Kafkas Univ Vet Fak Derg
21 (5): 645-652, 2015
DOI: 10.9775/kvfd.2015.12967

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

Investigate the Effects of Non-genetic Factors on Calving Difficulty and Stillbirth Rate in Holstein Friesian Cattle Using the CHAID Analysis

Bahri BAYRAM [1] Mehmet TOPAL [2] Vecihi AKSAKAL [1] Kadir ÖNK [3]

[1] Gumushane University, Aydin Dogan Vocational School, Department of Organic Agriculture, TR-29600 Kelkit, Gumushane - TURKEY
[2] Ataturk University, Faculty of Agriculture, Department of Biometry and Genetics, TR-25240 Erzurum - TURKEY
[3] Kafkas University, Kars Vocational School, TR-36100 Kars - TURKEY

Article Code: KVFD-2015-12967 Received: 08.01.2015 Accepted: 07.05.2015 Published Online: 12.05.2015

Abstract

A total number of 947 calving records from 613 Holstein Friesian cows raised at a private dairy farm in Kelkit, Turkey, from 2004 to 2006 were used to study the effect of non-genetic factors on calving difficulty and stillbirth rate using CHAID algorithm. The mean calf birth weight was 41.0±0.19 kg. The overall incidence of calving difficulty and stillbirths in the Holstein Friesian herd were 9.1% and 9.4%, respectively. Calf birth weight, birth type and calving season had the greatest impact on calving difficulty. The increase in calf birth weight was associated with a significant increase in calving difficulties (P<0.01). The calving difficulty risk in twins (18.9%) was higher than in singleton calves (5.0%). The main environmental variables affecting the stillbirth rate were parity number, calf birth weight, sex of calf, calving season and calving difficulty. Parity number was statistically the most relevant factor affecting the stillbirth rate, which was also higher in primiparous (18.7%) than in multiparous cows (5.4%). As the calf birth weight increased, a significant increase was also in the stillbirth rate (P<0.01). The stillbirth rate in winter (19.7%) was higher than in other seasons (3.6%) (P<0.01). Calving assistance was associated with an increased risk of stillbirth (P<0.05). As a result, calf birth weight, birth type and calving season had the greatest impact variables on calving difficulty, however, parity, calf birth weight, sex, calving season and calving difficulty were the most effective variables on stillbirth in Holstein Friesian Cattle.

Keywords: *Stillbirth, Calving difficulty, CHAID algorithm, Organic husbandry, Holstein Friesian*

Genetiksel Olmayan Faktörlerin Siyah Alaca Sığırlarda Güç ve Ölü Doğuma Etkilerinin CHAID Analizi İle İncelenmesi

Özet

Bu çalışmada, genetiksel olmayan bazı faktörlerin Siyah Alaca sığırlarda güç ve ölü doğuma etkilerinin CHAID algoritması ile analizi amaçlanmıştır. Bu amaçla, Gümüşhane ilinde faaliyet gösteren özel bir süt sığırı işletmesinde 2004 ile 2006 yılları arasında doğum yapan 613 Siyah Alaca ineğin 947 buzağılama kaydı kullanılmıştır. Buzağılara ait ortalama doğum ağırlığı 41.0±0.19 kg olmuştur. Sürüye ait ortalama buzağılama güçlüğü ve ölü doğum oranları sırasıyla %9.1 ve %9.4 olmuştur. Buzağılama güçlüğünü etkileyen en önemli çevresel değişkenler, buzağı doğum ağırlığı, buzağılama tipi ve buzağılama mevsimi olmuştur. Buzağılara ait doğum ağırlığı artıkça, buzağılama güçlüğü önemli oranda artmıştır (P<0.01). İkiz doğan buzağılarda güç doğum riski (%18.9), tek doğanlardan (%5.0) oldukça yüksektir (P<0.01). Ölü doğuma etkili en önemli çevresel değişkenler sırasıyla; doğum sırası, buzağının doğum ağırlığı, buzağı cinsiyeti, buzağılama mevsimi ve buzağılma güçlüğü olmuştur. Ölü doğum üzerine etkili en önemli değişken doğum sırası olup, ilkine doğum yapan ineklerde ölü doğum oranı (%18.7), çoklu doğum yapanlardan (%5.4) yaklaşık 3.5 kat daha yüksektir. Buzağıya ait doğum ağırlığı artıkça, ölü doğum oranı önemli oranda artmıştır (P<0.01). Kış mevsiminde gerçekleşen doğumlarda ölü doğum (%19.7), diğer mevsimlerden (%3.6) yüksektir (P<0.01). Güç doğan buzağılarda ölü doğum (%10.0), kolay doğanlardan (%1.9) daha yüksektir (P<0.01). Sonuç olarak, Siyah Alaca sığırlarda güç doğuma etkili değişkenler buzağı doğum ağırlığı, doğum tipi ve buzağılama mevsimi olurken ölü doğum üzerine doğum sırası, buzağının doğum ağırlığı, buzağı cinsiyeti, buzağılama mevsimi ve buzağılma güçlüğü en etkili değişkenler olmuştur.

Anahtar sözcükler: *Ölü doğum, Buzağılama güçlüğü, CHAID algoritması, Organik Hayvancılık, Siyah Alaca sığır*

İletişim (Correspondence)
+90 456 2331039
bbayram@gumushane.edu.tr

INTRODUCTION

A stillbirth is defined as the death of a calf right before, during or within 24-48 h from parturition [1-3]. Calving difficulty caused by a prolonged spontaneous calving or a prolonged or significantly assisted extraction is known as dystocia [4]. Mee et al.[5] reported that worldwide the stillbirth rate among dairy cattle varied between 2% and 10%, and dystocia ranged from 2% to 14%. However, several studies have reported an increase in stillbirth rates over the last few years in the United States and in several European countries [1,2,4,6-8].

The productivity of the beef and dairy industry is highly influenced by stillbirth and calving difficulty rates [7,9]. Meijering [10] reported that stillbirths and calving difficulties result into significant costs, which can be either direct (loss of calves, death of dams, veterinary assistance and labour) or long-term (culling rate, milk yield and fertility). It has been estimated that these losses in the dairy industry in the US and the UK amounted to US$ 125 million and £ 60 million, respectively [11]. McGuirk et al.[12]. estimated that the total cost attributable to a severe case of calving difficulty can be as high as 500 euros per case. In addition, calving difficulty is a welfare problem regarded as one of most painful conditions for calves [13].

Genetic, maternal, fetal, environmental and management factors influence stillbirths and calving difficulties [3,14], which however are generally explained by low degree of heritability. It is therefore important to determine the environmental factors causing stillbirths and calving difficulties [15,16].

The analysis of calving difficulty and stillbirth data has generally been conducted by different statistical methods, such as variance analysis [17] and logistic regression [18]. The last method is the most commonly used, because these data are binomial [19]. A potential alternative to the logistic regression is the classification tree method [20]. This technique belongs to the field of data mining, which also includes cluster analysis and artificial neural networks [21]. CHAID (Chi-Square Automatic Interaction Dedector) and CART (Classification and Regression Trees) are classified under data mining. These data mining techniques are predominantly applied in medicine, finance [22], animal farming and breeding [19,23-29]. CHAID analysis has various advantages over other statistical method. These advantages include the following [23,30]: (a) CHAID is a nonparametric method, which does not have to satisfy assumptions; (b) CHAID algorithm presents multiway splits instead of binary splits of the predictor variables; (c) CHAID can be applied for all types dependent variables (continuous, nominal and ordinal); (d) CHAID are invariant under transformations of independent variables; (e) CHAID algorithm includes the most important variables explaining the dependent variable and eliminates insignificant variables; (f) CHAID algorithm provides a graphical representation of the data and interactions within the data set can be determined and the graphical interpretation of complex results containing the interactions; (g) The model has the capability of overcoming missing values in the dependent and independent variables; (h) CHAID output is highly visual and easy to interpret.

In general, previous studies used analysis of variance and logistic regression analysis methods to determine the factors affecting calving difficulty and stillbirth rates in cattle. This study aimed to determine and classify the factors affecting calving difficulty and stillbirth rates in Holstein Friesian cattle using the CHAID algoritm.

MATERIAL and METHODS

Animals and Data Set

This study consists of a set of 947 calving records of 613 Holstein Friesian cows that calved from 2004 to 2006 at a private dairy farm located in Kelkit country in the province of Gumushane in the eastern Black Sea region of Turkey. This dairy farm was founded in the year 2003. During the time period, 5-8 month-pregnant Holstein Friesian cows were brought from farms managed under extensive conditions in the state of Wisconsin in the United States. The farm where the Holstein Friesain cattle herd under study was kept is located at an altitude of 1400 m asl. The climate in this region is relatively dry with rainfalls usually in spring and autumn. During the winter months, it snows a lot and the night temperature may drop even to -10°C. The average temperatures in this region in winter, spring, summer and fall are -1, 8.7, 18.9 and 10.9°C, respectively.

Management and Feeding

Feeding, housing and animal health were managed in compliance with the organic farming regulations issued by the Turkish Ministry of Agriculture and Rural Affairs [31,32] under the supervision of an independent control agency which ensured consistency with all legal requirements. The use of behaviour-regulating hormones and similar agents was forbidden and for mating purposes artificial insemination was mostly used. The ration of organically reared dairy cattle included 60% roughage and 40% concentrate feed. All feeds offered to the cows were grown organically at the farm. Dry meadow hay, dry alfalfa hay and corn silage were used as sources of roughage in the diets of the animals. In this farm, lactating cows were fed daily 6 kg/head of concentrate, 20 kg/head of dry meadow hay and dry alfalfa hay and 10 kg/head of corn silage. Cows were also fed a total mixed ration (TMR) throughout the year.

In this farm, all herd records were kept with great care and monitored on a daily basis. The farm staff in charge of calving management duly recorded all relevant data. The birth weights of all live-born calves were measured within 6 h from birth. Newly-born calves were allowed to suckle from their dams untill the end of first day *post-partum*. They were housed in outdoor calf hutches for 3 months, whereas adult animals were kept in a free stall barn.

In addition to birth weights, the current study also considered a data set with data about birth date, birth season, parity number, birth type (twin, singleton), calf sex, stillbirths, calving difficulty and abortion. The data were edited a few times so as to delete missing, questionable and duplicate records. In addition, gestation periods shorter than 260 days were referred to as abortions [33] and removed from the data set.

Definitions

Deaths prior or during calving, or within 48 h from calving were classified as stillbirths [1-3]. Stillbirths were coded with a 0, whereas live births were coded with a 1. Birth weights of calves that died before or during parturition were not measured and were coded as missing values. Births occurring spontaneously and requiring no intervention were defined as normal calvings, whereas those requiring assistance from a person and/or a veterinary were classified as calving difficulties [4]. Normal births were coded with a 1, whereas calving difficulties were coded with a 0. Parity number was coded as 1., 2., *etc*. The birth season was coded as winter (December-February), spring (March-May), summer (June-August) and autumn (September-November).

Statistical Analysis

The CHAID (Chi-squared Automatic Interaction Detection) method was used for the statistical analysis. It was used to determine the relationship between a dependent and predictor variables. The CHAID is a type of decision tree technique which classifies the population into subgroups setting the variation in the dependent variable within groups with a minimum value and among the groups with a maximum value [34]. It is a multivariate analysis technique which identifies the size and rank of statistically significant differences [35]. In the CHAID analysis, if the dependent variable is nominal, ordinal and continuous, respectively Chi-square test, likelihood ratio test and F test is used to specify the best next split at each step. In this study because dependent variable is nominal, chi-squared test was used to determine each split. The significant difference is measured by the *p*-value obtained from chi-squared test. If the *p*-value for any predictor is less than or equal to $\alpha_{split\text{-}merge}$, split is performed and this process is repeated until no forward splits are found. Conversely, the *p*-value is greater than $\alpha_{split\text{-}merge}$, forwad splits is not performed and process stoped [36]. The area under the ROC curve (AUC) which was used to test the compatibility of the CHAID model shows percentage of correct classifications. The AUC vary from 0.0 to 1.0. A value of 1.0, 0.0 and 0.5 indicates an excellent positive prediction, an excellent negative prediction, and poor prediction performance, respectively. In the CHAID analysis, it was planned to find values belonging to at least 10 individuals in the parent node and 5 individuals in the child nodes in order to identify the random effects of parity, calving season, calving year, birth type, calf sex and calf birth weight, which are the dependent variables. The statistical analysis was performed using the SPSS software package [37].

RESULTS

The birth weight of calves ranged from 23 to 64.2 kg (n = 894), the average birth weight was 41.0 kg (SE=0.19 kg) and 89 calves died with the death time distribution summarized in *Table 1*. CHAID model planned that values belonging to at least 10 individuals in the parent node and 5 individuals in the child nodes be found in order to identify the random effects of parity, calving season, calf year, birth type, calf sex and calf birth weight on calving difficulty *(Fig. 1)*, and parity, calving season, birth year, birth type, calf sex, calf birth weight and calving difficulty on stilbirths *(Fig. 2)*. In the CHAID model, the significant difference is measured by the p-value obtained from a Pearson chi-square test. The α_{merge} and α_{split} values were set at 5% level.

Decision tree diagram constructed via CHAID algorithm for calving difficulty was depicted in *Fig. 1*. According to the tree diagram based on the CHAID algorithm, the number and percentage of calving difficulties were presented in the root node (Node 0) at the top of the decision tree diagram. In this node, 90.9% of the births in the herd were normal, while 9.1% were associated with calving difficulties. This node was divided into four child nodes (Node 1, Node 2, Node 3 and Node 4) according to the level of calf birth weight, which was the most important predictor variable determining calving difficulty in the CHAID model. No calving difficulty was observed when weights of the Holstein Friesian cattle at birth were below the mean calf birth weight (≤33.6 kg) (Node 1). The calving difficulty rate in Node 2, where a considerable part of parturitions within the herd can be found (68.2%), was 5.8%.

The calving difficulty rate was 14.4% when birth weights were equal to almost 5 kg or higher (>45.6 kg) than the average birth weight of the herd (41.0±0.19) (Node 3). Since Node 1 and Node 3 were terminal nodes in

Table 1. *Death time distribution*
Tablo 1. *Buzağı ölümlerinin zamana dağılımı*

Death Time	Stillbirth rate	
	n	**%**
Prior or during birth	53	59.6
Birth-24 h	14	15.7
24-48 h	22	24.7
Total	89	9.4

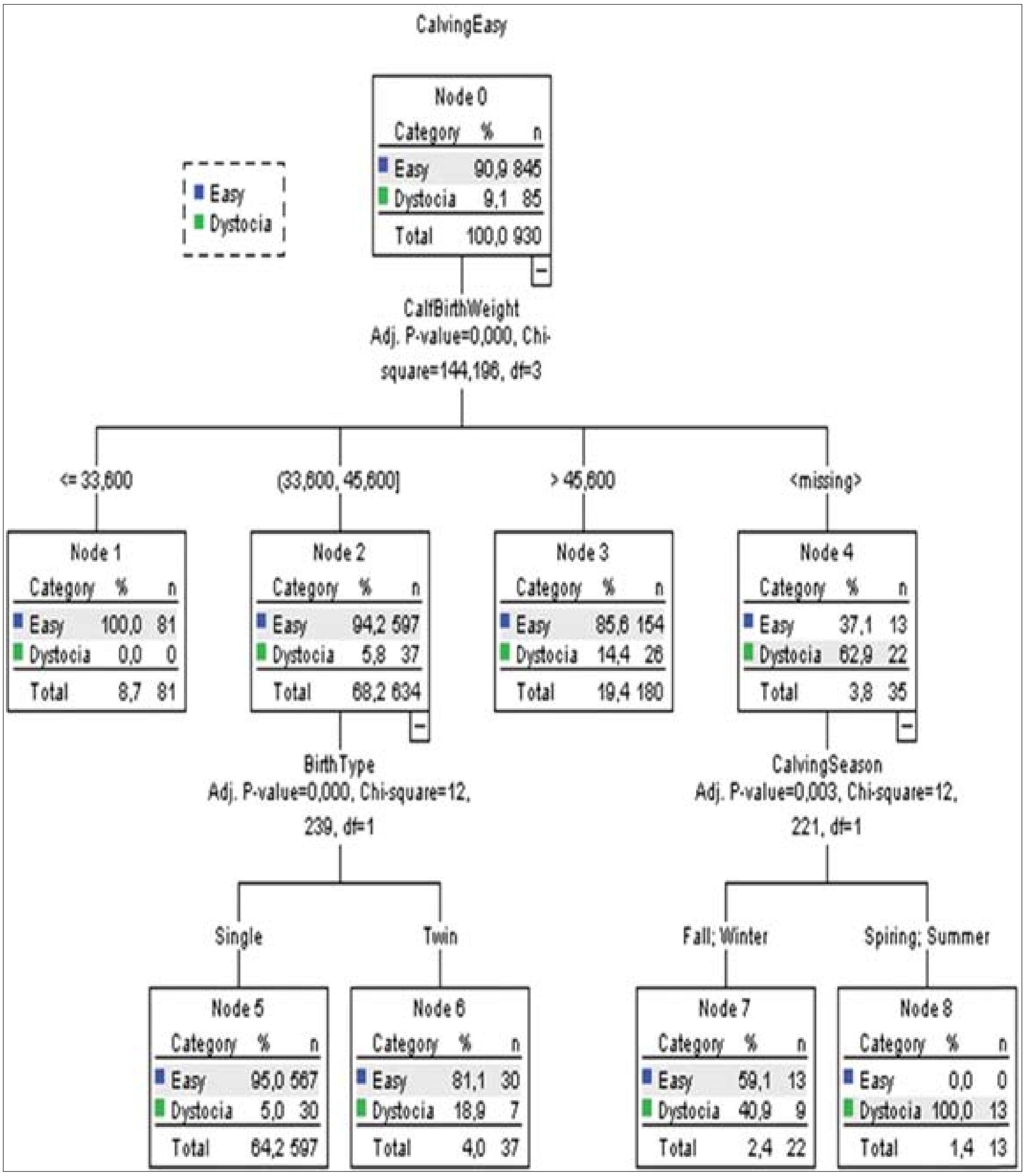

Fig 1. Diagram of the classification tree regarding the calving difficulty
Şekil 1. Buzağılama güçlüğüne ilişkin sınıflandırma ağacı diyagramı

terms of birth weight, they had a homogenous structure, as they were not separated into other nodes. Judging from CHAID diagram, a low level of calf birth weight resulted in significantly greater percentage of easy and smaller percentage of dystocia. It could be argued that when calf birth weight lower than 45.60 kg calving is easy and when it is higher than 45.60 kg the calving is dystocia.

Node 2 and Node 4, on the other hand, were not homogenous and were further divided into child nodes. Node 2, which corresponded to a calf birth weight between 33.6 and 45.6 kg, was furher broken down with respect to the birth type into two nodes, either singleton calf (Node 5) or twin calves (Node 6). The birth type was the second most important variable in causing calving difficulties *(Fig. 1)*. Node 4, which corresponded to a missing value (calves died before or during parturition), was furher split with respect to the calving season into two nodes, either fall-winter (Node 7) or spring-summer (Node 8). The calving season was the third most important variable in causing calving difficulties. While calving difficulties were observed in all stillborn calves born in the warm season, it dropped to 40.9% during the cold season *(Fig. 1)*. Since the other variables are not effective in calving difficulty determination, they are not shown in the tree diagram.

The percentage correct classification, risks, standart error of risk, AUC, standart error of AUC, and predicted

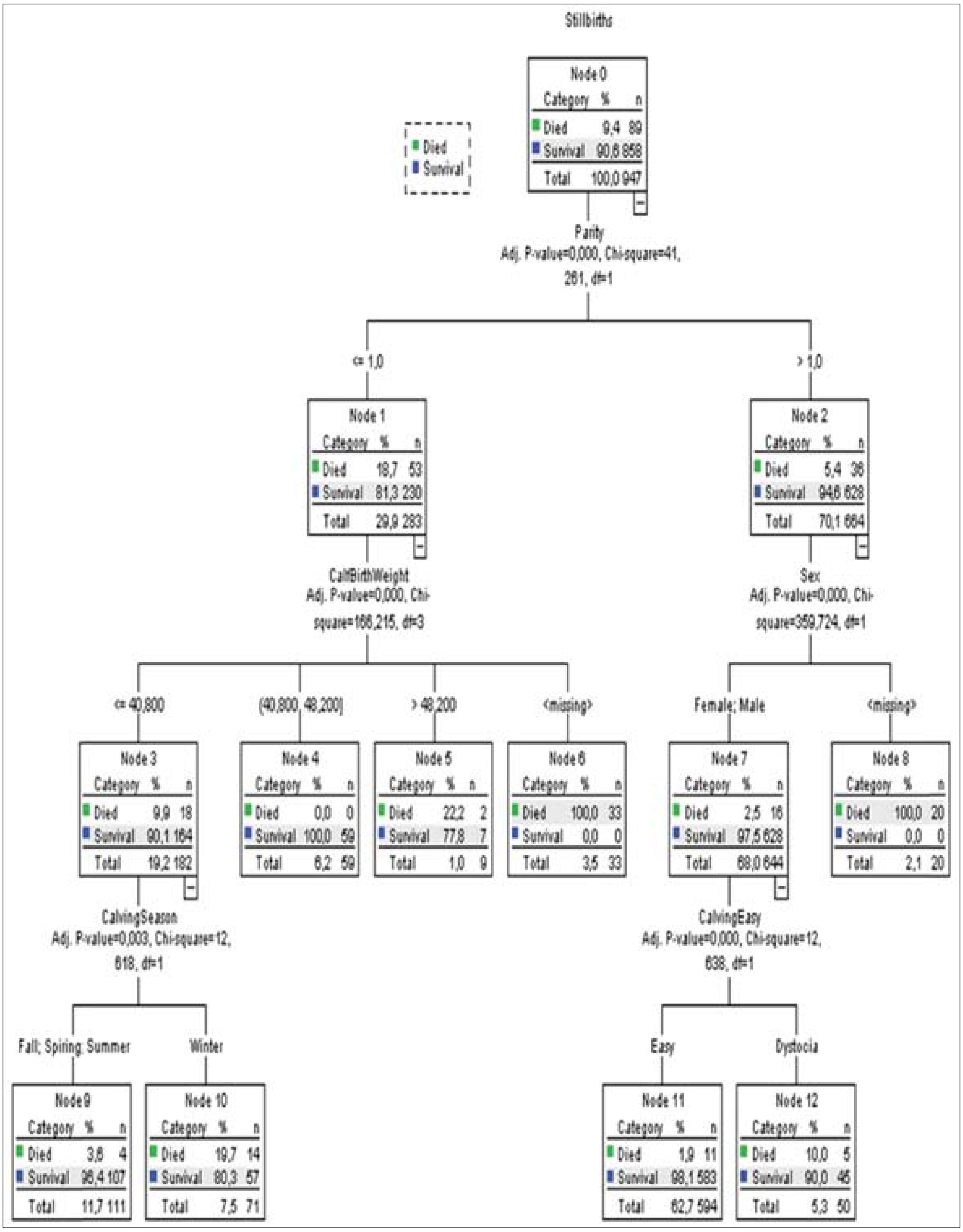

Fig 2. Diagram of the classification tree regarding stillbirth
Şekil 2. Ölü doğuma ilişkin sınıflandırma ağacı diyagramı

values obtained by the fitting CHAID model to predict the calving easy were given in *Table 2*.

According to CHAID analysis, 100% of easy calving and 15.3% of dystocia calving were correctly classified, while 0% of easy calving and 84.7% of dystocia calving were wrongly assigned by using calf birth weight, birth type and calving season variables. CHAID analysis correctly determined 92.3% of calving easy. The AUC and risk values of the model were used to test its compatibility *(Table 2)*. The compatibility of the model could be said to be favourable, because the CHAID analysis showed a fairly high efficiency (92.3%), a low risk value (7.7%), and the area under the ROC curve (AUC=0.752) significantly different from 0.5 (P<0.001) in explaining the model. These meaning that the CHAID algorihm classifies the group significantly better than by chance. AUC value close to 1.0 indicates perfect positive prediction.

Table 2. *Classification results in the CHAID analysis regarding the calving ease*
Tablo 2. *Buzağılama kolaylığı bakımından CHAID analizinde classification tree sonucu*

Calving Easy		Predicted		
		Easy	Difficult	Total
Observed	Easy	845 (100%)	0 (0%)	845
	Difficult	72 (84.7%)	13 (15.3%)	85
	Total	917 (98.6%)	13 (1.40%)	930 (100%)

Percentage Correct: *92.3%;* ***Risk:*** *0.077;* ***Standart Error of Risk:*** *0.009; AUC = 0.752***;* ***Standart Error of AUC*** *= 0.030; *** P<0.001*

Table 3. *Classification results of CHAID analysis regarding stillbirths*
Tablo 3. *Ölü doğum bakımından CHAID analizinde classification tree sonucu*

Stillbirths		Predicted		
		Survival	Death	Total
Observed	Survival	858 (100%)	0 (0%)	858
	Death	36 (40.4%)	53 (59.6%)	89
	Total	894 (94.4%)	53 (5.6%)	947 (100%)

Percent Correct: *96.2%;* ***Risk:*** *0.038;* ***Standart Error of Risk:*** *0.006; AUC= 0.740***;* ***Standart Error of AUC*** *= 0,023*

Decision tree diagram drawn for CHAID algorithm for stillbirths is shown in *Fig. 2.* In this Holstein Friesian herd, parturitions led 90.6% live births and 9.4% stillbirths. This node was divided into two child nodes (Node 1 and Node 2) according parity, which was the most important predictor variable in causin stillbirths in the CHAID model.

Node 1 was divided into four child nodes in terms of birth weight (Node 3, Node 4, Node 5, Node 6), which was the second most important predictor variable in causing stillbirths in *Fig. 2.* Node 2 was further separated with respect to sex of calf in to two child nodes, either female and male (Node 7; 628 survival and 16 died) or missing (Node 8; 0 survival and 20 died). Since the female and male calves were given in a single node (Node 7) in the CHAID diagram, no difference was found between sex of calf in terms of stillbirth rate. Node 3 was divided into two child nodes (Node 9 and Node 10) according to the calving season. The percentage of stillbirths among calves born in the winter months (19.7%) was higher than in the other seasons (3.6%).

Node 7 was divided into two child nodes: easy calving (Node 11) and difficult calving (Node 12). Among calves born normal, *i.e.* in births which required no assistance, the mortality rate was 1.9%, whereas it was 10% in births which required assistance. According to CHAID diagram, the most important variables in determination of stillbirths are parity, calf birth weight, sex, calving season and calving easy, respectively. Birth year and birth type were not effective in stillbirths determination, they are not shown in the tree diagram.

The percentage correct classification, risks, standart error of risk, AUC, standart error of AUC, and predicted values obtained by the fitting CHAID model to predict the stillbirths were given in *Table 3*.

According to CHAID analysis, 100% of survival calf and 40.4% of died calf were correctly classified, while 0% of survival calf and 59.6% of died calf were wrongly assigned by using parity, calf birth weight, sex, calving season and calving easy variables. CHAID analysis correctly determined 96.2% of stillbirths *(Table 3)*. The compatibility of the model could be said to be favourable, because the CHAID analysis had a fairly high efficiency (96.2%), a low risk value (3.8%), and the area under the ROC curve (AUC = 0.752) sifnificantly different from 0.5 (P<0.001) in explaining the model.

DISCUSSION

The average calving difficulty rate in the Holstein Friesian cows was 9.1%. This result was comparable to other study reported (5.4%-10.8%) for the same breed [1,4,5,15,16,38-40]. According to the classification tree technique, the most important variable affecting calving difficulty was the calf birth weight. This result was consistent with the outcome of earlier studies [8,14,15] that showed a increase in the calving difficulty incidence, when the birth weight increased. In dairy cattle breeds, calving difficulty caused by the disproportion between the size of calf and the pelvic area of mother was the most common. The phenotypic variations of these factors in calving difficulty were reported to be 50% and 5-10%, respectively [10].

Although the average calving difficulty rate in this study is comparable with that of Holstein Friesian cows, the calving difficulty rate with birth weights over 45.6 kg (recorded in almost 20% of the herd births) was higher (14.4%). According to the regulations for organic dairy farming in Turkey, daily rations for cattle can cointain 60% of roughage and 40% of concentrate. The use of less concentrate feed was expected to be a negative effect on the growth and development of cattle raised under organic conditions, but no difference was found in terms of age and live weight at first calving between the organic and conventional breeding systems [41-43]. However, further studies are required to reach conclusive results about this matter.

Calving difficulty for twins was almost 4 times greater (18.9%) than for singletons (5.0%). Twin births prolonged the birth process and caused pain to both the mother and the calves, therefore caused calving difficulties that required assistance. Mee et al.[5] reported that birth type was an important factor affecting calving difficulty, whereas Gundelach et al.[7] reported the contrary. The latter author reported that cows with twins had a higher risk of insufficient abdominal contractions.

In this farm, 89 calves were born within 48 h from the beginning of the parturition process. A high calving difficulty rate (62.9%) was associated with death before or during calving. In accordance with our study, Barrier et al.[11] reported that assistance was required and 57.1% of calves died before or during birth. Calving difficulties increase the likelihood of stillbirths due to trauma and anoxia [44]. The significant effect of the calving season on perinatal mortality was noted. Calving difficulties always led to stillbirths in the warm season, whereas this rate was only 40.9% in the cold season. Also earlier studies reported that the calving season is a significant factor affecting calving difficulty [3,4,9].

The average stillbirth rate in Holstein Friesian cows was 9.4%. This result was comparable to other study reported (4.06%-9.7%) for same breed [6,7,14-16,44]. In this study, the effect of parity on the stillbirth rate was significant as also mentioned by earlier authors [1,7,8,9,44]. In this respect the most important factor was the fetus-dam pelvis disproportion [1,5,8,9]. Uematsu et al.[9] reported that a high fetus weight in pregnant heifers with an immature pelvis increased the risk of calving difficulty and stillbirths. The study conducted by Gundelach et al.[7] in Holstein Friesain cows with pelvis sizes of >55 *versus* ≤55 reported stillbirth rates of 7.0% and 15.6%, respectively.

In our study, the stillbirth rate in primiparous cows (18.7%) was almost 3.5 times greater than in multiparous cows (5.4%). Although in some previous studies [1,44] differences were found in terms of parity, the differences reported for the primiparous group (7.97%-13.2%) and the multiparous group (4.51%-6.66) was lower compared those obtained in our study. These differences can be questioned in many respects. Firstly, the Holstein Friesian cattle is the dairy breed with the highest mortality rate [3], and the Northern American genotypes of this breed even have a higher mortality rate [4]. Secondly, a limited amount of concentrate feed was used in the organic dairy system. In Turkey, the daily rations for cattle can cointain 60% of roughage and 40% of concentrate, but, given the insufficient feed production and high prices, it is difficult to provide organic concentrate feed to cattle. Therefore, concentrate feed is given to cattle only in the most physiologically demanding periods. During growth and development, the diet is mainly based on roughage. This may a negative influence on the growth and development of heifers and is also thought to increase the stillbirth rate, given their narrow pelvis size at the time of calving. Further studies are required in order to reach conclusive results on this matter.

Birth weight of calf significantly affected the stillbirth rate as also reported by other authors [1,8,15]. This result was mainly attributable to a disproportion between the fetus and the dam pelvis [3]. In this study, a total 89 calves that died, more than half (n=53) died prior or during birth. This suggests that there were other problems in this farm apart from the fetus-pelvis disproportion that had a negative influence on the vitality of calves. It would be necessary to conduct an anatomical, pathological and histological examination of the calves which died before or during calving.

In accordance with previous studies [8,44,45], the stillbirth rate increased, due to the increase in dry matter intake lead to an increase in the birth weight during the winter months. Also, in cold weather increased gestation length and calf birth weight was a high risk for stillbirth, whereas in summer less intensive calving supervision and more oppurtinity for exercise at pasture was a low risk for stillbirth [5].

In accordance with the previous studies [1,3,7,11,16,44], the influence of calving difficulties on the stillbirth rate was significantly important. Some recent studies have reported that any degree of assistance (from limited to veterinary assistance) is an increased stillbirth [6] and even limited assistance (by one person) is also associated with an increased stillbirth risk [12]. It was pointed out that there is an interaction between parity and calving difficulty and that, while the stillbirth rate increased along with the prolongation of the birth process in primiparous cows, the stillbirth rate also increased in case of breech presentation and twins in multiparous cows [7].

It can be stated that in Holstein Friesian herd calving difficulty and stillbirth rates in our study is comparable to other international estimates. Calf birth weight, birth type and and calving season had the greatest impact on calving difficulty. The rates of stillbirth were significantly higher in primiparous (18.7%) than multiparous cows (5.4%). As the calf birth weight increased, a significant increase in stillbirth rate. Calving assistance was associated with an increased risk of stillbirth. Also this study demonstrates that a graphic model made with the classification tree technique makes it possible to clearly indicate factors affecting calving difficulty and stillbirth rates that the farmers and their staff may be required to manage.

Acknowledgments

The authors would like to thanks Dogan Organic Urunler A.S. Farm Directorship and Staff for the data provided.

REFERENCES

1. Meyer CL, Berger PJ, Koehler KJ, Thompson JR, Sattler CG: Phenotypic trends in incidence of stillbirth for Holstein in the United States. *J Dairy Sci,* 84, 515-523, 2001. DOI: 10.3168/jds.S0022-0302(01)74502-X

2. Berglund B, Steinbock J, Elvander M: Causes of stillbirth and time of death in Swedish Holstein calves examined post mortem. *Acta Vet Scand,* 44,111-120, 2003. DOI: 10.1186/1751-0147-44-111

3. Mee JF, Miguel CS, Doherty M: Influence of modifiable risk factors on the incidence of stillbirth/perinatal mortality in dairy cattle. *Vet J,* 199, 19-23, 2014. DOI: 10.1016/j.tvjl.2013.08.004

4. Mee JF: Prevalence and risk factors for dystocia in dairy cattle: A review. *Vet J,* 176, 93-101, 2008. DOI: 10.1016/j.tvjl.2007.12.032

5. Mee JF, Berry DP, Cromie AR: Risk factors for calving assistance and dystocia in pasture-based Holstein-Friesain heifers and cows in Ireland. *Vet J,* 187,189-194, 2011. DOI: 10.1016/j.tvjl.2009.11.018

6. Bicahlo R, Galvao K, Cheong S, Gilbert R, Warnick L, Guard C: Effect of stillbirths on dam survival and reproduction performance in Holstein dairy cows. *J Dairy Sci*, 90, 2797-2803, 2007. DOI: 10.3168/jds.2006-504

7. Gundelach Y, Essmeyer K, Teltscher MK, Hoedemaker M: Risk factors for perinatal mortality in dairy cattle: Cow and foetal factors, calving process. *Theriogenology,* 71, 901-909, 2009. DOI: 10.1016/j.theriogenology.2008.10.011

8. Bleul U: Risk factors and rates of perinatal and postnatal mortality in cattle in Switzerland. *Livestock Sci,* 135, 257-264, 2011. DOI: 10.1016/j.livsci.2010.07.022

9. Uematsu M, Sasaki Y, Kitahara G, Semeshima H, Osawa T: Risk factors for stillbirth and dystocia in Japanese Black cattle. *Vet J,* 198, 212-216, 2013. DOI: 10.1016/j.tvjl.2013.07.016

10. Meijering A: Dystocia and stillbirth an cattle - A review of causes, relations and implications. *Livest Prod Sci,* 11, 143-177, 1984. DOI: 10.1016/0301-6226(84)90057-5

11. Barrier AC, Mason C, Dwyer CM, Haskell MJ, Macrae AI: Stillbirth in dairy calves is influenced independently by dystocia and body shape. *Vet J,* 197, 220-223, 2013. DOI: 10.1016/j.tvjl.2012.12.019

12. McGuirk BJ, Forsyth R, Dobson H: Economic cost of difficult calvings in the United Kingdom dairy herd. *Vet Rec,* 161, 685-687, 2007. DOI: 10.1136/vr.161.20.685

13. Huxley JN, Whay HR: Curret attitudes of cattle practitioners to pain and the use of analgesics in cattle. *Vet Rec,* 159, 662-668, 2006. DOI: 10.1136/vr.159.20.662

14. Atashi H, Abdolmohammadi A, Dadpasand M, Asaadi A: Prevalence, risk factors and consequent of dystocia in Holstein dairy cows in Iran. *Asian-Australas J Anim Sci,* 25, 447-451, 2012. DOI: 10.5713/ajas.2011.11303

15. Piwczynski D, Nogalski Z, Sitkowska B: Statistical modeling of calving ease and stillbirths in dairy cattle using the classification tee technique. *Livest Sci,* 154, 19-27, 2013. DOI: 10.1016/j.livsci.2013.02.013

16. Zadeh NGH: Effect of dystocia on the productive performance and calf stillbirth in Iranian Holsteins. *J Agri Sci Techn,* 16, 69-78, 2014.

17. Naazie A, Makarechian MM, Berg RT: Factors influencing calving difficulty in beef heifers. *J Anim Sci,* 84, 515-523, 1989.

18. Olson KM, Cassell BG, McAllister AJ, Washburn SJ: Dystocia, stillbirth, geastation length, and birth weight in Holstein, Jersey and reciprocal crosses from a planed experiment. *J Dairy Sci,* 92, 6169-6175, 2009. DOI: 10.3168/jds.2009-2260

19. Piwczynski D, Sitowska B, Wisneiewska E: Statistical modeling of calving ease and stillbirths in dairy cattle using the classification tee technique. *Livestock Sci,* 154, 19-27, 2013. DOI: 10.1016/j.livsci.2013.02.013

20. Piwczynski D: Using classification trees in statistical analysis of discert sheep reproduction traits. *J Central Eurupean Agri,* 10, 303-310, 2009.

21. Grzesiak W, Zaborski D, Sablik P, Pilarczyk R: Detection of difficult conceptions cows using selected data mining methods. *Anim Sci Paper Rep,* 29, 293-302, 2011.

22. Feldman D, Gross S: Mortgage default: Classification trees anlaysis. The pinhas Sapir center for development Tel-Aviv University. *Discussion Paper,* 3, 1-46, 2003.

23. Topal M, Yağanoğlu AM, Sönmez AY, Arslan G, Hisar O: Using discriminant and chaid analysis methods to identify sex in Brown trout *(Salmo trutta fario)* by morphometric features. *Israeli J Aaquaculture - Bamidgeh,* 4, 251-259, 2010.

24. Eyduran E, Karakus K, Keskin S, Cengiz F: Determination of factors influencing birth weight using regression tree (RT) method. *J Appl Anim Res,* 34, 109-112, 2008. DOI: 10.1080/09712119.2008.9706952

25. Khan MA, Tariq MM, Eyduran E, Tatliyer A, Rafeeq M, Abbas F, Rashid N, Awan MA, Javed K: Estimating body weight from several body measurements in Harnai sheep without multicollinearity problem. *J Anim Plant Sci*, 24, 120-126, 2014.

26. Eyduran E, Yilmaz I, Tariq MM, Kaygisiz A: Estimation of 305-d milk yield using regression tree method in Brown Swiss cattle. *J Anim Plant Sci*, 23, 731-735, 2013.

27. Mohammad MT, Rafeeq M, Bajwa MA, Awan MA, Abbas F, Waheed A, Bukhari FA, Akhtar P: Prediction of body weight from body measurements using regression tree (rt) method for indigenous sheep breeds in Balochistan, Pakistan. *J Anim Plant Sci*, 22, 20-24, 2012.

28. Eyduran E, Yilmaz I, Kaygisiz A, Aktas ZM: An investigation on relationship between lactation milk yield, somatic cell count and udder traits in first lactation Turkish saanen goat using different statistical techniques. *J Anim Plant Sci*, 23, 956-963, 2013.

29. Mendes M, Akkartal E: Regression tree analysis for predicting slaughter weight in broilers. *Italian J Anim Sci*, 8, 615-624, 2009. DOI: 10.4081/ijas.2009.615

30. Koyuncugil AS, Ozgulbas N: Surveillance technologies and early warning systems: Data mining applications for risk detection. 160-164, IGI Global, USA, 2010.

31. Anonymous: The production, processing and marketing of plant and animal products produced by organic farming methods. Ministry of Agriculture and Rural Affairs Publ., Ankara, Turkey, 2002.

32. Anonymous: The production, processing and marketing of plant and animal products produced by organic farming methods. Ministry of Agriculture and Rural Affairs Publ., Ankara, Turkey, 2005.

33. Kornmatitsuk B, Franzen G, Gustafsson H, Kinddahl H: Endocrine measurements and calving performance of Swedish Red and White and Swidish Holstein dairy cattle with special respect to stillbirth. *Acta Vet Scand,* 44, 21-33, 2003.

34. Doğan İ: Investigation of the factors which are affecting the milk yield in Holstein by CHAID analysis. *Ankara Üniv Vet Fak Derg,* 50, 65-70, 2003.

35. Topal M, Aksakal V, Bayram B, Yağanoğlu AM: An analysis of the factors affecting birth weight and actual milk yield in Swedissh Red cattle using regression tree analysis. *J Anim Plant Sci,* 20, 63-69, 2010.

36. Rokach L, Maimon O: Data Mining and Knowledge Discovery Handbook. Second ed., Springer, 2010.

37. SPSS, 2004. SPSS for Windows, Release 17.0, SPSS Inc., Chicago, IL., USA.

38. Fiedlerova M, Rehak D, Vacek M, Volek J, Fiedler J, Simecek P, Masata O, Jiler F: Analysis of non-genetik factors calving difficulty in the Czech Holstein populatıın. *Czech J Anim Sci,* 53, 284-291, 2008.

39. Gevrekçi Y, Akbaş Y, Kizilkaya K: Comparison of different models in genetic analysis of dystocia. *Kafkas Univ Vet Fak Derg,* 17, 384-392, 2011. DOI: 10.9775/kvfd.2010.3606

40. Aksoy Ö, Özaydın İ, Kılıç E, Öztürk S, Güngör E, Kurt B, Oral H: Evaluation of fractures in calves due to forced extraction during dystocia: 27 cases (2003-2008). *Kafkas Univ Vet Fak Derg,* 15, 339-344, 2009. DOI: 10.9775/kvfd.2008.100-A

41. Kristensen T, Kristensen ET: Analysis and simulation modeling of the production in Danish organic and conventional dairy herds. *Livest Prod Sci,* 54, 55-65, 1998. DOI: 10.1016/S0301-6226(97)00053-5

42. Roesch M, Doherr MG, Blum JW: Performance of dairy cows on Swiss farms with organic and integrated production. *J Dairy Sci,* 88, 2462-2475, 2005. DOI: 10.3168/jds.S0022-0302(05)72924-6

43. Naute WJ, Baars T, Bovenhuis H: Converting to organic dairy farming: Consequences for production, somatic cell scores and calving interval of first parity Holstein cows. *Livest Sci,* 99, 185-195, 2006. DOI: 10.1016/j.livprodsci.2005.06.013

44. Atashi H: Factors affecting stillbirth and effects of stillbirth on subsequent lactation performance in a Holstein dairy herd in Isfahan. *Iranian J Vet Res,* 12, 24-30, 2011.

45. Johanson JM, Berger PJ: Birthweight as a predictor of calving ease and perinatal mortality in Holstein cattle. *J Dairy Sci,* 86, 3745-3755, 2003. DOI: 10.3168/jds.S0022-0302(03)73981-2