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Short Paper

Milk yield depression and its economic loss due to production diseases: Iran's large dairy herds

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Abstract

Background: Incidences of production and metabolic diseases in dairy cows have increased over the last few decades because of the increasing trends in milk production. Production diseases cause different and distinct depressions in milk production that lead to different and major economic losses in large dairy herds. **Aims:** The objective of this study was to determine milk production depression and its economic losses due to different production diseases in selected large dairy herds of Iran. **Methods:** Production and health data from 17 large dairy herds with a total of 146464 observations across three parities were obtained. Milk yield depressions were estimated for three phases of lactation including 1) 5-60, 2) 61-120, and 3) 121-180 days in milk. Data were analyzed using Mixed Models of SAS program (v. 9.3) with fixed effects of the diseases, calving year, calving month, parity, and herd with cow age at calving as covariates. **Results:** The data demonstrated significant effects of different production diseases on milk production depression during 5-60, 61-120, and 121-180 days in milk ($P<0.05$). During 5-60 days in milk, ketosis, displaced abomasums (DAs), laminitis, mastitis, metritis, retained placenta (RP), and dystocia resulted in, respectively, 253, 682, 39, 38, 110, 215, and 55 kg of milk yield depressions that were equivalent to 38.5, 103.7, 6.0, 5.8, 16.7, 32.6, and 8.4 U.S. Dollars (USD) economic losses. Milk yield depressions due to laminitis and mastitis over the 180 days in milk were, respectively, 207 and 404 kg equivalent to 31.5 and 63.0 USD economic losses. Since the milk yield depression constitutes about 20-35% of total costs of production and metabolic disorders, the total economic losses would be 3-5 times the above values. **Conclusion:** Displaced abomasum and laminitis caused the highest and lowest depressions in milk yield, respectively. The findings suggest that commercial dairy production management strategies in Iran require reassessment and refinement. Overfeeding of concentrates should be ceased. Future economic and reproductive studies are needed to enable developing effective strategies for optimizing modern and postmodern dairy production in Iran.

Key words: Dairy herd, Economic loss, Milk yield depression, Production disease

Introduction

The incidence of production diseases in dairy cows has increased over the last few decades mainly because of the increasing trends in milk production (Raboisson *et al*., 2015; Chegini *et al*., 2016). The efforts to maintain reproduction efficiency with increased milk yield have made dairy farming more challenging than before. In addition, different production disorders are highly interrelated. Hypocalcemia, for instance, may cause dystocia that could consequently lead to retained placenta (RP) and metritis (Mostert *et al*., 2018; Rezagholivand *et al*., 2018a, b). Hypocalcemia and milk fever impose major economic losses to modern dairy farming (Thirunavukkarasu *et al*., 2010; Seifi and Kia, 2018). These disorders alongside laminitis and mastitis can cause subclinical and clinical ketosis. In a recent study in the Netherlands (Mostert *et al*., 2018), the annual economic loss of each case of subclinical ketosis was estimated at 130 Euro with milk yield depression constituting 25% of the total losses. In another study in Canada (Gohary *et al*., 2016), 22% of total economic losses of subclinical ketosis was because of milk production depression, with the remaining losses being due to decreased fertility and increased culling, and other metabolic diseases. According to another study in India (Senthilkumar *et al*., 2013, 2015), approximately 30% of ketosis economic loss was because of milk yield depression in dairy cows (1481 Rupee) and buffalos (1456 Rupee). In other studies (VanLaarhoven, 2012; Klein Hanevel, 2013), direct costs of rumen acidosis and clinical ketosis per cow were 210 and 848 Euro, respectively. In a recent review (Ózsvári, 2017), the economic losses of each case of laminitis were estimated at 262 Euro in the UK, 127 Euro in the Netherlands, and 320 Euro in Hungary. In light of the essentiality for gaining profound economic insights into the biology of production and metabolic diseases, the impetus for the present study was the scarcity of scientific information on economic losses of major production diseases in large dairy herds of Iran. Production diseases cause different and distinct major economic losses due to milk yield depression. The objective of this study was to determine milk production depression due to different production diseases (mastitis, laminitis, RP, metritis, and displaced abomasums (DAs)) and estimate the resulting economic loss in selected large dairy herds of Iran.

Materials and Methods

Milk production and health data from 17 large dairy herds (Ferdows Pars Holding Co., Iran) were obtained and studied that included a total of 146464 observations (Table 1) across 3 parities of lactating Holstein dairy cows. The dairy farms had similar routines and policies in terms of nutrition, health protocols, and genetic programs. The incidences of different production diseases [mastitis, laminitis, RP, metritis, and DAs] in these herds were recorded (Table 1). Milk yield depressions, due to the above-mentioned production diseases, were estimated for 5-60 days in milk. Milk yield depressions due to mastitis and laminitis were estimated for 5-180 days in milk in three different stages (5-60, 61-120, and 121-180 days in milk). The entire depression was then estimated. The economic losses due to different production diseases were calculated by multiplying milk production depression (kg) by milk price at the time of the study (35000 Rials/kg or 0.15 U.S. Dollars (USD)/kg). Milk production data were analyzed using Mixed Models of SAS program (v. 9.3) with fixed effects of the diseases, calving year (14 levels), calving month (12 levels), herd (17 levels), and parity (3 levels). Cow age at calving was modeled as the covariate. Significant disease effects were declared at $P<0.05$. Trends for significance were declared at $0.05 \leq P<0.10$.

Results

The frequency of mastitis, laminitis, and RP increased as parity progressed ($P<0.05$; Table 1). However, the frequency of metritis and DAs was higher in cows with parity 1 compared to older cows (Table 1). Production diseases caused significant depressions in daily milk protein yield in all three periods of lactation ($P<0.05$) (Tables 2-4). Milk fat yield response to production diseases incidence was also significant ($P<0.05$). Results demonstrated significant effects ($P<0.05$) of different production diseases on the production of milk, milk fat, and milk protein during 5-60, 61-120, and 121-180 days in milk (Tables 2-4).

Discussion

The present study provides new applied information, in Iran, on milk production depressions associated with various production diseases during three distinct phases of lactation using a remarkably large sample size. These data show strong parity effects on the incidence of different production diseases. The greatest milk yield depression during 5-60 days in milk was due to DAs (12.4 kg milk/day or 685 kg/period) and the lowest depression in milk yield was for both laminitis and mastitis (0.7 kg/day or 39 kg/period). As a result of the depressed milk yield, economic losses were estimated at 103.7, 38.5, 32.7, 16.7, and 8.4 USD for DAs, ketosis, RP, metritis, and dystocia, respectively.

The milk production depression due to laminitis was 1.4 kg/day and 84 kg during 61-120 days in milk

Table 1: The frequency of major production diseases (%) in the dairy herds

Item	Parity 1	Parity 2	Parity 3	SEM	P-value
Number of dairy cows	65478	49084	31902		
Mastitis	8.6^c	13.2^b	16.1^a	0.002	<0.0001
Laminitis	6.3^b	6.7^b	8.1^a	0.001	<0.0001
Retained placenta	5.6^c	6.3^b	8.8^a	0.001	<0.0001
Metritis	17.9^a	7.9^b	7.6^b	0.002	<0.0001
Displaced abomasum	4.6^a	1.9^c	2.4^b	0.001	<0.0001

a, b, c Values with different superscript letters in each column are significantly different at P<0.05. SEM: Standard error of mean

Table 2: Depressions in yields of milk, milk fat, and milk protein due to production diseases during 5-60 days in milk

Item	Ket	MF	RP	Dys	Met	Mas	Lam	DAs
Healthy cow milk yield (kg/day)	36.8^a	36.9^a	37.0^a	37.4^a	36.9^a	36.8^a	36.8^a	37.0^a
Affected cow milk yield (kg/day)	32.2^b	32.3^b	33.1^b	36.4^b	34.9^b	36.1^b	36.1^b	24.6^b
SEM	0.38	0.22	0.13	0.21	0.12	0.13	0.14	0.23
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Healthy cow milk fat yield (kg/day)	1.54	1.54	1.55^a	1.56	2.29	1.50^a	1.57	2.35
Affected cow milk fat yield (kg/day)	1.48	1.43	1.36^b	1.52	2.48	1.95^b	1.52	2.09
SEM	0.04	0.05	0.03	0.04	0.03	0.03	0.03	0.15
P-value	0.49	0.40	<0.0001	0.0002	<0.0001	0.016	0.091	<0.0001
Healthy cow milk protein yield (kg/day)	1.18^a	1.18^a	1.18^a	1.19^a	1.18^a	1.18^a	1.18^a	1.71^a
Affected cow milk protein yield (kg/day)	1.06^b	1.06^b	1.09^b	1.17^b	1.13^b	1.15^b	1.16^b	1.51^b
SEM	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.006	<0.0001

Ket: Ketosis, MF: Milk fever, RP: Retained placenta, Dys: Dystocia, Met: Metritis, Mas: Mastitis, Lam: Laminitis, DAs: Displaced abomasums, and SEM: Standard error of mean. a, b Different superscripts between healthy and affected cows for yields of milk, milk fat, and protein for each production disease differ at P<0.05.

Table 3: Depressions in yields of milk, milk fat, and milk protein due to laminitis and mastitis during 61-120 days in milk

Item	Mastitis	Laminitis
Healthy cow milk yield (kg/day)	38.9[a]	38.7[a]
Affected cow milk yield (kg/day)	36.6[b]	37.3[b]
SEM	0.11	0.13
P-value	<0.0001	<0.0001
Healthy cow milk fat yield (kg/day)	1.36[a]	1.37[a]
Affected cow milk fat yield (kg/day)	1.29[b]	1.32[b]
SEM	0.02	0.02
P-value	<0.0001	0.0003
Healthy cow milk protein yield (kg/day)	1.21[a]	1.21[a]
Affected cow milk protein yield (kg/day)	1.15[b]	1.17[b]
SEM	0.01	0.02
P-value	<0.0001	<0.0001

[a, b] Different superscripts letters between healthy and affected cows for yields of milk, milk fat, and protein for each production disease differ at P<0.05. SEM: Standard error of mean

Table 4: Depressions in yields of milk, milk fat, and milk protein due to laminitis and mastitis during 121-180 days in milk

Item	Mastitis	Laminitis
Healthy cow milk yield (kg/day)	36.5[a]	36.3[a]
Affected cow milk yield (kg/day)	33.9[b]	34.9[b]
SEM	0.11	0.13
P-value	<0.0001	<0.0001
Healthy cow milk fat yield (kg/day)	1.31[a]	1.32
Affected cow milk fat yield (kg/day)	1.23[b]	1.26
SEM	0.02	0.02
P-value	<0.0001	0.0002
Healthy cow milk protein yield (kg/day)	1.15[a]	1.15[a]
Affected cow milk protein yield (kg/day)	1.09[b]	1.11[b]
SEM	0.01	0.01
P-value	<0.0001	<0.0001

[a, b] Different superscripts letters between healthy and affected cows for yields of milk and milk fat and protein for each production disease differ at P<0.05. SEM: Standard error of mean

(Table 3). Consequently, the economic loss for each case of laminitis was estimated at 12.8 USD during 61-120 days in milk. During the same period, the milk yield depression due to mastitis was 2.3 kg/day or 138 kg/period, being equivalent to 21 USD economic losses. During 121-180 days in milk, the milk production depressions due to laminitis and mastitis were 1.4 kg/day (84 kg/period) and 2.6 kg/day (156 kg/period), respectively. As a result, their respective economic losses were estimated at 12.8 and 23.7 USD. During the entire study period (5-180 days in milk), the milk yield depression (economic loss) was 414 kg (63.0 USD) for mastitis and 207 kg (31.5 USD) for laminitis.

During 5-60 days in milk, the greatest milk protein yield depression was due to DAs (200 g/day or 11 kg/period) and the lowest depression was due to laminitis and dystocia (20 g/day or 1.1 kg/period, respectively) (Table 2). During 61-120 days in milk, milk protein yield depressions due to laminitis and mastitis were 40 g/day (2.4 kg/period) and 60 g/day (3.6 kg/period), respectively (Table 3).

During 5-60 days in milk, RP led to a significant depression in milk fat yield (190 g/day or 10.5 kg/period), whereas mastitis increased milk fat yield by 450 g/day or 24 kg/period. During 5-60 days in milk, DAs, laminitis, dystocia, milk fever, and ketosis did not affect (P>0.10) milk fat yield (Table 2). During 61-120 days in milk, laminitis (50 g/day or 3 kg/period) and mastitis (70 g/day or 4.2 kg/period) led to significant depressions in milk fat yield (Table 3). During 121-180 days in milk, mastitis significantly depressed milk fat yield (80 g/day or 4.8 kg/period), whereas laminitis did not affect it (Table 4). The negative impact of mastitis on milk production has been previously reported (Banga *et al*., 2014). The findings of the current study are in agreement with the global philosophy of milk production depression in dairy cows affected by production diseases (Mostert *et al*., 2018). Studying 4 dairy herds in Isfahan, Mahnani *et al*. (2015) estimated the economic loss of each case of metritis at 165 USD. Forty percent of this loss was due to reduced fertility and 12% was due to depressed milk yield. These authors reported that the milk yield depression over the 305-day lactation period was about 130 kg. Investigating Khorasan's dairy herds, Mohammadi and Sedighi (2009) concluded that 35% of culling was due to suppressed fertility and 30% of it was due to rumen and digestive disorders, mastitis, and laminitis. In a provincial study (Ansari-Lari *et al*., 2012), about 20% of culling was due to laminitis, DAs, mastitis, and metabolic disorders of the transition period, while 32% was due to depressed fertility. Analyzing the data from 16 commercial herds in Iran (Ghavi-Hossein-Zadeh, 2014), depressions in yields of milk and milk fat due to severe dystocia were 749 and 40 kg/305 days of lactation, respectively. In a case of cesarean, depressions in yields of milk and milk fat were 942 and 125 kg, respectively (Ghavi Hossein-Zadeh, 2014).

Results of the current study revealed that during 5-60 days in milk, milk yield depressions due to each case of ketosis, DAs, laminitis, mastitis, metritis, RP, and dystocia were 253, 682, 39, 110, 38, 215, and 55 kg per cow, respectively, equivalent to 38.5, 103.7, 6.0, 5.8, 16.7, 32.7, and 8.4 USD economic losses per cow. Milk yield depressions due to laminitis and mastitis over the entire study period (5-180 days in milk) were 207 and 414 kg per cow, equal to 31.5 and 62.7 USD economic losses per cow, respectively. Since milk yield depression constitutes about 20-35% of total economic losses of production diseases, the total cost would be 3-5 times the above losses.

Analysis of the data from large commercial dairy herds in Iran during early and mid lactation revealed that production diseases including DAs, laminitis, mastitis, ketosis, metritis, milk fever, dystocia, and RP lead to significant depressions in milk production. Displaced abomasum and laminitis caused the highest and the lowest depressions in milk yield, respectively. Parity strongly affected production disease frequencies. Overall, modifications are needed in nutrition, reproduction, genetics, and health programs for more profitable and environmentally sustainable dairy production. Future studies on reproductive depressions are warranted to enable science-founded decisions for refining dairy management strategies in Iran and worldwide.

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Conflict of interest

The authors declare that they have no conflict of interest.

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