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RESEARCH ARTICLE

Economic Losses Associated with Fertility in Dairy Farms

İbrahim GÜLTEKİN[1], Mustafa TEKERLİ[2*]

[1]Afyon Kocatepe University, Faculty of Veterinary Medicine, 03200, Afyonkarahisar, Turkey
[2]Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Animal Science, 03200, Afyonkarahisar, Turkey

ABSTRACT

This investigation aimed to determine the effects of some environmental factors on fertility traits and economic losses caused by deviations from the ideal levels of these parameters.
The records of 126 Holstein and Simmental first-calf heifers from three dairy cattle enterprises in Afyonkarahisar during the period 2010 – 2016 were examined. The technique ANOVA were used to detect the effects of different environmental factors and fertility related economic losses were calculated.
The ages at first calving and services per conceptions were determined as 872.6 - 949.2 and 1.74 - 1.47 days in Holsteins and Simmentals. The effect of the year on services per conception was significant ($p<0.05$). Calving intervals were found to be 430.7 to 404.6 days, respectively. The average economic losses of farms caused by deviations from the ideal levels in age at first calving and first calving interval calculated in terms of calf losses (head) were in the ranges of 15.56 – 24.55 and 3.41 – 8.73 heads. These facts suggested that the deviations from the ideal levels in these traits could be unnoticed or ignored by the enterprise managers and reach to economically remarkable levels. The need for every farm operation must conduct its own economic analysis was unveiled consequently.

Keywords: Environmental factors, Economic losses, Fertility, Holstein, Simmental.

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Süt Sığırı İşletmelerinde Döl Verimi ile İlişkili Ekonomik Kayıplar

ÖZ

Döl verimi, süt işletmelerinin karlılığının önemli bir göstergesidir. Bu araştırma, bazı çevresel faktörlerin döl verimi özellikleri üzerindeki etkilerini ve bu parametrelerin ideal düzeylerinden sapmaların neden olduğu ekonomik kayıpları belirlemek amacıyla yapılmıştır.
2010- 2016 yılları arasında Afyonkarahisar ilindeki üç süt sığırcılığı işletmesinde yetiştirilen 126 Holştayn ve Simental ırkı ilkine buzağılayan düvenin kayıtları incelenmiştir. Farklı çevresel faktörlerin etkilerini tespit etmek için ANOVA tekniği kullanılmış ve döl verimine bağlı ekonomik kayıplar hesaplanmıştır.
İlk buzağılama yaşı Holştayn ve Simental ırklarında 872,2 ile 949,2 gün olarak belirlenmiştir. En küçük kareler ortalamaları, Holştayn ve Simental gebelik başına tohumlama sayısının 1.74 ve 1.47 olduğunu göstermiştir. Varyans analizleri, bu özellikteki etkisinin anlamlı olduğunu ortaya koymuştur ($p <0.05$). Holştayn ve Simental buzağılama aralıkları 430,7 ile 404,6 gün arasında bulunmuştur. Çevresel faktörlerin buzağılama aralığı üzerindeki etkisi önemsiz olmuştur. İlk buzağılama yaşı ve ilk buzağılama aralığındaki ideal düzeylerden sapmaların sebep olduğu ortalama ekonomik kayıpların bireysel buzağı kaybı (baş) cinsinden karşılıklarının 15.56- 24.55 ve 3.41- 8.73 baş aralığında olduğu saptanmıştır. Bu sonuçlar, ideal seviyelerden sapmaların işletme yöneticileri tarafından fark edilmeyebileceğini veya göz ardı edilebileceğini ve ekonomik olarak dikkat çekici seviyelere ulaşabileceğini göstermiştir. Her çiftliğin kendi ekonomik analizini yapması gerektiği ortaya çıkmıştır.

Anahtar Kelimeler: Çevresel faktörler, Döl verimi, Ekonomik kayıplar, Holştayn, Simental.

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ORCID ID; *İG: 0000-0003-4039-3550, MT: 0000-0002-8634-1193*

*Corresponding author e-mail: tekerli@aku.edu.tr

INTRODUCTION

While the improvement of the genetic structure occurs in a long time, the environmental readjustments show its effects in a short time. Different researchers (Akbulut, et al. 1992, Ray et al. 1992, Silva et al. 1992, Çilek and Tekin 2005, Wathes et al. 2020) reported that the feeding and management in herd, calving year and season, age, diseases, and hygiene were important for production and reproduction. Regular business management, pedigree and yield recording are obligatory to achieve the target. Recording of various milk and fertility parameters and their deviations from the economic values are also important for an optimal animal breeding. The inadequate assessment of the potential and the losses caused by various reasons particularly effects on Holstein breeders in semi-arid regions of Turkey. Some problems such as low milk yield, low fertility and mastitis that can be solved managerial adjustments are result in culling of cows from the herds in their early lives. Cows can remain in the herd for a longer period by improving the environment. This also increases profitability (Mundan and Karabulut 2008).

Dairy cattle breeding should be done technically. Otherwise, small mistakes can turn into major harms. Ideally, cows must give birth a calf once a year, to be lactated for 10 months, stay in a dry period for 60 days before birth and be inseminated within an appropriate service period to provide an economical production. Cows must be pregnant at the 85th inspection after birth (Tahtabiçen 2008). Age at first calving, services per conception and calving interval were found in the ranges of 26 - 41 moths, 1.47 – 1.69 services, 12.43 – 17.30 months by some researchers (Kumuk et al. 1999, Çilek and Tekin 2005, Kaygisiz and Elmaz 2008, Bayrıl and Yılmaz 2010) for Holsteins.

Increasing the number of cows in a herd is not a solution for a successful business. An unsuccessful management and poor quality of work force prohibit the growth and profitability of the operation. In this connection, Holstein cows can be inseminated for the first time when they reach about 340 kg weight and 14 - 16 months of age. The first calving should be in 23 - 25 months. Otherwise, financial losses will be inevitable. Ata (2013) reported that a one-day delay in the age at first calving and the calving intervals exceeding 365 days corresponded to ₺2.4 and ₺1.6 daily losses. Small cost increases may result in some unprecedented economic losses (Ali et al. 2013, Yılmaz et al. 2018, Ayvazoğlu et al. 2019).

Determination of the effects of some environmental factors on fertility traits and economic losses caused by deviations from the ideal levels of these parameters were targeted in this research.

MATERIALS and METHOD

Regular reproductive performance data of 126 Holsteins and Simmental first-calf heifers registered to Afyonkarahisar Provincial cattle breeders' Association were used in the study. The farm operations under study coded as A, B and C. Animals scattered as 58 and 27 Holsteins in farm A and B and 41 Simmentals in Farm C. The commercial feeding and management rules were generally applied in the enterprises. A total of 207 artificial insemination records taken from 2010 to 2016 were processed in the analyses. The age at first calving (AFC), calving interval (CI) and services per conception (SPC) were used as fertility traits. The target values of these criteria were accepted as 730 days for AFC, 365 days for CI and 1 for SPC, respectively according to the report of Uygur (2004). The observed values in respect of related criteria were determined for each cow, and then the differences between the actual and the target values were calculated.

In determination of the lost monetary amount, the cost of deviations from the ideals were calculated in line with the reports of Kumuk et al. (1999) and the losses were determined in terms of calf count for AFC and CI and number of services for SPC.

The approximate calf costs and artificial insemination prices (₺3,960 or $741.43) per calf and, (₺75 or $14.04) per service were calculated according to Afyonkarahisar Commodity Exchange daily stock bulletin dated January.01.2019. and the real market research. The effects of different environmental factors on reproductive traits were analyzed by the following statistical models:

$Y_{ijklm} = \mu + G_i + YS_j + SS_k + AS_l + F_{m(i)} + e_{ijklmn}$ for Services per conception (SPC) (1)

$Y_{ijklm} = \mu + G_i + CY_j + CS_k + CA_l + F_{m(i)} + e_{ijklmn}$ for Calving interval (CI) (2)

Where, Y_{ijklm} is the observation of the analyzed fertility trait (SPC and CA) of mth animal of ith genotype, jth year of service / calving year, kth season of service / calving season, lth age of service / calving age, mth farm within genotype. e_{ijklmn} is the random residual error accepted to be NID (0, σ^2). The calving seasons in the model were divided into four groups in the form of winter, spring, summer, and fall. Cows younger than 26 months of age were grouped as the first and those equal to or greater than 26 months as the second group. The season of service was grouped into winter, spring, summer, and fall. Age of service per cow grouped as younger than 18 months (I) and 18 months or older (II). Microsoft Excel (2016) and Minitab 18 (2017) software were used for data processing and ANOVA.

RESULTS and DISCUSSION

Descriptive statistics for age at first calving were presented in Table 1. The results of ANOVA for SPC and CI, the least-squares means, and the losses caused by the deviations of traits from the ideals in each farm operation were given in the tables (2 – 8).

Table 1: Descriptive statistics for first calving age in different breeds and farms.

Factors	Groups	n	Mean (days)	($S_{\bar{x}}$)	CV (%)	Sum	Min.	Max.
Age at first calving		126	897.5	19.0	23.79	113089.0	650.0	1840.0
Genotype								
	Holstein	85	872.6	23.0	24.27	74173.0	650.0	1840.0
	Simmental	41	949.2	32.9	22.17	38916.0	688.0	1496.0
Farm Operation								
	Farm A	58	828.2	19.4	17.88	48037.0	691.00	1141.0
	Farm B	41	949.2	32.9	22.17	38916.0	688.0	1496.0
	Farm C	27	968.0	55.4	29.75	26136.0	650.0	1840.0

Table 2: ANOVA for Services per Conception.

Factors	D.F.	Sum of Squares	Means Squares	F-Value	P-Value
Genotype	1	1.7357	1.73572	3.13	0.079
Year of services	2	4.6904	2.34518	4.23	0.017
Season of service	3	0.2846	0.09486	0.17	0.916
Age of service	1	0.6415	0.64150	1.16	0.284
Farm nested in genotype	1	0.9472	0.94717	1.71	0.194
Error	117	64.8082	0.55392		
Total	125	74.9286			

Table 3: Least-squares means for services per conception.

Factors		n	SPC
μ		126	1.6081±0.0871
Genotype			
	Holstein	85	1.7455±0.0971
	Simmental	41	1.471±0.133
Year of service			
	2013	19	1.432±0.216[b]
	2014	49	1.909±0.116[a]
	2015	58	1.483±0.134[b]
Season of service			
	Winter	18	1.575±0.192
	Spring	34	1.538±0.133
	Summer	56	1.618±0.125
	Fall	18	1.702±0.195
Age of service			
	Group I	64	1.526±0.127
	Group II	62	1.691±0.104
Farm nested in genotype			
	Farm A (Holstein)	58	1.588±0.156
	Farm C (Holstein)	27	1.903±0.153
	Farm B (Simmental)	41	1.471±0.133

Different letters (a, b, and c) are significantly different at 0.05 level.

Table 4: ANOVA results for Calving Interval.

Factors	D.F.	Sum of Squares	Mean Squares	F-value	P-value
Genotype	1	15206	15205.6	3.14	0.079
Calving year	3	29823	9941.0	2.05	0.111
Calving season	3	738	246.0	0.05	0.985
Calving age	1	7807	7807.4	1.61	0.207
Farm nested in genotype	1	8	7.5	0.00	0.969
Error	116	562067	4845.4		
Total	125	624252			

Table 5: Least-squares means for calving interval.

Factors		n	CA (days)
		126	417.6±10.5
Genotype			
	Holstein	85	430.7±11.1
	Simmental	41	404.6±14.3
Calving year			
	2013	12	456.4±24.8
	2014	11	397.6±25.2
	2015	46	421.1±12.7
	2016	57	395.5±13.0
Calving season			
	Winter	33	417.5±12.4
	Spring	58	421.4±13.4
	Summer	19	418.7±21.2
	Fall	16	413.0±20.5
Calving age			
	Group I	51	428.1±15.8
	Group II	75	407.2±10.3
Farm nested in genotype			
	Farm A (Holstein)	58	431.1±17.3
	Farm C (Holstein)	27	430.2±14.5
	Farm B (Simmental)	41	404.6±14.3

Table 6: Economic analysis for the deviation of age at first calving from the ideal level (24 months) in terms of the calf loses.

AFC	n	Total loss (TL) (month)	Calf equivalent of loses CEL=TL / 12 (head)	Monetary equivalent of total calf losses METCL=CEL * 3960 (₺†)	Monetary equivalent of Average calf Loss per individual animal (₺†)
Farm A	58	186.79	15.56	61639.71	1062.75
Farm B	41	294.62	24.55	97224.60	2371.33
Farm C	27	210.69	17.56	69527.70	2575.10

†: 1 US Dollar corresponds to 5.341 Turkish Liras (Central Bank of Turkey, 01.02.2019).

Table 7: The economic analysis of Services per conception deviated from the ideal level (1 insemination)

SPC	n	Sum of differences from the ideal level (Insemination Number) IN	Total excess SPC spending TESS=IN*75 (₺†)	Av. excess SPC spending per animal (₺†)
Farm A	58	31	2325	40.09
Farm B	41	26	1950	47.56
Farm C	27	24	1800	66.67

†: 1 US Dollar corresponds to 5.341 Turkish Liras (Central Bank of Turkey, 01.02.2019).

Table 8: Economic analysis of Calving interval deviated from the ideal level (12 months) in terms of the calf loses.

CA	n	Total loss (TL) (Month)	Calf equivalent of loses (CEL=TL/12) (Head)	Monetary equivalent of total calf losses METCL=CEL*3.960 (₺†)	Monetary equivalent of Average calf Loss per individual animal (₺†)
Farm A	58	104.89	8.74	34601.16	596.57
Farm B	41	40.95	3.41	13513.83	329.61
Farm C	27	59.80	4.98	19734.99	730.93

†: 1 US Dollar corresponds to 5.341 Turkish Liras (Central Bank of Turkey, 01.02.2019).

The mean age at first calving of 126 animals was 897.5 days, and this value varied from 650.0 to 1840.0 days among farm operations. The age at first calving in Holsteins was just beyond the value of 751 – 764 days reported by Berry and Cromie (2009) in the same breed. Meanwhile the value determined in the current study was in the range (804 – 921 days) of different literatures (Akbaş and Türkmut 1990, Kumuk et al. 1999, Galiç et al. 2005, Özkök and Uğur 2007, Tapkı et al. 2007, Tuna et al. 2007, Koçak et al. 2008, Bayrıl and Yılmaz 2010, Sarıözkan et al. 2012). Kaygisiz and Elmaz (2008) was found a relatively higher value of 1260 days in Holsteins cows. The age at first calving detected in the Simmentals in the study was just above values of 893.6 and 861.9 days reported by Akbaş and Türkmut (1990), Koçak et al. (2008) and Ulutas and Sezer (2009). Different feeding and management and origins of animals can be source of this variations.

The analysis of variance showed that the effect of the year of service on the SPC was significant ($p<0.05$). The least-squares means of SPC and CI were 1.746, and 430.7 days for Holsteins and 1.471 and 404.6 days for Simmentals. Differences between genotypes in both traits were marginally significant ($p<0.10$). Average service per conception founded for Holsteins was higher compared to some literature reports (Kumuk et al. 1999, Tapkı et al. 2007, Kaygisiz and Elmaz 2008, Bayrıl and Yılmaz 2010) but lower than that of Sarıözkan et al. (2012). SPC determined for Simmentals was behind the values of 1.76 and 1.96 reported by Çilek and Tekin (2004) and Erdem et al. (2015) in Simmentals of Kazova Agricultural enterprise and Gökhöyük state farm in Turkey. These differences may have been caused by research conditions. The year of service was uniquely significant ($p<0.05$) effect as an environmental factor for SPC. Çilek and Tekin (2004) reported similar results for this effect. Tapkı et al. (2007) reported that the effect of calving season was significant on SPC. Differences may have been due to the implementation of different models and climatic conditions. Meanwhile the data available may not be enough to detect the differences.

Average CI founded for Holsteins (430.7 days) was just above than the range (390.0 – 420.0 days) of some literature (Tapkı et al. 2007, Tuna et al. 2007, Kaygisiz and Elmaz, 2008, Berry and Cromie 2009, Bayrıl and Yılmaz, 2010, Sarıözkan et al. 2012) While Kumuk et al. (1999) found that the calving intervals of cows in different public farms in Turkey were changed from 487 to 526.6 days. The finding of this study was well behind of them. CI for Simmentals (379.1 days) was just above the findings of Çilek and Tekin (2004) Erdem et al. (2015). The effects of environmental factors in this trait were found to be nonsignificant. But optimum calving interval in average farm operations must be up to 12 – 13 months for economic reasons (Uygur 2004). However, this cannot be fully achieved in practice. As a matter of fact, the value found in the current research is about a month and a half above the optimum. Considering this information, it may be mandatory for businesses to work hard on the reasons prolonging CI. Genetic and reproductive health problems and poor estrus detection must be taken into account by breeders.

Calf losses due to prolonged age at first calving in the farm operations were ranged from 15.56 to 24.55 heads. The excess costs of artificial insemination were calculated in each farm and it was changed from ₺40.08 ($7.50) to ₺66.66 ($12.48) per animal in farms. Total calf losses due to extended CI in each farm were 8.73, 3.41 and 4.98 heads, respectively. Total costs of calf losses calculated in terms of head on farm basis were ₺34,601.16 ($6,478.40), ₺13,513.83 ($2,530.21$) and ₺19,734.99 ($3,695), respectively. The calculated total costs were divided by the number of animals and resulting average calf losses per animal per farm operation were ₺596.57 ($111.70), ₺329.60 ($61.71) and ₺730.92 ($136.85) respectively. Total calf losses due to age at first calving by farms were ₺61,639.71 ($11,540.86), ₺97,224.60 ($18,203.45) and ₺69,527.70 ($13,017.73), respectively. The extra artificial insemination costs were ₺2325 ($435.31), ₺1950 ($365.10) and ₺1800 ($337.01) in farms, respectively. The calculated total costs resulting from extended CI were divided by the number of animals and the resulting monetary values of average calf losses per animal were ₺596.57 ($111.70), ₺329.60 ($61.71) and ₺730.92 ($136.85) for each farm. In the lights of these findings, it is understood that the deviations from the ideal boundaries in terms of fertilization efficiency characteristics in different businesses of Afyonkarahisar can lead to significant money losses. Kumuk et al. (1999) reached similar results and stated that the main reasons for this phenomenon were the business administrations did not evaluate the importance of efficient fertility as well as the technical personnel not to pay attention to this issue and the related parameters not to be monitored adequately.

CONCLUSION

Holsteins and Simmentals reared in Afyonkarahisar conditions gave close values to the averages in Turkey in terms of fertility. It was determined that the fertility can be influenced by different environmental factors. ANOVA results showed that the differences between genotypes were in marginal significance ($p<0.10$). The tendencies in least-squares means showed Simmentals gave more positive values than Holsteins. Given the total economic losses in farm operations, fertility traits and their importance must be considered in a professional manner. Otherwise, the extend of economic losses can reach to harmful levels for the business. The significant environmental factors and administrative measures must be thought carefully in selection programs to improve genetics of animals, and to prevent farm operations from economic losses.

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Ethical Statement

This study is not subject to the permission of HADYEK in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees".

Conflict of Interest

The authors declared that there is no conflict of interest.

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