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Research Paper

# Application of path analysis for contribution of reproductive traits in lactation milk yield of half breed cattle

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**ABSTRACT :** The use of the path co-efficient analysis methodology in half breed cattle revealed that, the reproductive trait- lactation length (LL) had appreciable effect in total lactation milk yield (LMY). Correlation of LL with total LMY was highly significant ranges from 0.267 to 0.522. Direct effect of LL and indirect effects of SP and CI through LL were positive and higher in all lactations. The direct per cent contribution of LL in LMYwas 13.49 to 29.25 per cent. However, SP and CI showed negligible direct contribution in LMY upto 3rd lactation and for 4th to 6th lactation ranged from 4.887 to 14.276 and 5.189 to 22.903 in LMY.AFC showed significant and negative correlation with LMY. Its direct effect also negative and indirect effects through other traits were negligible in LMY.That indicates early age of first calving increases the LMY in different lactations. Therefore, it is suggested that more emphasis may be given on these traits (AFC, SP, CL and LL) for future breeding programme.

**KEY WORDS :** Half breed cattle, Direct and indirect path co-efficients, Correlation co-efficient, Reproductive traits, LMY

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## INTRODUCTION :

Live stock farming is very important and constituent part of agricultural fields, which plays a vital role in Indian agricultural economy. As a part, dairy farming is very important contributor to socio-economic development of farmer and food security.Milk is the important component of dairy industry on which the economics of dairy business depends.

As milk production is highly complex biological process, it is influenced by animals genetic potential and several other non-genetic factors. Association among the factors and direct and indirect contribution of these factors to milk production was studied by path co-efficient analysis.

Path co-efficient method has been widely used in plant breeding and social science research and to some extent in poultry for analysis of quantitative factors. However, it is used in animal breeding remained limited only to estimate the co-efficient of relationship and inbreeding. For estimating direct and indirect effects of reproductive traits, the method of Path co-efficient analysis was used (Wright, 1934). If the correlation is due to direct effect it reflects true relationship and for improving milk production such factors should be taken into consideration, as these are more important in

breeding programme. Further, to find out an alternative to daily milk recording to get the data, some studies were undertaken on test-day milk yields in buffaloes (Singh and Rana, 2008; Chakraborty *et al*., 2010 and Singh and Tailor, 2013). Keeping this in view, the present study were undertaken to estimate the contribution these traits for the milk yield in Half Breed cattle.

The secondary data is being used for this purpose from Research Cum Development Project (RCDP) on cattle at Mahatma Phule Krishi Vidyapeeth, Rahuri with the objectives to estimate the direct and indirect contribution of reproductive traits in the lactation milk yield.

## MATERIALS AND METHODS :

**Data collection:**

The secondary data of following reproductive traits of half breed cattle were collected *viz*., age at first calving (AFC), service period (SP), lactation length (LL), calving interval (CI) and lactation milk yield (LMY). For analysis considered only those cattle that completed 300 days milk yield.

Pairwise correlation among LMY and reproductive traits were also determined.For estimating the contribution of reproductive traits, the method of Path co-efficient analysis was used (Wright, 1934). Path co-efficient analysis is simply a standardized partial regression co-efficient which splits the correlation co-efficients into the measures of direct and indirect effects (Dewey and Lu, 1959). For decomposition of correlation between lactation milk yield and the reproductive traits like age at first calving (AFC), service period (SP), lactation length (LL), calving interval (CI)and their direct and indirect percentage contribution as follows:

$$\left.\begin{aligned} r_{y1} &= P_1 + P_2\, r_{12} + P_3 r_{13} + P_4\, r_{14} \\ r_{y2} &= P_1\, r_{21} + P_2 + P_3 r_{23} + P_4\, r_{24} \\ r_{y3} &= P_1\, r_{31} + P_2\, r_{32} + P_3 + P_4\, r_{34} \\ r_{y4} &= P_1\, r_{41} + P_2\, r_{42} + P_3 r_{43} + P_4 \end{aligned}\right\} \quad \text{(I)}$$

$$\text{and } 1 = \Sigma\, P_i^2 + 2\, \Sigma\Sigma\, P_i P_j r_{jj} + P_e^2 \quad \text{(II)}$$

where,

y = lactation milk yield

$x_1$= AFC, $x_2$= SP, $x_3$= LL and $x_4$= CI.

The analysis was carried out for separate lactations upto sixth lactation.

## RESULTS AND DATA ANALYSIS :

In half breed cattle, correlation between LMY and various reproductive traits were shown in Table 1. Correlation of LMY and age at first calving (AFC) ranged from -0.413 to -0.253 and it was negative and highly significant in all lactations. It was observed that the correlation of LMY with service period (SP) ranged from 0.135 to 0.360, it was significant and positive for 1st , 2nd, 4th and 5th lactations. In all lactations correlation of LMY with calving interval (CI) was ranged from 0.127 to 0.424 while, correlation between LMY and CI was positive and highly significant in all the different lactations except in 6th lactation.Highly significant and positive correlation between LMY and lactation length (LL) was observed in all lactations except 6th lactation; ranged from 0.267 to 0.522. Appannayar (1997) and Kokate *et al*. (2013) however, reported that the age at first calving had non-significant effect on monthly test day milk yields (MTDMY) in Murrah buffaloes and Karan Fries cattle, respectively. Further, Zaman *et al*. (1990) in Swamp buffaloes also reported the effect of age at first calving groups on first lactation 305 days milk yield to be significant.

Correlation of AFC with other traits were non-significant and negligible. The correlation between service period and calving interval was more and highly significant ranged from 0.592 to 0.961. While, in different lactations the correlation between service period and lactation length was significant and ranged from and 0.447 to 0.563.There was highly significant correlation between calving interval and lactation length in all lactations ranged from 0.552 to 0.663 (Table 1).

Path co-efficient analysis (Table 2) revealed direct and indirect effects of different traits affecting lactation milk yield was done for individual lactations upto sixth lactations. The direct effect of age at first calvingon LMY had negative for 1st to 6th lactations, ranges from -0.477 to -0.245. It had negative and highly significant correlation with LMY. The indirect effects of AFC with other traits were negligible. It was observed that the AFC was slightly affect the LMY in half breed cattle. It indicates that, early age of first calving increases the LMY. Sharma *et al*. (1987) and Naskar and Banik (2006) also observed negative contribution of AFC to LMY for different lactations in *Sahiwal* cattle.

The direct effect of SP with the LMY was positive in different lactations except in 1st and 5th lactation it

was negative. The indirect effects of SP through LL were positive and higher in all the lactations which ranges from 0.168 to 0.304 as compared to direct effect of SP and indirect effect of SP through other traits. The variability in LMY through SP was might be due to its indirect effect via LL.These results more or less similar with the Naskar and Banik (2006) in *Sahiwal* cattle.

Calving interval showed positive direct effect in 1st, 2nd and 5thand it was negative in 3rd, 4th and 6th lactations with LMY ranges from -0.258 to 0.479. But, indirect effects of CI through LL were higher and positive in all lactations ranges from 0.203 to 0.359; while for other traits indirect effects were negligible. CI was not directly affecting but,its indirect effect via LL affects the total LMY.

It was revealed that the direct contribution of lactation length was positive and high in LMYranges from 0.367 to 0.541. Indirect effects of LL through AFC, SP

**Table 1 : Correlation among reproductive traits and LMY in half breed cattle**

| | AFC | Service period | Calving interval | Lactation length |
|---|---|---|---|---|
| **First lactation (n=365)** | | | | |
| AFC | 1 | | | |
| Service period | 0.026 | 1 | | |
| Calving interval | 0.036 | 0.772** | 1 | |
| Lactation length | -0.015 | 0.563** | 0.663** | 1 |
| LMY | -0.255** | 0.249** | 0.321** | 0.522** |
| **Second lactation (n=248)** | | | | |
| AFC | 1 | | | |
| Service period | 0.074 | 1 | | |
| Calving interval | 0.094 | 0.754** | 1 | |
| Lactation length | 0.015 | 0.532** | 0.614** | 1 |
| LMY | -0.253** | 0.245** | 0.288** | 0.417** |
| **Third lactation (n=169)** | | | | |
| AFC | 1 | | | |
| Service period | -0.009 | 1 | | |
| Calving interval | -0.062 | 0.817** | 1 | |
| Lactation length | -0.075 | 0.483** | 0.591** | 1 |
| LMY | -0.366** | 0.135 | 0.160* | 0.367** |
| **Fourth lactation (n=112)** | | | | |
| AFC | 1 | | | |
| Service period | 0.044 | 1 | | |
| Calving interval | -0.007 | 0.879** | 1 | |
| Lactation length | 0.040 | 0.487** | 0.588** | 1 |
| LMY | -0.329** | 0.349** | 0.334** | 0.421** |
| **Fifth lactation (n=71)** | | | | |
| AFC | 1 | | | |
| Service period | 0.054 | 1 | | |
| Calving interval | 0.033 | 0.961** | 1 | |
| Lactation length | 0.072 | 0.473** | 0.552** | 1 |
| LMY | -0.285* | 0.360** | 0.424** | 0.489** |
| **Sixth lactation (n=44)** | | | | |
| AFC | 1 | | | |
| Service period | 0.088 | 1 | | |
| Calving interval | -0.030 | 0.592** | 1 | |
| Lactation length | 0.088 | 0.447** | 0.642** | 1 |
| LMY | -0.413** | 0.194 | 0.127 | 0.267 |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

and CI were meager and negative.It indicates that at most care should be taken about lactation length maximum since resulted in increase in the total LMY.The results are in agreement with Banik and Tomar (2002) to 300 days milk yield (300DMY) and LMY in Murrah buffalo, Naskar and Banik (2006) also observed similar results for LL to LMY in *Sahiwal* cattle.

It is evident that direct contribution is dominant, so is the reflection in the direct percentage contribution. No doubt, the contribution may be negative or positive but percentage contribution will be always positive. Hence, the direct or indirect percentage contribution will not be zero and that is what exactly is reflected in the Table 3.

Direct per cent contribution of AFC in LMY was ranged from 6.02 to 22.41in different lactations. About SP, direct per cent contribution was negligible upto 3rd

**Table 2 : Direct and indirect effects of reproductive traits towards LMY**

| | AFC | Service period | Calving interval | Lactation length | Correlation with LMY |
|---|---|---|---|---|---|
| **First lactation (n=365)** | | | | | |
| AFC | -0.245 | -0.002 | 0.001 | -0.008 | -0.255** |
| Service period | -0.006 | -0.064 | 0.016 | 0.304 | 0.249** |
| Calving interval | -0.009 | -0.050 | 0.021 | 0.359 | 0.321** |
| Lactation length | 0.004 | -0.036 | 0.014 | 0.541 | 0.522** |
| R-square= 33.53% | | | Residual variation= 66.47% | | |
| **Second lactation (n=248)** | | | | | |
| AFC | -0.267 | 0.001 | 0.008 | 0.006 | -0.253** |
| Service period | -0.020 | 0.007 | 0.062 | 0.195 | 0.245** |
| Calving interval | -0.025 | 0.005 | 0.082 | 0.226 | 0.288** |
| Lactation length | -0.004 | 0.004 | 0.050 | 0.367 | 0.417** |
| R-square= 24.68% | | | Residual variation=75.32% | | |
| **Third lactation (n=169)** | | | | | |
| AFC | -0.345 | -0.001 | 0.009 | -0.030 | -0.366** |
| Service period | 0.003 | 0.060 | -0.120 | 0.192 | 0.135 |
| Calving interval | 0.022 | 0.049 | -0.146 | 0.236 | 0.160* |
| Lactation length | 0.026 | 0.029 | -0.086 | 0.399 | 0.367** |
| R-square= 25.72% | | | Residual variation=74.28% | | |
| **Fourth lactation (n=112)** | | | | | |
| AFC | -0.363 | 0.017 | 0.002 | 0.016 | -0.329** |
| Service period | -0.016 | 0.378 | -0.200 | 0.188 | 0.349** |
| Calving interval | 0.003 | 0.332 | -0.228 | 0.227 | 0.334** |
| Lactation length | -0.015 | 0.184 | -0.134 | 0.385 | 0.421** |
| R-square= 33.74% | | | Residual variation=66.26% | | |
| **Fifth lactation (n=71)** | | | | | |
| AFC | -0.313 | -0.014 | 0.016 | 0.027 | -0.285* |
| Service period | -0.017 | -0.258 | 0.460 | 0.174 | 0.360** |
| Calving interval | -0.010 | -0.248 | 0.479 | 0.203 | 0.424** |
| Lactation length | -0.022 | -0.122 | 0.264 | 0.369 | 0.488** |
| R-square= 37.93% | | | Residual variation=62.07% | | |
| **Sixth lactation (n=44)** | | | | | |
| AFC | -0.473 | 0.019 | 0.008 | 0.033 | -0.413** |
| Service period | -0.042 | 0.221 | -0.153 | 0.168 | 0.194 |
| Calving interval | 0.014 | 0.131 | -0.258 | 0.241 | 0.127 |
| Lactation length | -0.041 | 0.099 | -0.166 | 0.375 | 0.267 |
| R-square= 30.56% | | | Residual variation=69.44% | | |

Diagonal direct and off-diagonal indirect effects

* and ** indicate significance of values at P=0.05 and 0.01, respectively

lactation and in 4th, 5th and 6thlactation it was 14.28, 6.65 and 4.89 per cent, respectively in LMY. The direct per cent contributions of CI for LMY were 5.19, 22.90 and 6.68 per cent in the 4th, 5th and 6th lactations while, it was negligible upto 3rd lactation. The direct contribution of LL in LMY was maximum (13.49 to 29.25 %) in different lactations as compared to the other reproductive traits. Pathodiya and Jain (2004) and Sarkar *et al*. (2006) also reported that the less milk yield was significantly influenced by the period of calving in Murrah buffaloes.

The contribution of these reproductive traits ranges near about from 24.68 to 37.93 per cent (Table 2) in different lactations. The magnitude of residual variations clearly indicated that these reproductive traits influenced LMY to great extent.

The results of path analysis revealed that more emphasis need to be given on the important reproductive traits *viz*., AFC, SP, CI and LL for future improvement in breeding programme.

## Conclusion :

– AFC showed significant and negative correlation with LMY. Its negative direct effect and indirect effect through other traits were negligible in LMY. These results clearly indicate that early age of first calving affects (reduces) the LMY in different lactations.

– The indirect effects of SP through LL were positive and higher in all lactations which ranges from 0.168 to 0.304. The variability in LMY through SP was might be due to its indirect effect via LL.

– Indirect effects of CI through LL were higher and positive in all lactations ranges from 0.203 to 0.359.

**Table 3: Percentage contribution of reproductive traits for LMY of half breed cattle**

| | AFC | Service period | Calving interval | Lactation length |
|---|---|---|---|---|
| **First lactation (n=365)** | | | | |
| AFC | 6.01 | 0.08 | -0.04 | 0.41 |
| Service period | | 0.42 | -0.21 | -3.92 |
| Calving interval | | | 0.04 | 1.48 |
| Lactation length | | | 0.00 | 29.25 |
| **Second lactation (n=248)** | | | | |
| AFC | 7.12 | -0.028 | -0.41 | -0.30 |
| Service period | | 0.005 | 0.09 | 0.28 |
| Calving interval | | | 0.67 | 3.70 |
| Lactation length | | | | 13.49 |
| **Third lactation (n=169)** | | | | |
| AFC | 11.89 | 0.04 | -0.63 | 2.07 |
| Service period | | 0.35 | -1.42 | 2.29 |
| Calving interval | | | 2.14 | -6.89 |
| Lactation length | | | | 15.88 |
| **Fourth lactation (n=112)** | | | | |
| AFC | 13.17 | -1.21 | -0.11 | -1.12 |
| Service period | | 14.28 | -15.14 | 14.17 |
| Calving interval | | | 5.19 | -10.32 |
| Lactation length | | | | 14.83 |
| **Fifth lactation (n=71)** | | | | |
| AFC | 9.79 | 0.87 | -0.99 | -1.66 |
| Service period | | 6.65 | -23.72 | -9.00 |
| Calving interval | | | 22.90 | 19.47 |
| Lactation length | | | | 13.60 |
| **Sixth lactation (n=44)** | | | | |
| AFC | 22.41 | -1.83 | -0.74 | -3.11 |
| Service period | | 4.89 | -6.77 | 7.41 |
| Calving interval | | | 6.68 | -12.44 |
| Lactation length | | | | 14.06 |

– SP and CI had almost negligible direct contribution, but the contribution of these traits was indirectly through LL to LMY.

– Correlation of LL with total LMY was highly significant ranges from 0.267 to 0.522. Direct effect of LL was maximum than other traits in all lactations in half breed cattle. Directly and indirectly from these traits LL showed maximum effect on the total LMY.

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