The Journal of Animal & Plant Sciences, 23(3): 2013, Page: 731-735
ISSN: 1018-7081

ESTIMATION OF 305-D MILK YIELD USING REGRESSION TREE METHOD IN BROWN SWISS CATTLE

E. Eyduran, I. Yilmaz, M. M. Tariq[*] and A. Kaygisiz[**]

Igdir University, Faculty of Agriculture, Department of Animal Science,76000, Iğdır,Türkiye
[*]Center for Advanced Studies in Vaccinology and Biotechnology (CASVAB), University of Balochistan, Quetta, Balochistan, Pakistan
[**]Kahramanmaras Sütcü Imam University, Faculty of Agriculture, Department of Animal Science, Kahramanmaras, Turkiye
Corresponding author: E mail: ecevit.eyduran@igdir.edu.tr or ecevit.eyduran@gmail.com

ABSTRACT

The aim of this study is to evaluate the relationship between 305-d milk yield and several environmental factors (calving season, calving year, parity, calving interval and dry period) for Brown-Swiss dairy cattle with respect to Regression Tree method. A total of 1884 lactation records were taken from 645 Brown Swiss cattle raised at Sultansuyu State Farm, Malatya province, located in the Eastern Anatolia region of Turkiye between the years of 1987-2010. In the current paper, dry period, parity, calving interval, calving season and year were considered as explanatory variables, and 305-d milk yield was a dependent variable. Calving year was statistically the most influential factor on 305-d milk yield of the Brown Swiss cattle ($F=40.468$, $df1=5$, $df2=1878$, $P<0.01$), followed by parity and calving interval in regression tree diagram ($P<0.01$). The parity factor had a significant influence on 305-d milk yield of cows with lactation records included in Node 1 ($F=17.606$, $df1=2$, $df2=775$, $P<0.01$), Node 2 ($F=9.530$, $df1=2$, $df2=194$, $P<0.01$), and Node 4 ($F=22.116$, $df1=1$, $df2=249$, $P<0.01$). However, calving interval factor noticeably influenced 305-d milk yield of cows with lactation records in Node 5 ($F=24.733$, $df1=1$, $df2=210$, $P<0.01$). From Node 7 to Node 9, 305-d milk yield illustrated to be a growing trend with increasing parity. Within these cows, those having calving interval greater than 352 were observed to be higher yield with an average of 3629.345 kg. Cows with parities higher than 2 generated higher yield than the cows with parities 1 and 2. There was a statistically significant effect of the calving year, calving interval and lactation parity on 305-d milk yield in Brown-Swiss cattle. Cows including calving year 1999 in the Node 3 had the highest 305-d milk yield with an average of 4520.183 kg. No significant factor on the 305-d milk yield of cows with lactation records on calving years later than 2003 was noted in Node 6. In some cases, the 305 milk yield increased with increasing parity and calving interval. Consequently, regression tree method enabled us to get sub-homogenous groups depending upon explanatory variables from records of the Brown-Swiss dairy cattle and to identify the combinations of environmental factors which produce the highest 305-d milk yield.

Key words: Brown Swiss, 305-d milk yield, Regression Tree Method, Least Squares Method.

INTRODUCTION

In dairy cattle, milk yield, one of the most important quantitative traits, is limited by a common effect of genotype and environmental factors (Topal *et al.*, 2010). This quantitative trait, which has considerable variation, may be progressed by applying an effective selection program along with providing appropriate environmental conditions. In order to conduct selection programs and to estimate genetic parameters on milk yield, pedigree records of all cows should be available. In addition, the effects of environmental factors such as calving year, calving interval, calving season, parity, herd and milking frequency on milk yield should also be investigated to perform selection programmes (Javed *et al.*, 2007).

It is a major consideration for investigators to genetically evaluate cows and bulls in terms of milk yield in dairy cattle with respect to 305-d milk yield records, a set of milk yield records taken from cows once a month (Cilek *et.al.*, 2008; Yilmaz *et al.*, 2011). With the reliable estimation of genetic evaluations, achievement in genetic improvement has been assured.

Influences of environmental factors viz. calving year, calving interval, calving season, parity, herd and milking frequency should be investigated on milk yield for estimating accurate breeding values of cows in dairy science. Previously, General Linear Model (GLM) has been employed widely in the determination of these environmental factors affecting 305-d milk yield. Similarly, Path Analysis has been preferred as a simple way to examine factors affecting 305-d milk yield (Isci *et al.*, 2004).

Regression Tree analysis, a visual analysis, does not require any assumption on distribution of independent variables compared to discriminant and cluster analysis techniques, and it provides more successfully solutions for very high number of independent variables, existence

of multicollinearity problem between these variables, and data with outliers (Mendes and Akkar *et al*, 2009).

Very little information has been known for 305-d milk yield on using Regression Tree Method (Dogan, 2003; Bakir *et al.*, 2010; Topal *et al.*, 2010), a nonparametric technique that admits of homogeneous subgroups and appoint proper cut off values in respect to independent variables. It is necessary that the conformity of Regression Tree Method without assumptions be evaluated to generalize earlier results of 305-d milk yield and to biologically make more accurate decision in better describing factors effective on 305-d milk yield for available herd. The current research was designed to investigate several factors (calving season, calving year, parity, calving interval and dry period) influencing 305-d milk yield in Brown-Swiss cattle using Regression Tree (RT) Method.

MATERIALS AND METHODS

In the current paper, 1884 lactation records were assessed for 645 Brown-Swiss dairy cattle reared at Sultansuyu State Farm, Malatya province, in the Eastern Anatolia region of Turkiye throughout 1987-2010. The year was separated into four seasons, spring (March, April, and May), summer (June, July, and August), autumn (September, October and November) and winter (December, January and February). In the present study, data regarding Brown Swiss cattle used previously by Kaygisiz (2010) were used with the aim of statistically evaluating performance of a different statistical (regression tree) method and obtaining new information different from previous studies. That is, the present study and Kaygisiz (2010) used completely different statistical techniques.

Variable Structures: Structures of the variables used in the paper can be given as follows:
MY305: 305-d milk yield as dependent (target=measurable) variable
CS: Calving season as an explanatory (discrete) variable
CY: Calving year as an explanatory (discrete) variable
PA: Parity, as an explanatory (discrete) variable
CI: Calving Interval as an explanatory (continuous) variable, and
DP: Dry period as an explanatory (continuous) variable

Regression tree method: As a tree based model, Regression Tree Method, identifies the best cut-off values for explanatory variables significantly affecting dependent variable. The aim of Regression tree method is to generalize prediction rules for a dependent (response) variable, according to the values of explanatory variables (Hébert *et al.*, 2006). In the regression tree method, initial node is "root node", and homogenous subgroups obtained by reducing variation in dependent variable, are named "terminal nodes" (Camdeviren *et al.*, 2007). Regression tree analysis technique converts continuous variables into categorical variables (Camdeviren *et al.*, 2005; Tariq *et al.*, 2012). See Camdeviren *et al.*, (2007) for more detail information.

In the current study, explanatory variables such as calving season, calving year, parity, calving interval, and dry period, and dependent variable (305-d milk yield) were fitted to Regression tree method. F test was the significance test used for regression tree method in the current paper as recommended by some authors (Hébert *et al.*, 2006; Tariq *et al.*, 2012).

RESULTS

Understanding of environmental factors that can influence 305-d milk yield is of great significance in dairy cattle. For establishing significant factors on 305-d milk yield in the Brown Swiss cattle, Regression tree analysis was applied to the current data. Regression tree diagram, defining significant explanatory variables (factors or covariates) on 305-d milk yield is depicted in Figure 1. In the current study, an average of the 305-d milk yield in the Brown Swiss cattle was 3513.334 kg, which was an average of all the records of the Brown Swiss cattle. According to Figure 1, calving year was significantly identified as the most important factor influencing 305-d milk yield of the Brown Swiss cattle ($F=40.468$, $df1=5$, $df2=1878$, $P<0.01$).

At the top of regression tree diagram, Node 0, which gave general descriptive statistics of 305-d milk yield, was divided into new six child nodes, with respect to calving year factor. The 305-d milk yield averages of these six child nodes, Nodes 1-6 were estimated as: 3052. 403, 3835.574, 4520.183, 3749.793, 3389.046 and 3973.593 kg, respectively. With an average of 4520.183 kg, Node 3 gave the highest 305-d milk yield out of the Nodes 1-6.Numbers (proportions) of lactation records were 778 (41.3%), 197 (10.5%), 104 (5.5%), 251(13.3%), 212 (11.3%), and 342 (18.2%) for Nodes 1-6, respectively, with a total of 1884 lactation records. The parity factor yielded a significant influence on 305-d milk yield of cows whose lactation records were included in Node 1 ($F=17.606$, $df1=2$, $df2=775$, $P<0.01$), Node 2 ($F=9.530$, $df1=2$, $df2=194$, $P<0.01$), and Node 4 ($F=22.116$, $df1=1$, $df2=249$, $P<0.01$). On the other hand, calving interval was an environmental factor that considerably influenced 305-d milk yield of cows whose lactation records was only in Node 5 ($F=24.733$, $df1=1$, $df2=210$, $P<0.01$). Parity and calving interval factors on 305-d-milk yield were secondarily significant.

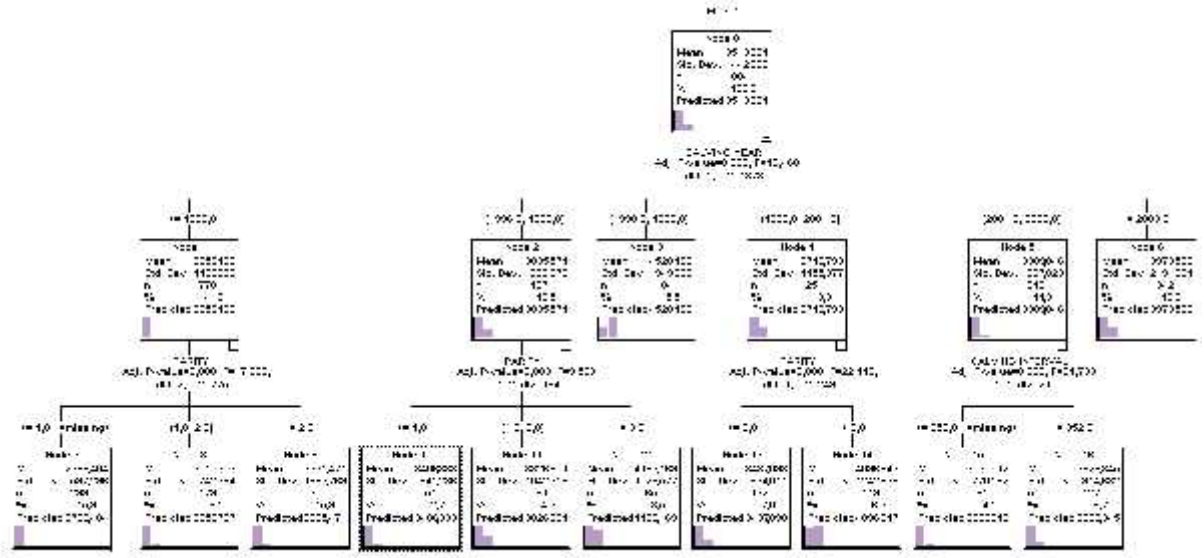
Node 1 was newly divided into Nodes 7, 8, and 9 respectively, depending on parity factor. Corresponding average values for these three new child nodes were 2769.404, 3050.707, and 3335.471 kg, respectively. Node 9 fulfilled the highest 305-d milk yield among these three Nodes. Numbers (proportions) of lactation records

obtained for the three Nodes were 299 (15.9%), 179 (9.5%), and 300 (15.9%), respectively. Among the factors, parity factor had an impact upon the 305-d milk yield of cows including calving years earlier than 1996 and 1996 in the Node 1. From Node 7 to Node 9, 305-d milk yield initiated an incremental trend due to increasing parity.

Node 2 was also re-branched into three child nodes as Nodes 10, 11, and 12, in association with parity factor, respectively. The 305-d milk yield averages for these three nodes were found as: 3406.333, 3826.901, and 4183.169 kg, respectively. Within the three Nodes, Node 12 produced the highest milk yield (4183.169 kg). Numbers (proportions) of lactation records were established as 51(2.7%), 81 (4.3%), and 65 (3.5%), respectively. Parity factor remarkably influenced the 305-d milk yield of cows whose lactation records were consisted of calving years 1997 and 1998 in the Node 2.

On account of the fact that Nodes 3 and 6 were terminal nodes, there was not any separation operation in further processes for providing satisfactory homogeneity in both nodes.

As illustrated in Figure 1, Node 4 was re-separated into Nodes 13 and 14 as two new child nodes, in relation to parity factor, respectively. The 305-d milk yield averages for these two child nodes were ascertained as: 3437.098 and 4096.647 kg respectively. Numbers (proportions) of lactation records with 132 (7.0%) and 119 (6.3%) were detected. As seen from Node 4, the 305-d milk yield of cows containing the lactation records belonging to calving years 2000 and 2001 were similarly affected by parity factor as in Nodes 1 and 2. Cows with parities higher than 2 produced higher yield as compared to the cows with parities 1 and 2, as expected physiologically.



Node 0 is a group of all the lactation records
Node 1 is a group of cows with lactation records on calving years from 1987 to 1996 (≤ 1996)
Node 2 is a group of cows with lactation records on calving years from 1997 to 1998 (1996 to 1998]
Node 3 is a group of cows with lactation records on the 1999 calving year (1998 to 1999]
Node 4 is a group of cows with lactation records on 2000 and 2001 calving years (1999 to 2001]
Node 5 is a group of cows with lactation records on 2002 and 2003 calving years (2001 to 2003]
Node 6 is a group of cows with lactation records on later calving years than 2003
Node 7 is a group of cows with lactation records with 1st parity and missing parity on calving years from 1987 to 1996 (≤ 1996)
Node 8 is a group of cows with lactation records on 2nd parity (1 to 2 parity] and calving years from 1987 to 1996 (≤ 1996)
Node 9 is a group of cows with lactation records on parity > 2 calving years from 1987 to 1996 (≤ 1996)
Node 10 is a group of cows with lactation records on 1st parity and calving years from 1997 to 1998 (1996 to 1998]
Node 11 is a group of cows with lactation records on 2nd and 3rd parities and calving years from 1997 to 1998 (1996 to 1998]
Node 12 is a group of cows with lactation records on parities > 3 and calving years from 1997 to 1998 (1996 to 1998]
Node 13 is a group of cows with lactation records on 1st and 2nd parities and 2000- 2001 calving years (1999 to 2001]
Node 14 is a group of cows with lactation records on parities > 2 and 2000- 2001 calving years (1999 to 2001]
Node 15 is a group of cows with lactation records on calving interval ≤ 352 and missing calving intervals and 2002-2003 calving years (2001 to 2003]
Node 16 is a group of cows with lactation records on calving intervals > 352 and 2002-2003 calving years (2001 to 2003]

Figure 1: Regression tree diagram for 305-d milk yield

Node 5 was re-separated into Nodes 15 and 16 with two new child nodes, in relation of calving interval, respectively (Figure 1). In Node 5, cows consisting of calving years 2002 and 2003 were statistically affected by calving interval. Among these cows, those having calving interval greater than 352 made available to higher yield average with 3629.345 kg. The 305-d milk yield averages for the two nodes were calculated as: 3030.012 and 3629.345 kg respectively. Corresponding record numbers (proportions) were 85 (4.5%) and 127 (6.7%), respectively.

When regression tree diagram was glanced, Nodes from 7 to 16 were understood to be terminal nodes; next separation operation for these nodes was not actualized in subsequent stages, owing to fact that the nodes were reached to reasonable homogeneity.

DISCUSSION

In the current study, from Node 10 to Node 12, the 305-d milk yield reflected a growing trend as a result of increasing parity, which supported the result of the regression tree method reported by Bakir *et al.* (2010) in Holstein cows. Among explanatory variables, parity and calving interval were also detected to be secondarily significant in regression tree diagram ($P<0.01$). This finding was in definitely agreement with the result of Bakir *et al.* (2010), who found the lactation parity as secondary effective on 305-d milk yield of Holstein cows for regression tree method.

Statistically significant effect of the calving year on 305-d milk yield in Brown-Swiss cattle has been observed many times. The finding was in accordance with those reported by numerous authors (Akbulut *et al.,* 1992; Duru and Tuncel, 2002; Bakır and Cetin, 2003; Kaya and Kaya, 2003; Ozcakır and Bakır, 2003; Tilki *et al.,*2003; Cilek and Tekin, 2005; Türkyilmaz *et al.,*2005; Akcay *et al.,* 2007; Erdem *et al.,*2007; Inci *et al.,* 2007; Orhan and Kaygisiz, 2007; Ozkok and Ugur, 2007; Bakir *et al.,* 2009; Çilek, 2009; Bayril and Yilmaz, 2010;

As obtained in the current study, many authors reported a significant effect of lactation parity on 305-d milk yield (Duru and Tuncel, 2002; Kaya and Kaya, 2003; Ozcakır and Bakır, 2003; Yaylak and Kumlu, 2005; Koc, 2006; Akçay *et al.,* 2007; Erdem *et al.,* 2007; Inci *et al.,* 2007; Ozkok and Ugur, 2007; Orhan and Kaygisiz, 2007; Bakir *et al.,* 2009). However, in the current study, the parity had a significant effect on 305-d milk yield of cows whose lactation records were in calving years earlier than 1996, 1997-1998, and 2000-2001 (Nodes 1, 2 and 4) in dairy cattle.

Unlike other studies, the calving interval was observed to have a statistically significant effect on 305-d milk yield of cows whose lactation records were in the calving years 2002 and 2003 (Node 5) in the current paper.

The differentiation between the current and previous studies in literature may be attributed to sample size, utilization of different breeds and farms, differential variables included in the model, and especially the utilization of variant statistical models. Due to these reasons, the results obtained in the current paper could not be precisely compared with the earlier papers.

Conclusion: Determining environmental factors that influence on 305-d milk yield is of importance for breeding purposes in dairy science. In regression tree diagram, calving year for 305-d milk yield of the Brown Swiss cattle was determined to be the most influential factor, followed by parity and calving interval secondarily in regression tree diagram ($P<0.01$). Present results could be summarized briefly as follows:

a) Calving interval merely influenced 305-d milk yield of cows whose lactation records were obtained in calving years 2002 and 2003.

b) Insignificant explanatory variables such as dry period and calving season were excluded automatically from regression tree diagram.

c) Parity only affected cows of 305-d milk yield whose lactation records were on calving years before years 1996, 1997-1998, and 2002-2003.

Regression tree method provides opportunity to obtain special information as compared to previous studies. Further investigations should be conducted on more animals and more different breeds in order to generalize the current results.

REFERENCES

Akbulut, O., N. Tuzemen and M. Yanar (1992). The performance of Holstein cattle in Erzurum eastern Turkey conditions: Reproduction and milk yield characteristics. Turk J Vet Anim Sci., 16: 523-533.

Akcay, H., M. Ilaslan, and A. Koc (2007). Effects of calving season on milk yield of Holstein cows raised at Dalaman State Farm in Turkey. J. Fac. Agric. ADU. 4: 59-61.

Bakir, G., A. Kaygisiz and S. Cilek (2009). Milk yield traits of Holstein cattle reared at Tahirova state farms in Balikesir province in Turkey. J. Anim Vet. Advances. 8: 2369-2374.

Bakır, G., S. Keskin and H. Mirtagioglu (2010). Determination of the effective factors for 305 days milk yield by regression tree (RT) method. J.Anim. and Vet. Advances. 9: 55-59.

Bakir, G. and M.Cetin (2003). Breeding characteristics and milk yield traits of Holstein cattle in Reyhanli agricultural farm. Turk. J. Vet. Anim. Sci. 27: 173-180.

Bayril, T. and O. Yilmaz (2010). Reproductive traits of holstein cows raised in kazova Vasfi Diren agriculture farm. YYU Vet Fac J. 21: 169-173.

Camdeviren, H., M. Mendes, M.M. Ozkan, F. Toros, T. Sasmaz, and S. Oner (2005). Determination of depression risk factors in children adolescents by regression tree methodology. Acta Med. Okayama. 59: 19-26.

Camdeviren, H., A.C.Yazici, Z. Akkus, R. Bugdayci, and M.A. Sungur (2007). Comparison of logistic regression model and classification tree; An application to postpartum depression data. Expert Systems with Applications. 32: 987–994.

Cilek, S. and M.E. Tekin (2005). Environmental factors affecting milk yield and fertility traits of Simental cows raised at the Kazova state farm and phenotypic correlations between these traits. Turk. J. Vet Anim. Sci. 29: 987-993.

Cilek, S., (2009). Milk yield traits of Holstein cows raised at polatli state farm in Turkey. J. Vet. Anim. Adv. 8: 6-10.

Cilek, S., Orhan H., Kaygisiz A., Sahin E.H. (2008) Estimation of breeding values of Anatolian population of Simmental cows using monthly test day milk yields. Archiv. Zootechnica, 11: 79-85.

Doğan, I. (2003). Investigation of the factors which are affecting the milk yield in Holstein by CHAID analysis. Ankara Univ. Vet. Fac. J. 50: 65-70.

Duru, S., and E. Tuncel (2002). An investigation on milk yield and reproductive performance of holstein friesian cows in Kocas state farm milk yield traits. Turk. J. Vet. Anim. Sci. 26: 97-101.

Erdem, H., S. Atasever, and E. Kul (2007). Milk yield and fertility traits of holstein cows raised at Gokhoyuk state farm fertility traits. J. Fac. Agric. 22: 47-54.

Hebert, M., and D.C. Vezina, I. Daigneault, N. Parent, and C. Tremblay (2006). Factors linked to outcomes in sexually abused girls: a regression tree analysis. Comp. Psychiatry. 47: 443-455.

Isci, O., C. Takma and Y. Akbas (2004). Proc. Turk. Suleyman Demirel Univ. IV. National Anim. Sci. Congress, 578-584. .

Inci, S., A. Kaygısız, E. Efe, and S. Bas (2007). Milk yield and reproductive traits in Brown Swiss cattle raised at Altınova state farm. Ankara Univ. Agr. Sci. J. 13: 203-212.

Javed, K., M. E. Babar, and M. Abdullah (2007). Within-herd phenotypic and genetic trend lines for milk yield in Holstein-Frisian dairy cows. J. Cell Anim. Biol. 1: 66-70.

Kaygisiz, A. (2010). Gene frequencies and heritability of supernumerary teats and its relationship with milk yields of Holstein and Brown Swiss. Kafkas Univ. Vet. Fak.Derg. 16(4): 561-566.

Kaya I. and A. Kaya (2003). Parameter estimates for persistency of lactation and relationship of persistency with milk yield in holstein cattle. Animal Prod. 44: 76-94.

Koc, A. (2006). Lactation milk yields and somatic cell counts of Holstein Friesian and Brown-Swiss cattle reared in Aydin province. Animal Prod. 47: 1-8.

Mendes, M. and E. Akkartal (2009). Regression tree analysis for predicting slaughter weight in broilers. Italian J. Anim. Sci. 8: 615-624.

Orhan, H. and A.Kaygisiz (2007). A Study on estimates of varyans components of milk production characters of Brown Swiss cattle. Süleyman Demirel Univ. Agr. Fac. J. 2: 1-6

Ozcakir, A. and G. Bakir (2003). Milk yield and reproduction characteristics of Holstein friesian cattle raised in Tahirova agricultural facility: 1. Milk yield traits. J. Fac. Agric. AU. 4: 145-149.

Ozkok, H. and F. Ugur (2007). Milk yield, age at first calving and service period in Brown Swiss and Holstein Friesian cattle reared in Turkey. Atatürk Univ. J. Agric. Fac. 38: 143-149.

Tilki, M., S. Inal, M. Colak, and M.E. Tekin (2003). The estimation of phenotypic and genetic parameters for calf birth weight and gestation length of Brown Swiss cows reared at the Bahri Dagdas International Agricultural Research Institute. Turk. J. Vet. Anim. Sci. 27: 1335-1341.

Topal, M., V. Aksakal, B. Bayram, and M. Yaganoglu (2010). An analysis of the factor affecting birth weight and actual milk yield in swedish red cattle using regression tree analysis. The J. Anim. Plant. Sci. 20: 63-69.

Turkyilmaz M.K., H.K. Bardakcioglu and A. Nazligul (2005). Effect of same factors on milk yield in Holstein cows. J. Fac. Vet. Med. KU. 11: 69-72.

Tariq M. M., M. Rafeeq, M. A. Bajwa, M.A. Awan, F. Abbas, A. Waheed, F. A. Bukhari and P. Akhtar (2012). Prediction of body weight from body measurements using regression tree (RT) method for indigenous sheep breeds in Balochistan, Pakistan. The J. Anim. Plant Sci. 22(1):20-24.

Yaylak, E. and S. Kumlu (2005). The effects of body condition score and some environmental factors on 305 days milk yield of Holstein cows. Ege Univ. Agric. Fac J. 42: 55-66.

Yilmaz, I., E. Eyduran, A. Kaygisiz and K. Javed (2011). Estimates of genetic parameters for lactation shape parameters with multivariate statistical technique in Brown Swiss cattle. International J. Agric. Biol., 13: 174–178.