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Determination of the Factors Effecting Lactation Milk Yield of Holstein Friesian Cows by the Path Analysis

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ABSRACT

The objective of this study was made to determine the factors effecting lactation milk yield of Holstein Friesian cows by the path analysis in order to improving the milk production. Namely, this study was carried out to determine the direct and indirect relationships, and total effects between lactation milk yield (LMY; Y) and lactation length (LL; X_1), average daily milk yield (DMY_{mean};X_2), maximum daily milk yield (DMY_{max}; X_3), service period (SP; X_4), first calving age (FCA; X_5), gestation period (GP; X_6) of 130 head of first lactating Holstein Friesian cows.When the direct determination coefficients of independent variables on dependent variable were analyzed via path analysis, it was determined that the lactation length (LL; X_1) and average daily milk yield (DMY_{mean}; X_2) were found to be more effective than the other independent variables. The path coefficients which show the direct effects of each variables on estimated variable were calculated as 0.60846 for X_1, 0.77329 for X_2, 0.03832 for X_3, 0.12079 for X_4, 0.00051 for X_5 and -0.01672 for X_6 respectively, and the determination coefficient (R^2) were found as 0.967. As a result, it was stated that the use of path analysis would be more appropriate in determining the factors effecting lactation milk yield.

1. Introduction

There are a lot of factors affecting yield on livestock. Therefore it's important to understand which environmental factor affects yield to what extent or which way, to success of selection. One of the most important proverbial statistical measures among variables is the coefficient of correlation. But solitarily coefficient of correlation is not a criteria to state that there is a cause and effect relation among the variables. As too much functional relations occur among variables, path analyze used to determine if variables have either direct or indirect effect separately or together on results and to determine interaction among variables.

Path analyze is a method that used to determine relations among variables, to determine such directly or indirectly revealed that the total effect of independent variables on dependent variables (Alpar 2011). As another feature of the path analyze, it can reveal relations among variables with diagrams that proper to purpose. As this feature make easier to identify objective relations, it also provides understandable logical flow at results interpretation (Martin and Meek 1986). Namely, path coefficients can be also described as standardized partial regression coefficients (Düzgüneş and Akman 1995; Düzgüneş et al. 1996). If causal variables do not depend on each other, path coefficients going from causal variables to outcome variables is equal to the correlation coefficient between these variable and outcome variables (Karabacak et al. 2013).

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This research was made to determine the direct or indirect relations of lactation time, daily average milk yield, maximum milk yield, service period, first calving age, gestation time which effect on lactation milk yield in Holstein Friesian Cows by Path analyze.

2. Materials and Methods

2.1. Materials

130 Holstein Friesian cows which raised in a private farm located in Karapınar County of Konya province in Turkey were used as research material. First lactation data were used. Lactation milk yield, lactation period, daily average milk yield, maximum milk yield, service period, first calving age and gestation period were determined from records.

2.2. Methods

Primarily, correlation coefficient of lactation milk yield, lactation period, average daily milk yield, maximum milk yield, service period, first calving age and gestation period were calculated in research. Afterwards variables standardized with regression analyze. Because of the coefficients standardized, a constant was zero. Multiple regression coefficients of this equation denotes path coefficients videlicet every variables direct effects on result variable (Gürbüz *et al.* 1999). Hereby lactation milk yield modeled as dependent variable and path analyze carried out to determine direct or indirect effects of other six variables on this variable. In path analyze it was shown as Y: lactation milk yield (1), X_1: lactation time (day), X_2: daily average milk yield (1), X_3: maximum daily milk yield (1), X_4: service period (day), X_5: first calving age (day) and X_6: gestation period (day).

X_1, X_2, X_3, X_4, X_5 and X_6 are independent variables and Y is dependent variable in the path analyze diagram given in Figure 1. Path coefficient indicates the variation caused by each feature which effects one character's formation. According to the direction of the path coefficient from reason to result, the relation was shown with one way arrow in the diagram at Figure 1, but thereby it doesn't states reason result relation, the correlation coefficients were indicated with two way arrow.

While correlation coefficient changes among +1 and -1, path coefficients could get beyond these limits. Also negative and positive efficient ones of path coefficients equalize each other's and keep correlation coefficients within these limits (Orhan and Kaşıkçı 2002).

In Figure 1, direct effect of X_1 variable on Y feature was indicated with P_{YX1}. Meanwhile effect of X_1 variable via X_2, X_3, X_4, X_5 and X_6 variables to Y, become X_1 variables indirect effects on Y.

Correlation coefficients among the lactation milk yield, lactation length, daily average milk yield, maximum daily milk yield, service period, first calving age and gestation period could be split as below.

$$r_{YX1} = P_{YX1} + r_{12}P_{YX2} + r_{13}P_{YX3} + r_{14}P_{YX4} + r_{15}P_{YX5} + r_{16}P_{YX6}$$

$$r_{YX2} = P_{YX2} + r_{12}P_{YX1} + r_{23}P_{YX3} + r_{24}P_{YX4} + r_{25}P_{YX5} + r_{26}P_{YX6}$$

$$r_{YX3} = P_{YX3} + r_{13}P_{YX1} + r_{23}P_{YX2} + r_{34}P_{YX4} + r_{35}P_{YX5} + r_{36}P_{YX6}$$

$$r_{YX4} = P_{YX4} + r_{14}P_{YX1} + r_{24}P_{YX2} + r_{34}P_{YX3} + r_{45}P_{YX5} + r_{56}P_{YX6}$$

$$r_{YX5} = P_{YX5} + r_{15}P_{YX1} + r_{25}P_{YX2} + r_{35}P_{YX3} + r_{45}P_{YX4} + r_{56}P_{YX6}$$

$$r_{YX6} = P_{YX6} + r_{16}P_{YX1} + r_{26}P_{YX2} + r_{36}P_{YX3} + r_{46}P_{YX4} + r_{56}P_{YX5}$$

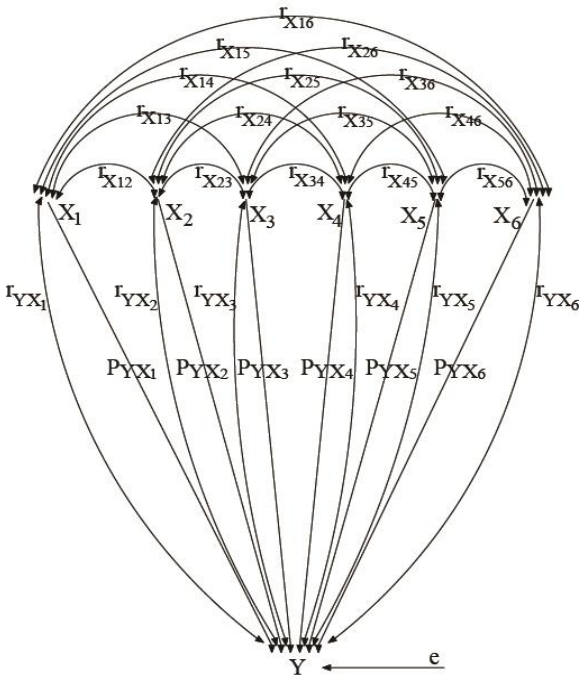

Figure 1

Path diagram among independent and dependent variables

In equivalents they were indicated as P_{Yi}: Path coefficient among i'$_{th}$ independent variable and Y dependent variable (direct effect), $r_{ij}P_{Yi}$: Effect of i'$_{th}$ independent variable via j'$_{th}$ independent variable to Y variable (indirect effect), r_{Yi}: Correlation coefficient among Y and i'$_{th}$ independent variables, r_{ij}: Correlation coefficient among independent variables. Sum of direct and indirect effects indicates correlation coefficient among Y and X_i.

These equivalents should be given with matrix notation as below;

$$\begin{vmatrix} P_{YX1} \\ P_{YX2} \\ P_{YX3} \\ P_{YX4} \\ P_{YX5} \\ P_{YX6} \end{vmatrix} = \begin{vmatrix} 1 & r_{12} & r_{13} & r_{14} & r_{15} & r_{16} \\ r_{21} & 1 & r_{23} & r_{24} & r_{25} & r_{26} \\ r_{31} & r_{32} & 1 & r_{34} & r_{35} & r_{36} \\ r_{41} & r_{42} & r_{43} & 1 & r_{45} & r_{46} \\ r_{51} & r_{52} & r_{53} & r_{54} & 1 & r_{56} \\ r_{61} & r_{62} & r_{63} & r_{64} & r_{65} & 1 \end{vmatrix}^{-1} \begin{vmatrix} r(X_1Y) \\ r(X_2Y) \\ r(X_3Y) \\ r(X_4Y) \\ r(X_5Y) \\ r(X_6Y) \end{vmatrix}$$

If we summarize this matrix equivalent as A = BC, when C matrix isolated, C= AB-1 equivalent and path coefficients become estimated. A matrix which achieved

with multiplication of matrix belong to Correlation (B) and path (C) coefficients was a matrix that direct and indirect effects occur together (Sıralı and Kayaalp1995).

3. Results and Discussions

Definitive statistics belong to lactation milk yield, lactation length, average daily milk yield, maximum milk yield, service period, first calving age and gestation period which established with herd management program of Holstein Friesian Cows are given in Table 1.

According to Table 1, lactation milk yield was 6732.3 l, lactation length was 307.5 day, average daily milk yield was 22 l, maximum milk yield was 30.73 l, service period was 90.68 day, first calving age was 746.4 day and gestation time was determined as 276.7 day.

It was shown that determined lactation milk yield, lactation time and daily average milk yield data in this research were similar with enounced data of Holstein Friesian Cows (Orhan and Kaşıkçı 2002), but service period data of the research has lower values than published literature (Orhan and Kaşıkçı 2002).

Correlation coefficients among lactation milk yield, lactation length, average daily milk yield, maximum milk yield, service period, first calving age and gestation period of Holstein Friesian Cows were given in Table 2.

While statistically significant correlations were found among lactation milk yield and lactation length, average daily milk yield, maximum milk yield, service period ($P<0.01$) and with first calving age ($P<0.05$), statistically insignificant and low correlations determined among lactation milk yield and gestation length ($P>0.05$).

Coefficients in standardized fractional regression equation was determined as $LMY = 0.60846LL + 0.77329DMY_{mean} + 0.03832DMY_{max} + 0.12079SP + 0.00051FCA - 0.01672GP$, and coefficient of determination (R^2) was calculated as % 96.7. Hereby a invariant was became zero hence coefficient standardized. Effects of partial regression coefficients of the equation (path coefficients), which shows direct effects of coefficients on result variable related to lactation length, average daily milk yield and service period were determined as significant ($P<0.01$), but the effects of maximum milk yield, first calving age and gestation length were determined as insignificant.

Analyzed features of Holstein Friesian cows as direct effects, indirect effects, Path (P), correlations (r), coefficients of direct and simultaneous determination (CDD and CSD), effect percentages (%) were given in Table 3.

When the values that indicates direct determination coefficient of X_1, X_2, X_3, X_4, X_5 and X_6 independent variables which indicates Y feature were analyzed, it was shown that P^2_{YX1} and P^2_{YX2} makes the most addition. The research results indicate that the coefficients of direct determination were detected as similar with other published values about Holstein cows and Brown Swiss by Orhan and Kaşıkçı (2002). It was observed that the lactation milk yield was responded at low rate by maximum milk yield, service period, first calving age and gestation length.

Table 1
Definitive statistics belong to analyzed features of Holstein Friesian Cows

Variables	N	$\overline{X} \pm S_{\overline{X}}$	Min	Max
LMY (l)	130	6732.3±97.50	4507.2	9865.3
LL (day)	130	307.5±3.34	247.0	401.0
DMY_{mean} (l)	130	22.00±0.26	16.13	29.62
DMY_{max} (l)	130	30.73±0.39	20.00	43.00
SP (day)	130	90.68±2.89	32.00	175.00
FCA (day)	130	746.4±4.16	693.00	896.00
GP (day)	130	276.7±0.54	260.00	296.00

LMY: lactation milk yield, LL: lactation length, DMYmean: average daily milk yield, DMYmax: maximum daily milk yield, SP: service period, FCA: first calving age, GP: gestation period

Table 2
Correlation coefficients among analyzed data of Holstein Friesian Cows

Features	LMY	LL	DMY_{mean}	DMY_{max}	SP	FCA
LL	0.567**					
DMY_{mean}	0.689**	-0.174*				
DMY_{max}	0.616**	-0.096	0.831**			
SP	0.548**	0.812**	-0.084	-0.045		
FCA	0.182*	0.208*	0.034	-0.028	0.250**	
GP	0.046	0.082	0.015	0.028	-0.002**	0.049

*: $P<0.05$; **: $P<0.01$

Table 3
Direct Effects, Indirect Effects, Path (P), Correlations (r), Coefficients of Direct and Simultaneous Determination (CDD and CSD), Effect Percentages (%) belonging to traits

Direct Effect	Indirect Effect	P	r (r_{XaXb})	CDD (P^2_{YXn})	CSD ($2.r_{XaXb}.P_{YXa}.P_{YXb}$)	EP (%)
X_1		0.60846		0.37022		71.889
	X_2	-0.13464	-0.174*		-0.1637396	15.908
	X_3	-0.00369	-0.096		-0.0044767	0.436
	X_4	0.09811	0.812**		0.1193573	11.592
	X_5	0.00011	0.208*		0.0001291	0.013
	X_6	0.00138	0.082		-0.0016684	0.163
X_2		0.77329		0.59798		83.915
	X_1	-0.10595				11.497
	X_3	0.03183	0.831**		0.0492492	3.454
	X_4	-0.01017	-0.084		-0.0156922	1.104
	X_5	0.00002	0.034		0.0000268	0.002
	X_6	-0.00026	0.015		-0.0003879	0.028
X_3		0.03832		0.00015		5.142
	X_1	-0.05869				7.875
	X_2	0.64232				86.185
	X_4	-0.00547	-0.045		-4.17×10^{-4}	0.734
	X_5	-0.00001	-0.028		-0.0000011	0.001
	X_6	-0.00047	0.028		-0.0000359	0.063
X_4		0.12079		0.01459		17.710
	X_1	0.49422				72.460
	X_2	-0.06514				9.550
	X_3	-0.00174				0.255
	X_5	0.00013	0.250**		3.08×10^{-5}	0.019
	X_6	0.00004	-0.002		0.0000081	0.006
X_5		0.00051		2.6×10^{-7}		0.275
	X_1	0.12647				68.108
	X_2	0.02663				14.341
	X_3	-0.00106				0.571
	X_4	0.03021				16.269
	X_6	-0.00081	0.049		-8.36×10^{-7}	0.436
X_6		-0.01672		2.8×10^{-4}		20.861
	X_1	0.05015				62.570
	X_2	0.01191				14.860
	X_3	0.00107				1.335
	X_4	-0.00027				0.337
	X_5	0.00003				0.037

P: Path Coefficient, r: Correlations (r_{XaXb}), CDD: Coefficient of Direct Determination (P^2_{YXn}), CSD: Coefficient of Simultaneous Determination ($2.r_{XaXb}.P_{YXa}.P_{YXb}$), EP: Effect Percentages, n-a-b: $X_1, X_2, \ldots, X_6$

There are indirect ways ($r_{YX1} = P_{YX1} + r_{12}P_{YX2} + r_{13}P_{YX3} + r_{14}P_{YX4} + r_{15}P_{YX5} + r_{16}P_{YX6}$) which cross over X_2, X_3, X_4, X_5 and X_6, except path coefficient among X_1 factor and Y feature and they are called as coefficient of associate determining (Table 3). Similarly there are other ways cross over Xn among other X factors (X_2, X_3, X_4, X_5 and X_6) and Y feature except P_{YXn} path coefficient ($r_{YX2} = P_{YX2} + r_{12}P_{YX1} + r_{23}P_{YX3} + r_{24}P_{YX4} + r_{25}P_{YX5} + r_{26}P_{YX6}$, $r_{YX3} = P_{YX3} + r_{13}P_{YX1} + r_{23}P_{YX2} + r_{34}P_{YX4} + r_{35}P_{YX5} + r_{36}P_{YX6}$, $r_{YX4} = P_{YX4} + r_{14}P_{YX1} + r_{24}P_{YX2} + r_{34}P_{YX3} + r_{45}P_{YX5} + r_{56}P_{YX6}$, $r_{YX5} = P_{YX5} + r_{15}P_{YX1} + r_{25}P_{YX2} + r_{35}P_{YX3} + r_{45}P_{YX4} + r_{56}P_{YX6}$, $r_{YX6} = P_{YX6} + r_{16}P_{YX1} + r_{26}P_{YX2} + r_{36}P_{YX3} + r_{46}P_{YX4} + r_{56}P_{YX5}$). It was detected that coefficient of simultaneous determination has broadly lower values.

4. Conclusions

When the values of the independent variables are examined, it is seen that lactation length and average daily milk yield are more effective than maximum milk yield, service period, first calving age, and gestation length which shows direct determination coefficients of lactation milk yield.

Relationship between cause variable which is undertaken as independent variable and effect variable which is undertaken as dependent variable can be analyzed in details according to elements of the relationship in path analysis. So that, when cause and effect relations are interpreted, not only direct effects but also indirect effects can be seen.

In short, the most important part of the path analysis is the creation of path diagram. It is important to reveal the relationship between direct and indirect variables. If relations are regulated wrong, these leads to incorrect results such as R2>1 or R2<0. Therefore, path analysis is been convenient to detect the factors effecting lactation milk yield to see its both direct and indirect effects.

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6. References

Alpar CR (2011). *Applied Multivariate Statistical Methods*. Detay Publishing, Ankara.

Düzgüneş O, Eliçin A, Akman N (1996). Hayvan Islahı. *Ankara Üniversitesi Ziraat Fakültesi Ders Kitabı:* 419, Yayın No: 1437, Ankara.

Düzgüneş O, Akman N (1995). Varyasyon Kaynakları. *Ankara Üniversitesi Ziraat Fakültesi Ders Kitabı*: 406, Yayın No: 1408, Ankara.

Gürbüz F, Başpınar E, Keskin S, Mendeş M, Tekindal B (1999). Path Analizi Tekniği. 4. *Ulusal Biyoistatistik Kongresi Bildirileri*, 23-24 Eylül, Ankara.

Karabacak A, Boztepe S, Keskin İ, Aytekin İ (2013). Investigation of Relationships between some Carcass Traits and Pelvic Fat Weight in Akkaraman Lambs by Path Analysis. *VIth International Balkan Animal Conference BALNIMALCON 2013*. 3-5 October 2013, Tekirdağ, Turkey.

Martin SW, Meek AH (1986). A path model of factors influencing morbidity and mortality in ontorio feedlot Calves. *Canadian Journal of Veterinary Research*, 50: 15-22.

Orhan H, Kaşıkçı D (2002). A Study on Comparison of the Correlation, Path, and Partial Regression Coefficients. *Animal Production*, 43 (2): 68-78.

Sıralı R, Kayaalp T (1995). Trakya Bölgesi Arılarının Bal Verim Özelliği ve Bu Özelliği Etkileyen Bazı Faktörlerin Path Analizi Yöntemi İle Saptanması. *Harran Üniversitesi Ziraat Fakültesi Dergisi*, 1(2): 211–218.