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Regression Tree Analysis for Determining of Affecting Factors to Lactation Milk Yield in Brown Swiss Cattle

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ABSTRACT

Lactation Milk Yield (LMY) in cows is one of the major characteristics for animal breeding programs. The aim of this study is to investigate the effects of possible environmental factors on lactation milk yield. In this study, 696 records of 280 Brown Swiss cattle that raised at Mus Alparslan State Farm in Turkey were analyzed using regression tree method to determine the several affecting factors to lactation milk yield. Lactation period, lactation number and calving season variables were considered to explanatory variables for lactation milk yield and all of these variables were found statistically significant factors. Lactation period was primarily and lactation number as well as calving season secondary factor. Thus, it can be concluded that optimal calving season may be winter and optimal lactation period can be considered as 307 days or greater for the increasing of milk yield. In addition, optimal lactation number should be greater than 1 for lactation duration is 263 to 292 days.

Key words: Cattle, breeding programs, lactation, node, regression tree

INTRODUCTION

Lactation Milk Yield (LMY) in cows is one of the essential traits for animal breeding programs. Many of the dairy cattle enterprises aim to increase milk yield and to obtain regularly a calf in each year. It can be state that Brown Swiss cows have ability to adapt to various climate conditions as well as having high performance in milk yield. Therefore, most of farms in Turkey prefer this race and struggle to improve milk yield by means of applying proper animal breeding programs. As in other quantitative traits, genotype and various environmental factors also play an important role in milk yield. As mentioned by Topal *et al.* (2010) lactation period and peak milk yield were important variables affecting the actual milk yield.

The knowledge about various genetic parameters is quite important to perform successful animal breeding programs in the farmers. The estimation of amount of various environmental factors' effects on some economical trait is also necessary (Khalid *et al.*, 2007; Kuthu *et al.*, 2007). Therefore it can be stated that precisely determination of influence of different affecting factors on milk yield is critical for dairy farms. Various statistical methods, such as standard linear regression, non-linear models or regression tree analysis can be used to determine these affecting factors. In general, standard regression analysis and analysis of variance have been largely used methods in the previous study to identify affecting factors for milk yield in cows. Standard regression analysis

is generally employed to determine the functional relationship between a dependent (response) variable and one or more independent (explanatory) variables. In this method, dependent and independent variables should provide normal distribution. However, in many studies, this assumption may not be provided or some independent variables may be nominal. In this case, regression tree method can be proposed. This method can be considered to nonparametric partition and identification of interaction between the independent and dependent variable. As compared to the other methods, regression tree method has some advantages. These advantages can be summarized follows; (1) This method is a nonparametric alternative to the standard regression method. In addition, this method also does not contain the assumptions required for the regression analysis, (2) It can be applied to continuous, nominal and ordinal dependent variables; therefore, in the regression tree method, dependent and independent variables can be continuous, nominal or ordinal, (3) Regression trees are invariant under transformations of independent variables, (4) The structure of the regression tree algorithm includes the most important variables explaining the dependent variable and eliminates insignificant variables, (5) Interactions within the data set can be determined and the graphical interpretation of complex results containing the interactions is easier, (6) The model has the capability of overcoming missing values in the dependent and independent variables (Dogan and Ozdamar, 2003).

There are rare studies about using regression tree method in literature. Therefore, this present study aims to determine and classify the factors affecting lactation milk yield in Brown Swiss cattle using the regression tree method. Thus, providing of utilization to regression tree method which is partially new method will contribute to determine accurately relationships among the factors that have effect on economical traits in animal breeding programs.

MATERIALS AND METHODS

In this research, totally 696 data obtained from 280 cows between 2005-2010 years were used. These data consist of lactation milk yield, lactation period, lactation number and Calving season. In the study, lactation milk yield was considered to dependent or response variable and others were employed to independent (explanatory) variables. Regression Tree method (RT) (Breiman *et al.*, 1998; Chang and Wang 2006; D'Alisa *et al.*, 2006; Hebert *et al.*, 2006) was conducted to evaluate the effects of independent variables on lactation milk yield as well as to detect interactions effect among the explanatory variables. SPSS (2004) statistical package program was used for all statistical computation.

RESULTS

As known, lactation milk yield is one of the main characteristics for dairy cattle enterprises and consists of large part of income. In order to increase their income, dairy cattle enterprises aim to increase milk production. Therefore, the factors affected to milk yield should be determined correctly by using proper statistical methods. According to regression tree method, summarized results for lactation milk yield are given in Table 1. Our results showed that lactation period, lactation number and calving season were significant variables to predict lactation milk yield. As seen from the Table 1, root node indicated as "node 0" which contained descriptive statistics of dependent variable. Node 0 was primarily divided into four child nodes (sub-groups) by the lactation period. The first sub-group is "node 1" and it consists of 70 heads (10.1% of the total) of cows having lower than 263 day lactation period. The average lactation milk yield was estimated as 3535.114 kg for this node. Similarly, the second sub-group, node 2, consists of 206 (29.9%) cows. Lactation duration of

Table 1: Descriptive statistics of nodes according to regression tree method for lactation milk yield

Node	Mean	n	Percent	Parent node	Variable	F value $_{(df1, df2)}$	Split values
0	4254.68±967.1260	696	100.0				
1	3535.11±728.7520	70	10.1	0	Lactation period	$41.180_{(3, 692)}$**	< = 262
2	3968.14±815.5030	206	29.6	0	Lactation period	$41.180_{(3, 692)}$**	(262, 292)
3	4239.57±921.8580	145	20.8	0	Lactation period	$41.180_{(3, 692)}$**	(292, 307)
4	4660.46±967.0320	275	39.5	0	Lactation period	$41.180_{(3, 692)}$**	> 307
5	3520.57±704.0520	58	8.3	2	Lactation no.	$27.454_{(1, 204)}$**	< = 1
6	4143.53±790.7130	148	21.3	2	Lactation no.	$27.454_{(1, 204)}$**	> 1
7	4532.82±1003.452	73	10.5	4	Calving season	$7.669_{(2, 272)}$**	< = 1
8	4908.56±1012.238	120	17.2	4	Calving season	$7.669_{(2, 272)}$**	(1, 3)
9	4411.01±770.8020	82	11.8	4	Calving season	$7.669_{(2, 272)}$**	> 3

**: $p<0.01$, $R^2 = 80.15\%$

this subgroup ranged from 263 to 292 days and average LMY is estimated as 3968.136 kg. The third sub-group, that is node 3, contains 145 (20.8%) cows having 293 to 307 days lactation duration. Average lactation milk yield for this node was estimated as 4239.572 kg. The fourth sub-group had the highest lactation duration with greater than 307. This sub-group, node 4, consists of 275 (39.5%) cows and average LMV was estimated as 4660.458 kg for this node.

In the second order, node 2 and node 4 were subdivided into 2 and 3 child nodes by lactation number and calving season, respectively. However, there was no sub-grouping for node 1 and node 3. Therefore, these nodes are called terminal node and can be considered to more effective than node 2 and 4 to LMV.

For the node 2, cut off value of lactation number is 1. 148 (21.3%) cows that have lactation number greater than 1 were grouped into node 6 and estimated LMV value of this node was found higher than those of node 5. Likewise, node 4 was divided into tree nodes: node 7, 8 and 9 by calving season. Node 7 consists of 73 heads (10.5% of the total) of cows that calved in spring season and estimated LMV of this node was 4532 kg. Similarly, node 8 contains 120 (17.2%) cows that calved in autumn and winter seasons. This node has the highest estimated LMV (4908 kg). The last node in the diagram is node 9 and consists of 82 cows that calved in summer season.

DISCUSSION

Many researchers (Bakir and Cetin, 2003; Ozcakir and Bakir, 2003; Kaya and Kaya, 2003; Yaylak and Kumlu, 2005; Sehar and Ozbeyaz, 2005; Erdem *et al.*, 2007; Akcay *et al.*, 2007; Kocak *et al.*, 2007; Cilek, 2009) reported that the effect of calving season on 305 days milk yield was significant and indicated that milk yield was higher in autumn and winter. Similarly, Stott and Delorenzo (1988) noted that both of Jersey and Holstein breeds, milk yields were highest following calving in the first quarter (Jan. to Mar.) of the year and the lowest following calving in the third quarter (Jul. to Sep.). In the same way, Barash *et al.* (2001) stated that Jersey cows calved in December, January and February months have higher milk production than that of cows calved in the other months. This may be because of high environmental temperature and high humidity in summer season in Mediterranean climates. Thus, it can be stated that winter is more preferable than others as calving season.

Dogan (2003) pointed out that primary variable affecting 305 days milk yield in Holstein cows was 55-74 days dry period and 10-16 months first mating age was the most related variable with

this trait. Bakir *et al.* (2010) also noted that milk yield is seriously affected by dry period, calving age and calving season. Hence, 60 days dry period seems to be increasing factor for economic benefit in high yielding cows.

Teke and Akdag (2010) indicated that the effect of calving year and lactation number on lactation yield and 305 days milk yield are significant while the effect of dry period was significant for only 305 days milk yield. Similarly, Bayril and Yilmaz (2010) stated that effects of calving year, lactation number, birth season, calving age and body weight were significant on 305 day milk yield mature-age 305 days milk yield in Holstein cows. Likewise, Gurses and Bayraktar (2012) reported that effects of factors; enterprise, calving year, calving season, calving age and lactation number were found significant on 100, 200 and 305 days milk yield. In the same way, Gorgulu (2011) emphasized that age and number of lactation were the most important factors affecting milk yield components.

Unalan and Cankaya (2010) used variance analysis for determining effects of calving year, calving month and lactation number. Their results showed that all factors' effects were statistically significant on lactation milk yields. Similarly, Ozkan and Gunes (2011) conducted a study to investigate the effects of some environmental factors on milk yields of Simmental cattle raised at private farms in Kayseri. Their results indicated that effects of farm type and season were significant on the real and 305 days milk yield and season was significant for the duration of lactation, however all the factors were non-significant on the dry period.

Mundan *et al.* (2009) discussed best Linear Regression model to determine the effects of some traits on lactation yield of the Holstein cows. Their findings confirmed that age of cow, first service age, first calving age, lactation length, calving interval and service period and calf birth weight affected significantly to lactation yield of Holstein cows in Kocas State Farm. Similarly, Mirtagioglu *et al.* (2008) purposed regression tree method for determining of affecting factor to 305-day milk yield. Their results showed that age was primary effective factor; lactation duration and calving season were secondary effective factors for 305-day milk yield. In addition, Zhao *et al.* (2012) pointed out that the second and third parity, calving in winter, reaching the milk peak at 60-80 day postpartum, calving for the first time at the age of 24-27 month and a 360-390 day calving interval are optimum for best milk performance in dairy cattle.

As similar to previous results, our findings showed that lactation duration is primarily factor for LMY and the cows calving in winter season have higher milk yield than that of calving in summer season. Thus, it can be states that our findings are largely in line with the results reported by previous studies. On the other hand, few researchers (Pelister *et al.*, 2000; Bilgic and Alic, 2005; Turkyilmaz *et al.*, 2005) noted that effect of calving season on 305 days milk yield was non-significant in commercial farms.

CONCLUSION

In this study, lactation duration, lactation number and calving season were found significant factors for lactation milk yield in Brown Swiss cows. Lactation duration was primarily and lactation number as well as calving season was secondary factor. In this research, the highest milk yield is obtained during the winter season. On the other hand, the lower milk yield is determined during the summer season. Therefore, it can be proposed that optimal lactation duration can be considered as 307 days for the increasing of milk yield. Likewise, optimal lactation number should be greater than 1 for cows that lactation duration is 263 to 292 days. Consequently, it can be concluded that this information may be valuable for animal breeders and commercial farms to increase lactation

milk yields. In addition, providing of utilization to regression tree method which is partially new will contribute to determine accurately relationships among the factors that have effect on economical traits in animal breeding programs.

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