormalities. Age has been reported as a factor increases the risk of culling in dairy farms, As keeping cows too long in a farm might impair the herd's genetic improvement [41,46,51,52]. In Switzerland, high age resulted in 15.5% culling rate [50]. This value is greater than the rate of culling due to age (4.15–7.85%) recorded in this study. However, in Iran, cows are culled due to aging in a percentage of 1.1% [41]. In Sudan, about 79% of farmers are culling their animals on the basis of age and low milk production [52]. In the present study, the culling for low milk yield ranged from 3% to 12%. On the same bases, low milk yield leads to culling rates of 3.7% in New Zealand, 6.2% in Sweden, 6.9%–7.5% in Canada, and 12.1% in the United States [30,42,53,54]. However, low milk production results in high culling rates of 16.6% in France, 23.4% in Spain, and 29%–36% in Turkey [5,16]. Furthermore, low milk yield leads to low culling rates of 0.4% in Iran [41]. These low rates of milk yield are attributed to the fact that the decision makers of culling in cows' farms keep the cow with low milk yield if it is fertile to complete the lactation cycle and then culled to benefit from their calves [23]. The high elimination rate adversely affects the average herd milk production. This is attributed to those replacements produce less milk than the substituted animals in the first few months [15,55]. The high producing herds have a significantly higher culling rate than the low producing herds [44]. High milk producing cows usually suffer from general health problems and reduced fertility and subsequently decreased milk yield and high risk of culling [55-57]. A high milk production increases the risk of culling five times more, of culling cows due to udder problems [18]. In the current study, culling rates for mastitis was (2.43-5.89%). Similarly, culling for mastitis is 6.5% in Iran [25]. On the contrary, high culling rates due to mastitis are registered (8.5%) in Sudan, 11.3-12.5% in Canada, 12.1% in the United States, 13.5-15.6% in Spain, 16.4-18.5% in Germany and Switzerland, 18.0-23.0% in Turkey, and 22.5% in Sweden [3,5,13,23,30,32,42,49,50]. Mastitis was the primary culling reason for 15% of the cows that were culled [25,43,50]. However, mastitis appeared as the third cause of culling in the decision tree [24]. The incidence of mastitis is increased with increasing age and parity of the cow [25,58,59]. In the United States, in high producing Holstein herds, culling is high for reproduction, abortion, injury/lame and diseases, and is low for mastitis and production [44,46,60]. In Swedish dairy farms, impaired fertility and mastitis are accounted for approximately 24% of total culls [61]. In this study, the culling rate due to reproductive tract abnormalities was 1.64-4.65%. Nearly similar rate (6.96%) is recorded in Austria [10]. In the present study, the most common reasons for culling across all seasons were failure to conceive, abortions, udder conformation, general health, and injury/lame. Besides, there was no significant difference in culling rates between seasons for all causes of elimination. On the other hand, studying the causes of culling at different times of the year can help identify seasonal problems in the dairy farm production system [3]. Culling and mortality were high during the hot season [3]. Reproductive disorders as causes of culling increased during September-December. This increase could be explained as these cows suffer from heat stress during the hot season (May-August) and suffered from a negative energy balance before parturition [14,56]. In the current study, the common reasons for culling in the four seasons across all years were failure to conceive, abortions, udder conformation, general health, and injury/lame. There was no clear difference in culling rates for these reasons between seasons across all years. On the other side, season significantly affects the cause for culling cows. More cattle are culled in winter and spring, or during autumn (September-October) [12,46]. Culling is lower for animals which calved in winter and summer compared with spring months [25]. In Spain, culling and mortality are high during the hot season (May-October) that affect reproductive performance of dairy cows [3,62]. Results of the present study showed that the reasons for culling in all months across 6 years were failure to conceive, abortions, general health, low milk yield, and mastitis. Failure to conceive resulted in elimination of cows across all years commonly in the months April, May, June, August, October, November, and December. This result might be explained as culling due to failure to conceive was the most frequent cause of elimination all over the study. Culling due to abortions was commonly recorded in June, July, August, and October across all years. These are the hottest months all over the year in Saudi Arabia that might exert heat stress on dairy cows leading to abortions. Cows were culled for general health across all year's most commonly during March, July, and September. This type of culling for general health might be attributed to increased

incidence of respiratory, digestive and metabolic diseases during these months. Also, age and parity might be prone to culling within the fore mentioned months. Low milk yield resulted commonly in culling of cows all over the study in seven months named January, April, May, June, July, November, and December. The distribution of culling due to low milk yield over seven months might be attributed to the farm policy of eliminating primiparous and plauriparous cows with milk production less than 40 and 45 litres, respectively all over the year. Cull rates by month are bimodal occurring most frequently at the beginning or end of lactation [46,64-66]. Culling cows for mastitis across all years were recorded mainly during January, February, and April.

CONCLUSION

The prevalence of mastitis is higher in wet than in dry season. Furthermore, the high incidence of bacterial mastitis occurs during the cold months. Two conclusions can be extracted from the present study. First, the culling rate in the high milk production dairy farm ranges from 16 to 24%. Second, the common causes for culling cows are abortions, failure to conceive, general health, and udder conformation during all seasons across all years.

CONFLICTS OF INTEREST

The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. The authors confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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