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Genotypic Correlations among First Lactation Profitability, Linear Type Traits and Production Characteristics of Holstein Friesian Cows in Turkey

Türkiye’de Yetiştirilen Siyah Alaca İneklerin Doğrusal Tip Özellikleri, Birinci Laktasyon Karlılığı ve Verim Özellikleri Arasındaki Genotopik Korelasyonlar

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ABSTRACT

Objective: The aim of this study is to determine genetic correlations between linear type traits, yield characteristics and first lactation profitability for use in selection programs.

Material and Methods: The research was carried out in Hatay province between 2012-2017. A total of 810 cows in the first lactation were used in the study. Analysis of variance and covariances of genetic parameters was carried out with Multivariate Limited Maximum Likelihood test.

Results: The average first lactation net profit, 305-d milk yield, first calving age, conception rate at first service, and calving ease rate were determined as 540 US\$, 6008 kg, 793 d, 61.6%, and 91.7%, respectively. Heritabilities of linear type and production traits ranged from 0.10 to 0.42 and 0.04 to 0.39, respectively. The genetic correlations between first lactation profitability and type traits ranged from -0.08 and 0.42, while between first lactation profitability and production traits ranged from 0.06 and 0.34. The highest genetic correlation was between first lactation profitability and central ligament (0.42), while the lowest genetic correlation was between first lactation profitability and udder depth (-0.08). The highest genetic correlation was between first lactation profitability and lactation protein yield (0.34), while the lowest genetic correlation was between first lactation profitability and conception rate at first service (0.09). Genetic correlations between type and production traits varied from -0.42 (FA and CFS) to 0.49 (DC and 305-d MY).

Conclusion: These results showed that primiparous cows having more angular, strong fore udder attachments, strong foot and legs structure were more profitable and opportunities of selection programs by using genetic correlations between linear type traits and production characteristics. It also concluded that the first lactation profitability could be used successfully in Turkish dairy cattle breeding programs.

ÖZ

Amaç: Bu çalışmanın amacı, ıslah programlarında kullanılmak üzere doğrusal tip özellikleri, verim özellikleri ve birinci laktasyon karlılığı arasındaki genetik korelasyonların tespitini yapmaktır.

Materyal ve Metot: Araştırma 2012-2017 yılları arasında Hatay ilinde yürütülmüştür. Araştırmada toplam 810 baş birinci laktasyonda olan inek kullanılmıştır. Genetik parametrelerinin varyans ve kovaryanslarının analizi ise Multivariate Limited Maximum Likelihood testi ile gerçekleştirilmiştir.

Bulgular: Ortalama inek başına birinci laktasyon net kar, 305-gün süt verimi, ilk buzağılama yaşı, ilk tohumlamada gebe kalma oranı ve kolay doğum oranı 540 US\$, 6008 kg, 793 gün, %61.6 ve %91.7 olarak belirlenmiştir. Doğrusal tip özellikleri ile verim özelliklerinin kalıtım dereceleri sırasıyla; 0.10-0.42 ve 0.04-0.39 arasında tahmin edilmiştir. Birinci laktasyon karlılığı ile doğrusal tip özellikleri arasındaki genetik korelasyonlar -0.08 ve 0.42 arasında, birinci laktasyon karlılığı ile verim özellikleri arasındaki korelasyonlar 0.06 ve 0.34. arasında tahmin edilmiştir. Birinci laktasyon karlılığı ile en yüksek korelasyonu meme merkez bağı (0.42) gösterirken, en düşük korelasyonu meme derinliği (-0.08) göstermiştir. Yine birinci laktasyon karlılığı ile en yüksek korelasyonu süt proteini verimi (0.34) gösterirken, en düşük korelasyonu ilk tohumlamada gebe kalma oranı (0.09) göstermiştir. Doğrusal tip özellikleri ile verim özellikleri arasındaki genetik korelasyonlar -0.42 (Ayak açısı ve ilk tohumlamada gebe kalma oranı) ile 0.49 (Sütçü tip özelliği ve 305-gün süt verimi) arasında değişiklik göstermiştir.

Sonuç: Araştırma sonuçları, birinci laktasyondaki daha fazla sütçü tipe sahip, ön meme bağlantısı güçlü, güçlü ayak ve bacak yapısına sahip ineklerin, birinci laktasyonda daha karlı olduklarını ve süt sığırları ıslah programlarında doğrusal tip özellikleri ile verim özellikleri arasındaki bu genetik korelasyonlardan yararlanılarak, daha isabetli seleksiyon yapılabileceğini ortaya koymuştur.



INTRODUCTION

Milk production is the primary target of dairy cattle breeding. Milk, fat, and protein yields and fat and protein percentages are the main economic characteristics for selection in modern dairy cattle production. Accurate estimates of genetic parameters are required to estimate reproduction values using mixed models or selection indices (Chauhan and Hayes, 1991). Recently, functional traits such as reproductive and health characteristics have been more focused on biological, economic and ethical causes and also because of animal welfare concerns. The profitability of dairy cattle depends not only on the production of milk but also on non-production traits such as fertility and health (Toghiani, 2012; Dahiya et al., 2020). Today's production efficiency in farm animals has become the primary concern of breeders in the livestock industry. Increasing profitability by enhancing gross income per cow is in the milestone of breeders in the last decades (Zwald et al., 2004). The phenomenon, fertility, is a combination of several aspects that numerous definitions have given. Pryce et al. (2004) portrayed fertility as "the accomplishment of pregnancy at the desired time" whereas Hyppanen and Juga (1998) described it as "the ability to produce a living offspring during the economically and physiologically approved period". Fertility is "the ability of the animal to conceive and maintain pregnancy if served at the appropriate time in relation to ovulation" according to Darwash et al. (1997) and reported as the ability of the cow to return on heat within an acceptable period, to show the heat properly, and to become pregnant with a minimum number of inseminations; by DeGroen et al. (1997) and (Tiezzi and Maltecca, 2011). Due to the continuous deterioration of genetic structure in terms of health and production traits, more functional traits except for production traits have been taken as selection criteria in selection programs in international genetic evaluations (Berry et al., 2004). As a result of the long-time interval required and problems in recording related production traits, identifying additional traits that can easily be measured and have larger heritability of the individual traits of interest has risen. Linear type traits define biological sense for a series of visual traits of the cow (Berry et al., 2004).

Eighteen functional type traits which approved by the International Committee for Animal Recording (ICAR) used in this research are evaluated in the genomic selection of bulls in intensive dairy cattle production (Anonymous, 2018). The linear type traits program of Wilson (1979) is widely utilized in most

countries by dairy breed associations and artificial insemination (AI) organizations. Production traits have become the primary target of dairy cattle breeders in the whole world. Unfavorable genetic correlations between fertility and production resulted in a severe phenotypic and genetic decline in the dairy industry (Makgahlela et al., 2009). Karslıoğlu Kara et al. (2010) stated that cows' productive life was determined 36.8 ± 2.60 month and it was found that 50% of cows were culled from voluntary reasons, while 50% of involuntary reasons. In another study, Yaylak (2007) expressed that it was found significant that correlations of body depth with dairy form (0.29), body depth with depth udder (-0.54), rear udder height with rear udder width (0.46), rear udder width with rear legs rear view (0.51), dairy form with rump width (0.31). Correlations among major classification categories with linear descriptive traits for all parity were found generally low and medium level and significantly. Numerous studies were conducted to measure the effect and importance of functional type traits and production characteristics on lactation profitability in modern dairy cattle production (Perez-Cabal and Alenda, 2002; Caraviello et al., 2003; Forabosco et al., 2004; Forabosco et al., 2005; Perez-Cabal et al., 2005; Sewalem et al., 2005; Sewalem et al., 2008).

There are only a small number of studies in which the genetic correlations between a cow's economic profitability, production, and linear type traits were estimated from their embryo stage to the end of the first lactation period. The main objective of this study was to investigate the genetic relationships between first lactation profitability, linear type traits, and production characteristics of Holstein Friesian cows.

MATERIALS and METHOD

This research was conducted in five private dairy cattle farms between 2012-2017 in Hatay, Turkey. The farms are located between 36 °E 20 longitudes and 36 °N 18 latitudes in the Eastern Mediterranean region of Turkey. Similar five dairy farms in terms of herd management, feeding, housing and use of technology were selected from the members of Hatay Dairy Cattle Breeding Association. A total of 810 head primiparous cows and 16 sires, which had at least 20 daughters, were used in 5 dairy farms. The linear type scoring was made following the guidelines of the International Committee for Animal Recording (ICAR, 2010).

Dairy farms were visited at weekly intervals, records of production traits, and her pedigrees were collected. Also, eighteen linear type traits were scored



on a scale of 1-9 at the beginning of the first lactation just before morning milking (between 15-30 days postpartum). Cows were milked twice a day, morning and evening.

UNIVARIATE test was used for the analysis of normality of population data and the analysis of means and standard deviations using GLM (General Linear Model) procedure, and Chi-Square (non-parametric) test of SPSS was used for the statistical analysing of conception rate at first service and calving ease traits (SPSS Version 22.0, 2015). The variance and covariance components of the genetic parameters were determined as Multivariate Limited Maximum Likelihood (MTDFREML) by using an animal model. (Boldman et al., 1995).

The following basic models with fixed effects were used;

$$Y_{ipjkl} = \mu_p + H_j + Y_k + S_l + \alpha(x - \bar{x}) + e_{ipjkl}$$

where:

Y_{ipjkl} = observation for trait p on animal i,

μ_p = overall mean value for trait p,

H_j = fixed effect of j. Herds (1., 2., 3., +...5. dairy farms)

Y_k = fixed effect of k. calving year (2012, 2013, 2014, 2015, 2016 and 2017)

S_l = fixed effect of l. calving season (spring, summer, autumn and winter),

$\alpha(x - \bar{x})$ = regression on the production traits,

e_{ipjkl} = residual effect (random error).

Maternal age and the first breeding age were taken as the covariant factors.

A compound of production and linear type traits defines the biological portion of profit per cow. Only the profitability values of the cows in the first lactation period were taken into account in the calculation of revenue and costs. In calculating the revenues, costs and first lactation net profits of cows, the prices in the year when the cows were in the first lactation period were taken as basis. Profit per cow was defined as the difference between returns and costs, with returns (R) and costs (C) as follows;

Returns: [(FLMY x MP) + AMQI + LCP + MVD]

Costs: [CFC + CMP + HOC + CFC + CWOC + DEP]

Where, FLMY was the first lactation milk yield (kg); MP was milk price; AMQI was additional milk income including subventions, incentives, bonuses, cooled and qualified milk; LCP was live calf price; MVD was monetary value difference of cow from other contemporary cows having high genetic merit in

relation to high milk yield and good linear type traits; CFC was calf food costs including milk, hay and concentrate feed; CMP was calf mortality price; COC was other contemporary calves cost related to calf rearing (veterinary, labor, housing, medicine, vaccine etc), CFC was cow food costs including hay, concentrate feed, CWOC was other contemporary cows' costs (veterinary, labor, housing, medicine, vaccine, insemination etc.). The useful life of the cows was taken as 5 years in depreciation calculate and the depreciation was calculated by dividing the marketing values of the cows by its useful life. If a cow did not have a first lactation period greater than 305 d, its returns and costs were not corrected and they were considered as the actual value of the first lactation period.

RESULTS and DISCUSSION

The means, standard deviations and descriptions of linear type and production traits are summarized in Table 1. According to Table 1, the average scores of the type traits ranged from 3.01 (foot angle) to 7.12 (rump width). The average scores of conformation type traits such as dairy character, rump angle, rear leg sets, foot angle, fore-udder attachment, udder depth, rear udder height, central ligament, rear teat placement, hock development, and locomotion were evaluated as low levels. The average scores regarding the type traits are closely similar to the results reported by Gökçe and Burgut (2019). Gökçe and Burgut (2019) stated that the average scores of stature, dairy character, body depth, rump width, rump angle, rear legs side view, chest width, foot angle rear legs placement, rear legs rear view, fore udder attachment, rear udder height, suspensory ligament, udder depth, teat placement, teat length and rear teat placement linear type traits were 144,21±2,03 cm; 6,23±0,63; 5,78±0,71; 5,03±0,58; 5,90±0,71; 5,03±0,91; 5,36±0,60; 4,76±0,66; 4,55±0,71; 4,59±0,94; 4,95±0,98; 4,64±0,81; 5,93±0,89; 5,28±0,92; 5,71±0,84; 4,70±0,51 and 5,12±0,86 respectively.

Heritability values and genetic relationships between first lactation profits (US\$) and linear type traits are shown in Table 2. The heritabilities of type traits varied from 0.10 (foot angle and central ligament) and 0.42 (dairy character). Heritabilities of all foot, leg, and udder type traits were estimated as low or moderate. Also, the heritability of first lactation profit was estimated as 0.35. The dairy character, stature, hock development, teat length, and first lactation profit traits had higher heritability values than the other all type traits. Genetic relations between first lactation profit (US\$) and type traits

**Table 1.** Average scores of linear type traits and production characteristics (means±SE)**Çizelge 1.** Doğrusal tip özellikleri ile üretim özelliklerine ait ortalamalar ve standart hataları

Linear Type Traits	Abbreviations	SCORES		Mean	S.E
		1	9		
Stature	STA	Short	Tall	5.35	0.59
Chest width	CW	Narrow	Wide	6.42	0.64
Body depth	BD	Shallow	Deep	6.11	0.57
Dairy character	DC	Tight rib	Open rib	3.37	0.31
Rump angle	RA	High pins	Very slope	3.14	0.40
Rump width	RW	Narrow	Wide	7.12	0.81
Rear leg set (rear)	RLSR	Hock-in	Parallel	3.98	0.28
Rear leg set (side)	RLSS	Straight	Sickled	3.26	0.21
Foot angle	FA	Low	Very steep	3.01	0.30
Fore-udder attachment	FUA	Loose	Strong	3.74	0.25
Teat length	TL	Short	Long	5.79	0.63
Udder depth	UD	Below hock	Shallow	4.68	0.37
Rear udder height	RUH	Very low	High	4.31	0.33
Front teat placement	FTP	Outside	Inside	5.56	0.40
Central ligament	CL	Broken (flat)	Strong	3.92	0.20
Rear teat placement	RTP	Outside	Crossing	4.52	0.31
Hock development	HD	Swollen	Dry	3.78	0.35
Locomotion	L	Short stride	Long stride	4.16	0.30
Production Traits*					
First lactation profit (US\$)	PFL			540	51.2
Lactation length (d)	LL			314	34.7
305-d milk yield (kg)	MY			6008	807.2
305-d fat yield (kg)	FY			229	27.3
305-d protein yield (kg)	PY			233	30.6
First breeding age (d)	FBA			487	63.3
First calving age (d)	FCA			793	92.8
Services per conception	SC			2.1	0.19
Conception rate in the first (%)	CFS			61.6	4.2
Interval to first service (d)	IFS			81.4	6.4
Open days (d)	OD			138	12.2
Calving ease (%)	CAEAS			91.7	8.7

*All production traits except first breeding and calving age are belong to the first lactations

Table 2. Heritabilities (h^2) and genetic relationships (r_g) between first lactation profit and type traits (means±SE)**Çizelge 2.** Doğrusal tip özellikleri ile birinci laktasyon karlılık durumuna ait kalıtım dereceleri ve özellikler arasındaki genotipik korelasyonlar (ortalama±SH)

Linear Type Traits	Heritabilities	Genetic correlations
First lactation profit (US \$)	0.35±0.05	-----
Stature	0.39±0.04	0.04±0.00
Chest width	0.26±0.05	0.20±0.01
Body depth	0.27±0.03	-0.06±0.00
Dairy character	0.42±0.08	0.40±0.06
Rump angle	0.20±0.02	0.09±0.00
Rump width	0.20±0.01	0.16±0.01
Rear leg set (rear)	0.24±0.02	0.21±0.03
Rear leg set (side)	0.20±0.01	0.37±0.05
Foot angle	0.10±0.01	0.25±0.03
Fore-udder attachment	0.14±0.01	0.27±0.02
Teat length	0.36±0.04	0.05±0.00
Udder depth	0.19±0.02	-0.08±0.00
Rear udder height	0.12±0.01	0.23±0.03
Front teat placement	0.15±0.02	0.31±0.04
Central ligament	0.10±0.01	0.42±0.04
Rear teat placement	0.18±0.02	0.29±0.03
Hock development	0.37±0.04	0.25±0.02
Locomotion	0.28±0.03	0.26±0.03

varied from -0.08 (udder depth) and 0.42 (central ligament). The type traits showing the highest genetic correlation with the first lactation profitability were central ligament, dairy character, rear leg set (side), and front teat placement (Table 2). The genetic correlations are similar to Prestes et al., 2017). The heritabilities of foot, leg and udder traits agree with the other research results (Short et al., 1991; Brotherstone, 1994; Gengler et al., 1999; Pryce et al., 2001; Pérez-Cabal et al., 2005; Némcová et al., 2011), without Mrode and Swanson (1994), Dahiya (2005), Dal Zotto et al. (2007), and Viegas et al. (2015) that heritabilities of foot and leg traits were expressed in higher or lower levels in these studies than this study. Most udder traits had low heritabilities except for teat length (0.36). The heritability values of most udder traits were similar to previously published studies (Mrode and Swanson, 1994; Veerkamp and Brotherstone 1997; Vollema and Groen, 1997; Toghiani, 2011; Bohlouli et al., 2015; Viegas et al., 2015; Prestes et al., 2017).



The other functional traits in strict relationship with the body size had mostly moderate level heritabilities without dairy form (0.42) (Table 2). In this study, the heritabilities of body traits are consistent with those reported by Gengler et al. (1999), Špehar et al. (2012) and Prestes et al. (2017).

The heritabilities of production traits were estimated between 0.04 (open days) and 0.39 (lactation fat yield). Genetic correlations between first lactation profit (US\$) and production traits ranged from 0.06 (first breeding age) and 0.42 (lactation protein yield). The heritabilities of production traits and genetic relationships between the first lactation profit and production traits varied from 0.04 (open days) to 0.39 (lactation fat yield) and from 0.05 (interval to the first service) to 0.34 (lactation protein yield). All reproductive traits had low heritabilities (Table 3). The heritabilities of reproductive traits are in agreement with Cue et al. (1990), Dematawewa and Berger (1998), Weigel and Rekaya (2000), Berry et al.

(2003), Kadarmideen (2004), Biffani et al. (2005), Mitchell et al. (2005), Banos et al. (2007), Gredler et al. (2007) and Sun et al. (2010).

Table 3. Heritabilities (h^2) and genetic relations (r_g) between first lactation profit and production traits (means \pm SE)

Çizelge 3. Üretim özellikleri ile birinci laktasyon karlılık arasındaki genotipik korelasyonlar (r_g) ve özelliklere ait kalıtım dereceleri (h^2) (ortalama \pm SE)

Production Traits	Heritabilities	Genetic correlations
First lactation profit (\$US/per cow)	0.35 \pm 0.04	----
Lactation length (d)	0.15 \pm 0.01	0.24 \pm 0.03
305-d milk yield (kg)	0.31 \pm 0.02	0.31 \pm 0.02
Lactation fat yield (kg)	0.39 \pm 0.04	0.33 \pm 0.04
Lactation protein yield (kg)	0.38 \pm 0.05	0.34 \pm 0.02
First breeding age (d)	0.08 \pm 0.01	0.06 \pm 0.00
First calving age (d)	0.08 \pm 0.01	0.27 \pm 0.03
Services per conception	0.09 \pm 0.01	0.20 \pm 0.01
Conception rate at first service (%)	0.05 \pm 0.01	0.09 \pm 0.01
Interval to first service (d)	0.12 \pm 0.02	0.05 \pm 0.01
Open days (d)	0.04 \pm 0.01	0.11 \pm 0.02
Calving ease (%)	0.27 \pm 0.03	0.24 \pm 0.03

Table 4. Means of economic parameters, revenues, costs and total net profit of cows

Çizelge 4. İneklerin yıllık gelir, gider ve net karı gibi ekonomik parametrelerine ait ortalamalar

Parameters	Minimum	Maximum	Means
Cow's price in calving (US\$)	1875	2325	2065
Milk sales price (US\$)	0.231	0.277	0.257
305-d milk yield (kg)	4786	7234	6008
Total net profit (US\$)	373	712	540
Revenues (US\$)			
Live calf value	451	502	475
Total milk sales	1505	1915	1639
Additional milk sales supports	26	73	53
Average total revenue per cow			2167
Costs (US\$)			
Veterinary and medicine costs of cow's mother	27	145	59
Veterinary and medicine costs per cow	95	131	107
Insemination cost of cow's mother	26	74	40
Insemination cost per cow	34	86	58
Labour cost of cow's mother	13	50	29
Labour cost per cow	206	259	224
Feeds cost per cow	782	1014	865
Depreciation cost per cow	238	358	245
Total cost per cow			1627

The detailed statistics of economic parameters are summarized in Table 4. According to Table 4, the total cost, revenue and net profit per cow in the first lactation were calculated as 1627, 2167, and 540 US\$, respectively.

Genetic correlations between linear type and production traits varied from -0.47 (between rump angle and interval to first service) and 0.49 (between dairy character and lactation milk yield) (Table 5). There were positive correlations between dairy character and lactation length, 305-d milk, fat, and protein yields, while a negative correlation was found between dairy character and services per conception. The services per conception and conception rate at

first service were negatively affected in taller cows. Services per conception increased, while the conception rate at first service of taller cows decreased. There were negative correlations between chest width and services per conception, the interval to first service, open day, and calving ease, while positive correlations were found between body depth, rump angle, rear leg set (side) and hock development, and calving ease. Rear udder height positively affected lactation length, milk, fat, and protein yields, but negatively affected services per conception, conception rate at first service, the interval to first service and open day. There were positive correlations between body depth and calving ease, while negative



correlations were found between body depth and services per conception, and open days. Also, there was a positive correlation between fore udder attachment and services per conception (Table 5). The results of this study are similar to Cue et al. (1990) and Berry et al. (2004) and Yaylak (2007), but were not in agreement with Shapiro and Swanson (1991), and

Bohlouli et al. (2015). These differences may be due to the difference in methodology of heritability estimation, different linear type traits scoring methods and/or cattle population used. In general, linear models (applied to categorical variables) gave lower heritabilities than threshold models, and animal models gave higher heritability than sire models.

Table 5. Genotypic (r_g) relations between 18 conformation type and 11 production traits means (above) and S.E (below)

Çizelge 5. Onsekiz konformasyon ve onbir üretim özelliği arasındaki genotipik korelasyonlar (yukarıdaki) ve standart hataları (aşağıdaki)

Type Traits	LL	LMY	LFY	LPY	FBA	FCA	SC	CFS	IFS	OD	CAEAS
Stature	0.11 (0.01)	0.28 (0.04)	0.15 (0.01)	0.09 (0.00)	-0.26 (0.03)	-0.23 (0.02)	-0.46 (0.07)	-0.37 (0.05)	-0.24 (0.03)	-0.31 (0.03)	0.30 (0.02)
Chest width	0.20 (0.01)	0.28 (0.03)	0.21 (0.02)	0.14 (0.01)	0.31 (0.04)	0.25 (0.03)	-0.36 (0.05)	0.03 (0.00)	-0.43 (0.06)	-0.38 (0.05)	-0.38 (0.05)
Body depth	0.17 (0.01)	0.27 (0.02)	0.22 (0.02)	0.17 (0.01)	-0.33 (0.04)	0.19 (0.01)	-0.44 (0.06)	0.18 (0.01)	-0.13 (0.01)	-0.39 (0.06)	0.39 (0.06)
Dairy character	0.41 (0.05)	0.49 (0.06)	0.46 (0.06)	0.47 (0.05)	0.32 (0.03)	0.37 (0.05)	-0.41 (0.05)	-0.29 (0.03)	0.30 (0.03)	-0.15 (0.01)	-0.17 (0.01)
Rump angle	0.12 (0.01)	0.32 (0.03)	0.34 (0.03)	0.33 (0.04)	0.07 (0.00)	-0.13 (0.02)	-0.23 (0.03)	0.02 (0.00)	-0.47 (0.05)	0.22 (0.02)	0.43 (0.06)
Rump width	0.09 (0.00)	0.31 (0.04)	-0.06 (0.00)	-0.01 (0.00)	0.26 (0.03)	0.12 (0.02)	0.27 (0.03)	0.14 (0.01)	-0.33 (0.03)	-0.30 (0.03)	0.29 (0.03)
Rear leg set (rear)	0.29 (0.03)	0.02 (0.00)	0.10 (0.01)	0.09 (0.00)	0.31 (0.04)	0.24 (0.03)	0.01 (0.00)	0.01 (0.00)	-0.32 (0.03)	0.27 (0.02)	0.01 (0.00)
Rear leg set (side)	0.27 (0.04)	0.41 (0.04)	0.45 (0.06)	0.38 (0.05)	0.44 (0.06)	0.39 (0.05)	0.02 (0.01)	0.02 (0.00)	-0.41 (0.04)	0.27 (0.04)	0.42 (0.05)
Foot angle	0.23 (0.02)	0.20 (0.01)	0.12 (0.01)	0.03 (0.00)	0.29 (0.03)	0.19 (0.02)	-0.01 (0.00)	-0.04 (0.01)	0.16 (0.01)	0.19 (0.02)	-0.23 (0.01)
Fore udder attachment	-0.09 (0.00)	-0.14 (0.01)	-0.12 (0.01)	-0.07 (0.00)	0.02 (0.00)	0.06 (0.01)	0.43 (0.05)	0.31 (0.04)	-0.30 (0.02)	-0.27 (0.03)	0.01 (0.00)
Teat length	0.04 (0.00)	-0.04 (0.00)	-0.09 (0.00)	-0.01 (0.00)	0.01 (0.00)	-0.04 (0.01)	0.06 (0.01)	0.01 (0.00)	0.19 (0.01)	0.23 (0.02)	0.02 (0.00)
Udder depth	-0.39 (0.05)	-0.44 (0.03)	-0.41 (0.04)	-0.46 (0.07)	0.29 (0.04)	0.27 (0.03)	-0.11 (0.01)	-0.01 (0.00)	-0.13 (0.01)	-0.15 (0.01)	0.09 (0.01)
Rear udder height	0.40 (0.04)	0.42 (0.05)	0.45 (0.05)	0.43 (0.05)	0.16 (0.01)	0.11 (0.01)	-0.38 (0.05)	-0.40 (0.05)	-0.41 (0.05)	-0.38 (0.05)	0.12 (0.01)
Front teat placement	0.26 (0.03)	0.24 (0.02)	0.20 (0.02)	0.18 (0.02)	0.27 (0.03)	0.12 (0.01)	0.11 (0.01)	0.13 (0.01)	0.10 (0.01)	0.14 (0.01)	0.11 (0.02)
Central ligament	0.33 (0.04)	0.29 (0.03)	0.25 (0.03)	0.31 (0.03)	0.11 (0.01)	0.07 (0.00)	0.15 (0.01)	0.25 (0.02)	0.06 (0.01)	-0.08 (0.01)	-0.07 (0.01)
Rear teat placement	0.24 (0.02)	0.30 (0.04)	0.20 (0.02)	0.23 (0.02)	0.02 (0.00)	0.01 (0.00)	-0.29 (0.03)	0.03 (0.01)	0.25 (0.03)	0.27 (0.03)	0.02 (0.00)
Hock development	-0.21 (0.02)	-0.24 (0.02)	-0.19 (0.01)	-0.16 (0.01)	0.32 (0.03)	0.30 (0.04)	0.31 (0.02)	0.20 (0.02)	0.19 (0.01)	0.15 (0.01)	0.41 (0.05)
Locomotion	0.21 (0.02)	0.19 (0.01)	0.17 (0.01)	0.14 (0.02)	0.25 (0.02)	0.21 (0.01)	0.29 (0.03)	0.16 (0.01)	0.10 (0.01)	0.09 (0.01)	0.20 (0.02)

LL: Lactation length, LMY: Lactation milk yield, LFY: Lactation fat yield, LPY: Lactation protein yield, FBA: First breeding age, FCA: First calving age, SC: Services per conception, CFS: Conception rate at first service, IFS: Interval to first service, OD: Open days, CAEAS: Calving ease.

CONCLUSIONS

The cows that had a genetically taller and wider body, more angulars, shallower udders with lower foot angle, toe-out rear legs, higher pins rump angle had lower genetic merit for services per conception, conception rate at first service, the interval to the first service, open days and calving ease, while genetically more angular, higher rear udder heights had higher genetic merit for lactation length, milk, fat and protein yields. These results showed that primiparous cows having more angular, strong fore udder attachments,

strong foot and legs structure were more profitable and opportunities of selection programs by using genetic correlations between linear type traits and production characteristics. It also concluded that the first lactation profitability could be used successfully in Turkish dairy cattle breeding programs.

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