Risk factors affecting the culling of Iranian Holstein dairy cows

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Abstract This experiment was conducted to determine the association between several risk factors which may affect culling of the Iranian Holstein cows. The data consisted of 329,772 lactation records collected by the Animal Breeding Center of Iran (2003 to 2012).The logistic regression was applied to investigate the associations between the response variable, the risk of culling, and predictor variables including the calving season, parity, birth type, calving ease, standardized 305-d milk yield, age at the first calving, region and the number of calving cows in the herd. The risk of culling increased (P< 0.001) with parity and twinning. The odds ratio (OR) of a cow leaving the herd were 1.32, 1.55, 1.62, 1.67 and 1.88 for parities 2 to 6, respectively, and 1.09 for twinning. The OR increased with increasing in calving difficulty score except for the farmer- assisted cows. The OR were 1.12, 1.36 and 1.23 for herds with 26 to 53, 54 to 125 and ≥126 calving cows, and the risk of culling was increased with increases in the number of calving cows in the herd. Calving in hot season increased the risk of culling and cows calved in cool seasons had lower risk of culling. The OR were 0.87, 0.79 and .077 for summer, fall and winter respectively. Cows in the warm and dry and warm and semi-arid regions had a higher (P< 0.001) risk of culling compared with the cows in temperate or cold and wet regions. Risk of culling (P< 0.001) decreased with increases in the standardized 305-d milk yield. Cows that calved first at about 24 months of age had a lower risk of culling; higher ages at first calving increased the risk of culling. The findings showed that the studied risk factors significantly affected the culling rate in Iranian Holstein cows, and can be used as management tools by dairy farmers.

Keywords: risk factors, Holstein cows, culling, Iran

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Introduction

Culling is defined as the departure of cows from the herd because of sale, slaughter, salvage, death, age, and fertility (Fetrow et al., 2006). Culling of dairy cows causes financial losses, including decreased milk production, cow selling price, and extra labor costs (Raboisson et al., 2011), and in most cases a higher cost of replacing the culled cows (Fetrow et al., 2006). Culling rate has been rising recently due to sub-optimal health and inadequate welfare, structural factors and management practices (Smith et al., 2000; Thomsen et al., 2006 and McConnel et al., 2008). Factors that influence culling decisions may include herd, location (state or region), time or cow-related characteristics such as calving season, lactation number, milk production (kg), milk fat (%), milk protein (%) and the breed (Booth et al., 2004). Some studies have discussed risk factors for culling mainly focused on herd characteristics and management style (Shahid et al., 2015). However, very few studies investigated the association between cow attributes and culling risk. Shahid et al. (2015) reported that the risk of culling increased with higher milk fat percent, cows with male calves, cows carrying multiple calves, increased parity, increased calving difficulty score, breed and herd size. They also showed that cows in herds with higher milk yield had lower mortality. Alvasen et al. (2012) and Raboisson et al. (2011) also reported that culling of dairy cows increased with larger herd size and with the proportion of purchased cows but decreased with increasing milk yield. Besides, at the cow level, higher mortality was associated with lower milk yield (Pinedo et al., 2010) and increasing parity (Raboisson et al., 2011). Quantification of the association between risk

factors and culling is useful for making culling decisions and helps motivate efforts to reduce or eliminate the risk factors (de Vries et al., 2010). Therefore, the aim of this study was to investigate the effects of risk factors associated with the culling rate in Iranian Holstein dairy cows.

Materials and methods

Data

Data collected by the Animal Breeding Center of Iran, and including all calving records from March 21st, 2003 to March 20th, 2012 were used. Records with missing parity number, calving and culling date and production data in each year were omitted. Cows with calving intervals lower than 300 and greater than 600 d, and cows with first calving before the age of 20 or after the age of 40 months and with parity more than 12 were excluded. Also, the data of herds with less than 10 milking cows per year were removed from the study.

Outcome and predictor variables

The outcome variable was the risk of culling regardless of reason, and the predictor variables included the calving season [spring (21 March to 21 June), summer (22 June to 22 September), fall (23 September to 21 December) and winter (22 December to 20 March)], birth type (single or twins), calving ease scores: [(1 = normal (not assisted), 2 = moderate assistance (farmer), 3 = moderate assistance (veterinarian called as precaution), 4 = difficult (extraction by farm staff) and 5 = very difficult calving (veterinary assistance)]- because the number of cows with score 5 was low (less than 0.2%), categories 4 and 5 were merged as 4 = very difficult, parity (1, 2, 3, 4, 5 and ≥ 6), three geographic (Unesco, 1979) regions [North and West (temperate or cold and wet, annual rainfall more than 350 mm and mean temperature between -2.5 to 25 °C), Central (warm and semi-arid , annual rainfall from200 to 350 mm and mean temperature from 5 to 32.5 °C), and East and South (Warm and dry, annual rainfall less than 200 mm and mean temperature from7.5 to 35 °C)], age at first calving with 4 categories based on quartiles (≤727 d, 728 to 762 d, 763 to 815 d and ≥816 d), the number of calving cows with 4 categories (≤ 25, 26 to 53, 54 to 125 and ≥126), and the standardized 305-d milk production with categories based on quartiles (≤ 7354, 7354 to 8596, 8596 to 9872, and ≥ 9872 kg).

Statistical analysis

The logistic regression was used to analyze the associations between predictors and response variable. The effect of variables of interest on the odds ratio (OR=P/1-P) and risks of culling was estimated by using the logit-link in GLIMMIX procedure (SAS, 2008).

The GLIMMIX procedure fits statistical models to data with correlations or no constant variability and where the response is not necessarily normally distributed and assume normal (Gaussian) random effects. The logistic regression model used for analysis was:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_2 x_{i7} + \varepsilon_i, \ i = 1, 2, ..., n,$$

where the response variable was risk of culling (y_i), takes on the values either 0 or 1, and the predictor variables were calving season (x_{i1}), twins (x_{i2}), calving ease (x_{i3}), standardized 305-d milk yield (x_{i4}), age at first calving (x_{i5}), region and number of calving cows (x_{i6}), parity (x_{i7}), and ε_i is the error term.

Results and discussion

Descriptive statistics

After editing, 329,772 calving records were available for the years 2003-2012. The number of herds increased from 300 in 2003 to 730 in 2012 and median of calving cows increased from 47 in 2003 to 61 in 2012. Descriptive statistics for the number of calving cows, number and percentage of culled cows, and their distribution are shown in Table 1. The highest percentage of calving cows during different year was found in parity 1, and the highest percent of culling occur in parities 1 and 2. Between seasons, the highest calving occurred in summer and fall, and the highest culling in winter. The percentage, number of culled cows and the ratio of culling are shown in Figures 1 to 3.

Parity

The risk of culling (P< 0.001) increased with parity. The OR of culled cows were 1, 1.32, 1.55, 1.62, 1.67 and 1.88 for parities 1 to 6, respectively (Table 2). These results agrees with de Vries et al. (2010), who reported increases in culling rate with parity; with the risk of culling for culled cows being 1, 1.51, 2.14, 2.68, 3.11, and 3.46 for parities 1 to 6, respectively. Studies showed that higher mortality was associated with increasing parity (Miller et al., 2008; Pinedo et al., 2010; Raboisson et al., 2011). The reason for increased culling rate with parity may be the incidence of certain diseases in older cows (Shahid et al., 2015).

In other studies, culling risks also increased linearly with parity in dairy cattle in the United States (Pinedo et al., 2010), and in Danish herds risk of mortality was hig-

Table 1. Descriptive statistics and distribution of studied variables in Iranian Holstein dairy cattle through the years.

Year		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of herds(n)		300	312	349	425	477	580	648	685	704	730
Number of cows(n)		22148	23081	23730	28870	29653	31078	27695	38019	47549	57949
Cows per region[1] (n)	1	680	1172	1297	1385	704	1006	1674	2159	2543	1753
	2	16476	16754	16504	20690	21586	20193	18730	28399	37191	48879
	3	4992	5155	5929	6795	7363	9879	7291	7461	7815	7317
Calving cows(n)	Q1	22.0	22.0	23.0	24.3	27.00	22.00	21.00	23.25	26.00	31.5
	Median	47.0	48.0	51.0	51.0	55.00	51.00	45.00	51.00	61.00	61.0
	Q3	116.0	131.0	134.8	128.5	137.75	123.00	107.00	112.50	126.00	144.0
Milk 305-d(kg)	Q1	6620.5	6835.1	7046.5	7182.5	7208.3	7280.9	7383.4	7628	7700.8	7942.5
	Median	7726.2	7951.4	8216.1	8374.6	8421.9	8540	8607.4	8808.9	9001.9	9244.7
	Q3	8800.1	9011.8	9359.7	9519.7	9639.5	9820.9	9821.3	10031.4	10306	10615.3
Age at first calving(d)	Q1	744	740	737	735	734	732	726	718	714	712
	Median	778	771	769	768	767	766	761	753	748	744
	Q3	829	820	820	820	821	821	815	806	799	794
Parity%	1	34.78	33.33	34.16	36.39	35.45	35.02	35.37	37.42	37.34	37.76
	2	25.13	26.12	24.71	24.19	26.42	24.64	24.77	24.18	24.81	25.33
	3	17.11	17.48	17.74	16.57	16.34	17.28	17.47	16.7	16.46	16.23
	4	10.2	10.74	10.86	10.59	10.16	10.66	10.57	10.21	10.4	10.08
	5	6.39	5.99	5.89	6.07	5.87	6.29	5.87	5.78	5.66	5.71
	≥6	6.38	6.36	6.64	6.18	5.77	6.11	5.95	5.71	5.32	4.89
Twins%	Singleton	96.54	96.78	96.4	96.62	96.21	92.88	94.95	95.08	96.78	96.62
	Twin	3.46	3.22	3.6	3.38	3.79	7.12	5.05	4.92	3.22	3.38
Dystocia[2]%	1	89.809	88.159	90.013	86.689	86.571	88.551	85.037	86.444	84.216	86.112
	2	5.436	6.248	5.133	6.096	6.815	7.015	11.702	9.766	11.308	10.806
	3	3.599	4.606	4.05	6.058	5.693	3.504	2.82	3.183	4.053	2.702
	4	1.156	0.988	0.805	1.157	0.921	0.93	0.441	0.607	0.423	0.379
Calving season%	Spring	22.45	23.29	20.65	21.98	20.57	25.55	22.55	16.31	15.62	19.33
	Summer	26.75	27.71	26.41	26.85	25.95	28.47	29.41	30.43	27.15	25.53
	Fall	25.84	26.52	26.38	28.09	26.62	24.49	26.53	29.56	30.9	29.05
	Winter	24.95	22.48	26.56	23.08	26.85	21.49	21.51	23.69	26.33	26.08
Culling parity%	1	18.72	21.70	23.94	27.92	29.41	31.30	32.28	31.89	34.10	33.71
	2	24.41	24.45	23.69	23.69	24.95	24.64	24.52	24.42	24.16	25.11
	3	19.67	19.81	19.48	19.25	18.61	17.94	17.60	17.76	17.52	17.20
	4	13.27	13.36	12.90	12.56	12.15	11.80	11.58	11.67	10.86	10.90
	5	7.58	9.40	8.65	7.28	7.40	6.81	7.10	6.65	6.31	6.47
	6	16.35	11.28	11.33	9.31	7.47	7.50	6.93	7.61	7.04	6.60
culling season%	1	22.27	20.36	22.00	21.47	23.9	21.45	21.80	21.32	21.22	20.56
	2	25.36	24.29	24.40	24.93	24.25	25.32	24.61	25.23	24.78	25.49
	3	24.88	27.45	27.39	26.86	25.85	26.49	26.96	26.68	27.22	26.49
	4	227.49	27.90	26.21	26.74	26.81	26.74	26.64	26.77	26.77	27.47
twins culling%	Singleton	94.31	95.81	96.14	96.16	96.16	95.84	94.82	95.04	94.96	95.31
	Twin	5.69	4.19	3.86	3.84	3.84	4.16	5.18	4.96	5.04	4.69
Culling dystocia score %	1	91.23	91.17	89.52	90.42	89.07	87.76	88.21	86.52	86.06	86.55
	2	5.45	4.79	5.34	4.62	5.36	5.74	6.37	8.29	9.15	9.42
	3	2.84	3.00	3.92	4.07	4.53	5.35	4.49	4.25	3.74	3.51
	4	0.47	1.02	1.20	0.87	1.02	1.12	0.92	0.91	1.03	0.49

[1]1=North and West (temperate or cold and wet, annual rainfall more than 350 mm and mean temperature from -2.5 to 25 °C), 2= Central (warm and semi-arid, annual rainfall from 200 to 350 mm and mean temperature from 5 to 32.5 °C), and 3= East and South (Warm and dry, annual rainfall less than 200 mm and mean temperature from 7.5 to 35°C).

[2]1 = normal (non-assisted); 2= moderate assistance (farmer); 3= moderate assistance (veterinarian called); 4= very difficult.

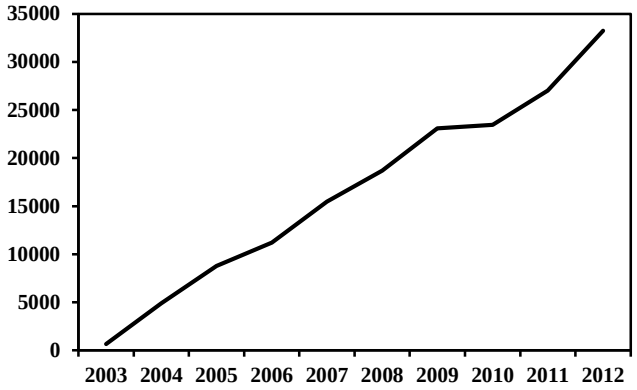

Figure 1. Number of culled Iranian Holstein cows through the years

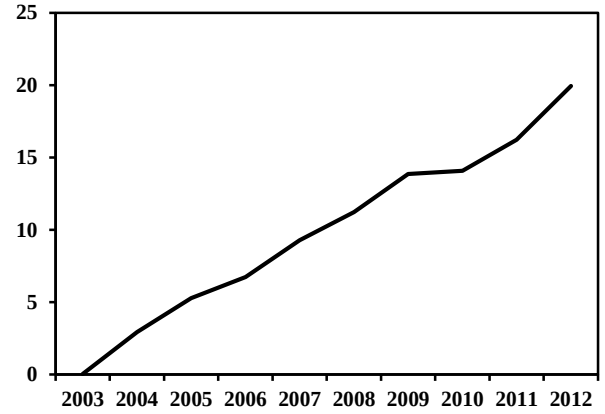

Figure 2. Percentage of culled Iranian Holstein cows through the years

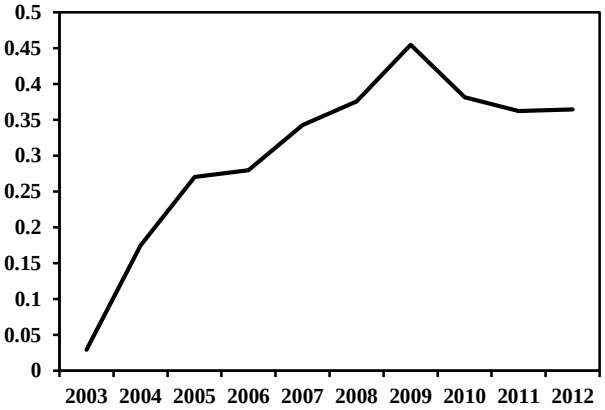

Figure3. Culling ratio of Iranian Holstein cows through the years

her for parity ≥3 compared with cows in the first and second parity (Thomsen et al., 2004; Miller et al., 2008). Thomsen and Houe (2006) showed that the most often reported disposal code in parity 3 and ≥ 4 was death. Also, Thomsen et al. (2004) and Miller et al. (2008) reported that higher parity cows were at a greater risk for live culling and death. Azizzadeh (2011) showed that in Holstein-Friesian dairy cows in Iran, the risk of culling significantly increased with parity and cows in parity ≥5 were at greater risk for culling compared parity 1, 2, 3 or 4. Ansari-Lari et al. (2012) and Mohammadi and Sedighi (2009) also showed that the age was one of the most important factors for culling Iranian Holstein cows, and that culling rate significantly increased in old cows. In contrast, Harris (1989) and White and Nichols (1965) reported that there was no significant difference in mortality or culling among cows at different ages. This occurrence may be due to the differences in management or differences in policy and decisions for culling.

Twin and Dystocia

Twinning and calving difficulty (P< 0.001) increased the risk of culling, with the OR being 1.09 for twinning, and 0.89, 1.22 and 1.49 for dystocia score of 2 to 4, respectively (Table 2). Although with increases in the degree of calving difficulty (categories 3 and 4) the risk of culling increased, unexpectedly, the risk of culling in category 2 (farmer assistance) decreased. McConnel et al. (2008) reported that reproductive problems and dystocia were associated with increased mortality levels. Dystocia can increase the risk of reproductive tract diseases, decrease the dry matter intake after calving, and change the hormonal status, resulting in reduced milk, milk fat and milk protein production (Barrier and Haskell, 2011; Atashi et al., 2012), and therefore, can increase the risk of culling.

Shahid et al. (2015) reported that mortality risk was greater for cows with calving difficulty scores 3, 4 and 5, respectively, compared with cows without calving difficulty. Dematawewa and Berger (1998) showed that cows with calving difficulty score 5 had 4% higher mortality than cows with score 1(calving without assistance), and Bicalho et al. (2007) reported about 20% higher risk of culling with more severe calving difficulty of scores to 3 and 4 compared with scores 1 and 2. The lowest culling risk of cows recorded in category 2 may be due to presence of an assistant at parturition, provision of parturition confinement, better treatment and nutrition and therefore produce more milk compared with the other groups (Eaglen et al., 2011) and error in classification by the farmer.

de Vries et al. (2010) reported that twinning cows had higher calving difficulty scores and were more likely to be culled. Also, Shahid et al. (2015) and Atashi et al. (2012) showed that twinning cows had a higher odds ratio for dystocia, and mortality risk was 7% greater among the cows that had twins than cows with singleton birth. Bicalho et al. (2007) also concluded that

Table 2. Final logistic regression model, odds ratio, 95% confidence interval and P-value for risk factors in Iranian Holstein dairy cattle.

Predictor variable		OR	95% confidence interval	P-value
Births	singleton	1.0	Ref	<0.001
	twins	1.09	1.05-1.13	
Calving ease[1]	1	1.0	Ref	<0.001
	2	0.89	0.87-0.92	
	3	1.22	1.17-1.27	
	4	1.49	1.36-1.62	
Calving season	Spring	1.0	Ref	<0.001
	Summer	0.87	0.85-0.89	
	Fall	0.79	0.77-.8	
	Winter	0.77	.0.75-0.79	
Parity	1	1.0	Ref	<0.001
	2	1.32	1.3-1.35	
	3	1.55	1.51-1.59	
	4	1.62	1.57-1.66	
	5	1.67	1.62-1.73	
	6	1.88	1.82-1.95	
Age at first calving	≤727	1.0	Ref	<0.001
	728 to 762	1.42	1.39-1.46	
	763 to 815	1.46	1.43-1.49	
	≥816	1.46	1.43-1.5	
Calving cows(n)	≤ 25	1.0	Ref	<0.001
	26to53	1.12	1.1-1.15	
	54to125	1.36	1.33-1.39	
	≥126	1.23	1.2-1.26	
Region[2]	1	1.0	Ref	<0.001
	2	1.79	1.71-1.87	
	3	2.64	2.53-1.76	
Milk305-d	≤ 7354	1.0	Ref	<0.001
	7354 to 8596	0.83	0.82-0.85	
	8596 to 9872	0.7	0.69-0.72	
	≥ 9872	0.51	0.5-0.52	

[1] 1=normal (non-assisted); 2 = moderate assistance (farmer); 3 = moderate assistance (veterinarian called); 4 = very difficult.

[2]1=North and West (temperate or cold and wet, annual rainfall more than 350 mm and mean temperature from -2.5 to 25 °C), 2= Central (warm and semi-arid, annual rainfall from 200 to 350 mm and mean temperature from 5 to 32.5 °C), and 3= East and South (Warm and dry, annual rainfall less than 200 mm and mean temperature from 7.5 to 35°C).

cows that calved twins had 42% higher hazard of death or culling than those with singletons. Higher risk of mortality among twinning cows may be due to the problems such as increased dystocia, retained placenta, metritis, displaced abomasum, and ketosis (Bell and Roberts, 2007; Fricke, 2001).

Region

The region had a significant effect (P< 0.001) on culling risk (Table 2), where the cows in category 2 and 3 (warm and dry and semi-arid regions) had a higher risk of culling than cows in category 1 (temperate or cold and wet region). Smith et al. (2000) reported different culling rate according to region in the US and showed that culling percentage for Holstein herds was higher in the Southern regions than the Northern ones. They also reported that herds in the Southern region had a higher percentage of cows leaving the herd (36.3%) than herds in the Southern region (34.5%) (P < 0.05). Alvasen et al.

(2012) studied the regional differences in mortality rate and reported that the length of the legislated pasture season may be the reason of such differences. Incidence of disease, differences in physical environment, nutrition, and management factors and weather condition, other management practices such as feeding a total mixed diet, balance rations (McConnel et al, 2008), different feeds, housing and price of feeds and higher cost for maintenance may be associated with different level of culling in regions in this study.

Season

Our results showed that cows calved in hot seasons (spring and summer) had a higher (P< 0.001) risk of culling than cows calved in cool seasons (fall and winter). The OR for culling in summer, fall and winter were 0.87, 0.79 and 0.77, respectively (Table 2). Calving season played a significant role in contributing to the likelihood of a cow being culled in a study by Hadley et al. (2006). These results are in agreement with the results of Dechow and Goodling (2008) and Alvasen et al. (2012) who reported that the unfavorable effect of season on cow survival was more pronounced during the hottest calving months. Also, Pinedo and de Vries (2010) and Miller et al. (2008) reported that cows calved during spring and summer had a greater risk of death and live culling compared with the cows calving in fall and winter. Diseases can also increase the risk of involuntary culling in dairy cows. Madadzadeh et al. (2013) showed that some diseases like claw lesions occurred with greater frequency during the warm season and therefore could increase the risk of culling. In contrast to our results, Pinedo et al. (2014) reported no clear association between culling and calving season, and Booth et al. (2004) and Hadley et al. (2006) showed that cows calving during summer and autumn had reduced culling risk compared with those calving in winter, and that the culling risk for spring-calving cows was not different from that for winter-calving cows. Climatic differences characterizing the season affect cow health, milk production level, feed availability, milk price, and profitability, and thus can affect the variation in culling risk (Hadley et al., 2006). Seasonal variations in milk production, conception and milk price also can affect culling rate in dairy herds (Delorenzo et al., 1992).

Number of calving cows

The OR of culling increased with increasing number of calving cows (Table 2). These results confirmed the findings of Alvasen et al. (2012) who reported that culling rate increased with herd size and the largest herd size group had a greater culling rate than other herd size groups. Furthermore, Thomsen et al. (2006), McConnel et al. (2008) and Pinedo et al. (2010) concluded that mortality increased with herd size, but Batra et al. (1971) did not find any relation between herd size and culling risk. Raboisson et al. (2011) explained that increased mechanization, less personal attention, and greater levels of physiologic stress could explain the higher culling risk in large compared with small herds. According to Norgaard et al. (1999), average milk production, concentrate consumption and less time available to spend on individual cows could also be involved.

Standardized 305-d milk yield

Significant (P< 0.001) decrease in culling risk was observed with increasing standardized 305-d milk yield (OR 1, 0.83, 0.70 and 0.51 for category 1, 2, 3 and 4, respectively) (Table 2). Pinedo et al. (2010) and Shahid et al. (2015) reported similar association between milk yield and culling rate. They showed that at the cow level, higher culling was associated with lower milk yield. Pinedo et al. (2010) investigated the effects of 305-d milk production on live culling rate and death and reported that annualized culling rate decreased with increasing 305-d milk yield. Sanjabi et al. (2013), Davasazetabrizi (2012) and Mohammadi and Sedighi (2009) showed that an important reason for voluntary culling of Holstein dairy cows in Iran was low milk production. Alvasen et al. (2012) stated that milk yield was associated with the level of management, high average milk yields were achieved with good management, and the farmer who is able to obtain a high milk production probably does many other things right, thereby reducing the risk of culling. Also, Dematawewa and Berger (1998) explained that preferential treatment by the farmer for high-yielding cows made their culling risk lower than those for low-producing cows. Beside these, cows with lower milk production are less profitable, and therefore, the risk of culling of these cows increases.

Age at first calving

Cows with the age at first calving of about 24 months had a lower risk of culling with the risk of culling being increased with increasing age at first calving. Heinrichs (1993) suggested that optimum age at first calving in Holstein cows for achieving maximum profit should be 23 to 24 months. Our results are agreement with Zavadilova and Stipkova (2013) who found that the highest risk ratio of culling occurred for the cows that were older at first calving. The reason for this association may be better productive and reproductive perform-

ance in cows calving at about 24 months of age. Vukasinovic et al. (2001) showed a slight increase in culling risk in cows that calved very early or, especially, very late. Similar to our results, Ducrocq (2005) and M'hamdi et al. (2010) observed an in increase culling risk with increased age at first calving but Ducrocq (1994) or Ojango et al. (2005) did not find any significant effect of age at first calving on culling risk.

Conclusions

The risk of culling Holstein cows in Iran significantly increased with parity, twinning, calving difficulty and decreased with increase in the standardized 305-d milk yield. Also, the number of calving cows, calving in hot season and different regions had a significant effect on culling rate. The association between individual risk factors and culling rate suggested that better farm management and greater farming skill may reduce the risk of culling dairy cows.

References

Alvasen, K., Jansson Mörk, M., Hallén Sandgren, C., Thomsen, P. T., Emanuelson, U., 2012. Herd-level risk factors associated with cow mortality in Swedish dairy herds. *Journal of Dairy Science* 95, 4352–4362.

Ansari-Lari, M., Mohebbi-Fani, M., Rowshan-Ghasrodashti, A., 2012. Causes of culling in dairy cows and its relation to age at culling and interval from calving in Shiraz, Southern Iran. *Veterinary Research Forum* 3, 233 – 237.

Atashi, H., Abdolmohammadi, A., Dadpasand, M., Asaadi, A., 2012. Prevalence, Risk Factors and Consequent Effect of Dystocia in Holstein Dairy Cows in Iran. *Asian-Australasian Journal of Animal Sciences* 4, 447 – 451.

Azizzadeh, M., 2011. Characterisation and pattern of culling in Holstein-Friesian dairy herds in Khorasan Razavi Province, Northeast of Iran. *Veterinary Research Forum* 2, 254 – 258.

Barrier, A. C., Haskell, M. J., 2011. Calving difficulty in dairy cows has a longer effect on saleable milk yield than on estimated milk production. *Journal of Dairy Science* 94, 1804–1812.

Batra, T. E., Burneside, E. B., Freeman. M. G., 1971. Canadian dairy cow disposals: II. Effects of herd size and production level on dairy cow disposal patterns. *Canadian Journal of Animal Science* 21, 85–87.

Bell, M. J., Roberts, D. J., 2007. Effect of twinning on the feed intake, performance and health of dairy cows. *Livestock Science* 107, 274– 281.

Bicalho, R. C., Galvao, K. N., Cheong, S. H., Gilbert, R. O., Warnick, L. D., Guard, C. L., 2007. Effect of stillbirth on dam's survival and reproduction performance in Holstein dairy cows. *Journal of Dairy Science* 90, 2797–2803.

Booth, C. J., Warnick, L. D., Gro ¨hn, Y. T., Maizon, D. O., Guard, C. L., Janssen, D., 2004. Effect of Lameness on Culling in Dairy Cows. *Journal of Dairy Science* 87, 4115–4122.

Davasazetabrizi, A., 2012. Survey of reasons of culling in dairy Holstein herds in Tabriz area of Iran. *Journal of Animal and Veterinary Advances* 11, 4246-4249.

Dechow, C. D., Goodling, R. C., 2008. Mortality, live culling by sixty days in milk, and production profiles in high- and low-survival Pennsylvania herds. *Journal of Dairy Science* 91, 4630–4639.

Delorenzo, M., Spreen, T., Bryan, G., Beede, D., 1992. Optimizing model: Insemination, replacement, seasonal production, and cash flow. *Journal of Dairy Science* 75, 885–895.

Dematawewa, C. M., Berger, P. J., 1998. Genetic and phenotypic parameters for 305-day yield, fertility, and survival in Holsteins. *Journal of Dairy Science* 81, 2700–2709.

de Vries, A., Olson, J. D., Pinedo, P . J., 2010. Reproductive risk factors for culling and productive life in large dairy herds in the eastern United States between 2001 and 2006. *Journal of Dairy Science* 93, 613–623.

Ducrocq V., 2005. An improved model for the French genetic evaluation of dairy bulls on length of productive life of their daughters. *Journal of Animal Science* 80, 249–256.

Eaglen, S. A. E., Coffey, M. P., Woolliams, J. A., Mrode, R., Wall. E., 2011. Phenotypic effects of calving ease on the subsequent fertility and milk production of dam and calf in UK Holstein-Friesian heifers. *Journal of Dairy Science* 94, 5413–5423.

Fetrow, J., Nordlund, K. V., Norman, H. D., 2006. Culling: Nomenclature, definitions, and recommendations. *Journal of Dairy Science* 89, 1896–1905.

Fricke, P. M., 2001. Review: Twinning in dairy cattle. *The Professional Animal Scientist* 17, 61–67.

Hadley, G. L., Wolf, C. A., Harsh, S. B., 2006. Dairy cattle culling patterns, explanations, and implications. *Journal of Dairy Science* 89, 2286– 2296.

Harris, B. L., 1989. New Zealand dairy cow removal reasons and survival rate. *New Zealand Journal of Agricultural Research* 32, 355-358.

Heinrichs, A. J., 1993. Raising dairy replacements to meet the needs of the 21st century. *Journal of Dairy Science* 76, 3179–3187.

Madadzadeh, T., Nouri, M., Nowrouzian, I., 2013. Breed and season effects on the claw lesions of dairy cows in Ardebil, Iran. *Research Journal of Animal Sciences* 7, 18 - 22.

McConnel, C. S., Lombard, J. E., Wagner, B. A., Garry, F. B., 2008. Evaluation of factors associated with increased dairy cow mortality on United States dairy operations. *Journal of Dairy Science* 91, 1423–1432.

M'hamdi, N., Aloulou, R., Brar, S.K., Bouallegue, M., Ben Hamouda, M., 2010. Study on functional longevity of Tunisian Holstein dairy cattle using a Weibull proportional hazards model. *Livestock Science* 132, 173 –176.

Miller, R. H., Kuhn, M. T., Norman, H. D., Wright, J. R., 2008. Death losses for lactating dairy cows in herds enrolled in dairy herd improvement test plans. *Journal of Dairy Science* 91, 3710–3715.

Mohammadi, G. R., Sedighi, A., 2009. Reasons for culling of Holstein dairy cows in Neishaboor area in northeastern Iran. *Iranian Journal of Veterinary Research* 10, 278 -282.

Norgaard, N. H., Lind, K. M., Agger, J. F., 1999. Cointegration analysis used in a study of dairy-cow mortality. *Preventive Veterinary Medicine* 42, 99–119.

Ojango J. M. K., Ducrocq V., Pollott, G. E., 2005. Survival analysis of factors affecting culling early in the productive life of Holstein-Friesian cattle in Kenya. *Livestock Production Science* 92, 317–322.

Pinedo, P. J., de Vries, A., 2010. Effect of days to conception in the previous lactation on the risk of death and live culling around calving. *Journal of Dairy Science* 93, 968–977.

Pinedo, P. J., de Vries, A., Webb, D. W., 2010. Dynamics of culling risk with disposal codes reported by Dairy Herd Improvement dairy herds. *Journal of Dairy Science* 93, 2250–2261.

Pinedo, P. J., Daniels, A., Shumaker, J., de Vries, A., 2014. Dynamics of culling for Jersey, Holstein, and Jersey × Holstein crossbred cows in large multibreed dairy herds. Journal of Dairy Science 97, 2886–2895.

Raboisson, D., Cahuzac, E., Sans, P., Allaire, G., 2011. Herd-level and contextual factors influencing dairy cow mortality in France in 2005 and 2006. *Journal of Dairy Science* 94, 1790–1803.

Sanjabi, M. R., Rouzban Javanmardi, J., Zandi, M., Khamoushi, S., Rani, K., 2013. Breeding management amongst Holstein farms: A case study. *International Research Journal of Applied and Basic Sciences* 4, 3781-3784.

SAS, 2008. SAS User's Guide: Statistics. Version 9.2. SAS Institute Inc. Cary, North Carolina.

Shahid, M. Q., Reneau, J. K., Chester-Jones, H., Chebel, R. C., Endres, M. I., 2015. Cow- and herd-level risk factors for on-farm mortality in Midwest US dairy herds. *Journal of Dairy Science* 98, 4401- 4413.

Smith, J. W., Ely, L. O., Chapa, A. M., 2000. Effect of region, herd size, and milk production on reasons cows leave the herd. *Journal of Dairy Science* 83, 2980–2987.

Thomsen, P. T., Houe, H., 2006. Dairy cow mortality: A review. *Veterinary Quarterly* 28, 122–129.

Thomsen, P. T., Kjeldsen, A. M., Sorensen, J. T., Houe, H., 2004. Mortality (including euthanasia) among Danish dairy cows (1990– 2001). *Preventive Veterinary Medicine* 62, 19–33.

Thomsen, P. T., Kjeldsen, A. M., Sorensen, J. T., Houe, H., Ersboll, A. K., 2006. Herd- level risk factors for the mortality of cows in Danish dairy herds. *Veterinary Record* 158, 622–626.

Unesco, 1979. Map of the world distribution of arid regions. Map at scale 1:25,000,000 with explanatory note. The United Nations educational, scientific and cultural organization, Paris, 54 pp. ISBN 92-3-101484-6.

Vukasinovic, N., Moll J., Casanova L., 2001. Implementation of a routine genetic evaluation for longevity based on survival analysis techniques in dairy cattle populations in Switzerland. *Journal of Dairy Science* 84, 2073–2080.

White, J.M., Nichols, J.R., 1965. Reasons for disposal of Pennsylvania Holstein cattle. *Journal of Dairy Science* 48, 512-514.

Zavadilová, L., Stipkova, M., 2013. Effect of age at first calving on longevity and fertility traits for Holstein cattle. *Czech Journal of Animal Science* 58, 47–57.

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تاثیر مولفه های خطرزا (Risk factors) بر حذف گاوهای هولشتن ایران

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چکیده این پژوهش برای بررسی ارتباط بین مولفه های انفرادی و محیطی خطرزا با حذف گاوهای شیری هولشتن در ایران انجام شد. داده‌ها در برگیرنده ۳۲۹۷۷۲ رکورد زایش و شیردهی بین سال‌های ۸۲ تا ۹۱ در مرکز اصلاح نژاد بود. روش رگرسیون لجستیک برای واکاوی داده ها به کاربرده شد. متغیر پاسخ، حذف گاوهای شیری، و متغیرهای مستقل: فصل زایش، شکم زایش، دوقلو یا تک قلو زایی، سخت زایی، شیر تولیدی در ۳۰۵ روز، سن در نخستین زایش، منطقه و شمار گاوهای زایش کرده در گله بودند. واکاوی داده ها نشان داد که نسبت شانس حذف با افزایش شمار زایش‌های هر گاو و دوقلوزایی ($P< 0.001$) افزایش یافت. هم‌چنین، به جز گاوهایی که درجه سخت زایی ۲ (زایش با کمک دامدار) داشتند با افزایش درجه سخت زایی احتمال حذف هم ($P< 0.001$) افزایش پیدا کرد. نسبت شانس حذف برای گله‌هایی که شمار گاو زاییده درآن‌ها ۲۶ تا ۵۳ راس، ۵۴ تا ۱۲۵ و بیشتر از ۱۲۵ بود به ترتیب، برابر ۱/۱۲، ۱/۳۶ و ۱/۲۳ به‌دست آمد. زایش در فصل گرم هم شانس حذف را ($P< 0.001$) افزایش داد ولی گاوهای زاییده در فصل سرد احتمال حذف کمتری داشتند. نسبت شانس حذف در تابستان، پاییز و زمستان به ترتیب ۰/۸۷، ۰/۷۹ و ۰/۷۷ بود. پرورش گاو در منطقه‌های گرم خشک و نیمه خشک شانس حذف را افزایش داد. نسبت شانس حذف برای گاوهایی که تولید شیر بالاتری داشتند ($P< 0.001$) کمتر بود، و گاوهایی که نخستین گوساله‌زایی آن‌ها حدود ۲۴ ماهگی بود نیز کمترین شانس حذف را داشتند. به طور کلی نتایج نشان داد که مولفه های انفرادی و محیطی خطرزا حذف را تحت تاثیر قرار می دهند و با مدیریت آن‌ها می توان حذف گاوهای شیری را کنترل کرد.