Scientific Papers. Series D. Animal Science. Vol. LXI, Number 1, 2018
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

ESTIMATES OF THE TRENDS COMPONENTS IN THE MILK YIELD OF HOLSTEIN FRIESIAN COWS

Muhittin TUTKUN[1], Sadık Metin YENER[2]

[1]Dicle University, Faculty of Agriculture, Department of Animal Science, 21280 Diyarbakır, Turkey
[2]Ankara University, Faculty of Agriculture, Department of Animal Science, 06110 Ankara, Turkey

Corresponding author email: tutkunmuhittin@yahoo.com

Abstract

This study was carried out to estimate the trend components (the phenotypic, genetic and environmental trends) for 305-day milk yield in Holstein Friesian Cattle raised between the years 1989-2012 at the Ceylanpınar State Dairy Farm. In order to estimate the trend components 6165 lactation records of 2055 Holstein cows was analysed. It was found that the lactation period average was 313.23 ± 28.47 days, the annual average lactation milk yield was 6197.88 ± 1681.35 kg and adjusted 305-day lactation milk yield was found to be 6164.41 ± 1713.90 kg. In order to estimate of genetic parameters, standardized milk yield according to 305-day lactation period (lactation 1, 2 and 3) were analysed primarily with repeated-measured animal models by using MTDFREML programs. According to the data obtained in the study, the lactation length, average lactation milk yield and average 305-days milk yield adjusted were calculated as 313.23 ± 28.47 days, 6197.88 ± 1681.35 kg and 6164.41 ± 1713.90 kg, respectively. The phenotypic, environmental and genetic trends for 305-days milk yield were found to be -70.72 kg/year, -70.53 kg/year and -0.19 kg/year, respectively.

***Key words**: Ceylanpınar, Holstein, genetic trends, phenotypic trends.*

INTRODUCTION

In order to increase yield per animal can be grouped into two groups: one is to regulate environmental factors and the other is to improve the genotypic level. While the impact of the rehabilitation of the environment arises shortly, it takes longer to heal the genotype. However, the positive effect of the created environment and the increase in productivity are limited by the genotype of the animal. The genotypic correction to be carried out in parallel with the improvement of environmental conditions is carried out by separating the individuals identified as having high genotypic value as parents and contributing to their next generations (Özyurt and Akman, 2009).

Genetic trends are the best parameter for an efficient selection prediction (Falconer and Mackay, 1996). Selection of genotypes suitable for the environment is possible by evaluating genotype performances based on scientific researches (Gönül, 1974).

While the impact of the rehabilitation of the environment arises shortly, it takes longer to heal the genotype. However, the increase in the yield due to the positive environment effect is limited by the genotype of the animal (Akman, 1993).

Main problem in animal breeding research is determining genetic gain that resulted from performing animal breeding programs during several years. In a population, which selection has carried out and mating between animal designed based on genetic characteristics, deal of changes that obtained in several years from animal breeding programs must investigated, thus genetic trend of selected traits in population estimated. Estimation of genetic trend may be providing investigation of animal breeding methods (Wilson and Willham, 1986; Kovac and Groeneveld, 1990).

The change in production per unit of time due to change in mean breeding value is called the genetic trend (Harville and Hendeason, 1966).

For the estimation of efficient selection, the best parameter is genetic trend (Falconer and Mackay, 1996). Genetic changes in a population should be checked in the case of selection on more traits at the same time because that is the most powerful analysis to evaluate the selection work in a population. Dairy cattle have a long generation interval end low reproductive rate. In addition, it is costly and time-consuming to carry out dairy cattle selection on a large experimental scale. Methods to determine variance component have been greatly improved over the last three decades (Mashhadi et al., 2008). The estimation of genetic trend is the best tool to follow genetic changes in a population (Potocnik et al., 2007).

Several researchers (Burnside and Legates, 1967; Lee et al., 1985; Meinert and Pearson, 1992; Powell et al., 1977; VanVleck et al., 1986) have studied genetic trends in dairy cattle. Most of these researchers estimated genetic trends over periods of less than 20 years. The precision of genetic trend estimates is enhanced greatly as the number of years studied increases (Burnside and Legates, 1967).

In the State-owned Agricultural Enterprises, although records of milk yields have been recorded for many years, it can be seen that these records are not utilized sufficiently for cattle breeding (Tuna et al., 2007).

As in other countries, also in Turkey as a result of work done in terms of dairy cattle, with effect share of the yield increases achieved in milk production genotype and environmental factors, these factors need to be discussed will be focused on what level of culture has been a major issue. There are many studies on how cattle breeding studies, which have been carried out for many years in especially livestock advanced countries, have been influenced by genetic and environmental sources. Various researchers estimated the annual genetic change by evaluating the yield records obtained under different conditions with appropriate statistical methods for their own trial materials (Alpan and Arpacık, 1998).

MATERIALS AND METHODS

In this study, 6165 records of milk production of Holstein Friesian Cattle raised between the years 1989-2012 at the Ceylanpınar State Dairy Farm in Turkey were used. In this study, the records of 305-days the first three lactation and twice milking per day were used.

Prediction of Lactation Milk Yield

The lactation milk yields were calculated using the Test Interval Method that is the reference method by ICAR (ICAR, 2003).

$$LMY = I_0M_1 + I_1 \text{ x } M_1 + M_2/2 + I_2 \text{ x } M_2 + M_3/2 + \ldots + I_{n-1} \text{ x } M_{n-1} + M_n + I_nM_n$$

In which:

$M_1, M_2, \ldots, M_n$ is milk yielded in 24 hours of the recording day, kg;

$I_1, I_2, \ldots, I_{n-1}$ is the intervals between recording dates, days;

I_0 is the interval between the lactation period start date and the first recording date, days;

I_n is the interval between the last recording date and the 305th lactation day, days.

Estimation of Genetic Parameters

Repeated-measure animal models was used to estimate genetic parameters by using the MTDFREML program (Van Vleck and Boldman, 1995). In the analysis, the additive genetic effect, the maternal additive genetic effect, the mother effect and permanent environmental effect included to the model as genetic effects and calving year-season, calving year-lactation order, calving year-age and service period as the environmental factors. In addition, the first calving age was included as a co-variable to the model.

The analysis model used to predict the genetic parameter are as follows:

$$Y_{ijklm} = \mu + CYS_i + CYLO_j + CYA_k + IP_l + A_{ijklm} + MA_m + PE_m + bX_{ijklm} + e_{ijklm}$$

In which:

Y_{ijklm} is 305-days total lactation milk yield corrected (lactation 1, 2 and 3)

μ is 305-days average lactation milk yield corrected

$CYS_{i.}$ is calving year-seasonal effect;

$CYLO_{j.}$ is calving year-lactation order effect;

$CYA_{k.}$ is calving year-age effect;

IP_l is Involution period effect (1: heifer, 2: 0-60 days, 3: 61-90 days, 4: 91-120, 5: 121-150, 6: ≥151days);
A_{ijklmn} is additive genetic effect;
MA_m is maternal additive genetic effect;
PE_m is uncorrelated random effect of cow;
b is regression coefficients;
X_{ijklm} is co-variable (first calving age: 20, 21, 22, 23, … ,50 and more);
e_{ijklm} is random environmental effect.

The Phenotypic trends as regressions of the corrected milk yield averages on years for 305-days milk yield. The environmental effect on the phenotypic trend was estimated by using corrected milk yield and lactation length records of cows for 2 consecutive years. The difference between the first and second year milk records of a cow was assumed to be a result of environmental fluctuations. The genetic trend was calculated as the regression of cow's breeding values to cow birth years.

RESULTS AND DISCUSSIONS

Lactation Milk Yield

Test Interval Method was used to estimate Lactation Milk Yield from control day yields. According to the results of the research, average annual lactation milk yield, 305-days corrected lactation milk yield and average lactation length was calculated as 6197.88 ± 1681 kg, 6164.4 ± 1713 kg and 313.23 ± 28.4 days, respectively (Table 1).

Table1. Average annual milk yield, corrected 305 days milk yield and lactation length

	N	Mean	SE	Min	Max.	Cv
Lactation milk yield	6165	6197.88	1681.35	715.2	13684.8	27.13
Lactation length	6165	313.23	28.47	198.6	355.2	9.09
Corrected 305-day lactation yields	6165	6164.41	1713.90	1014.8	13561.1	27.80

Lactation milk yield has been observed to be much higher than average lactation milk yield due to the purchase of high-yielding dairy cows from other enterprises between 2009 and 2012. The changes in lactation milk yield during the years is shown in Figure 1.

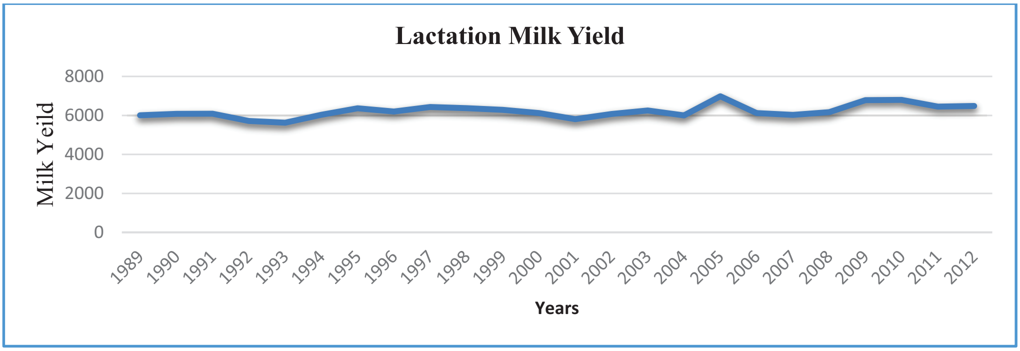

Figure 1. 305- day milk yields during the years

Between 1989 and 2012, the average lactation milk yield was calculated as 6197.88 ± 1681.35 kg. The highest milk yield was calculated as 6979.90 ± 1480.59 kg in 2005 and the lowest milk yield was 5625.08 ± 1600.63 kg in 1993. Milk yield has shown fluctuation over the years (Table 2).

Table 2. Average Lactation milk yields by the years 1989-2012

Years	N	Mean	SE	Min.	Max.	CV
1989	7	6004.69 [cdef]	1860.44	4565.8	9957.4	30.98
1990	155	6074.72 [cdef]	1700.96	2945.8	11758.4	28.00
1991	267	6087.83 [cdef]	1758.45	2260.8	12821.2	28.88
1992	358	5714.83[ef]	1738.31	1684.0	11865.0	30.42
1993	316	5625.08[f]	1600.63	715.2	11394.4	28.46
1994	258	6033.61 [cdef]	1534.17	1768.8	9881.6	25.43
1995	252	6365.91[bcd]	1481.84	2611.0	11145.0	23.28
1996	245	6198.22 [cdef]	1581.60	1900.8	11605.0	25.52
1997	268	6432.30[bc]	1652.29	2517.4	11864.4	25.69
1998	273	6367.88[bcd]	1705.40	825.6	11992.0	26.78
1999	248	6284.30[bcde]	1599.05	2243.6	11725.8	25.45
2000	297	6117.98 [cdef]	1698.04	1336.8	10835.4	27.75
2001	348	5806.65[def]	1635.30	855.4	9892.0	28.16
2002	311	6073.81 [cdef]	1674.15	829.4	10889.6	27.56
2003	317	6253.17[bcde]	1365.19	2198.0	12399.4	21.83
2004	274	6000.11 [cdef]	1330.21	1943.4	11197.2	22.17
2005	332	6979.90[a]	1480.59	2669.2	12258.0	21.21
2006	313	6119.31 [cdef]	1463.56	2061.6	9917.6	23.92
2007	354	6025.48 [cdef]	1668.63	1241.2	11044.0	27.69
2008	307	6166.96 [cdef]	1769.92	893.6	13402.4	28.70
2009	314	6783.72[ab]	2132.68	1727.0	13520.8	31.44
2010	205	6794.63[ab]	1935.36	2575.4	13684.8	28.48
2011	120	6447.06[abc]	1646.95	2371.8	10290.6	25.55
2012	26	6484.67[abc]	1486.10	3672.0	8830.0	22.92

$P<0.05$

305-day milk yield (6164 kg) calculated in this study shown similarity to the results obtained by the other researchers (Özçakır and Bakır, 2003; Bakır and Çetin, 2003; Şahin, 2012; Arslan and Cak, 2013).

305-day milk yield in this study was lower than the reports of (Soysal and Özder, 1989; Yener et al., 1994; Yaylak, 2003; Uğur, 2000; Özkök and Uğur, 2007; Erdem et al., 2007; Yılmaz and Bayrıl, 2010; Şahin and Ulutaş, 2010).

It has been calculated higher than the reports of Şekerden et al. (1987), Kumlu et al. (1989), Gürdoğan and Alpan (1990), Soysal and Özder (1990), Ulutaş et al. (2002), Bilgiç and Alıç (2005), Bilgiç and Yener (1999), Duru and Tuncel (2002), Koç (2006), Tapkı et al. (2007), Akkaş and Şahin (2008), Çilek (2009).

Lactation length

The average lactation length calculated from records obtained between 1989 and 2012 was found as 313.23 ± 28.47 days (Table 3).

Lactation length calculated in this study shown similarity to the results obtained by the researchers (Southern, 1971; Bakır and Çetin, 2003; Koç, 2006; Özçakır and Bakır, 2003).

Table 3. Lactation length by the years 1989-2012

Years	N	Mean	SE	Min.	Max.	CV
1989	7	304.94[c]	36.73	239.0	342.2	12.05
1990	155	309.96[abc]	28.57	226.6	351.2	9.22
1991	267	311.02[abc]	28.07	206.6	351.2	9.03
1992	358	311.49[abc]	29.16	200.6	352.2	9.36
1993	316	306.86[bc]	30.18	201.6	353.2	9.84
1994	258	308.61[abc]	30.74	203.6	352.2	9.96
1995	252	313.47[abc]	28.38	209.6	354.2	9.05
1996	245	314.12[abc]	28.01	207.6	353.2	8.92
1997	268	312.63[abc]	27.60	207.6	353.2	8.83
1998	273	314.64[abc]	29.27	200.6	352.2	9.30

1999	248	316.03^{ab}	27.66	201.6	353.2	8.75
2000	297	310.35^{abc}	30.86	204.6	351.2	9.94
2001	348	315.06^{abc}	25.99	210.6	355.2	8.25
2002	311	316.47^{ab}	27.69	204.6	353.2	8.75
2003	317	318.11^{a}	24.09	211.6	352.2	7.57
2004	274	315.86^{ab}	26.88	212.6	352.2	8.51
2005	332	316.54^{ab}	26.38	206.6	351.2	8.33
2006	313	317.67^{a}	23.40	244.0	352.2	7.37
2007	354	312.67^{abc}	28.31	201.6	352.2	9.05
2008	307	313.33^{abc}	27.02	200.6	352.2	8.62
2009	314	311.68^{abc}	31.01	198.6	352.2	9.95
2010	205	314.27^{abc}	29.41	201.6	350.2	9.36
2011	120	308.43^{abc}	36.62	198.6	350.2	11.87
2012	26	284.01^{d}	42.34	198.6	348.2	14.91
	6155	**313.23**	**28.47**			

$P<0.05$

Lactation length in this study (313.23 days) was lower than the reports of Soysal and Özder (1989), Gündoğdu and Özder (1993), Yener et al. (1994), Özcan and Altınel (1995), Atay et al. (1995), Kumlu and Akman (1999), Yaylak (2003), Yener et al. (1994), Şahin (2009).
Lactation length in this study (313.23 days) was higher than the reports of Özcan and Pekel (1976), Şekerden and Pekel (1982), Özkütük and Pekel (1986), Kumlu et al. (1989), Kumlu et al. (1991), İpek (1993), Erdem (1997), Kaygısız (1997), Bilgiç and Yener (1999), Duru and Tuncel (2002), Özçelik and Arpacık (2000), Pelister et al. (2000a), Pelister et al. (2000b), Bilgiç and Alıç (2005), Sehar and Özbeyaz (2005), Çilek (2009).
Lactation length has shown fluctation between the years 1998-2015 (Figure 2).

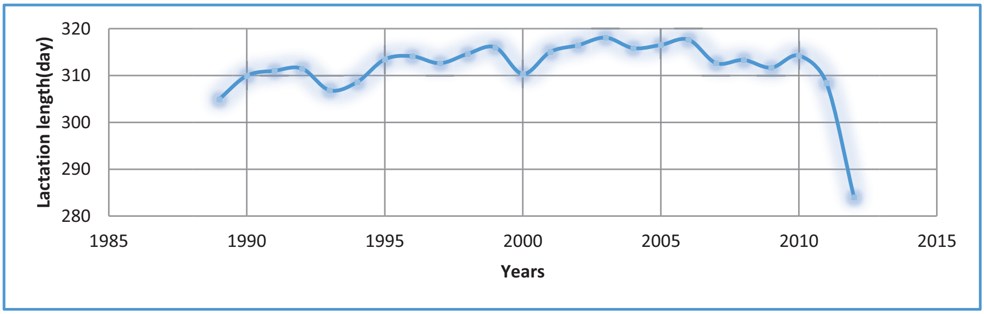

Figure 2. Changes of lactation length according to years

The Trend Components

The Trend Components was shown in Table 4. The genetic trends of cow breeding values were calculated by taking regression into cow birth years were found as -0.19 kg/year for 305-day milk yield.

.

Table 4. Estimates of Trend Components

Years	N	Phenotypic trends	Environmental trends	Genetic trends
1989	7	7175.9	7443.74	-267.79
1990	155	7652.9	7796.67	-143.74
1991	267	7368.2	7467.25	-99.01
1992	358	6878.2	6923.90	-45.65
1993	316	6546.4	6523.05	23.40
1994	258	6504.5	6438.48	65.99
1995	252	6132.7	6085.45	47.22

1996	245	5937.1	5918.63	18.46
1997	268	5980.3	5987.91	-7.58
1998	273	6075.6	6137.80	-62.16
1999	248	6285.1	6356.53	-71.44
2000	297	6560.9	6602.96	-42.05
2001	348	6238.8	6275.63	-36.87
2002	311	6590.2	6616.19	-25.95
2003	317	6526.9	6522.04	4.84
2004	274	6371.3	6243.95	127.31
2005	332	6516.6	6370.23	146.33
2006	313	5470.2	5295.73	174.45
2007	354	5025.8	4872.02	153.77
2008	307	4715.9	4665.50	50.41
2009	314	5487.2	5608.03	-120.80
2010	205	5348.1	5589.18	-241.03
2011	120	5831.1	6108.88	-277.83
2012	26	6340.7	6572.38	-231.64
		Regressions of the corrected milk yield for 305 days		
		Y=7115.73-70.72X	Y=7149.23-70.53X	Y=-33.48-0.19X

X=Year

The Phenotypic trends as regressions of the corrected milk yield averages on years for 305-days milk yield were found -70.72 kg/year ($P<0.01$). The environmental effect on the phenotypic trend was estimated by using corrected milk yield records of cows for 2 consecutive years. The difference between the first and second year milk records of a cow was assumed to be a result of environmental fluctuations.

The environmental change for 305-days milk yield per year was estimated as -70.53 kg/year (Figure 3).

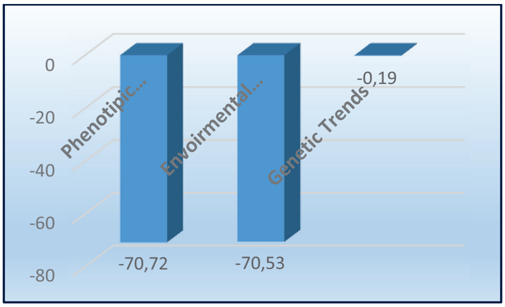

Figure 3. Distribution of Trends Components

The annual genetic trends value (-019 kg/year) obtained in this study was higher than the reported by Yener et al. (1978) -2.3 kg/year, Tonhati and Lobo (1997) -10.20 kg/year, Kaygısız (2000) -78 kg/year.

This value was found lower than Mc Daniel et al. (1961) reported 71.7 kg / year, Verde et al. (1974) 33 kg/year, Siam and Düzgüneş (1984) 78 kg/year, Lee and Freeman (1985) 55 kg/year, Akar and Pekel (1988) 53.6 kg/year, Tusuruta et al. (1990) 73.2 kg/year, Gürdoğan and Alpan (1990) 149 kg/year , Avandano et al. (1992) 74 kg/year, Zuk et al. (1994) 10.5 kg/year, Kaygısız (1996) 83,7 kg/year, Hansen (2000) 116 kg/year, Posadas et al. (2001) 29 kg/year, Duraes et al. (2001) 18.4 kg/year, Akman and Kumlu (2004) 84 kg/year, Abou-Bakr (2009) 2.19 kg/year, Gaidarska (2009) 26.48 kg/year, Golverdi et al. (2011) 6.79 kg/year, Yaeghoobi et al. (2011) 19,61 kg/kg and Katok and Yanar (2012) 3.73 kg/year.

When studies conducted by different researchers in different countries were examined, it was found that the trends of the annual genetic trends were positive except for some of the values calculated by some researchers (Yener et al., 1978; Tonhati and Lobo, 1997; Kaygısız, 2000) It was also observed that the value of genetic trends gradually decreased in recent years.

CONCLUSIONS

This result indicates that there are deficiencies in the environmental conditions such as management, nutrition and herd management applied in the cattle enterprises. Breeders have to make continuous selection regardless of their genetic and environmental trends. In the enterprises, these assessments give the opportunity to measure the success of applications up to now. A negative phenotypic trend in terms of milk yield in the farm may be due to insufficient environmental factors. Despite the right choice in the selection of the enterprise, environmental factors have led to a decrease in productivity. Annual fluctuations for these traits, maybe due to sudden changes in climate condition, management changes, nutrition and hygienic levels or interaction between genetic and environment. In this context, it is proposed to improve the environmental conditions of maintenance feeding and barn.

ACKNOWLEDGEMENTS

This study was derived from my Phd Thesis aceppted in 2015 by Ankara University Graduate School of Natural And Applied Sciences. Thanks to Ceylanpınar State Farm Autority and Supervisor Prof.Dr. Sadık Metin Yener.

REFERENCES

Abou-Bakr S., 2009. Genetic And Phenotypic Trends Of 305-Day Milk Yield of Holstein Cows Raised At Commercial Farm In Egypt. Egyptian Journal of Animal Production, 46(2), 85-92.

Akar M., Pekel E., 1988. Türkiye Şeker Fabrikaları A.Ş. Eskişehir Tohum Üretme Çiftliğinde Yetiştirilen Saf ve Melez Esmer Sığırların Süt Verimindeki Genetik ve Fenotipik Yönelimler. Ziraat Fakültesi Dergisi, 3, 51-65, Adana.

Akkaş Ö., Şahin E.H., 2008. Holştayn Irkı Sığırlarda Bazı Verim Özellikleri, Kocatepe Vet. Dergisi, 1, 25-31.

Akman N., Kumlu S., 2004. Türkiye Siyah Alaca Populasyonunda 305-Gün Süt Verimine Ait Genetik ve Fenotipik Parametreler Tarım Bilimleri Dergisi,10 (3), 281-286.

Alpan O., Arpacık R., 1998. Sığır yetiştiriciliği. Ankara. Medisan.

Arslan S., Cak B., 2013, Yozgat İli Boğazlıyan İlçesinde Özel Bir Süt İşletmesinde Yetiştirilen Holştayn İneklerin Süt Verim Özellikleri. YYU Veteriner Fakültesi Dergisi, 24 (3), 101 – 104.

Avandaño L.R., Mondragón I.V., Ochoa G.P., 1992. Genetic And Environmental Trends in Milk Production of First Lactation Holstein Cows In Mexico. Journal of Dairy Science, 75 (1), 150.

Bakır G., Çetin M., 2003. Reyhanlı Tarım İşletmesinde yetiştirilen Siyah Alaca Sığırlarda Döl ve Süt Verim Özellikleri. Turkish Journal of Veterinary and Animal Science, 27, 173-180.

Bilgiç N., Yener M., 1999. Ankara Üniversitesi Ziraat Fakültesi Zootekni Bölümü Sığırcılık İşletmesinde yetiştirilen Siyah Alaca İneklerde bazı süt ve döl verimi özellikleri. Ankara Ün. Ziraat Fakültesi Tarım Bilimleri Dergisi, 5, 81-84.

Bilgiç N., Alıç D., 2005. Polatlı Tarım Đşletmesinde yetiştirilen Siyah Alaca ineklerin bazı süt verim özellikleri. S.Ü. Ziraat Fak. Derg., 19, 36, 116-119.

Burnside E.B., J.E. Legates, 1967. Estimation of genetic trends in dairy populations. J. Dairy Sci., 50, 1448-1457.

Cilek S., 2009. Milk Yield Traits of Holstein Cows Raised at Polatli State Farm in Turkey. Journal of Animal and Veterinary Advances, 8 (1), 6-10.

Duraes M.C., Fereitas A.F., Valenta J., Teixeira N.M., Barra R.B, 2001. Genetic Trend for Milk and Fat Productivity for Holstein Cattle in Minas Gerais State. Revista Brasileira de Zootecnia, 30(1), 66-70.

Duru S., Tuncel E., 2002. Koçaş Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Süt Ve Döl Verimleri Üzerine Bir Araştırma. 1. Süt Verim Özellikleri. Turkish Journal Of Veterinary And Animal Science, 26, 97-101.

Erdem H., Atasever S., Kul E., 2007. Gökhöyük Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Süt Ve Döl Verim Özellikleri, 1. Süt Verim Özellikleri. OMÜ Ziraat Fakültesi Dergisi, 22(1), 41-46.

Falconer D.S., Mackay T.F.C., 1996. Introduction to Quantitative Genetics. 4th Edn., Longman, England, 464.

Gaidarska V., 2009. Evaluation Of Genetic Trend of The Bulgarian Dairy Population. Biotechnology in Animal Husbandry, 25 (5-6), 639-644.

Golverdi A.Y., Hafezian H, Chashnidel Y., Farhadi A., 2011. Genetic Parameters And Trends Of Production Traits İn Iranian Holstein Population. African Journal Of Biotechnology, 11(10), 2429-2435,

Gürdoğan T., Alpan O., 1990. Ankara Şeker Fabrikası Çiftliğinde Yetiştirilen Holştayn Sürüsünde Süt Verimine İlişkin Genetik Parametreler ve Genetik İlerleme Hızı. A.Ü. Vet. Fak. Derg., 37 (1), 101-115.

Hansen L.B., 2000. Consequences of Selection for Milk Yield from a Genetisist's Viewpoint. Journal of Animal Science, 83, 1145-1150.

Harville D.A., Hendeason C.R., 1966. Environmental and Genetic Trends in Production and Their Effects on Sire Evaluation. Department of Animal Husbandry, Cornell University, Ithaca, New York.

ICAR, 2003. International Agreement of Recording Practices. International Committee for Animal Recording ed., Interlaken, Switzerland.

Katok N., Yanar M., 2012. Milk traits and estimation of genetic, phenotypic and environmental trends for milk and milk fat yields in Holstein Friesian cows.

International Journal of Agriculture and Biology, 14(2), 311-314.
Kaygısız A., 1996. Kahramanmaraş Tarım İşletmesi Siyah Alaca Sürüsümde Süt Verimine İlişkin Yönelim Unsurlarının Tahmini, Tarım Bilimleri Dergisi Ankara, 2(3), 71-73.
Koç A. 206. Aydın İlinde Yetiştirilen Siyah-Alaca ve Esmer Irkı Sığırların Laktasyon Süt Verimleri ve Somatik Hücre Sayıları, Hayvansal Üretim Dergisi 47(2), 1-8.
Kovac M., Groeneveld E., 1990. Genetic and enviromental trends in German swine herdbook populations. J. Anim. Sci., 68, 3523-3535.
Kumlu S., 1989. Türkiye Damızlık Siyah Alaca Sürülerinin Süt Verimlerinde Genetik Ve Fenotipik Yönelimler. Akdeniz Üniversitesi Ziraat Fakültesi Dergisi, 12, 11-24.
Lee K.L., Freeman A.E., Johnson L.P., 1985. Estimation of genetic change in the registered Holstein cattle population. J. Dairy Sci., 68, 2629-2638.
Mashhadi M.H., Kashan N.E.J., Nassiry M.R., Torshizi R.V., 2008. Prediction breeding value and genetic parameter in Iranian holstein bulls for milk production traits. Pak. J. Biol. Sci., 11, 108-112.
Mc. Daniel B.T., Plowman, R.D., Davis R.F., 1961. Causes and Estimation of Environmental Change in a Dairy Herd. J. Dairy Sel., 44, 699-707.
Meinert T.R., Pearson R.E., 1992. Estimates of genetic trend in an artificial insemination progeny test program and their association with herd characteristics. J. Dairy Sci., 75: 2254-2264.
Özçakır A., Bakır G., 2003. Tahirova Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Döl Ve Süt Verim Özellikleri 1. Süt Verim Özellikleri. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, Cilt 34, Yayın 2.
Özkök H., Uğur F., 2007. Türkiye' de Yetiştirilen Esmer ve Siyah Alaca Sığırlarda Süt Verimi, İlk Buzağılama Yaşı ve Servis Periyodu. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 38 (2), 143-149.
Pelister B., Altınel A., Güneş H., 2000a. Özel işletme koşullarında yetiştirilen değişik orijinli Siyah Alaca sığırların süt verimi özellikleri üzerinde araştırmalar. İstanbul Üniversitesi Veteriner Fakültesi Dergisi, 26(1), 201–214.
Pelister B., Altınel A., Güneş H., 2000b. Özel işletme koşullarında yetiştirilen değişik orijinli Siyah Alaca sığırların döl ve süt verimi özellikleri üzerinde bazı çevresel faktörlerin etkileri. İstanbul Üniviversitesi Veteriner Fakültesi Dergisi, 26(2), 543–559.
Posadas M.V, Lopez F.J., Waldenegro H.M., Keown J.F., Van Vleck L.D., 2001. Genetic Evalution for Milk Production in Holstein Cattle in Mexico. Tektran, United State Department of Agriculture.
Potocnik K., Stepec M., Krsnik J., 2007. Genetic trends for production and non-production traits in Simmental breed in Slovenia. Biotechnol. Anim. Husbandry, 23, 47-53.
Powell R.L., Norman H.D., Dickinson F.N., 1977. Trends in breeding value and production. J. Dairy Sci., 60, 1316-1326.
Siyam A., Düzgüneş E., 1984. Türkgeldi ve Sarmısaklı Devlet Kuruluşlarında Yetiştirilen Siyah Alaca Sığır Sürülerinde Süt Verimim Bakımından Genotipik ve Fenotipik Yönelimler, Ankara Üniversitesi Fen Bilimleri Enstitüsü, No: ZT-3, Ankara.
Şahin A., Ulutaş Z., 2010. Polatlı Tarım İşletmesinde yetiştirilen Siyah Alaca ineklere ait süt ve döl verim Özellikleri. Anadolu Tarım Bilimleri Dergisi, Cilt 25, Yayın 3
Şekerden Ö., 1987. Laktasyon Veriminin Hesaplanmasında Kullanılan Çeşitli Hesaplama Metodlarının Ve Değişik Süt Verim Kontrol Periyodlarının Karşılaştırılması. 19 Mayıs Üniversitesi Ziraat Fakültesi Dergisi, 2, 133-148.
Tapkı İ., Şahin M., Okyay M.S., 2007. Ceylanpınar Tarım İşletmesinde Yetiştirilen Siyah Alaca Sığırların Süt ve Döl Verim Özellikleri 1. Süt Verim Özellikleri. MKU Ziraat Fakültesi Dergisi, 12 (1-2), 1-8.
Tonhati H., Lôbo R.B., 1997. Estimation of The Genetic Trend For Milk And Milk Fat Yields in Holstein. Revista da Sociedade Brasileira de Zootecnia, 26(4), 714-718.
Tuna Y.T., Gürcan E.K., Savaş T., 2007. Sarımsaklı Tarım İşletmesi'nde yetiştirilen Siyah Alaca ırkı süt sığırlarının döl verim özellikleri. Tekirdağ Ziraat Fakültesi Dergisi, 4(3).
Uğur F., 2000. Kumkale Tarım İşletmesinde Yetiştirilen Siyah Alaca sığırların bazı süt verim özellikleri. Selçuk Üniversitesi Ziraat Fakültesi Dergisi, 14, 50-59.
Ulutas Z., 2002. Estimation of genetic and phenotypic trends of 305-day milk yield for Holsteins reared at Gelemen state farm in Turkey. Indian Journal of Animal Sciences, 72(10), 875-877.
Van Vleck L., Westell D.R.A., Schneider J.C., 1986. Genetic change in milk yield estimated from simultaneous genetic evaluation of bulls and cows. J. Dairy Sci., 69, 2963-2965.
Verde O.G., Wilcox C.J., Martin F.G., Reaves C.W., 1972. Genetic Trends in Milk Production in Florida Dairy Herd Improvement Association Herds. Journal of Dairy Science, 55(7), 1010-1012.
Wilson D.E., Willham R.L., 1986. Within-herd phenotypic, genetic and environmental trend lines for beef cattle breeders. J. Anim. Sci., 63, 1087-1094.
Yaeghoobi R., Doosti A., Noorian A.M., Bahrami A., 2011. Genetic Parameters and Trends of Milk and Fat Yield in Holstein's Dairy Cattle of West Provinces of Iran. International Journal of Dairy Science, 6(2), 142.
Yılmaz O., Bayrıl T., 2010. Kazova Vasfi Diren Tarım İşletmesinde yetiştirilen Siyah Alaca ırkı ineklerin süt verimi özellikleri. Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Dergisi. 21 (2). 115-119.
Yener S.M., Tuncel E., Eker M. 1978. Atatürk Orman Çiftliğinde Yetiştirilen Siyah Alaca Sığırların Süt Veriminde Genetik Yönelim. Ankara Üniversitesi Ziraat Fakültesi Yıllığı, Cilt:28, s:820. Ankara.
Żuk B., Łoś P., Łukaszewicz M., Sobek Z., Zwolin´ska, Bartczak I., 1994. Genetic trend of Dairy Traits in the Polish Cattle. Animal Science Papers and Reports - Polish Academy of Sciences, Institute of Genetics and Animal Breeding Jastrzębiec, 12(2), 87-98.