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Genetic Study of Milk Production and Reproduction Traits of Local Born Simmental Cattle in Turkey

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Abstract: Data from 232 Simmental cows calved between 1990 to 2000 obtained from Kazova state farm were used to estimate phenotypic and genetic parameters for milk (305-day milk yield, lactation length, dry period) and reproduction traits (service period and calving interval). Estimates of variance components and parameters of milk and reproduction traits were obtained by restricted maximum likelihood analyses fitting an animal model. Heritability estimates were 0.15, 0.04, 0.04, 0.07 and 0.02 for 305-day milk yield, LL, DP, SP and CI, respectively. Genetic correlations between 305-day MY and each of SP and DP were negative, whereas the correlation between 305-day MY and each of LL and CI are positive. Phenotypic correlation between 305-day MY and each of LL, SP and CI were positive except DP. Results indicate that the heritability of fertility traits in dairy cattle is lower than the other economically important milk traits. The low heritability of fertility traits indicates that the influence of herd management and other environmental effects are greater than the genetic background. The heritabilities and genetic correlations estimated in this study also indicate that selection to improve some of the traits will be possible, but response to selection will be slow.
Keywords: Dairy Cattle, Milk Production, Fertility Traits, Genetic Parameters

Yerli Simmental Sığırlarının Süt ve Döl Verim Özelliklerine ait Genetik Çalışmalar

Özet: Bu çalışma Kazova Devlet Üretme Çiftliğinde yetiştiriciliği yapılan 232 Simmental ineğinin süt (305-gün süt verimi, laktasyon uzunluğu, kuruda kalma süresi) ve döl (servis periyodu ve buzağılama aralığı) verim özelliklerine ait fenotipik ve genetik parametreleri hesaplamak için yapılmıştır. Süt ve döl verim özelliklerine ait varyans bileşenleri ve parametreler bireysel hayvan modeli esas alınarak REML yöntemiyle tahminlenmiştir. 305-gün süt verimi, laktasyon uzunluğu, kuruda kalma süresi, servis periyodu ve buzağılama aralığına ait kalıtım derecesi sırası ile 0.15, 0.04, 0.04, 0.07 ve 0.02 hesaplanmıştır. 305-gün süt veriminin servis periyodu ve kuruda kalma süresi arasındaki genetik korelasyon negatif, laktasyon uzunluğu ve buzağılama aralığı ile pozitif olarak bulunmuştur. 305-gün süt veriminin laktasyon uzunluğu, servis periyodu ve buzağılama aralığı arasındaki fenotipik korelasyon pozitif kuruda kalma süresi ile negatif bulunmuştur. Sonuçlardan döl verim özelliklerine ait kalıtım derecesinin ekonomik olarak önemli süt verim özelliklerinden düşük olduğu görülmektedir. Döl verim özelliklerine ait kalıtım derecesinin düşük olması sürü idaresi ve diğer çevresel faktörlerin etkisinin genetik faktörlerden daha fazla olduğunu göstermektedir. Bu çalışmada elde edilen kalıtım derecesi ve genetik korelasyonların bazı karakterlerin geliştirilebileceğine ancak genetik ilerlemenin yavaş olacağına işaret etmektedir.
Anahtar kelimeler: Süt sığırı, süt verimi, döl verim karakterleri, genetik parametreler

1. Introduction

Cattle husbandry is one of the main area of the animal breeding due to having great marketing impact on breeding stock with exporting sperm, embryos or alive. Although, the relative importance of the characters in cattle breeding programmes may change from country to country according to farmer and consumer requirements, milk yield traditionally has been the most important trait of dairy cattle selection programs in every country. Additionally, many secondary traits such as reproduction traits (Haile-Mariam et al. 2003) and health (Pryce, 1997) are also economically important for dairy enterprise.

Many studies have shown that relationship between milk yield and fertility traits are antagonistic (Damatawewa and Berger, 1998; Bagnato and Oltenacu, 1993; Pryce et al., 1997; Haile-Mariam et al., 2003). This antagonistic relationship between milk production and reproduction is becoming more important for dairy breeders, because the maximum level of milk production is nearly achieved. Generally, selection for increased milk yield reduces reproductive performance and this could affect culling rates and reduce the genetic gain from primary traits (Grosshans et al., 1997; Damatawewa and Berger, 1988, Pryce, 1997; Haile-Mariam et al., 2003). Many authors have stated that the main reason for this antagonistic relationship is assumed to be influenced by the level of production and management systems (Nebel and McGillard, 1993, Grosshans et al., 1997; Damatawewa and Berger, 1988, Pryce, 1997). On the other hand, relationships between milk yield and fertility traits and health were assumed to be that cows produce milk at a maximum level when they are expected to show oestrous and conceive (Haile-Mariam et al. 2003).

Consequently, fertility traits should be included in breeding programmes besides production traits. Lately, in Scandinavia some health and fertility traits were already included in breeding programmes to counter the deterioration in health and fertility due to selection for increased milk yields (Ericson and Wretler, 1990). In the UK, several dairy recording services now offer comprehensive recording of health, fertility and culling information (Pryce, 1997).

The main objectives of this study are to estimate variance components, genetic and phenotypic parameters for 305 day milk yield, dry period, lactation length, service period and calving interval for Simmental cattle reared in Kazova state farm.

2. Material and Methods

2.1. Data

Data consisted of lactation records of 232 cows born from 1987 and onwards and recorded between 1990 to 2000. Pedigree information and the data used in this study were obtained from the Kazova state farm. Prior to analyses, abnormal records affected by diseases or abortion and animals having calving interval less than 310 and greater then 650 days, and lactation length less then 220 and greater then 550 days were excluded from the data set. Additionally, parities more than 5 were also removed form the data set due to less number of observations. Productive traits studied were 305 day milk yield (305-day MY), lactation length (LL), dry period. Reproductive traits were service period (SP) and calving interval (CI). The calving months were grouped into four seasons: December to February (winter), March to May (spring), June to August (summer), and September to November (autumn).

After editing, the data set consisted of 691 multiple lactation records (up to parity 5) on 232 cows which are daughters of 67 sires. Milk records were pre-adjusted for 305-day lactation length. Characteristics of the data set are given in Table 1.

Table 1. Characteristics of the Data Set Used for Genetic Parameter Estimates.

Description	Total
Records in data	691
Cows in data	232
Sires in data	67
Dams in data	163
Animals in pedigree	407
Years (1990-2000)	11
Seasons	4
Lactation classes	5

2.1. Statistical analyses

Preliminary analyses were conducted for the traits to identify the significant fixed effects, eliminating non-significant terms by backwards elimination until all factors were significant ($P<0.05$) using a General Linear Model (Minitab, 1998). The univariate animal model used to estimate for heritabilities, permanent environmental effects described below was fitted to each trait:

$$Y_{ijklm} = \mu + cm_i + cy_j + l_k + \beta j Age(l_k) + a_l + p_l + e_{ijklm}$$

Where, Y_{ijklm} is the observation of cow milk yield; a_l is the random direct additive genetic effect of lth animal; p_l is the random permanent environmental effect lth animal; cm_i is the effects of calving season (1,..,4); cy_J is the effects of calving year (1990,..,2000); l_k is the effects of lactation (1,..,5); βj is the regression coefficient for age at calving (Age) nested within lactation k (l_k); and e_{ijklm} the random residual term. Genetic and phenotypic correlations were estimated using bivariate animal model. (Co) variance components and genetic parameters and correlations were estimated using the statistical software package, ASREML (Gilmour et al., 1998).

3. Results and Discussion

3.1. Descriptive Statistics

Lactation-wise and overall phenotypic means of fertility traits and production traits were presented in Table 2.

Table 2. Lactation-wise and Overall Phenotypic Mean (Standard Deviations) of Fertility and Production Traits

Parity	N	305-Day MY	LL	GL	CI	DP	SP
0-1	232	3773(894)	300(37)	284(10)	-	-	-
1-2	191	4104(915)	298(33)	285(8)	373(41)	72(32)	88(41)
2-3	159	4425(954)	298(30)	283(9)	367(36)	70(33)	84(36)
3-4	66	4599(930)	301(31)	284(14)	368(45)	71(37)	84(48)
4-5	42	4699(1046)	296(26)	284(15)	381(46)	73(42)	97(48)
Overall		4150(978)	299(33)	284(10)	371(41)	71(34)	87(41)

Mean (±standard deviations) for age at calving were 29.4 ± 3.42, 41.9±3.90, 54.7±4.25, 66.0±4.91 and 79.4±5.75 months, for lactations 1 to 5 respectively. First calving age were reported as 30-36 months and 27-30 months for Simmentals originated from Switzerland and Germany respectively (French et al., 1966). More recent studies indicate that first calving age for Switzerland originated Simmentals were 30-30.5 months (Kunzi et al., 1996; Schmitz, 1998).

Means of calving interval and dry period were estimated to be as 371±41 and 71±34 days respectively. Calving intervals were reported as 374-382 and 391-398 days in the studies carried out in Switzerland (Schmitz, 1998) and Poland (Polanski et al. 1995), respectively. Studies in Turkey indicate that there is a regular decrease in calving intervals for Simmentals. Chronologically, 439.2, 408.4 and 394.6 days were reported for calving intervals of Simmentals by Ilaslan et al. (1978), Tumer et al. (1985) and Deliomeroglu et al. (1996). Dry period should be between 45 and 60 days to be ready for the next lactation period and to provide the increased needs of calf during the last months of the pregnancy. Dry period mean was estimated as 71±34 days indicating that the scheme for a calf per year and optimum lactation length (305 days) were achieved.

305-day MY (4150 kg) obtained in this study were higher than that estimated for Simmentals raised in Turkey (Alpan et al., 1976; Tümer et al., 1985 and Deliömeroğlu et al., 1996) which ranged from 2350 to 3559 kg. This could be as a result of improvement of management system and/or adaptation to the environment.

Mean lactation lengths were estimated as 299±33, near to standard 305 days, the difference could arise from the 3-4 days longer gestation length of Simmentals than the other comparable well known breeds. On the other hand, lactation length reported here was longer than that in some other studies (Ivanov 1978a, 1978b, Rycken 1997) and shorter than the others (Brinzej ve Rostija 1976, Panic et al., 1985). Generally, differences between studies in terms of characters examined here could arise from differences in climatic and management conditions and genetic potential of the herds.

3.2. Genetic Parameters

The heritability (h^2) and the ratio of the permanent environmental variance (c^2) due to animal and (co) variance components for milk yield and reproduction traits from single trait analysis are given in Table 3. Estimates of heritability for SP and CI were lower than 305-day MY, while they were similar to the other milk production traits LL and DP (Table 4). Estimates of c^2 were within the range of 0.0000012 (for CI) to 0.002 (for LL) and much lower than 305-day milk yield.

Table 3. Estimates of (Co) Variance Components and Genetic Parameters (Standard Errors) for Milk Yield and Reproduction Traits

Traits	h^2	c^2	σ^2_A	σ^2_{PEA}	σ^2_E	σ^2_P
305-day MY	0.15 (<0.001)	0.19 (<0.001)	85513	103658	370135.0	559306
LL	0.04 (0.056)	0.002 (0.064)	44.6	2.07	1002.0	1048.67
DP	0.04 (0.070)	0.15e-05 (0.079)	44.90	0.0019	1219.7	1264.60
SP	0.07 (0.068)	0.64e-05 (0.080)	73.25	0.00683	997.0	1070.26
CI	0.02 (0.065)	0.12e-05 (0.079)	23.62	0.00149	1228.0	1251.62

Heritability estimate for 305-day MY was 0.15. Lower estimates of h^2 for milk yield were also reported by many authors, that ranged from 0.07 to 0.17 (Hansen et al., 1983; Sallam et al., 1990; Dahlin, et al., 1998; Saatci et al., 2000; Ertugrul et al., 2002 and Ulutas et al., 2004). However, Visscher and Thompson (1992), Pryce (1997), Gomez and Tewolde (1999) Kadermideen, et al. (2003), Kaya et al. (2003) and Akman and Kumlu (2004) reported high h^2 for 305-day milk yield ranged from 0.22 to 0.49.

The h^2 estimate of LL was 0.04± 0.056. The present estimate is similar to the values of 0.01, 0.09, 0.10 and 0.13 reported by Ertugrul et al. (2002), Tuzemen et al. (1999), Khattab and Atil (1999) and Atil et al. (2001) respectively. On the other hand, higher h^2 estimates for LL were also reported by Murdia and Tripatti (1991), Atay et al. (1995) and Kaygisiz and Vanli (1997) using different breed's data sets and ranged from 0.17 to 0.48.

The h^2 estimate for DP was 0.04 ± 0.070. This result was in agreement with the findings of Katoch et al. (1991), who found that heritability for DP were between 0.05 and 0.06. The major part of the variation in lactation length and dry period is due to non-genetic factors and rapid response could be expected by improving environmental conditions such as feeding regime and management system.

The heritability estimate for SP was 0.07 (Table 4). Berger et al. (1981), Hansen et al. (1983), Faust et al. (1989), Hayes et al. (1992) Marti and Funk, (1994), and Atil et al. (2001) reported similar h^2 estimates for SP (between 0.00 and 0.09) although there were marked differences in data sets, breed types, estimation models and procedures among researches.

The heritability of calving interval reported here was close to 0.022 reported by Kadarmideen et al. (2003), but slightly lower than 0.032 reported by Pryce et al. (1997). However, Dong and Van Vleck (1988), Campos et al. (1994), Ertugrul et al. (2002) and Ulutaş et al. (2004) reported higher heritability estimates for CI than this study, ranged 0.07 to 0.16.

The heritabilities of fertility traits in dairy cattle are lower than many other economically important traits. The low heritability of fertility traits indicate that the influence of herd, management and other environmental effects greater than the genetic background. This was also reported by Schaffer and Henderson (1972) and Kadarmideen et al. (2003).

3.3. Genetic and Phenotypic Correlations

Estimates of genetic and phenotypic correlations (r_g and r_p, respectively) among the six traits studied are presented in Table 4.

Table 4. Genetic Correlations (below diagonal) and Phenotypic Correlations (above diagonal) with Standard Errors Between Fertility and Production Traits

Traits	305-day MY	LL	DP	SP	CI
305-day MY	-	0,65±0.081	-0.07±0.065	0.13±0.143	0.41±0.094
LL	0.49±0.061	-	-0.05±0.112	-0.04±0.105	0.78±0.084
DP	-0.47±0.234	-0.17±0.293	-	0.10±0.078	0.09±0.102
SP	-0.60±0.272	-0.32±0.195	0.51±0.243	-	0.70±0.005
CI	0.35±0.072	0.89±0.076	-0.1±0.017	0.37±0.037	-

Phenotypic correlation between 305-day MY and each of LL, SP and CI were positive except DP. This indicates that the average 305-day MY will increase with the increase of SP, LL and CI. Negative r_p between 305-day MY and DP indicate that cows with shorter DP will produce more milk. Estimates of r_p obtained in this study for the same traits are also followed similar direction in some of the studies (Khattab and Atil, 1999: Kadarmideen et al; 2003).

Genetic correlations between 305-day MY and each of SP and DP were negative, whereas the correlation between 305-day MY and each of LL and CI are positive. Negative r_g between 305-day MY and each of SP and DP indicates that selection for these traits will also increase milk yield. The r_p between 305-day MY and LL ranged from 0.6 to 0.9 (see for a review Syrstad, 1993).

Observed antagonistic r_g between 305-day MY and CI (0.35) was higher than that reported for dairy cattle in New Zealand (0.19) (Groshans et al., 1997) and lower than that reported for Australian Holstein-Friesian (0.48) (Haile-Mariam et al., 2003) and for Turkish Holstein-Friesian (0.69) (Ulutas et al., 2004). A recent review showed that the r_g between CI and MY was in the range of 0.22 to 0.59 (Pryce and Veerkamp, 2001).

Genetic correlation between SP and each of CI and DP were positive and being 0.37 and 0.51, respectively. Basu and Gahi (1980) reported that DP was positively correlated with CI and SP. Khattab and Atil (1999), Kadarmideen et al. (2003) have also reported positive and high genetic correlation between SP and CI, being 0.44 and 0.97 respectively. The estimates of r_g suggested that selection for reduced SP would result in reduced CI (Kadearmideen et al, 2003; Khattab and Atil, 1999). Genetic and phenotypic correlation between LL and CI were positive and very high, whereas the correlation between LL with DP and SP negative (Table 5). Present results were in agreement with Khattab and Atil (1999) who were also reported high r_g between LL and CI and low negative r_g between LL with DP but low positive r_p between LL and SP. High positive r_p between 305-day MY and LL indicate that MY can be used for evaluating the milk producing ability of cows (Khattab and Atil, 1999).

Finally, estimates of heritability, genetic and phenotypic correlations were in agreement with the most of the earlier reports. Selection for short dry period, service period and calving interval will lead to increase in milk production. Low h^2 estimates of fertility traits also indicate that a major part of variation in these characters was environmental and selection would contribute little improvement for reproductive traits. On the other hand, high h^2 estimated for 305-day MY indicated that it could be improved through selection. The heritabilities and genetic correlations estimated in this study also indicate that selection to improve some of the traits will be possible, but response to selection will be slow.

The estimates were obtained from a relatively small data set, and analysis should be evaluated with care. Therefore, a similar study with a larger data may bring more reliable results. In any case applying these kind of analyses, together with milk and reproduction traits, in country-wide rage helps to bring the livestock industry to a defined level in order the compare with other countries outputs.

References

Akman, N. and Kumlu, S., 2004. Genetic and phenotypic parameters fro 305-day milk yield of Turkish Holstein population. Tarım Bilimleri Dergisi, 10, 281-286.

Alpan, O., Yosunkaya, H. and Alıç, K. 1976. Türkiye'ye ithal edilen Esmer Holştayn ve Simmental sığırlar üzerinde karşılaştırmalı bir adaptasyon çalışması. Lalahan Hayvancılık Araştırma Enstitüsü Dergisi, 6, 3-18

Atay, O., Yener, S.M., Bakır, G. and Kaygısız, A. 1995. Estimates of genetic and phenotypic parameters of milk production characters of Holstein cows raised at the Ataturk foresty farm in Ankara. Turk J. Vet. Anim. Sci. 19, 441-446.

Atil, H., Khattab, S. and Yakupoglu, C., 2001. Genetic analyses for milk traits in different herds of Holstein Friesian cattle in Turkey. Online J. of Biological Sci., 1, 737-741.

Bagnato, A. and Oltenacu, P.A., 1993. Genetic study of fertility traits and production in different parities in Italian Friesian cattle. J. Anim. Breed. Genet., 110, 126-134.

Basu, S.B. and Ghai, A.S., 1980. Studies on inheritance of some reproductive and relationship with milk production in cross-breed cattle. Indian J. Anim. Sci., 50, 119-125.

Berger, P.J., Shanks, R.D., Freeman, A.E. and Laben, R.C., 1981. genetic aspects of milk yield and reproductive performance in jersey cattle. J. Dairy Sci., 64, 114-124.

Brinzej, M. and Rastija, T., 1976. Dairy performance at large farms and body conformation of Yugoslav and imported Austrian Simmentals. Stocarstvo, 30, 419-430.

Campos, M.S., Wilcox, C.J., Beceril, C.M. and Diz, A., 1994. Genetic parameters for yield and reproductive traits of Holstein and Jersey cattle in Florida. J. of Dairy Sci., 77, 867-873.

Dahlin, A., Khan, U.N., Zafar, A.H., Saleem, M., Chaudhry, M.A. and Philipsson, J. 1998. Genetic and environmental causes of variation in milk production traits of Sahiwal cattle in Pakistan. Anim. Sci., 66, 307-318.

Deliomeroglu, Y., Bakir, A. and Alpan, O. 1996. İthal Simmental sığırların Kazova Tarım İşletmesi şartlarında süt ve döl verimleri. Lalahan Hayvancılık Araştırma Enstitüsü Dergisi, 362, 42-53.

Dematawewa, C.M.B. and Berger, P.J., 1998. Genetic and phenotypic parameters for 305-day yield fertility and survival in Holsteins. J. Dairy Sci., 84, 266-275.

Dong, M.C. and Van Vleck, L.D., 1988. Estimates of genetic and environmental covariances for milk yield survival and calving interval. Genetics Research 1987-1988 Report to Eastren Artificial Insemination Cooperative Inc., pp: 58.

Eriksson, J.A., Wretler, E., 1990. Sire evaluation for diseases in Sweden. World Review of Animal Production, 25, 29-32.

Ertugrul, O., Orman, M.N. and Guneren, G., 2002. Some genetic parameters of milk yield the Holstein breed. Turk. J. Vet. Anim. Sci., 26, 463-469.

Faust, M.A., McDaniel, B.T. and Robison, O.W., 1989. Genetics of reproduction in primiparous Holsteins. J. of Dairy Sci., 72, 194-201.

French, M.H., Johansson, I., Joshi, N.R. and Mclaughlin, E.A., 1966. European Breeds of Cattle Vol I and II. FAO Agricultural Studies No: 67 Rome.

Gilmour, A.R., Cullis, B.R., Welham, S.J. and Thompson, R., 1998. “ASREML”. NSW Agriculture Orange Australia.

Gomez, C.H. and Tewolde, A., 1999. Genetic parameters of milk production evaluation of sires and characterization of dairy farms in the humid tropics of Costa Rica. Archivos Latinoamericanos de Produccion Animal, 7, 19-37.

Grosshans, T., Xu, Z.Z., Burton, L.J., Johnson, D.L. and Macmillan, K.L., 1997. performance and genetic parameters for fertility of seasonal dairy cows in New Zealand. Livest. Prod. Sci., 51, 41-51.

Haile-Mariam, M., Bowman, P.J. and Goddard, M.E., 2003. Genetic and environmental relationship among calving interval survival persistency of milk yield and somatic cell count in dairy cattle. Livest. Prod. Sci., 80, 189-200.

Hansen, L.B., Freeman, A.E. and Berger, P.J., 1983. Yield and fertility relationship in dairy cattle. J. Dairy Sci., 66, 293-305.

Hayes, J.F., Cue, R.I. and Monardes, H.G., 1992, Estimates of repeteability of reproductive traits in Canadian Holsteins. J. of Dairy Sci., 75, 1701-1706.

Ilaslan, M., Aşkin, Y., Geliyi, C. and Alatas, I., 1978. Kars Deneme ve Üretme İstasyonunda Yetiştirilen Esmer ve Simmental Irkı Sığırların Vücut Yapısı Süt ve Döl Verimleri ile İlgili Özellikleri. Kars Deneme ve Üretme İstasyonu Yayınları, No:5. Kars.

Ivanov, M., 1978a. Ayrshire crossbreds deserve more attention. Zhivotnovdstvo, 3210, 11-14.

Ivanov, M., 1978b. Husbandry value and biological characteristics of crosses of Bulgarian Simmental cows with Ayrshire bulls. III. Milk production of F1 crosses. Zhivotnovdstvo, 154, 3-10.

Kadarmideen, H.N., Thompson, R., Coeffey, M.P. and Kossaibati, M. A., 2003. Genetic parameters and evaluation from single- and multiple- trait analyses of dairy cow fertility and milk production. Livest. Prod. Sci., 81, 183-195.

Katoch, S., Yadav, M.C. and Manuja, N.K., 1991. Factors affecting first dry period in jersey cows in Himachal Pradesh. Indian Vet. J., 684, 323-326.

Kaya I., Akbas Y., Uzmay C. 2003, Estimation of breeding values for dairy cattle using test-day milk yilds. Turk. J. Vet. Anim. Sci., 27, 459-464.

Kaygısız, A. and Vanlı, Y.C., 1997. genetic analyses of the Brown cattle herd of Van Agricultural Vacational High School. Tarım Bilimleri Dergisi, 2, 111-115.

Khattab, A.S. and Atil, H., 1999. Genetic study of fertility traits and productive in a local born Friesian cattle in Egypt. Pakistan J.Biological Sciences, 24, 1178-1183.

Kunzi, N., Wuest, A., Kaufmann, A. and Leuenberger, H., 1996. Wirtschaftlicher Vergleich der drei Rindertypen, Holstein Jersey Simmentaler. Ergebnisse der Rindertypenversuche der ETH 4. Teil An economic comparison of 3 dairy cattle breeds, Holstein Jersey and Simmental. Results of investigations into different dairy cattle breeds conducted by the ETH Part 4. KB-Mitteilungen, 34, 28-29.

Marti, C.F. and Funk, D.A., 1994. Relationship between production and days open at different levels of herd production. J. of Dairy Sci., 77, 1682-1690.

Minitab, 1998. “Minitab reference manual. Release 12 for Windows”. Minitab Inc.

Murdia, C.K. and Tripathi, V.N. 1999. Direct and correlated responses to selection in performance traits in Jersey cattle. Indian J. of Anim.Sci., 6110, 1096-1100.

Nebel, R.L. and McGillard, M.L., 1993. Interactions of high milk yield and reproductive performance in dairy cows. J. Dairy Sci., 76, 3257-3268.

Panic, M., Novogradic, M. and Latinovic, D., 1985. Long lactations and their effect on milk yield and fertility of cows. Anim. Breed. Abst.; 53, 2651-2660.

Polanski, S., Felenczak, A. and Gil, Z. 1995. Ksztaltowanie sie dlugosci okresu miedzywycieleniowego u krow rasy simentalskiej i jego wplyw na wydajnosc mleczna The effect of calving interval on dairy performance of Simmental cows. Zeszyty Naukowe Akademii Rolniczej im.

Pryce, J.E. 1997. Genetics of health and fertility in dairy cattle. PhD thesis. The University of Edinburg UK.

Pryce, J.E. and Verkamp, R.F., 2001. The incorporation of fertility indices in genetic improvement programmes. In,Diskin M.G. Ed.. fertility in the High-producing dairy Cow vol.1. British Society of Animal Sci., 237-250.

Rycken, M., 1997. Ergebnisse der Milchleistungsprufungen beim Schweizer Fleckvieh im Kontrolljahr 1996/97. Milchmenge und Eiweissgehalt wieter steigend Results of milk recording in Simmental cows in 1996-97. Milk yield and milk protein yield are still increasing Schweizer Fleckvieh; 7, 26-41.

Saatci, M., Ulutas, Z., Dewi, I.A. and Akkus, I., 2000. Environmental effects variance components and estimated breeding values of milk yield for Holstein cows in Dalaman State farm. Ataturk Univ. Ziraat Fakultesi Dergisi, 312, 97-101.

Sallam, M.T., El-Feel, F.M. and Khattab, A.S., 1990. Effect of genetic. and non-genetic fa ctors for productive and reproductive traits in Friesian cows in Egypt. El-Minia. J. Agric. Res. Egypt, 12, 521-528.

Schaeffer, I.R., Henderson, C.R. 1972. Effects of days dry and days open on Holstein milk production. J. Dairy Sci., 55, 107-114.

Schmitz, H.F., 1998. Die wichtigsten Milchleistungsergebnisse im Kontrolljahr 1996/97 The most important milk recording results in 1996-97. Schweizer Fleckvieh; 1,2-8.

Syrstad, O., 1993. Milk yield and lactation length in tropical cattle. World Animal Review, 74, 68-72.

Tumer, S., Kircalioglu, A. and Nalbant, M., 1985. Ege Bölge Zirai Araştırma Enstitüsünde Yetiştirilen Siyah-Alaca Esmer ve Simmental Sığırların Çeşitli Verim Özellikleri Üzerinde Araştırmalar. Ege Bölge Zirai Araştırma Enstitüsü Yayınları No:53. İzmir.

Tuzemen, N., Yanar M., Aydın, R. and Akbulut, O., 1999. Estimates of genetic and phenotypic parameters of milk characteristics of Holstein cows raised in the farm of Agriculture College at Ataturk University. Uluslararası Hayvancılık Kongresi 21-24 Eylul 1999 Izmir Turkey.

Ulutas, Z., Akman, N. and Akbulut, O., 2004. Estimates of genetic and environmental Co variances for 305-day milk yield and calving intervals in Holstein Friesian cattle. Turk. J. Vet. Anim. Sci., 28, 101-105.

Visscher, P. M. and Thompson R., 1992. Univariate and multivariate parameter estimates for milk production traits using an animal model. I. Description and results of REML analyses. Genetics Selection Evoluation, 24, 415-430.