Canadian Journal of Applied Sciences. 1(3): 382-387; January, 2013
ISSN 1925-7430; Available online http://www.canajas.ca

Original Research Article

DETERMINATION OF NON-GENETIC FACTORS INFLUENCING BIRTH WEIGHT USING REGRESSION TREE METHOD IN BROWN-SWISS CATTLE

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ABSTRACT

The aim of this study was to determine the influence of non-genetic factors on the birth weight of Brown-Swiss calves, maintained at Sultansuyu State Farm (lat. 38^0 E, long. 38^0 N, and 981 m above sea level) of Malatya province in the Eastern Anatolia Region of Turkey during the years 1984-2010. Data on birth weight, calving season, calf sex, and calving year were collected from 3168 Brown Swiss calves. The data were exposed to regression tree method, which is a tree-based and a non-parametric method. In this method, birth weight, an important trait in cattle breeding, was a response variable and environmental factors such as calf sex, calving season and year were accepted as explanatory variables. Statistical evaluations were done using SPSS (Exhaustive CHAID) statistical package program. In the present study, birth year was the most significant factor for birth weight ($P<0.01$), followed by sex ($P<0.01$) and calving season ($P<0.01$). The highest average birth weight was recorded for the calves born during the years 1999-2001. The calves born in summer and fall seasons of 2002-2004 years were lighter than those born in winter and spring seasons of same years. Sex of calf influenced birth weight of calves born between the years 1991 and 1995 ($P<0.01$). Among factors, calving season was a factor that had highly statistical influence on birth weight of the group of calves born between 2002 and 2004 years. As a result, use of regression tree method, which is not influenced by multicollinearity, outlier, and missing values is recommended with the objective to identify factors that can be statistically significant on birth weight of Brown Swiss calves.

Key words: Birth weight, Brown Swiss, Calving Season, Calving Year, Calf sex, Regression Tree.

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INTRODUCTION

As a breed of dairy cattle, Brown Swiss originating in the Swiss Alps has a good adaptability against harsh conditions, high altitudes, and hot or cold climates, and has been reared with

the aim of obtaining milk and milk products for many years. Since 1925, this breed has been imported different times in the Turkey as one of the most preferred breeds among dairy cattle breeds [1].

Birth weight is a trait accentuated not only for breeding purposes but also for economic causes in order to improve the profitability in meat production. Principally, a good recording system in dairy raising is required to assess genetic improvement in birth weight, a reliable measurement of prenatal period which affects postnatal growth-development [2] Afterwards, the recorded data must be subjected to the truest-the most effective estimation methods on the purposes of estimating reliable genetic parameters on the trait as an early selection criteria. However, knowledge on environmental factors significantly influencing the trait has played a vital role in the best estimation of genetic parameters on the trait [3-5]

In the literature, General Linear Model has been mostly preferred to decide environmental factors that could be influential on the birth weight, which is influenced by farm, parity, calving year, calving season, and fodder availability etc. [2, 6], but Regression Tree Method, one of visual-non parametric methods, provides easier interpretation of results of statistical analysis [7,8]. Because, in regression tree method forming homogenous sub-groups for available data, no assumptions are required about the underlying distribution of explanatory variables. In addition, Regression tree method is not influenced by multicollinearity, outlier, and missing values [9].

In recent years, use of regression tree method is popular in different fields, but there were only a few reports on determination of noteworthy factors with use of Regression Tree Method for the birth weight trait [7,10]. Hence, an attempt was made in the present study to determine significant environmental factors affecting the birth weight in the Brown Swiss cattle reared at Sultansuyu State Farm in Malatya province of Turkey.

MATERIALS AND METHODS

Records of 3168 Brown Swiss calves the birth weight in the Brown Swiss cattle kept at Sultansuyu State Farm (lat. 38^0 E, long. 38^0 N, and 981 m above sea level) of Malatya province in the Eastern Anatolia Region of the Turkey were provided for the present study.

Generally, winter and spring months are rainy. The state farm has a continental climate which is dry and hot in summers, and cold in winters. Therein, the highest and lowest temperatures are 43 ^{0}C and – 23 ^{0}C, respectively with an average precipitation of 255.3 mm in the last decade. In the present study, birth weight, sex, calving year, calving season, and parity records were taken from the Brown Swiss calves during 1984 and 2010 years.

In the present study, data regarding Brown Swiss cattle used previously by Kaygisiz [11] 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 [11] used completely different statistical techniques.

Statistical analysis

In the present study, Regression Tree Method was used to identify the best cut-off values for explanatory variables significantly affecting response variable and to generalize prediction rules with regard to a response variable, depending upon the values of explanatory variables [12]. In the regression tree method, first node is called “root node”, and homogenous subgroups formed as a result of reducing variation on response variable with help of explanatory variables, are named “terminal nodes” [13]. Regression tree method turned response (continuous=quantitative) variables into discrete (categorical) variables using

suitable cut-off values [8, 14].

In the present study, explanatory variables such as calving season, calving year, parity, calving interval, and dry period, and response variable (birth weight) were exposed to Regression tree method on the basis of F test that was used as the significance test for a continuous dependent variable as recommended by [12].

All the statistical computations were performed using SPSS (Exhaustive CHAID) package program.

RESULTS AND DISCUSSION

In the General linear model with a R^2 value of 0.323, sex ($P<0.01$), calving year ($P<0.01$), sex x calving year interaction ($P<0.05$), and calving year x calving season interaction ($P<0.01$) were statistically found, whereas calving season, sex x calving season interaction, and sex x calving year x calving season interaction were insignificant (data not shown).

Figure I presents regression tree diagram drawn with the aim of determining factors significantly affecting birth weight in the Brown-Swiss cattle. In the present paper, the most influential factor on birth weight was year ($P<0.01$), followed by sex ($P<0.01$) and calving season ($P<0.01$), secondarily.

Average birth weight for the Brown Swiss cattle was found 43. 834 (S=4.970) kg from Node O, root node, at the top of regression tree diagram. Node 0, a group of all the Brown Swiss calves in the present paper, was divided into eight child nodes (Nodes 1-8), respectively with respect to year factor. Among these eight nodes, Node 5 produced the heaviest birth weight, whereas, Node 1 had the lightest birth weight with an average of 39.434 (S=4.245) kg as illustrated in the regression tree diagram.

Birth average weight for Nodes 1-8 ranged from 39.434 kg (S=4.245) to 46.350 kg (S= 4.385). The birth weight fluctuated considerably from year to year. Node 1, a group of calves born in 1988 and earlier years, was divided into two child nodes, Nodes 9 and 10 in terms of sex factor, respectively. Sex factor had a significant impact on birth weight for a group of calves in Node 1.

Average of male calves (Node 9) was heavier in the birth weight than the average of female ones in Node 10 (40.541 vs. 38.375 kg).

Nodes 2, 4, 5, 7, and 8 were terminal nodes in the advanced stage of the regression tree diagram. The five Nodes reached to sufficient homogenous in regression tree diagram.

Node 2, a group of calves born in the years 1989 and 1990, had an average of 42.323 (S=4.508) kg. Node 4, a group of calves born between the years 1996 and 1998, was with the birth weight of 45.541 (S=4.417) kg.

The birth weight of 46.350 (S= 4.385) kg was obtained from Node 5, a group of calves born between 1999 and 2001. Node 7 (a group of calves born between 2005 and 2006 among all the calves) and Node 8 (a group of calves born later than 2006) produced the birth weight averages of 42.378 (S=4.794) kg and 45.312 (S=5.184).Node 3, a group of calves between the years 1991 and 1995, was statistically influenced by sex factor and was re-branched into two child Nodes 11-12 by sex factor, respectively. Male birth weight average (Node 11) was heavier than female average (Node 12).

In the regression tree diagram, Node 6, a group of calves born between 2002 and 2004 years, was divided into the new child nodes, Nodes 13 and 14, based on calving season, respectively. Node 13 (a group of calves born in fall and summer between 2002 and 2004

calving years) yielded lighter calf birth weight compared to Node 14, a group of calves born in winter and spring seasons between same years.

Present result revealed that Nodes 9-14 as terminal nodes showed sufficient homogeneity in the regression tree diagram. Thus, re-division for these terminal nodes was stopped in the advanced stage of the regression tree analysis. In the regression tree diagram, year, sex, and season factors had significant influence on birth weight. In a study, carried out in private organic diary cattle enterprise in Kelkit district of Gümüshane province, in Turkey, Birth type, sex, season, and body condition scores at birth were reported by [10] using regression tree method.

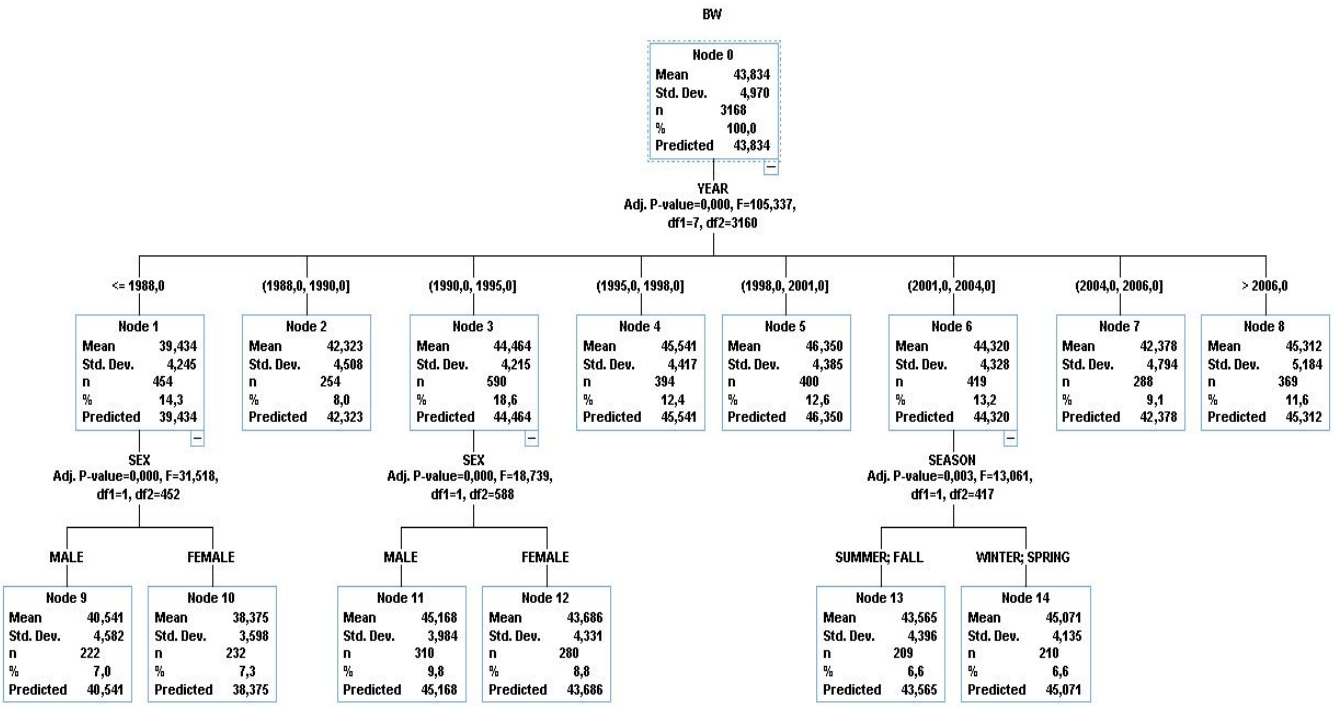
Significant effect of year factor was also reported by many authors [6, 15-18] similarly.

Present results were in agreement with those reported by numerous authors, who found a significant influence of sex factor on the birth weight [6, 15-18].

In previous reports, calving season was a significant factor on the birth weight as observed in the present paper [6, 16, 18].

The dissimilarities of present results with previous published results may be attributed to use of similar or different breeds at various managerial, and ecological conditions, and use of various statistical methods in statistically evaluating data. As a consequence of using different statistical analysis, present results (regression tree method) could not discuss logically with those of other papers (general linear model) published in literature.

Figure 1. Regression Tree Diagram for Birth Weight



CONCLUSION

In dairy science, use of regression tree method, which is not affected by multicollinearity, outlier, and missing values, is relatively limited. Due to these advantageous, the effects of some environmental factors on birth weight were investigated by using regression tree method. In present paper, results of regression tree method reflected that the statistically significant effects of calving year, sex, and season on birth weight of Brown Swiss cattle were noted. The obtained results could be summarized as follows:

- The highly significant factor which statistically affected birth weight of Brown Swiss cattle were calving year, followed by sex and season factors in the regression tree diagram.
- The greatest birth weight average was from the group of calves born among 1999-2001 years at Node 5.
- Birth weight of Node 1, which was the group of calves born in 1988 and earlier years than 1988, was statistically affected by sex factor ($P<0.01$).
- Birth weight of Node 3, which was the group of calves born between 1991 and 1995 years, was also statistically affected by sex factor ($P<0.01$).
- Calving season had a highly statistical influence on birth weight of Node 6, which was the group of calves born between 2002 and 2004 years ($P<0.01$).
- Average birth weight of Node 13, the group of calves born in summer and fall seasons of 2002-2004 years was lighter than those born in winter and spring seasons of same years.

In conclusion, the most special information about the interactions of environmental factors which were studied was very different compared to the information of earlier studies.

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