



Lactation Curve and Factors Affecting Persistency in Ongole Cattle

B. Nageswara Reddy¹, M.V. Dharma Rao², P. Pandu Ranga Reddy³,
D. Ashok Reddy³, V. Harideep⁴, S. Syam⁴

10.18805/ag.D-6156

ABSTRACT

Background: The present study was aimed to investigate the lactation curve and factors influencing persistency in Ongole cattle, utilizing the daily milk production records and history sheets available in the Livestock Research Station, Mahanandi.

Methods: Key parameters such as peak yield (PY), day of peak yield (DPY), average weekly yield (AWY), lactation length (LL), standard lactation milk yield (SLMY), total lactation milk yield (TLMY) and persistency indices given in three prominent reports (denoted as P1, P2 and P3 in the ascending order of reporting years) were computed using the milk production records. Other parameters such as parity, age at first calving (AFC), season of calving (Rainy, Autumn, Winter, or Summer), sex and birth weight of calf were extracted from the history sheets.

Result: The findings revealed that the lactation curve typically displayed a concave downward shape, with the peak of milk production occurring around the eighth week of lactation. The mean values of P1, P2 and P3 were 75.799 ± 0.979 , 88.038 ± 0.929 and 57.897 ± 0.775 per cent, respectively. All the three persistency indices (P1, P2 and P3) showed a significant positive correlation with SLMY and TLMY. The P1 and P2 had a significant positive correlation with DPY, LL and AFC. Further, P1 exhibited a significant negative correlation with parity, while P2 was significantly influenced by the season of calving. The coefficients of determination for the regression models of P1, P2 and P3 were 0.622, 0.282 and 0.223, respectively. In conclusion, the study suggests that the lactation curve in Ongole cattle follows a typical concave downward shape with the peak milk yield occurring in the eighth week of milking. Furthermore, lactations characterized by higher LMY tend to have greater persistency.

Key words: Lactation curve, Lactation milk yield, Parity, Peak yield, Persistency.

INTRODUCTION

The shape of the lactation curve and persistency are crucial traits in dairy cattle. The lactation curve is a graphical representation of milk yield and time after calving (ŞEahin *et al.*, 2015). It generally shows an ascending phase from calving to peak yield and a descending phase from the peak to drying off. Lactation persistency is an important trait of lactation curve and it usually refers to the ability of a cow to sustain milk production at a high level after peak yield (Pedrosa *et al.*, 2021). There are various definitions of lactation persistency in the literature, as are the measures of it.

Traditionally, the selection of dairy cattle has been primarily done based on the lactation milk yield which indicates gross income from milk per lactation. The persistency which denotes efficiency of milk production and net return from a cow has often been ignored in selection programmes due to the challenges in its measurement (Ferris *et al.*, 1985). A higher persistency may lead to reduction in costs associated with feeding and health care due to lower peak yield and consequent freedom from negative energy balance and stress associated metabolic and reproductive disorders during peak production (Koloi *et al.*, 2018; Torshizi and Mashhadi, 2018). For lactations of 305 days, selection based on persistency effects only the feed and health care costs, but for other lactation lengths, it had a greater impact on milk returns per lactation than on the costs involved in milk production. Therefore, inclusion of

¹Krishi Vigyan Kendra, ICAR National Institute for Research on Commercial Agriculture, Kalavacharla-533 297, Andhra Pradesh, India.

²Livestock Research Station, Sri Venkateswara Veterinary University, Mahanandi-518 502, Andhra Pradesh, India.

³College of Veterinary Science, Sri Venkateswara Veterinary University, Proddatur-516 360, Andhra Pradesh, India.

⁴College of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati-517 502, Andhra Pradesh, India.

Corresponding Author: P. Pandu Ranga Reddy, College of Veterinary Science, Sri Venkateswara Veterinary University, Proddatur-516 360, Andhra Pradesh, India.

Email: panduvet@gmail.com

How to cite this article: Reddy, B.N., Rao, M.V.D., Reddy, P.P.R., Reddy, D.A., Harideep, V. and Syam, S. (2025). Lactation Curve and Factors Affecting Persistency in Ongole Cattle. *Agricultural Science Digest*. 1-9. doi: 10.18805/ag.D-6156.

Submitted: 20-08-2024 **Accepted:** 31-01-2025 **Online:** 01-04-2025

the persistency as a tool of selection in cattle breeding programmes is the need of hour.

Most of the studies reported on this topic (Shija *et al.*, 2022; Hermiz and Hadad, 2020; Güler and Yanar, 2009) were conducted on high yielding cattle and there is a dearth of information regarding lactation persistency of medium and low yielding breeds. Thus, the objective of the present

study was to know about the lactation curve and factors affecting persistency in the medium yielding cattle breed i.e. Ongole which may provide valuable information about selection of animals and herd management.

MATERIALS AND METHODS

The present study was carried out with daily milk production records and history sheets of the Ongole cattle available in the Livestock Research Station, Mahanandi of Sri Venkateswara Veterinary University, Andhra Pradesh. A total of 92,100 morning and evening milk yields of 137 lactations recorded between 2018-2023 were considered for the present study.

The cows were allowed to stay in calving shed along with their calves for a week after calving. After that, the cows were transferred to milch animal shed for extracting milk for sale and the calves were transferred to calf shed. Calves were allowed to suckle before and after milking as weaning is not in practice in the farm.

The milk yields of morning and evening sessions of milking were aggregated to obtain the daily yields. Various milk production traits such as peak yield (PY), day of peak yield (DPY), lactation length (LL), standard lactation milk yield (SLMY) and total lactation milk yield (TLMY) were computed using the daily milk yields. PY is the highest daily milk yield and DPY is the day of the highest yield in a lactation. LL is the total days in milking in a lactation. SLMY

was obtained by adding daily milk yields up to 305 days of lactation. TLMY is the total milk yield from an animal in a lactation.

Weekly milk yields were obtained by dividing the lactation length into weeks and summing the daily yields. The average weekly yield (AWY) for a week of lactation was calculated as the average of total milk yields during that week across all lactations. The formulae given by Turner (1926), Ludwick and Petersen (1943) and Prasad *et al.* (1999) were used for calculation of the lactation persistency index as presented in Table 1.

Parity, age at first calving (AFC), season of calving (Rainy, Autumn, Winter or Summer), sex and birth weight of calf were obtained from the history sheets available in the farm.

To visualize the lactation curve, Average Weekly Yields (AWYs) were plotted against different weeks of lactation using MS Excel 2016. One-way ANOVA, independent samples t-test and correlation were used to know the effect of PY, DPY, LL, SLMY, TLMY, parity, AFC, season of calving, sex and birth weight of calf on the persistency and multiple linear regression was used to evolve the prediction equations for the persistency indices through SPSS Software.

RESULTS AND DISCUSSION

Lactation curve

The lactation curve provides information about the pattern of milk production over the period of lactation. Complete

Table 1: Formulae of lactation persistency index used in the present study.

Formula given by	Code	Formula	Description
Turner (1926)	P1	$P1\% = \frac{300 \text{ day milk yield}}{\text{Peak monthly milk yield} \times 10} \times 100$	---
Ludwick and Petersen (1943)	P2	$P2\% \text{ (if LL is } \geq 368 \text{ days)} = \frac{\frac{4 M_2 + 3 M_3 + 2 M_4}{M_1 M_2 M_3}}{9} \times 100$ $P2\% \text{ (if } 288 \text{ days} \leq \text{LL} < 368 \text{ days)} = \frac{\frac{3 M_2 + 2 M_3}{M_1 M_2}}{5} \times 100$ $P2\% \text{ (if } 208 \text{ days} \leq \text{LL} < 288 \text{ days)} = \frac{M_2}{M_1} \times 100$	M_1 is total milk yield of animal from 48th day to 128th day of lactation, M_2 is total milk yield of animal from 128th day to 208th day of lactation, M_3 is total milk yield of animal from 208th day to 288th day of lactation, M_4 is total milk yield of animal from 288th day to 368th day of lactation.
Prasad <i>et al.</i> (1999)	P3	$P3\% = \frac{\text{Average daily milk yield during post peak period}}{\text{Peak yield}} \times 100$	---

knowledge about the lactation curve helps in conducting feeding trials with lactating cattle, estimating total lactational yield from incomplete records and forecasting performance of a herd. The lactation curve obtained using the AWYs starting from 2nd week of lactations was depicted in Fig 1. The AWYs starting from 2nd week of lactations were given in Table 2, which elucidated the weekly milk production trends, providing specific data points for each week of lactation.

The lactation curve obtained in the present study was of typical concave downward shape and it has an ascending part till peak yield followed by a descending part (Fig 1). Shija *et al.* (2022), Khalifa *et al.* (2018), ŞEahin *et al.* (2015)

andersen *et al.* (2011) and Ali *et al.* (1996) reported similar shaped lactation curves in Ayrshire cows, Holstein cows, Anatolian buffaloes, Norwegian Red and Holstein Friesian cows, respectively. The peak of average weekly milk yield (21.570 ± 0.568 kg) occurred in eighth week of lactation in the present study (Table 2) which was almost similar to the values reported by Khan (1997); Raja *et al.* (2018) and Bhutkar *et al.* (2014) in Sahiwal, Frieswal and Deoni cows, respectively. The consistent findings across different studies and cattle breeds underscore the universal nature of the lactation curve. The identification of the time of peak yield and understanding the dynamics of milk production throughout the lactation period are crucial for optimizing

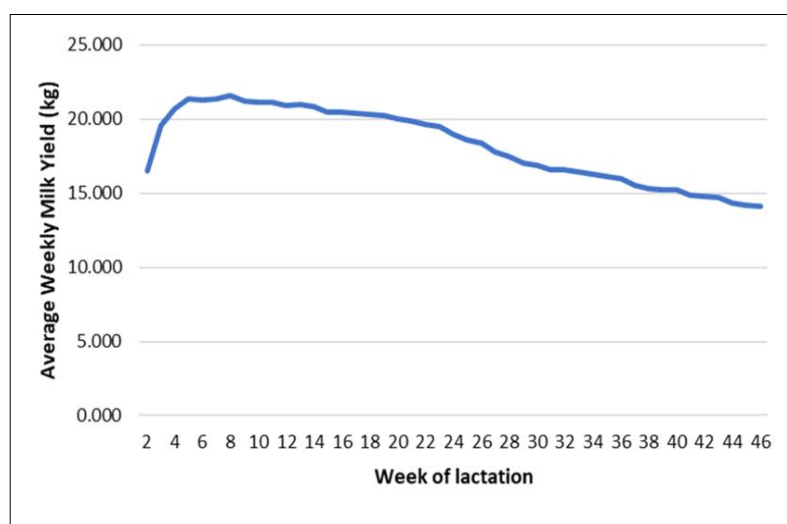


Fig 1: The lactation curve obtained from the AWYs.

Table 2: AWYs.

Week of lactations	Average weekly milk yield (Kg)	Week of lactations	Average weekly milk yield (Kg)	Week of lactations	Average weekly milk yield (Kg)
2	16.524 $\pm$ 0.453 (137)	17	20.402 $\pm$ 0.571 (137)	32	16.579 $\pm$ 0.540 (127)
3	19.539 $\pm$ 0.508 (137)	18	20.320 $\pm$ 0.608 (137)	33	16.401 $\pm$ 0.523 (123)
4	20.708 $\pm$ 0.531 (137)	19	20.255 $\pm$ 0.595 (137)	34	16.288 $\pm$ 0.513 (121)
5	21.352 $\pm$ 0.559 (137)	20	19.988 $\pm$ 0.586 (137)	35	16.100 $\pm$ 0.529 (120)
6	21.295 $\pm$ 0.561 (137)	21	19.881 $\pm$ 0.584 (137)	36	15.994 $\pm$ 0.508 (117)
7	21.334 $\pm$ 0.572 (137)	22	19.658 $\pm$ 0.581 (137)	37	15.518 $\pm$ 0.501 (116)
8	21.570 $\pm$ 0.568 (137)	23	19.508 $\pm$ 0.560 (137)	38	15.293 $\pm$ 0.518 (111)
9	21.188 $\pm$ 0.586 (137)	24	19.003 $\pm$ 0.569 (137)	39	15.276 $\pm$ 0.569 (106)
10	21.124 $\pm$ 0.568 (137)	25	18.631 $\pm$ 0.553 (137)	40	15.224 $\pm$ 0.556 (102)
11	21.175 $\pm$ 0.596 (137)	26	18.411 $\pm$ 0.548 (136)	41	14.858 $\pm$ 0.574 (99)
12	20.939 $\pm$ 0.575 (137)	27	17.791 $\pm$ 0.529 (136)	42	14.772 $\pm$ 0.629 (97)
13	20.992 $\pm$ 0.589 (137)	28	17.495 $\pm$ 0.529 (136)	43	14.728 $\pm$ 0.582 (91)
14	20.807 $\pm$ 0.592 (137)	29	17.033 $\pm$ 0.510 (135)	44	14.328 $\pm$ 0.637 (87)
15	20.499 $\pm$ 0.589 (137)	30	16.864 $\pm$ 0.518 (133)	45	14.213 $\pm$ 0.665 (82)
16	20.472 $\pm$ 0.588 (137)	31	16.562 $\pm$ 0.527 (130)	46	14.121 $\pm$ 0.677 (79)

Figure in the parenthesis indicates sample size.

Table 3: Results of analysis of various factors affecting lactation persistency.

Factor	Turner (1926)P1%	Ludwick and Petersen (1943)P2%	Prasad <i>et al.</i> (1999)P3%
Overall	75.799±0.979 (137)	88.038±0.929 (131)	57.897±0.775 (137)
Peak yield (kg)	NS	NS	NS
Below 4.00	76.512±1.563 (61)	88.031±1.579 (58)	57.873±1.181 (61)
4.00 and above	75.227±1.248 (76)	88.044±1.110 (73)	57.917±1.033 (76)
Day of peak yield	**	**	NS
Below 50	73.856 ^a ±1.730 (51)	86.734 ^a ±1.618 (49)	57.686±1.372 (51)
50-100	73.264 ^a ±1.828 (33)	83.107 ^a ±1.938 (31)	59.756±1.478 (33)
100-150	76.323 ^{ab} ±1.895 (30)	88.640 ^a ±1.542 (29)	58.560±1.468 (30)
150 and above	83.063 ^b ±1.967 (23)	97.095 ^b ±1.013 (22)	54.834±1.919 (23)
Lactation length (days)	**	**	NS
Below 300	65.340 ^a ±1.491(49)	83.672 ^a ±1.955 (43)	58.163±1.546 (49)
300-400	81.335 ^b ±0.962(53)	88.959 ^b ±1.298 (53)	57.537±1.221 (53)
400 and above	82.061 ^b ±1.207(35)	92.007 ^b ±1.210 (35)	58.070±1.103 (35)
Standard LMY (kg)	**	**	*
Below 500	64.702 ^a ±2.259 (20)	81.924 ^a ±2.475 (17)	53.422 ^a ±1.833 (20)
500-700	74.992 ^b ±2.337 (36)	85.274 ^{ab} ±2.453 (35)	56.007 ^{ab} ±1.567 (36)
700-900	78.083 ^b ±1.312 (41)	89.953 ^b ±1.144 (40)	58.925 ^{ab} ±1.510 (41)
900 and above	79.733 ^b ±1.365 (40)	91.220 ^b ±1.272 (39)	60.783 ^b ±1.180 (40)
Total LMY (kg)	**	**	*
Below 500	64.033 ^a ±2.274 (19)	81.428 ^a ±2.582 (16)	53.128 ^a ±1.908 (19)
500-700	72.840 ^b ±2.827 (27)	84.254 ^{ab} ±2.791 (26)	55.831 ^{ab} ±1.947 (27)
700-900	76.764 ^{bc} ±1.601 (33)	87.836 ^{abc} ±1.748 (32)	58.219 ^{ab} ±1.873 (33)
900-1100	78.436 ^{bc} ±1.442 (32)	91.042 ^{bc} ±1.431 (31)	60.129 ^b ±1.325 (32)
1100 and above	83.000 ^c ±1.387 (26)	92.556 ^c ±1.375 (26)	60.374 ^b ±1.221 (26)
Parity	NS	NS	NS
1	78.920±1.771 (35)	88.356±1.935 (34)	56.589±1.299 (35)
2	78.070±2.452 (23)	86.372±2.443 (23)	57.192±1.896 (23)
3	74.208±3.115 (17)	90.920±2.492 (16)	57.723±2.070 (17)
4	76.151±2.789 (17)	89.029±2.225 (16)	57.469±2.491 (17)
5	72.704±2.776 (16)	85.556±2.599 (16)	59.406±1.973 (16)
6	67.272±3.524 (10)	84.831±4.250 (9)	56.770±3.020 (10)
7 and above	75.506±2.408 (19)	90.044±2.277 (17)	61.023±2.675 (19)
AFC (years)	*	NS	NS
Below 4	71.727 ^a ±2.778 (16)	87.543±2.972 (16)	59.334±2.628 (16)
4-5	74.376 ^a ±1.558 (64)	87.495±1.337 (59)	57.926±1.267 (64)
5-6	76.697 ^{ab} ±1.545 (43)	86.862±1.732 (42)	57.719±1.191 (43)
6 and above	84.203 ^b ±1.663 (14)	94.421±1.899 (14)	56.673±1.565 (14)
Season of calving	NS	**	NS
Rainy	76.558±1.766 (47)	88.866 ^b ±1.950 (47)	58.143±1.366 (47)
Autumn	78.444±2.548 (18)	92.926 ^b ±1.624 (18)	59.821±2.960 (18)
Winter	76.506±1.390 (48)	88.213 ^{ab} ±1.031 (45)	57.796±1.136 (48)
Summer	70.917±2.704 (24)	81.619 ^a ±2.311 (21)	56.176±1.607 (24)
Sex of calf	NS	NS	NS
Female	75.818±1.468 (68)	88.279±1.409 (65)	58.716±1.103 (68)
Male	75.780±1.310 (69)	87.800±1.226 (66)	57.090±1.089 (69)
Birth weight of calf (kg)	NS	NS	NS
20-25	74.369±2.814 (14)	86.740±2.053 (14)	56.749±1.271 (14)
25-30	76.601±1.191 (87)	87.670±1.223 (84)	57.851±0.949 (87)
30-35	74.417±2.121 (36)	89.525±1.797 (33)	58.455±1.809 (36)

NS: Non-significant, *: P<0.05, **: P<0.01. Means without a common superscript differ significantly in each factor. Fig in the parenthesis indicates sample size. The lower sample size in the case of P2 was due to the fact that it couldn't be calculated for lactations of less than 208 days.

milk production in dairy cattle through effective management.

Lactation Persistency

The lactation persistency is an important economic trait of dairy cattle because of its impact on fertility, health and feed costs (Dekkers *et al.*, 1998). It is generally defined as the ability of cow to maintain the same level of production during lactation. Some studies (Cole and Null, 2009) reported that the cows with high persistency produced less milk than expected at the beginning and more than expected at the end of lactation. The mean values of P1, P2 and P3 in the present study were 75.799 ± 0.979 , 88.038 ± 0.929 and 57.897 ± 0.775 per cent respectively (Table 3). The result regarding P1 was in agreement with those of George *et al.* (2021) in Tharparkar cows. However, Kaushal *et al.* (2016), Yilmaz and Koc (2013) and Kumar and Singh (2006) reported higher values in Sahiwal, Red Holstein and Karan Fries cows, respectively than the present study which might be due to breed variations. Chaudhari *et al.* (2022), Zurwan *et al.* (2017) and Pareek and Narang (2015) reported similar values of P2 in Jaffarabadi buffaloes, Sahiwal cattle and Murrah buffaloes, respectively. The value of P3 was similar to that of George *et al.* (2021) in Tharparkar cattle. These findings suggest that the persistency indices observed in Ongole cattle are consistent with those reported in other cattle and buffalo breeds, indicating the uniformity of the persistency trait across different genetic backgrounds.

Table 4: Correlation coefficients of factors and persistency indices.

Factor	P1	P2	P3
Peak yield (kg)	-0.077	0.023	0.055
Day of peak yield	0.316**	0.361**	-0.118
Lactation length (days)	0.631**	0.293**	-0.064
Standard LMY (kg)	0.410**	0.321**	0.312**
Total LMY (kg)	0.455**	0.358**	0.262**
Parity	-0.192*	0.013	0.150
AFC (years)	0.282**	0.185*	-0.070
Sex of calf (Female-1 and Male-2)	-0.002	-0.023	-0.090
Birth weight of calf	-0.016	0.093	0.066

*: $P < 0.05$, **: $P < 0.01$.

Factors affecting lactation persistency

The analysis of various factors influencing lactation persistency was conducted and the results were presented in Table 3. Additionally, the correlation coefficients between factors and persistency indices were provided in Table 4.

Peak yield (PY)

It refers to the highest recorded daily milk production during a lactation period. Most of cows attain the peak yield by 45 to 90 days in milking and then slowly lose production over time (Litherland, 2021). In the present study, lactations grouped based on Peak Yield did not exhibit significant differences in terms of persistency (Table 3). Moreover, a non-significant negative correlation was found between PY and the persistency index P1, while a non-significant positive correlation was observed between PY and the persistency indices P2 and P3 (Table 4). Previous research has yielded varied findings regarding the relationship between Peak Yield and lactation persistency. Some studies reported significant negative correlations (Yamazaki *et al.*, 2011; Sorensen *et al.*, 2008; Fadlelmoula *et al.*, 2007; Hickson *et al.*, 2006; Kumar and Singh, 2006), while others found significant positive correlations (Albarrán-Portillo and Pollott, 2011) or non-significant associations (Garudkar *et al.*, 2018). The discrepancies were probably due to variations in breeds, management practices and environmental factors. Further investigation is warranted to unravel the intricacies of this relationship in dairy cattle.

Day of peak yield (DPY)

The present study revealed that the values of P1 and P2 differ significantly with the time of peak yield and there was a significant positive correlation ($P < 0.01$) between the time of peak yield and persistency, indicating that lactations with delayed peak yields are more persistent. This finding aligns with the results reported by Torshizi and Mashhadi (2018), ŞEahin *et al.* (2015), Albarrán-Portillo and Pollott (2011) and Yamazaki *et al.* (2011).

Lactation length (LL)

In the present study, it was found that lactations of different lengths differed significantly ($P < 0.01$) in terms of persistency (P1 and P2), with a significant ($P < 0.01$) positive correlation observed between Lactation Length and persistency (P1 and P2). This suggests that the longer the

Table 5: Regression equation, regression coefficients and coefficients of determination.

Equation	Y = a + b ₁ X ₁ + b ₂ X ₂ + b ₃ X ₃ + b ₄ X ₄ + b ₅ X ₅ + b ₆ X ₆								
$\hat{Y}$	a	b ₁	b ₂	b ₃	b ₄	b ₅	b ₆	Sig.	R ²
P1	13.661	0.036	0.148	0.064	-0.053	-0.041	1.133	0.000	0.622
P2	54.230	0.043	0.011	0.000	0.009	0.800	3.164	0.000	0.282
P3	56.409	-0.023	-0.060	-0.006	0.022	0.437	1.655	0.000	0.223

Y is predicted value of dependent variable (Persistency index); a is intercept; X_1 , X_2 , X_3 , X_4 , X_5 and X_6 are values of independent variables (DPY, LL, SLMY, TLMY, parity and AFC, respectively); b_1 , b_2 , b_3 , b_4 , b_5 and b_6 are unstandardised regression coefficients for first, second, third, fourth, fifth and sixth independent variable respectively; R^2 is coefficient of determination.

LL, the higher the persistency. These findings are supported by Garudkar *et al.* (2018). However, ŞEahin *et al.* (2015) reported no significant association between LL and persistency, which could be attributed to variations in the methodology of calculating the persistency index.

Standard LMY and Total LMY

It was revealed that the lactations grouped based on LMYS differ significantly in terms of persistency and there was a significant ($P < 0.01$) positive association between LMY and persistency. It was in agreement with the findings of Garudkar *et al.* (2018), Torshizi and Mashhadi (2018), ŞEahin *et al.* (2015), Albarrán-Portillo and Pollott (2011) and Tekerli *et al.* (2000). However, no association between LMY and persistency was reported by Yamazaki *et al.* (2011).

Parity

The ANOVA results indicated that the persistency indices had not differed significantly with parity. However, correlation

analysis revealed a significant negative association between parity and persistency index P1, while the association with P2 and P3 was non-significant. This discrepancy between ANOVA and correlation analysis results may stem from the grouping of samples for ANOVA. Previous studies including Hermiz and Hadad (2020), Zurwan *et al.* (2017), Pareek and Narang (2015), Albarrán-Portillo and Pollott (2011) and Fadlelmoula *et al.* (2007) reported a significant effect of parity on persistency. However, Garudkar *et al.* (2018), Güler and Yanar (2009) and Das *et al.* (2007) found no effect of parity on persistency, which could be attributed to variations in the persistency measures used.

Age at first calving (AFC)

The study revealed that there was a significant positive association between persistency indices (P1 and P2) and AFC. These findings contradict the reports of Garudkar *et al.* (2018), who found no effect of AFC on persistency. The variation between results of ANOVA and correlation

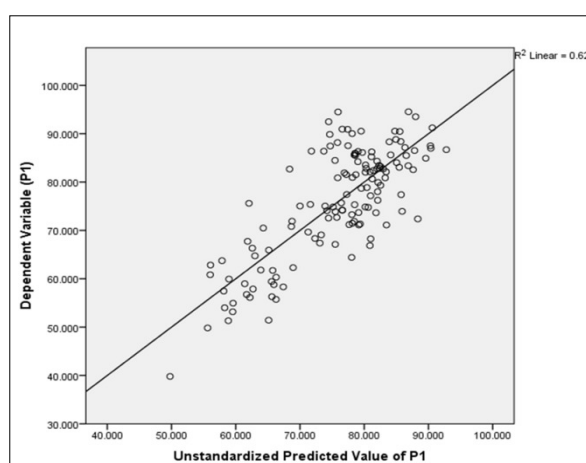


Fig 2: Relationship between actual values of P1 and its predicted values.

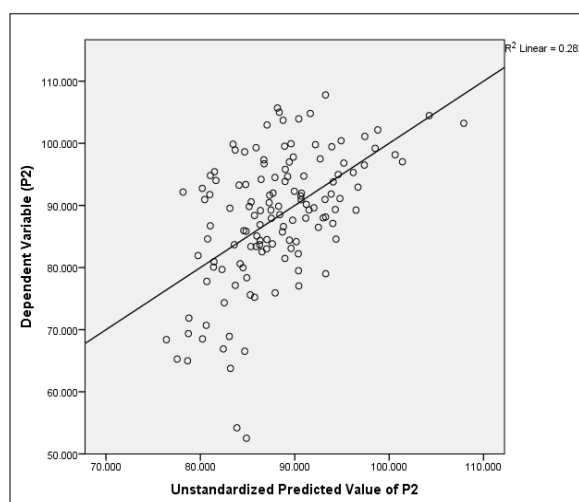


Fig 3: Relationship between actual values of P2 and its predicted values.

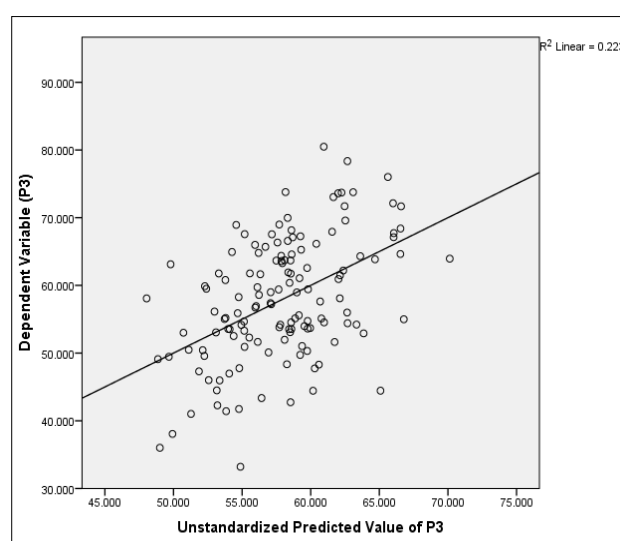


Fig 4: Relationship between actual values of P3 and its predicted values.

regarding the association of P2 with AFC was probably due to the effect of grouping in ANOVA. The association between P3 and AFC was non-significantly negative which was in agreement with Atashi *et al.* (2021), who observed that an increased AFC was associated with decreased persistency.

Season of calving

The values of persistency index P1 and P3 were not influenced by the season. However, the values of persistency index P2 exhibited significant variation ($P < 0.01$) among seasons of calving, with the highest value recorded in Autumn ($92.926 \pm 1.624\%$) and the lowest in Summer ($81.619 \pm 2.311\%$). Contrary to this, Elmaghraby (2009) noticed higher lactation persistency in summer and spring seasons. The results regarding P1 and P3 were similar to those of Hermiz and Hadad (2020), Garudkar *et al.* (2018) and Fadlelmoula *et al.* (2007) while the result pertaining to P2 was in agreement with those of Hermiz and Hadad (2020), Zurwan *et al.* (2017), Albarrán-Portillo and Pollott (2011) and Güler and Yanar (2009).

Sex and birth weight of calf

Both the Sex and birth weight of calf had no effect on persistency and there is no significant correlation between them and persistency. Hermiz and Hadad (2020) reported similar results. Contrary to the results of the present study, Chegini *et al.* (2015) reported that lactations with female calves were of higher persistency.

Prediction of persistency

Based on the significant correlations found in case of DPY, LL, SLMY, TLMY, parity and AFC, prediction equations were evolved for the persistency indices using multiple linear regression. The regression equation, regression coefficients and coefficients of determination were

depicted in Table 5. Additionally, the relationships between actual values of dependent variables (P1, P2 and P3) and their predicted values were depicted in Fig 2, 3 and 4.

The P1 could be predicted from the regression equation $[P1\% = 13.661 + 0.036 (DPY) + 0.148 (LL) + 0.064 (SLMY) - 0.053 (TLMY) - 0.041 (\text{parity}) + 1.133 (AFC)]$ with an accuracy of 62.20 percent and the regression equations $P2\% = 54.230 + 0.043 (DPY) + 0.011 (LL) + 0.000 (SLMY) + 0.009 (TLMY) + 0.800 (\text{parity}) + 3.164 (AFC)$ and $P3\% = 56.409 - 0.023 (DPY) - 0.060 (LL) - 0.006 (SLMY) + 0.022 (TLMY) + 0.437 (\text{parity}) + 1.655 (AFC)$ could be used for prediction of P2 and P3 with 28.20 and 22.30 percent of accuracy respectively (Table 5). Though all the three regression models of P1, P2 and P3 were statistically significant, the P1 can be considered as better measure for predicting persistency as its regression model had higher precision and its calculation is easy.

CONCLUSION

In conclusion, the study had several key findings regarding lactation curve and persistency in Ongole cattle. Firstly, the study concluded that the lactation curve is of a typical concave downward shape, with the peak occurring around the eighth week of lactation. Secondly, the study underscored the importance of selecting an appropriate measure for calculating lactation persistency, as different metrics may yield varying results. Thirdly, the study showed that lactations characterized by higher Lactation Milk Yield demonstrate greater persistency. Lastly, the persistency index formula proposed by Turner (1926) emerged as a preferable measure compared to that of Ludwick and Petersen (1943) and Prasad *et al.* (1999) for assessing persistency in Ongole cattle.

ACKNOWLEDGEMENT

The present study was supported by the Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

No approval of Committee of Experimental Animal care was required to accomplish the goals of this study.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

- Albarrán-Portillo, B. and Pollott, G.E. (2011). Environmental factors affecting lactation curve parameters in the United Kingdom s commercial dairy herds. *Archivos de Medicina Veterinaria*. 43(2): 145-153.
- Ali, A. K.A. Al-Jumaah, R.S. and Hayes, E. (1996). Lactation curve of Holstein Friesian cows in the Kingdom of Saudi Arabia. *Asian-Australasian Journal of Animal Sciences*. 9(4): 439-448.
- Andersen, F. Østerås, O. Reksen, O. and Gröhn, Y.T. (2011). Mastitis and the shape of the lactation curve in Norwegian dairy cows. *Journal of Dairy Research*. 78(1): 23-31.
- Atashi, H. Asaadi, A. and Hostens, M. (2021). Association between age at first calving and lactation performance, lactation curve, calving interval, calf birth weight and dystocia in Holstein dairy cows. *PLoS ONE*. 16(1): e0244825. <https://doi.org/10.1371/journal.pone.0244825>.
- Bhutkar, S.S. Thombre, B.M. and Bainwad, D.V. (2014). Effect of non-genetic factors on production traits in Deoni cows. *IOSR Journal of Agriculture and Veterinary Science*. 7(12): 09-14.
- Chaudhari, P.N. Kapadiya, P.S. and Gadariya, M.R. (2022). Characteristics, curve and persistency of lactation in jaffarabadi (Bubalus bubalis) buffaloes. *Indian Journal of Veterinary Sciences and Biotechnology*. 18(2): 81-84.
- Chegini, A. Zadeh, N.G.H. and Moghadam, H.H. (2015). Effect of calf sex on some productive, reproductive and health traits in Holstein cows. *Spanish Journal of Agricultural Research*. 13(2): e0605, <http://dx.doi.org/10.5424/sjar/2015132-6320>.
- Cole, J.B. and Null, D.J. (2009). Genetic evaluation of lactation persistency for five breeds of dairy cattle. *Journal of Dairy Science*. 92(5): 2248-2258.
- Das, A. Das, D. Goswami, R.N. and Bhuyan, D. (2007). Persistency of milk yield and its correlation with certain economic traits in swamp buffaloes of Assam. *Buffalo Bulletin*. 26(2): 36-39.
- Dekkers, J.C.M. Ten Hag, J.H. and Weersink, A. (1998). Economic aspects of persistency of lactation in dairy cattle. *Livestock Production Science*. 53(3): 237-252.
- Elmaghraby, M.M.A. (2009). Lactation persistency and prediction of total milk yield from monthly yields in Egyptian buffaloes. *Lucrări Științifice*. 53(15): 242-249.
- Fadlelmoula, A.A. Yousif, I.A. and Abu Nihaila, A.M. (2007). Lactation curve and persistency of crossbred dairy cows in the Sudan. *Journal of Applied Sciences Research*. 3(10): 1127-1133.
- Ferris, T.A. Mao, I.L. and Anderson, C.R. (1985). Selecting for lactation curve and milk yield in dairy cattle. *Journal of Dairy Science*. 68(6): 1438-1448.
- Garudkar, S.R. Pachpute, S.T. and Deokar, D.K. (2018). Studies on persistency of milk yield and its association with production traits in Phule Triveni synthetic cow. *International Journal of Current Microbiology and Applied Sciences*. Special Issue- 6: 1585-1589.
- George, L. Gupta, I.D. Gupta, A.K. Vineeth, M.R. Achankunju, J.P. and Aruna, T.S. (2021). Estimation and comparison of different Lactation persistency methods in Tharparkar cattle. *Indian Journal of Dairy Science*. 74(3): 244-249.
- Güler, O. and Yanar, M. (2009). Factors influencing the shape of lactation curve and persistency of Holstein Friesian cows in high altitude of Eastern Turkey. *Journal of Applied Animal Research*. 35(1): 39-44.
- Hermiz, H.N. and Hadad, J.M.A. (2020). Factors affecting persistency and repeatability in several breeds of dairy cattle. *Plant Archives*. 20(1): 9-12.
- Hickson, R.E. Lopez-Villalobos, N. Dalley, D.E. Clark, D.A. and Holmes, C.W. (2006). Yields and persistency of lactation in Friesian and Jersey cows milked once daily. *Journal of Dairy Science*. 89(6): 2017-2024.
- Kaushal, S. Gandhi, R.S. Singh, A. Chaudhari, M.V. Prakash, V. and Gupta, A. (2016). Efficiency of various measures of persistency of milk yield in Sahiwal cattle. *Indian Journal of Animal Research*. 50(2): 268-270.
- Khalifa, M. Hamrouni, A. and Djemali, M. (2018). The estimation of lactation curve parameters according to season of calving in Holstein cows under North Africa environmental conditions: the case of Tunisia. *Journal of New Sciences*. 50: 3048-3053.
- Khan, M.S. (1997). Lactation curve of Sahiwal cattle. *Pakistan Veterinary Journal*. 17: 107-110.
- Koloi, S. Pathak, K. Karunakaran, M. and Mandal, A. (2018). Lactation persistency and its genetic evaluation in cattle- A review. *Research and Reviews: Journal of Dairy Science and Technology*. 7: 1-8.
- Kumar, A. and Singh, A. (2006). Genetic and Environmental factors influencing persistency of milk production in Karan Fries cattle. *Indian Journal of Animal Research*. 40(2): 95-100.
- Litherland, N. (2021). Improving peak milk yields. The University of Minnesota. Available: <https://extension.umn.edu/dairy-milking-cows/improving-peak-milk-yields>. (8th March, 2024).

- Ludwick, T. M. and Petersen, W. E. (1943). A measure of persistency of lactation in dairy cattle. *Journal of Dairy Science*. 26: 439-445.
- Pareek, N.K. and Narang, R. (2015). Effect of non-genetic factors on persistency and milk production traits in Murrah buffaloes. *Journal of Animal Research*. 5(3): 493-495.
- Pedrosa, V.B. Schenkel, F.S. Chen, S.Y. Oliveira, H.R. Casey, T. M. Melka, M.G. and Brito, L.F. (2021). Genomewide association analyses of lactation persistency and milk production traits in Holstein cattle based on imputed whole-genome sequence data. *Genes*. 12: 1830.
- Prasad, S. Singh, R. and Bisht, G.S. (1999). Measure of persistency and its relationship with peak yield and lactation milk yield. *Indian Journal of Dairy Science*. 52(5): 308-314.
- Raja, T.V. Kumar, R. Rathee, S.K. Prakash, B. and Singh, U. (2018). Effect of certain factors on first lactation peak yield and days to attain peak yield in Frieswal cattle. *Indian Journal of Animal Sciences*. 88 (1): 121-00.
- ŞEahin, A. Uluta^o, Z. Arda, Y. Yüksel, A. and Serdar, G. (2015). Lactation curve and persistency of Anatolian buffaloes. *Italian Journal of Animal Science*. 14(2): 150-157.
- Shija, D.S. Mwai, O.A. Ojango, J.M. Komwihangilo, D.M. and Bebe, B.O. (2022). Assessing Lactation Curve Characteristics of Dairy Cows Managed under Contrasting Husbandry Practices and Stressful Environments in Tanzania. *World*. 3(4): 1032-1052.
- Sorensen, A. Muir, D.D. and Knight, C.H. (2008). Extended lactation in dairy cows: effects of milking frequency, calving season and nutrition on lactation persistency and milk quality. *Journal of Dairy Research*. 75(1): 90-97.
- Tekerli, M. Akinci, Z. Dogan, I. and Akcan, A. (2000). Factors affecting the shape of lactation curves of Holstein cows from the Balikesir province of Turkey. *Journal of Dairy Science*. 83(6): 1381-1386.
- Torshizi, M.E. and Mashhadi, M.H. (2018). A study on milk yield persistency using the best prediction and random regression methodologies in Iranian Holstein dairy cows. *Revista Cubana de Ciencia Agrícola*. 52(2): 127-139.
- Turner, C.W. (1926). A quantitative form of expressing persistency of milk or fat secretion. *Journal of Dairy Science*. 9: 203-214.
- Yamazaki, T. Takeda, H. Nishiura, A. Sasai, Y. Sugawara, N. and Togashi, K. (2011). Phenotypic relationship between lactation persistency and change in body condition score in first-lactation Holstein cows. *Asian-Australasian Journal of Animal Sciences*. 24(5): 610-615.
- Yilmaz, H. and Koc, A. (2013). A research on milk yield, persistency, milk constituents and somatic cell count of red Holstein cows raised under mediterranean climatic conditions. *Bulgarian Journal of Agricultural Science*. 19(6): 1401-1407.
- Zurwan, A. Moaeen-ud-Din, M. Bilal, G. and Khan, M.S. (2017). Estimation of genetic parameters for persistency of lactation in Sahiwal dairy cattle. *Pakistan Journal of Zoology*. 49(3): 877-882.