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Factors Affecting Milk Yield Estimated with Different Methods in Brown Swiss Cattle[#]

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ABSTRACT

The aim of this study was to determine the effects of some environmental factors on milk yield levels that were estimated with different methods in Brown Swiss cattle raised in Altınova Farm. Study was carried out under similar feeding and management program. The effects of lactation turn, year and season were analysed in terms of measurable environmental factors. The data was statistically analyzed by means of the least-square method for the determination of the effects of environmental factors and by *contrast-test* (GLM procedure). Lactation milk yield (6294.7 kg, 6320.8 kg, 6313.9 kg) and 305 day milk yield (5927.1 kg, 6016.2 kg and 6047.5 kg) were estimated by Dutch (Holland), Swedish and Trapez methods in Brown Swiss cattle. The effects of lactation turn, year and season on lactation milk yield and 305 day milk yield were found as statistically significant (P<0.001).

Key Words: Brown Swiss, milk yield, environmental factors

ÖZET

ESMER SIĞIRLARIN FARKLI METOTLARA GÖRE TAHMİN EDİLEN SÜT VERİMLERİ ÜZERİNE BAZI FAKTÖRLERİN ETKİLERİ

Bu çalışma, Altınova Tarım İşletmesi'nde yetiştirilen Esmer sığırların farklı metodlar ile belirlenen süt verimlerine ait düzeyler ve bunlar üzerindeki bazı çevre faktörlerinin etkilerinin belirlenmesi amacıyla yapılmıştır. Araştırmadaki hayvanlara ortak bir bakım ve besleme programı uygulanmıştır. Çalışmada etkisi ölçülebilir çevre faktörleri olarak laktasyon sırası, yıl ve mevsimin etkileri üzerinde durulmuştur. Verilerin istatistik analizlerinde, çevresel faktörlerin etki paylarının belirlenmesinde minimum kareler metodu ve bunların karşılaştırılmasında *contrast-testi*, GLM prosedürü kullanılarak yapılmıştır. Çalışmadaki Esmer sığırların Hollanda (Dutch), İsveç ve Trapez metodlarına göre laktasyon süt verimi 6294,7 kg, 6320,8 kg ve 6313,9 kg, 305 günlük süt verimleri ise 5927,1 kg, 6016,2 kg ve 6047,5 kg belirlenmiştir. Süt verimlerinde laktasyon sırası, yıl ve mevsim faktörlerinin önemli olduğu bulunmuştur (P<0,001).

Anahtar Kelimeler: İsviçre Esmeri, süt verimi, çevre faktörleri

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[#] This study was summarized from the first author's PhD thesis.

Introduction

Milk yield can be increased with optimizing the environmental conditions and improving the genetic structure of the animals. This can be managed by applying an accurate selection program to the animals that are obtained with inbreeding of highly productive import animals or crossbreeding them with the native breeds.

Determination both of individual milk yield value of the animals and effects of measurable environmental factors on this value are depended on choosing an accurate and systematic selection method for improving milk yield characteristics in cattle breeding.

Lactation milk yield is determined in periodically exercising milk yield controls by different methods. When control intervals are not equal Dutch (Holland) method, since its practical, is the most preferred one among these methods. The mean milk control value is considered to be maintained during lactation in the Dutch method.

In the Swedish method which is accepted as more sensitive, milk yield control day is considered to be in the middle of control period and milk yield in control day is accepted as average daily milk yield of animals in this period.

According to Trapez method, milk yield in both between calving – first control date and between last control – drying date were accepted as stayed the same as in daily milk yield in both first control and last control respectively. The average milk yield of two consecutive control days also accepted as daily milk yield during the period of these control dates.

Thus lactation milk yield is estimated by adding the milk yields in the beginning and last period and random periods of lactation (Everett and Carter, 1968; Gönül, 1971; Gönül et al., 1986; Gravert, 1987; Güneş, 1996; Johansson, 1961).

Yield characters are determined by genetic structure and environmental factors during the production period which consists of measurable affects such as age, year and season and non-measurable affects such as climate, illness, and grazing. High production level can be obtained by improving both genetic structure and environmental conditions. Accurate stud selection is possible with determination of effect of measurable environmental factors on production yields and using these in standardization of an individual.

The aim of this study was estimating both lactation milk yield and 305 days milk yield by Dutch, Swedish and Trapez methods and evaluating some environmental factors that effect on these characters in Brown Swiss cattle raised in Altınova Farm.

Materials and Methods

This study was carried out with the data obtained from Brown Swiss cattle in Altınova Farm that is located in Konya Kadıhanı and related to General Directorate of Agricultural Enterprises.

Yield values between 1991 and 1997 of Brown Swiss cattle in the enterprise were used. Individual care and feeding programme was applied to the animals in Altınova Farm.

Animals were milked twice a day. Milk yield on the 15th day of each month was taken into consideration for performing milk yield controls. Computer based controlling and feeding system that was introduced in 1990-1991 to the farm, determined the standard feeding ratio of concentrate feed and grass hay for animal survival rate. Furthermore, additional concentrate feed was given according to computer based program depending on the milk yield value of the animals. The equations below were used to calculate milk yield according to Dutch (M_H), Swedish (M_S) and Trapez (M_T) methods (Gönül, 1971; Gönül et al., 1986; Güneş, 1996):

$$M_H = \frac{\sum_i^n k_i}{\sum_i^n n} * L \qquad M_S = \left[a * \sum_i^n k_i \right] - \left[\left[\left(\frac{a}{2} \right) - (A_1 - D) \right] * k_1 \right]$$

$$M_T = [\,(A_1 - D) * k_1\,] + \left[\sum_i^n \left[\left(\frac{k + k'}{2} \right) * (A' - A) \right] \right] + [\,(S - A_n) * k_n\,]$$

In which *M*: lactation milk yield, *L:* lactation duration, *D*: calving date, *S*: drying date, *n*: is number of milk yield control, *a:* control period, *A* and *A'*: consecutive milk control dates, *k* and *k'*: milk yield in consecutive controls.

Lactations which lasted less than 305 days were taken directly without using any corrections for calculating milk yield of 305 days. For longer lactation periods correction factors were not use, they were calculated with the controls up to 305 days. Incomplete lactation milk yields and parameters of lactation periods less than 270 days were not evaluated. Lactation turn, year and season effects were pointed out in this study.

The equation below was used for statistics analyzes about yield characteristics of Brown Swiss in this study:

$Y_{ijkl} = \mu + L_i + S_j + M_k + e_{ijkl}$

In which: Y_{ijkl}: Yield value of the examined trait, μ: Expected mean, L_i: Effect of the lactation turn (*i*= 1-8), S_j: Effect of the year (*j*= 1991-1997), M_k: Effect of the season (*k*= Winter, spring, summer and autumn), e_{ijkl}: Random error.

Since there were no daily milk yield values, real milk yield could not been detected.

In the study, lactation milk yield is not given because there are not the values of daily milk yield. Therefore instead of determining the closest prediction method to reality, the differences between mean values of common groups and subgroups of three different models were compared.

In order, to find the effect ratios of the factors showing classified variation and the ratios of environmental factors in general variation were estimated by *least square method* and significance control among means of effect proportions (Searle, 1971) was determined by *contrast-test*. The data were analysed with the *general linear models (GLM) procedure* (Goodnight and Harvey, 1978; Searle et al,. 1980).

Results

Statistical controls of overall and corrected means of lactation and 305 days milk yield estimated by Dutch, Swedish and Trapezoid methods in Brown Swiss cattle raised in Altinova Farm and differences among subgroups that were created according to lactation turn, lactating started years and seasons and effectiveness of these factors and determination degrees were given in Tables 1 and 2.

Expected means of lactation milk yield were found 6294.7 kg, 6320.8 kg and 6313.9 kg according to Dutch, Swedish and Trapez methods. Lactation milk yield determination degrees of factors, whose effects were examined, were calculated as 19.1%, 18.8% and 18.9% respectively. General effect of the factors whose effects were examined on lactation milk yield, lactation order and the effects of lactation year and season were found significantly important at $P<0.001$ level for each three methods.

The differences among corrected mean values, which were obtained by gathering into groups of lactation milk yield prediction methods according to lactation turn, lactation year and lactation season, were found statistically significant (P<0.05).

In comparison of Dutch, Swedish or Trapez methods neither expected mean, nor mean values of subgroups, were found statistically different.

According to Dutch, Swedish and Trapez methods expected means of 305 days milk yield, were found 5972.1 kg, 6016.2 kg and 6047.5 kg respectively. According to prediction methods 305 days milk yield effectiveness of examined factors were estimated as 24.7%, 24.5% and 24.4% respectively. As in lactation milk yield, independent and general influence of lactation turn, year and season factors on 305 days milk yield was also found statistically significant in P<0.001 level.

The lowest and the highest prediction values in subgroups of both lactation milk yield and 305 days milk yield were also found in the same subgroups of prediction methods.

Table 1. General and corrected means of lactation milk yield (kg) by Dutch (Holland), Swedish and Trapez methods, effect proportions of the observed factors, comparison among the groups, significance level (*F values*) and determining degree (R^2) of Brown Swiss cattle.

Tablo 1. İsviçre Esmer sığırlarda Hollanda, İsveç ve Trapez metotlarına göre genel ve düzeltilmiş laktasyon süt verim ortalamaları (kg), gözlenen faktörlerin etki düzeyi, gruplar arası karşılaştırmalar, önem düzeyi (*F değeri*) ve belirleme derecesi (R^2).

Factors	n	Dutch (Holland)	Sweden	Trapez
Overall means	1316	6219.6±46.18^A	6249.1±46.34^A	6242.0±46.32^A
Expected means	1316	6294.7±41.78^A	6320.8±42.01^A	6313.9±41.97^A
All factors - *F value* (R^2)		*19.20*** (0.191)*	*18.79*** (0.188)*	*18.91*** (0.189)*
Lactation turn - *F value* (R^2)		*13.14*** (0.057)*	*12.98*** (0.057)*	*13.05*** (0.057)*
1	439	-687.47^c	-680.02^c	-684.20^c
2	325	-0.53^b	4.28^b	-1.33^b
3	223	208.02^{ab}	213.58^{ab}	210.23^{ab}
4	130	362.51^a	380.28^a	375.74^a
5	83	265.72^{ab}	250.61^{ab}	261.35^{ab}
6	57	0.44^{ab}	35.92^{ab}	13.80^{ab}
7	30	48.13^{ab}	25.79^{ab}	37.53^{ab}
8	29	-196.82^{abc}	-230.44^{bc}	-213.12^{abc}
Year - *F value* (R^2)		*26.87*** (0.100)*	*25.91*** (0.097)*	*26.32*** (0.099)*
1991	157	-1242.91^e	-1231.56^e	-1239.36^e
1992	156	-194.41^d	-201.59^d	-194.16^d
1993	178	87.76^{cd}	96.15^{cd}	91.63^{cd}
1994	183	203.64^{bc}	214.10^{bc}	215.70^{bc}
1995	236	463.12^{ab}	408.29^{ab}	435.12^{ab}
1996	244	574.71^a	586.30^a	579.46^a
1997	162	108.09^{cd}	128.31^{bc}	111.61^{cd}
Season - *F value* (R^2)		*11.09*** (0.021)*	*11.20*** (0.021)*	*10.94*** (0.020)*
Winter	315	338.29^a	331.95^a	328.85^a
Spring	442	27.88^b	35.35^b	45.45^b
Summer	337	-349.48^c	-360.96^c	-353.48^c
Autumn	222	-16.69^b	-6.34^b	-20.82^b

$^{a, b, c, d, e}$: Differences between sub-groups with different superscripts are statistically significant (P<0.05).
^{A}: The differences between overall means are not significant (P>0.05).
***: P<0.001.

Table 2. General and corrected means of 305 days milk yield (kg) by Dutch (Holland), Sweden and Trapezoid methods, effect proportions of the observed factors, comparison among the groups, significance level (*F values*) and determining degree (R^2) of Brown Swiss cattle.

Tablo 2. İsviçre Esmer sığırlarda Hollanda, İsveç ve Trapez metotlarına göre genel ve düzeltilmiş 305 günlük süt verimi ortalamaları (kg), gözlenen faktörlerin etki düzeyi, gruplar arası karşılaştırmalar, önem düzeyi (*F değeri*) ve belirleme derecesi (R^2).

Factors	*n*	Dutch (Holland)	Sweden	Trapezoid
Overall means	1316	5844.8±38.55^{B}	5923.7±39.31^{AB}	5953.3±39.88^{A}
Expected means	1316	5927.1±33.67^{B}	6016.2±34.35^{AB}	6047.5±34.88^{A}
All factors - *F value* (R^2)		26.56*** (0.247)	26.41*** (0.245)	26.22*** (0.244)
Lactation turn - *F value* (R^2)		*21.77*** (0.088)*	*22.26*** (0.090)*	*21.74*** (0.088)*
1	439	-712.39^{d}	-741.26^{d}	-746.88^{d}
2	325	-33.27^{b}	-34.15^{b}	-38.11^{b}
3	223	214.65^{ac}	216.73^{ac}	212.00^{ac}
4	130	363.82^{a}	360.42^{a}	368.68^{a}
5	83	336.94^{a}	338.23^{a}	327.79^{a}
6	57	38.71^{ab}	70.04^{ab}	44.74^{ab}
7	30	21.71^{ab}	-0.63^{ab}	32.45^{ab}
8	29	-230.17^{bc}	-209.38^{bc}	-200.68^{bc}
Year - *F value* (R^2)		*33.95*** (0.118)*	*32.65*** (0.113)*	*32.95*** (0.115)*
1991	157	-1084.95^{d}	-1089.96^{d}	-1116.61^{d}
1992	156	-199.86^{c}	-203.39^{c}	-198.49^{c}
1993	178	45.30^{bc}	33.39^{bc}	43.57^{bc}
1994	183	166.50^{b}	153.01^{b}	172.41^{b}
1995	236	470.12^{a}	423.65^{a}	451.12^{a}
1996	244	541.54^{a}	568.00^{a}	562.16^{a}
1997	162	61.35^{bc}	115.30^{bc}	85.84^{b}
Season - *F value* (R^2)		*11.81*** (0.020)*	*12.35*** (0.022)*	*12.49*** (0.021)*
Winter	315	275.39^{a}	281.97^{a}	288.62^{a}
Spring	442	60.42^{b}	64.08^{b}	65.90^{b}
Summer	337	-286.42^{c}	-304.07^{c}	-309.65^{c}
Autumn	222	-49.39^{b}	-41.98^{b}	-44.87^{b}

$^{a, b, c, d, e}$: Differences between sub-groups with different superscripts are statistically significant (P<0.05).
$^{A, B}$: The differences between overall means are significant (P<0.05).
***: P<0.001.

Discussion

Lactation milk yields that predicted by Dutch, Swedish and Trapez methods were found close to each other, differences were determined as non-significant.

After the inspection of overall values, observed maximum difference among the methods was 29.5 kg. Accordingly one of these three methods can be used for prediction of lactation milk yield. Predicted 305 days milk yield were also found close to each other. However the difference between Dutch and Trapez methods were found significantly important at the level of P<0.05. Coincidence or milk yield divergences in before and after 305 days controls could be the reasons of the importance of even a few differences. These foundings resemble the conclusions of Mundan et al. (2006) in which according to controls performed in 21-56 days intervals, differences between Dutch and Swedish methods were reported as non-significant.

Comparison of observed milk yields and predicted milk yields were performed by

Mundan et al. (2006), however only predicted milk yields were compared in this study.

Findings of this study were also similar with a study of by Kaya et al. (2002). It based on the comparison of different milk yield control applications and estimation methods in Holstein, Simmental and Brown Swiss cattle and reported that differences among 305 days milk yield determined by Dutch and Trapez methods were found significant.

In the present study, the differences between prediction methods in milk yield were not significant. In contrast to the current study Orman and Ertuğrul (1999) reported significant differences among Wood, Schaeffer and Glasbey prediction methods in Holstein. Sargent et al. (1968) reported that Trapez method was more advantageous comparing to the Swedish method, however both methods were equally trustable. Gönül (1971) compared two results with similar accuracy by Swedish and Dutch methods and concluded similar results.

Lactation turn, as an important factor in milk yield, was increased in following lactations. Most Young cattle in first calving and some in advanced years not produce as much milk as mature ones could. It is expected that the beginning age of lactation and lactation turn is important for milk yield. Lactation turn effects milk yield of lactation and 305 days that were evaluated separately by Dutch, Swedish and Trapez methods, were found significant at the $P<0.001$ level. An increase was observed in the 4th lactation turn and non-significant decreases were observed between following lactations until the 8th lactation turn.

These findings were similar with the results of some other studies (Dağ et al., 2003; Fuerst and Sölkner, 1994; Koçak and Ekiz, 2006; Özbeyaz and Küçük, 1999; Tilki et al., 2005) and similar with the findings of a study examining the fertility and milk yield of Brown Swiss cattle raised in Altınova Farm performed by İnci et al. (2006).

Milk yield will improve in following years by keeping the high yielded animals in herd, using potentially high yielded bulls in insemination, increasing the lactation number and applying an adequate management program.

Year was the most important determination factor in this study ($P<0.001$). The highest increase in milk yield was observed in the years between 1991 and 1992 by modifications in care and feeding.

Although health, care and management were optimized, animals could not reach the desirable yield values. Since animals were fed in herd, feeding them according to their individual requirements would help to increases milk yield (Alpan, 1964). Since computer based individually feeding programme was started to be applied milk yield was increased in the modification period.

The results of this study show that year factor effect on milk yield in Brown Swiss cattle was significant as in the other similar studies (ASR, 2006; BSA, 2007; İnci et al., 2006; SBZV, 2007).

Although cattle were kept under the same care and feeding conditions the whole year, it was observed with all prediction methods that season effected on milk yield significantly at the $P<0.001$ level.

Milk yield of the ones whose lactation started in summer was determined significantly lower than the others ($P<0.05$). The highest milk yield was found in the ones whose lactation started in winter. Accordingly it can be concluded that animals are affected from high temperature during summer more than other seasons.

Conclusion

Although the differences among the overall lactation milk yield and subgroups for both lactation and 305 days milk yield were not significant, the only significant differences was found among overall means of 305 days milk yield with Dutch, Swedish and Trapez methods. Milk yield increased up to 5th lactation than decreased greatly.

It was observed that milk yield increases till the 5th lactation but later it decreases. Therefore milk yield of the herd can be increased by culling cattle after their 5th or 6th lactation turn and keeping the persistency of lactation period that milk yield riches at the highest level.

As a conclusion it was determined that lactation turn, year and season effects that are observed as an environmental factors, caused important variations on yield characteristics. Especially the effect of year factor on yields was determined as positive in following years. Applying care and feeding program, selection and election actively also cause to improve yield and these differences reflected as an important effect of year factor.

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