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Path Analysis for Factor Affecting the 305- Day Milk Yield of Holstein Cows

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Abstract: Path Analysis is one of the most widely used methods in animal husbandry, especially in dairy science. This method, which is used to calculate the direct and indirect effects of the dependent and independent variables in the model on each other, offers researchers a very detailed interpretation. In this study, direct and indirect effects of lactation number, calving season, dry period, service period and insemination number variables on 305-day milk yield of 1007 Holstein cows were investigated by Path analysis. Analysis of the study was carried out with IBM SPSS 26.0 and IBM SPSS AMOS 21 program. The direct effects of lactation number (-0.061) and calving season (0.027) variables on 305-day milk yield were not statistically significant (p>0.05). The direct effects of dry period (-0.354), service period (-0.505) and insemination number (0.386) variables on 305-day milk yield were found to be statistically significant (p<0.05).

Keywords: 305-day milk yield, Correlation, Path Analysis, Path Coefficients.

Holstein İneklerinin 305-Gün Süt Verimini Etkileyen Faktörler İçin Path Analizi

Öz: Path Analizi, süt sığırcılığı başta olmak üzere hayvancılık alanında yaygın kullanılan yöntemler arasındadır. Modelde bulunan bağımlı ve bağımsız değişkenlerin birbirleri üzerinde doğrudan ve dolaylı etkilerinin hesaplanmasında kullanılan bu yöntem araştırmacılara oldukça ayrıntılı yorumlama imkânı sunmaktadır. Bu çalışmada, 1007 baş Holstein ırkı süt sığırına ilişkin laktasyon sayısı, buzağılama mevsimi, kuru dönem, servis periyodu ve tohumlama sayısı değişkenlerinin 305-gün süt verimi üzerine doğrudan ve dolaylı etkileri Path analizi ile araştırılmıştır. Çalışmanın analizleri IBM SPSS 26.0 ve IBM SPSS AMOS 21 programı ile gerçekleştirilmiştir. Laktasyon sırası (-0.061) ve buzağılama mevsimi (0.027) değişkenlerinin 305-gün süt verimi üzerine doğrudan etkilerinin istatistiksel açıdan anlamlı olmadığı görülmektedir (p>0.05). Kuru dönem (-0.354), servis periyodu (-0.505) ve tohumlama sayısı (0.386) değişkenlerinin 305-gün süt verimi üzerine doğrudan etkilerinin istatistiksel açıdan anlamlı olduğu tespit edilmiştir (p<0.05).

Anahtar Kelimeler: 305-gün süt verimi, Korelasyon, Path Analizi, Path Katsayısı.

1. Introduction

Several statistical techniques have been developed to help animal science researchers deal with studies involving the analysis of cause-effect relationships among multiple variables and evaluating traits with high economic value. Milk yield is one of the features with high economic value and financial importance. Among the main objectives of statistical analysis, processes are to improve the yield characteristics that are the subject of milk production and to reveal the affecting factors and effects considering scientific results. Regression and correlation analyses are widely used to interpret the relationships between the variables that represent the examined characteristics. However, when there are indirect effects in the relationship between the variables, in other words, when the relationship between two variables occurs due to another third variable, correlation and regression analyses may be insufficient in interpreting the cause-effect relationship between the variables (Alpar, 2011). At this point, it is recommended to use Path analysis to determine the direct and indirect effects of independent variables affecting dependent variables and to interpret cause-effect relationships (Lleras, 2005). Path analysis is an extension of multiple regression analysis and provides estimates of the magnitude and significance of hypothesized causal connections between variables (Stage et al., 2004).

Path analysis was developed by geneticist Sewall Wright in the 1920s to examine model effects in phylogenetic studies (Wright, 1921; Wright, 1934). Path analysis, widely used in various fields of animal husbandry, especially dairy cattle, has been the subject of successful applications. Erb et al., (1981) used Path model to investigate causes and effects of dystocia, retained placenta, metritis, cystic follicle, and luteal cyst. Also, Direct, indirect and multivariate relationships of diseases were interpreted. Erb et al., (1985) studied with Path models of the interrelationships among breeding performance, yield, diseases, and culling. They examined the direct and indirect relationships among age, milk yield traits and related diseases, body weight, reproductive disorders and performance, and culling. Curtis et al., (1985) were used Path analysis and logistic regression to model direct and indirect relationships among the incidence of metabolic and reproductive disorders and estimated nutrient intakes in the last 3 weeks of the dry period. Grings et al., (2008) evaluated milk yield and body weight of beef cows born and raised within three calving systems and weaned at 2 ages as calves. They interpreted the direct and indirect effects of various measures on calf ADG (kg/d) from birth to weaning and total milk yield (kg) via Path analysis. Various studies on body weight and body condition score in cattle are available in the literature (Heuer et al., 1999; Tyasi et al., 2020). Yakubu (2011) determined the relationships between milk yield and conformation traits of Bunaji (White Fulani) cows using Path analysis. Scientific studies have been conducted to examine the direct and indirect effects of various factors on lactation milk yield and 305-day milk yield in dairy cattle. Tahtalı et al (2011) performed a Path analysis to examine the factors affecting milk productivity of Brown Swiss cows, and they interpretated the percentages of direct effects of factors on actual milk yield. Orhan and Kaşıkçı (2002) calculated the direct and indirect effects between lactation milk yield and independent variables defined as lactation period, 305-day milk yield, age, service period, and daily average milk yield in Holstein and Swiss Brown cattle by Path analysis. According to the direct determination coefficients, the researchers reported that lactation milk yield was affected by the highest lactation period (24.35%) in Holstein and 305-day milk yield (44.57%) in Swiss Browns. In addition, it was determined that the lowest effect on lactation yield was the service period in Holsteins and age in Swiss Browns. The coefficient of determining the lactation milk yield of the variables examined in the study was calculated as (95.2%). Naskar et al., (2006) investigated the factors affecting lactation milk yield in Sahiwal cattle by Path analysis. It was observed that lactation length had the highest effect on lactation milk yield in all lactations (74.08%). In addition, the indirect effect of lactation length with a yield of 305 days was reported as 39.22%. Görgülü (2011a) used Path analysis to determine the relationships between age, the number of lactations, calving season, and 305-day milk yield in Jersey cattle. As a result of the research, it was reported that age and the number of lactation variables were the most important factors affecting milk yield components. In addition, in terms of direct effects, it was observed that the age variable had the highest positive effect on 305-day milk yield. In another study conducted by the researcher on Simmental cattle, direct or indirect effects on 305-day milk yield were investigated by Path analysis. Görgülü (2011b), in his study, used the number of lactations, the age, calving season, dry period, age in the first conception, and age at first calving variables. According to study results, age had the highest effect (r = 0.712) on 305-day milk yield, while calving season had the lowest effect. Güneri et al., (2015) determined the direct and indirect effects of parity, year of calving, and lactation length on 305-day milk production via Path analysis. Results of the analysis show that the direct effects of the parity, year of calving, and lactation length on 305-day milk production were found as 0.12, 0.10, and 0.46, respectively. In the literature, there are various studies on modeling annual milk yield with dairy farm data (Bidwe et al., 2009; Kaplan and Çiçek, 2022), lactation milk yield in cattle (Aytekin et., 2016; Banik and Tomar, 2003), and 305-day milk yield (Boğa et al., 2022; Sevinç et al., 2020; Sharma et., 2020; Tahtalı et al., 2019).

In this study, the direct and U- effects of lactation number, calving season, dry period, service period and insemination number on 305- day milk yield of 1007 head of Holstein cows were investigated by Path Analysis.

2. Material and Method

2.1. Data Source

The dataset contains milk yield information from Holstein cows registered on a private dairy farm. The study material consisted of 305-day milk yield, lactation number (1-3), calving season (1-4), dry period, service period, and insemination number of 1007 Holstein cows. The dependent variable in the study was determined as 305-day milk yield. Analysis of the study was carried out with IBM SPSS 26.0 and IBM SPSS AMOS 21 program.

2.2 Path Analysis

Path analysis was chosen as the data analysis technique. This technique is used to interpret the comparative strength of direct and indirect relationships among variables (Lleras, 2005). In the Path analysis process, first of all, Path diagrams are created in order to determine the amount and direction of the relationship between the variables. The Path diagram shows the causal variation of variables on other variables. In Figure 1, it can be seen that possible causal relationships underlying a covariation. One-way arrows indicate the existence of a cause-effect relationship between the variables in the relationship types shown in Figure 1. In the "a" representation, it is seen that the X variable directly affects the Y variable. The direct effect here is defined by the Path coefficient. The presence of indirect effect in Path analysis is included in the "c" representation on Figure 1. Here, variable Z is seen as a cause of both X and Y variable, but the effect of Z on Y is mediated by the effect of X on Y (Stage et al., 2004). Examples that are causally open to external influences according to their covariations are given in the notation's "d" and "e". The "d" representation on Figure 1 represents the unanalyzed effect- U effect, which is another type of effect encountered in Path analysis (Güneri et al., 2017; Kocakaya and Gönen, 2013). A curved two-way arrow between the X and Z variables indicates that there is a relationship between these variables, but no cause-effect relationship. Here, the relationship between X-Y variables and Z-Y variables is defined as the unanalyzed effect. The U effect calculation is performed by multiplying the Path coefficient between the X and Y variables and the correlation coefficient with another variable that does not have a cause-effect relationship between the X variable. In other words, the U effect is obtained by multiplying the direct effect of the X variable on the Y variable and the correlation coefficient between the X and Z variables. The notation "e" on the diagram represents the spurious effect - S effect, which occurs for common reasons. Covariation between X and Y results from in addition to the direct effect of X on the Y variable from their direct sharing of the Z variable, which is a common cause (Nie et al., 1975). It is calculated by multiplying the S effect Z variable between the X and Y variables and their Path coefficients (Alpar, 2011).

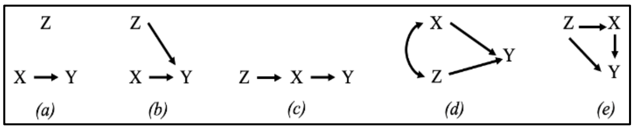

Figure 1. Causal relationships underlying a covariation (Baron and Kenny, 1986; Stage et al., 2004).
Şekil 1. *Kovaryasyonun altında yatan nedensel ilişkiler.*

Path analysis is one of the multivariate statistical analysis methods used to examine the relationships between variables and reveal the influence of independent variables on the dependent variable (Xing et al., 2016). It is also based on multiple linear regression models adjusted simultaneously to explain a range of dependent variables from directly or indirectly related independent variables (Çankaya and Abacı, 2012; Geiser, 2013; Görgülü 2011a). The Path coefficient is denoted by the letter "P"; it expresses the causality between the variables in the model and is the standardized regression coefficient without units (β) (Xing et al., 2016). However, the Path coefficient equals the direct effect correlation coefficient calculated between the independent and dependent variables (Güneri et al., 2015). Path analysis is carried out as a sequential and more than one multiple linear regression analysis, where equations are resolved simultaneously to determine the estimation of parameters (β) (Sanchez et al., 2021). The regression constant is not included in the standardized regression equation obtained after the dependent and independent variables are standardized. Here, the Path coefficient, namely β, expresses the change in the dependent variable based on standard deviation when there is a change of one standard deviation in the independent variable (Alpar, 2011; Tahtalı et al., 2011). For an interrelated system, such as the effect of environmental factors on milk yield estimation, in the presence of more than one independent variable (x_i) and one dependent variable (y), the multiple linear regression equation is shown in Equation 1:

$$y = b_0 + b_1x_1 + b_2x_2 + .. + b_nx_n \quad (i=1,2,...n) \qquad (1)$$

The mathematical notation for calculating the Path coefficient is given in Equation 2. Where; b_i: Partial regression coefficient, S_{x_i}: Standard deviation of x, S_y: Standard deviation of y. Standard deviation's formulas are shown in Equation 3 and Equation 4.

$$P_{yx_i} = b_i \frac{S_{x_i}}{S_y} \qquad (i = 1,2,\ldots,n) \qquad (2)$$

$$S_x = \sqrt{\frac{1}{n-1}\left(\sum_{i=1}^{n}(x_i - \bar{x})^2\right)} \qquad (3)$$

$$S_y = \sqrt{\frac{1}{n-1}\left(\sum_{i=1}^{n}(y_i - \bar{y})^2\right)} \qquad (4)$$

Path coefficients can be obtained with the following solution of the matrix equation, as shown in Equation 5, based on Equation 1. The definitions for the matrix equation are as follows: $r_{x_ix_j}$ is the correlation coefficient between x_i and x_j, $P_{yx_i}$is the direct Path coefficient x_i to y, it shows how x_i directly affects y_i.

The indirect effect of the first independent variable (x_1) on the dependent variable (y) through the second independent variable (x_2) is defined as follows, $r_{x_1x_2} \times P_{yx_2}$ (Şahinler and Görgülü, 2000).

$$\begin{bmatrix} 1 & r_{x_1x_2} & \cdots & r_{x_1x_n} \\ r_{x_2x_1} & 1 & \ddots & r_{x_1x_n} \\ \vdots & \vdots & & \vdots \\ r_{x_nx_1} & r_{x_nx_2} & \cdots & 1 \end{bmatrix} \begin{bmatrix} P_{yx_1} \\ P_{yx_2} \\ \vdots \\ P_{yx_n} \end{bmatrix} = \begin{bmatrix} r_{x_1y} \\ r_{x_2y} \\ \vdots \\ r_{x_ny} \end{bmatrix} \quad (5)$$

Path analysis is a method that can be applied when there is a complex relationship, such as a causality between many independent variables or when some independent variables have indirect effects on the dependent variable through other independent variables (Xing et al., 2016).

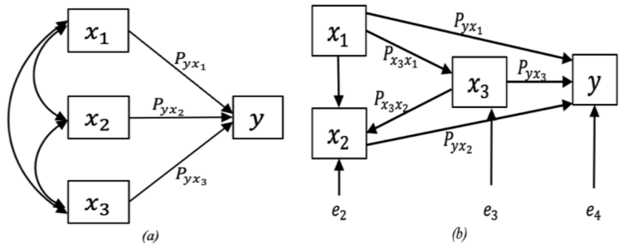

Figure 2. Path diagram representations of one-equation and three-equation models.
Şekil 2. *Bir denklemli ve üç denklemli modellerin Path diyagram gösterimleri.*

Path diagram representations of direct and indirect effect, U-effect, and S-effect are included in Figure 2. The causal models' graphical representations are shown in Figure 2(a) and Figure 2(b) for the one-equation and three-equation models, respectively. The regression equations for models and the standardized regression coefficients of the variables should be obtained for obtaining Path coefficients (Alpar, 2011). In Figure 2 (a), the direct effect of the independent variable (x_1) on the dependent variable (y) is expressed by P_{yx_1}. Similar expressions can be used for P_{yx_2} and P_{yx_3}. In Figure 2(b), besides the direct effect, the presence of indirect and S-effect is in question.

$$r_{x_3y} = P_{yx_3} + P_{x_3x_2} \times P_{yx_2} + P_{x_3x_1} \times P_{yx_1} + P_{x_3x_1} \times P_{x_2x_1} \times P_{yx_2} \quad (6)$$

When it is desired to obtain correlation coefficients with the help of path coefficients, the direction of the relations determined on the path diagram and effect types are used. For example, when r_{x_3y} is to be calculated, as can be seen in Equation 6 and Figure 2(b), the mathematical expressions represented are as follows: "P_{yx_3}" is direct effect, "$P_{x_3x_1} \times P_{x_2x_1} \times P_{yx_2}$" and "$P_{x_3x_1} \times P_{yx_1}$" are S-Effect and "$P_{x_3x_2} \times P_{yx_2}$" is indirect effect. In this study, direct and U-effect were studied.

3. Results and Discussion

Descriptive statistics for the variables were calculated in the first step of the analysis process. Pearson correlation coefficient and multiple linear regression analysis were used to make preliminary evaluations. Also, Kolmogorov- Smirnov method was used to investigate normality. To interpret the direct and U-effects of the independent variables on the dependent variable, a Path diagram was created, and Path analysis was performed. The figural view of the Path diagram designed in this study is given in Figure 3. The expression of P_{yx_1}, P_{yx_2}, P_{yx_3}, P_{yx_4} and P_{yx_5} on the figure represents the Path coefficients. They also express the direct effect of independent variables on 305-day milk yield.

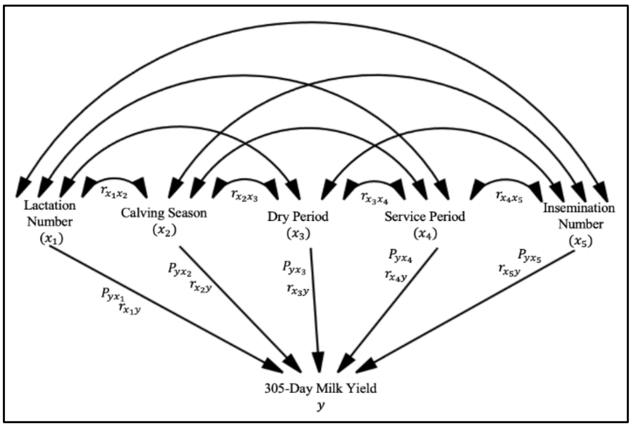

Figure 3. Path diagram for 305-day milk yield.
Şekil 3. *305-günlük süt verimi için Path diyagramı.*

The correlation values of the variables in the research model are summarized in Table 1. Accordingly, when the correlation between 305-day milk yield and independent variables was examined, positive correlations with lactation number (0.254), negative correlations with the dry period (-0.318), and negative correlations with the service period (-0.248) were found statistically significant ($p<0.05$). According to the estimated correlations between the variables, it was determined that the highest values were between the lactation number-dry period (-0.805) and between the service period-insemination number (0.687).

The standardized regression coefficients representing the direct effect of the independent variables in the model, significant values, and the variance inflation factors (VIF) and tolerance values calculated to investigate the multi-connection situation are given in Table 2.

Table 1. Correlation matrix for milk yield traits
***Çizelge 2.** Süt verim özellikleri için korelasyon matrisi*

	Calving Season	Dry Period	Service Period	Insemination Number	305-Day Milk Yield
Lactation Number	-0.056	-0.805**	-0.024	0.051	0.254**
Calving Season	.	0.056	-0.004	0.020	0.020
Dry Period	.	.	0.029	0.002	-0.318**
Service Period	.	.	.	0.687**	-0.248**
Insemination Number	.	.	.	.	0.036
305-Day Milk Yield	.	.	.	.	.

**Correlation is significant at the 0.01 level ($p < 0.01$),*Correlation is significant at the 0.05 level ($p < 0.05$)

The direct effects of dry period, service period and insemination number variables on 305-day milk yield was found to be statistically significant (p<0.01). In the process of obtaining the path coefficients, regression equations are used, and many regression analyses are performed. Therefore, the assumptions applied in the regression analysis are still valid in the Path analysis (Alpar, 2011). In the constructed regression model, when the independent variable group has a high correlative relationship, the actual contribution of each of the examined variables to the result of interest may not be shown (Domecq et al., 1996). To investigate this situation, Pearson correlation coefficients, VIF, and tolerance values were calculated between the independent variables of the regression models to detect collinearity. It was determined that the VIF values calculated in the model were at a satisfactory level. In addition, the correlation of errors was investigated with Durbin-Watson statistics ($d = 1.507$).

Table 2. Standardized Regression Coefficients and Collinearity Statistics
***Çizelge 3.** Standartlaştırılmış regresyon katsayıları Collinearity istatistikleri*

Variables	Lactation Number	Calving Season	Dry Period	Service Period	Insemination Number
Coefficients (β^*)	-0.061	0.027	-0.354	-0.505	0.386
Sig. (p)	0.195	0.332	0.000**	0.000**	0.000**
VIF Values	2.881	1.005	2.858	1.913	1.927
Tolerance	0.347	0.995	0.350	0.523	0.519

*** Significant at the 0.01 level* ($p < 0.01$)

As can be seen in Figure 3, the calculated Path coefficients, correlation values, and figural representations representing the relationships between the variables are on the Path diagram. At the same time, the direct effect values of the independent variables on the dependent variable and the U-Effect value can be seen in the Path model. Each effect value was formulated and calculated separately with the help of the Path diagram.

In Table 3, the research results obtained as a result of the Path analysis are summarized. Numerical calculations of the direct effects and U-effects of lactation number, calving season, dry period, service period and insemination number, as indicated as independent variables, on 305-day milk yield were performed. The direct effects of lactation number ($P_{yx_1} = -0.061$) and calving season ($P_{yx_2} = 0.027$) variables on 305-day milk yield were not found to be statistically significant (p>0.05). The direct effects of the dry period ($P_{yx_2} = -0.354$), service period ($P_{yx_2} = -0.505$), and insemination number ($P_{yx_2} = 0.386$) variables on 305-day milk yield were found to be statistically significant (p<0.05). Accordingly, it can be interpreted that as a result of Path analysis, one standard deviation increase in the service period causes a 0.505 standard deviation decrease in 305-day milk yield.

When the path coefficients are evaluated in terms of numerical size, it is seen that the highest direct effect occurs with the service period. After the service period, the insemination number, dry period, calving season, and lactation number variables are ranked according to numerical sizes. As seen in Table 3, the correlation values between the variables in the research model consist of the sum of the direct effects of the variables and the U-Effect values representing the relationships on the other variables.

In the total amount of effect on the 305-day milk yield of the lactation number, it was determined that the U-effect on the dry period of the lactation number (75.162%) had the greatest effect. However, it is also seen that there is a statistically significant negative strong correlation (-0.805) between the two mentioned variables (p<0.01). The direct effect of the lactation number (16.089%) is followed by the U-effects of the number of inseminations (5.1925%) and the service period (3.159%). It is seen that the correlation and direct effect values obtained in our study on lactation number are at a much lower level than the values calculated in the study conducted by Görgülü (2011a). Görgülü (2011b) studied different Path models in dairy cattle for four different years in his study. When the study, as mentioned above, results are examined every year, it is seen that the correlation values obtained in our study regarding the lactation number are in the same direction and are very close to each other. However, when the direct effect values are compared, it is seen that the lactation number has a lower effect in our study. The numerical values obtained regarding the lactation number in our study were found to be compatible with the correlation values obtained in the study performed by Güneri et al., (2015). In our study, the direct effect value related to the lactation number was calculated as negatively, unlike the Güneri et al., (2015)'s study. The correlation results of our study are in accordance with Sharma et al., (2020).

Table 3. The Effect Values Among Variables
Çizelge 3. *Değişkenler Arası Etki Değerleri*

Pathways		P_{ij}	Effect Value	%
Lactation Number vs. 305-day Milk Yield				
Direct Effect of Lactation Number		P_{yx_1}	-0.061	16.089
U-Effect via	Calving Season	$r_{x_1x_2}.P_{yx_2}$	-0.001	0.3963
	Dry Period	$r_{x_1x_3}.P_{yx_3}$	0.2849	75.162
	Service Period	$r_{x_1x_4}.P_{yx_4}$	0.0119	3.159
	Insemination Number	$r_{x_1x_5}.P_{yx_5}$	0.0196	5.1925
Total Correlation (r_{yx_1})		0.2541**		~100
Calving Season vs. 305-day Milk Yield				
Direct Effect of Calving Season		P_{yx_2}	0.027	45.03
U-Effect via	Lactation Number	$r_{x_2x_1}.P_{yx_1}$	0.0033	5.6619
	Dry Period	$r_{x_2x_3}.P_{yx_3}$	-0.019	33.062
	Service Period	$r_{x_2x_4}.P_{yx_4}$	0.0020	3.3689
	Insemination Number	$r_{x_2x_5}.P_{yx_5}$	0.0077	12.875
Total Correlation (r_{yx_2})		0.0203		~100
Dry Period vs. 305-day Milk Yield				
Direct Effect of Dry Period		P_{yx_3}	-0.354	84.278
U-Effect via	Lactation Number	$r_{x_3x_1}.P_{yx_1}$	0.0491	11.69
	Calving Season	$r_{x_3x_2}.P_{yx_2}$	0.0015	0.3599
	Service Period	$r_{x_3x_4}.P_{yx_4}$	-0.014	3.4866
	Insemination Number	$r_{x_3x_5}.P_{yx_5}$	0.0007	0.1837
Total Correlation (r_{yx_3})		-0.3172**		~100
Service Period vs. 305-day Milk Yield				
Direct Effect of Service Period		P_{yx_4}	-0.505	64.576
U-Effect via	Lactation Number	$r_{x_4x_1}.P_{yx_1}$	0.0014	0.1872
	Calving Season	$r_{x_4x_2}.P_{yx_2}$	-0.000	0.0138
	Dry Period	$r_{x_4x_3}.P_{yx_3}$	-0.010	1.3127
	Insemination Number	$r_{x_4x_5}.P_{yx_5}$	0.2651	33.909
Total Correlation (r_{yx_4})		-0.2487**		~100
Insemination Number vs. 305-day Milk Yield				
Direct Effect of Insemination Number		P_{yx_5}	0.386	52.353
U-Effect via	Lactation Number	$r_{x_5x_1}.P_{yx_1}$	-0.003	0.4219
	Calving Season	$r_{x_5x_2}.P_{yx_2}$	0.0005	0.0732
	Dry Period	$r_{x_5x_3}.P_{yx_3}$	-0.000	0.096
	Service Period	$r_{x_5x_4}.P_{yx_4}$	-0.346	47.055
Total Correlation (r_{yx_5})		0.0357		~100

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level

The direct effect of the calving season on the 305-day milk yield has the highest share (45.03%) in the total correlation. This value is followed by the U-effect on the dry period (33.062%). The reason why the calving season does not have high values in terms of both correlation and direct effect is interpreted as the seasonal transitions in the region where the research was carried out are not very severe. In our study, the effect of the calving season was calculated as positive and very close to zero in terms of both correlation and direct effect, unlike the studies conducted by Görgülü (2011a) and Görgülü (2011b).

The direct effect of the dry period on the 305-day milk yield was obtained at a very high value (84.278%). The U-effect value of the dry period on the 305-day milk yield on the lactation period was 11.69%, and the U-effect value on the service period was calculated as 3.4866%. The correlation value obtained for the dry period in our study is negative, similar to the values Görgülü (2011b) calculated. In the general evaluation of direct effect, a higher direct effect value was found to be.

The direct effect of the service period on the 305-day milk yield has a share of 64.576% in the total effect.

This value is followed by U-effect values on the number of inseminations (33.909%) and lactation number (0.1872%). In our study, the correlation value (-0.248) between the service period and 305-day milk yield was obtained in a negative direction and higher value, unlike the correlation analysis (0.121) performed by Orhan and Kaşıkçı (2002).

The insemination number appears to have a direct effect of 52.353% on the 305-day milk yield. At the same time, the insemination number shows a U-effect of 47.055% on the service period. It was determined that the insemination number had a direct effect of 52.353% on the total amount of effect on the 305-day milk yield. This value is closely followed by the U-effect of the insemination number on the service period (47.055%). As a matter of fact, the correlation value between the service period and the insemination number was calculated as 0.687.

In the 305-day milk yield models performed using path analysis, it is seen that the variables that deal with different environmental effects, apart from the variables used in our study, can be used successfully as in our study (Tahtalı et al., 2011; Boğa et al., 2022). However, Path analysis has been the subject of successful applications in lactation milk yield studies to interpret environmental effects, as in our study, as well as 305-day milk yield (Aytekin et al., 2016; Naskar et al., 2006).

4. Conclusion

Path analysis offers researchers a versatile evaluation in 305-day milk yield modeling and provides an instrumental technique. The direct and U-Effects of lactation number, calving season, dry period, service period, and insemination number variables among the environmental factors affecting 305-day milk yield in Holstein cows, which are the research subject, were shown with the help of correlation coefficient and Path coefficients. The research report results show that the dry period, service period, and lactation number significantly affect the 305-day milk yield. Regarding U-effects, lactation number on the dry period, insemination number on the service period and lactation number have greater importance on 305-day milk yield. As a result of the path analysis, it can be interpreted that the dry period, service period, and lactation number variables can be taken as essential criteria in the selection studies for 305-day milk yield in Holstein cows and in the decision-making processes related to herd management.

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