

Characteristics, Curve and Persistency of Lactation in Gir Cows

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How to cite this paper:

Chaudhari, P. N., Kapadiya, P. S., Gadariya, M. R., Gamit, P. M., & Savaliya, B. D. (2022). **Characteristics, Curve and Persistency of Lactation in Gir Cows.** *International Journal of Livestock Research*, 12(1), 12-18. <https://dx.doi.org/10.5455/ijlr.20211027045505>

Received : Nov 02, 2021
Accepted : Dec 26, 2021
Published : Jan 31, 2022

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Abstract

Lactation milk yield in dairy bovines is closely related with peak yield, persistency and lactation length. Therefore, characteristics, curve and persistency of lactation were studied in Gir cows. A total of 2,24,748 morning and evening milk production records of 300 lactations of 1-6 parity Gir cows present at Cattle Breeding Farm, JAU, Junagadh, Gujarat over a period of 31 years (1986-2016) were used for this study. Overall lactation length (LL), total lactation milk yield (TLMY) and standard lactation milk yield (SLMY) of the Gir cows averaged 371.59 ± 5.42 days, 2674.21 ± 48.79 lit and 2380.79 ± 37.68 lit, respectively. Overall daily peak yield (DPY) was 13.25 ± 0.17 lit/day, attained at 48.47 ± 2.40 days postpartum. Overall weekly peak yield (WPY) and weeks to attain WPY averaged 82.08 ± 1.11 lit/week and 6.54 ± 0.31 weeks, respectively. Weekly milk yield could be predicted using linear function $[(y \approx 79.5139 + (-1.1002 \times X)]$ and logarithmic function $[(y \approx 1.9378 \times (-0.00965)^X)]$ with an accuracy of 86 to 95%, while monthly milk yield could be predicted using linear function $[(y \approx 348.52 + (-20.26 \times X)]$ and logarithmic function $[(y \approx 2.588 \times (-0.042)^X)]$ with comparatively higher R² value of 94.01 to 98.05%. Overall persistency, in terms of weekly and monthly milk yield was estimated to be $96.82 \pm 0.13\%$ and $88.77 \pm 0.37\%$, respectively.

Keywords: Gir Cows, Lactation Characteristics, Lactation Curve, Linear Regression, Peak Yield, Persistency

Introduction

Gir breed is one among the few best dairy cattle of the country known for higher milk production. Milk production, an economically important trait, is influenced principally by maximum initial production, the persistency with which such yields are maintained and the length of the production period. Total milk production of an animal is closely correlated with peak yield and persistency. Persistency of milk production is the ability of animal to maintain milk production at a high level after peak production, or usually refers to the rate of decline in daily yield after the peak of lactation (Togashi and Lin, 2004).

Different linear and non-linear mathematic models have been suggested by various workers for fitting the lactation curve of dairy cattle. Studies conducted by various workers suggest that the models differ in their efficiency of fitting the lactation curve in different cattle breeds as one model suited to one particular breed may not fit to another breed perfectly. Hence, it becomes imperative to find the best suitable model which can explain the variation in lactation milk yield effectively. Moreover, perusal of available literatures also revealed very scanty work found on the lactation curve modelling as well as on lactation persistency in Gir cows. Therefore, the characteristics, curve and persistency of lactation in Gir cows were studied.

Materials and Methods

A total of 2,24,748 morning and evening milk production performance records in 300 lactations of 1st to 6th parity of Gir cows (N = 50) lactating at the Cattle Breeding Farm, JAU, Junagadh, Gujarat over a period of 31 years (1986-2016) were utilized for the study. Averages along with standard error were worked out for various lactation characteristics and means were compared using Duncan's multiple range test in SPSS Statistics for Windows, Version 17.0 (SPSS Inc., 2008).

Total milk production was partitioned into 43 weekly milk yield and 10 monthly milk yield and persistency was calculated using ratio method as below-

$$\text{Persistency (\%)} \text{ of milk yield of } X^{\text{th}} \text{ week or month} = \frac{\text{Milk yield of } X^{\text{th}} \text{ week or month}}{\text{Milk yield of } (X - 1)^{\text{th}} \text{ week or month}} \times 100$$

Prediction equations were evolved for monthly and weekly milk yield of Gir cows using simple linear and logarithmic regression functions as follows:

$$\hat{Y} = a + bX \text{ (simple linear regression)}$$

$$\hat{Y} = a + b \log X \text{ (logarithmic regression)}$$

Where,

\hat{Y} , predicted weekly or monthly milk yield,

a , intercept value,

b , regression coefficient of milk yield (Y) on independent variable (X), and

X, independent variables (week or month).

The coefficient of determination (R^2) was calculated on the basis of following formula:

$$R^2 = \frac{\text{Regression sum of square}}{\text{Total sum of square}} \times 100$$

Results and Discussion

Lactation Characteristics

Information on production performance of Gir cows in terms of lactation length (LL), total lactation milk yield (TLMY) and standard lactation milk yield (SLMY) are presented in Table 1. Overall LL, TLMY and SLMY of the

Gir cows averaged 371.59 ± 5.42 days, 2674.21 ± 48.79 lit and 2380.79 ± 37.68 lit, respectively. Researchers have reported average TLMY of 2276.6 ± 171.3 kg (Dangar and Vataliya, 2015) and SLMY of 1917.3 ± 28.5 lit (Savaliya *et al.*, 2016) in Gir cows. Gadariya *et al.* (2017) reported LL, TLMY and SLMY of Gir cows as 281 ± 4.6 days, 2006.3 ± 48.8 lit and 1819.7 ± 45.4 lit, respectively. Higher performance of Gir cows observed in present study might be because of large sample size (lactation record, 300) and the cows which performed and retained in the herd for 6 or more normal lactations with minimum 210 lactation days constituted the base of the investigation.

The effect of parity was significant ($P < 0.01$) on all the production traits of Gir cows, being significantly lower in first lactation. Production performance during 2nd to 6th lactations, the values were at par. Numerically, lactation milk yield (SLMY and TLMY) were observed highest in 3rd lactation. Gajbhiye *et al.* (2016) observed significant parity effect on lactation yield in their study on Gir cows from 1965 to 2010. They also observed maximum yield of 2132.0 ± 123.4 lit in 2nd lactation, then gradual reduction of yield during later parities. Dangar and Vataliya (2015) and Gadariya *et al.* (2017) observed gradual increase in milk yield up to 5th parity (maximum yield of 2694.20 ± 184.94 kg and 2423.65 ± 106.34 liter/ lactation, respectively) and thereafter gradual reduction of yield.

Overall daily peak yield (DPY) was 13.25 ± 0.17 lit/day, attained at 48.47 ± 2.40 days postpartum in the Gir cows. Overall weekly peak yield (WPY) and weeks to attain WPY of the Gir cows averaged 82.08 ± 1.11 lit/week and 6.54 ± 0.31 weeks, respectively. Parity of cows significantly ($p < 0.01$) affected the peak yield, being lowest in first lactation. Numerically, maximum daily and weekly peak yields were observed in 4th lactation. Nanavati and Qureshi (1996) observed mean peak yield of 211 Gir cows was 10.0 ± 0.10 kg/day, which was achieved on 47.0 ± 0.83 days in milk. Singh (1983) found average weekly and daily peak yield in Gir cow were 59.68 and 9.53 kg attained at 10.53th week and 61.25th day after calving, respectively. Vataliya *et al.* (2019) reported daily peak yield of Gir cows was 10.29 ± 0.22 lit/day, reached on 58.73 ± 0.65 days after calving.

Table 1: Parity wise daily and weekly peak yield and lactation milk yield along with lactation days of Gir cows

Parity	N	DPY, lit	Days to attain DPY	WPY, lit	Weeks to attain WPY	SLMY, lit	TLMY, lit	Lactation Days
		Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE
1	50	$10.38^a \pm 0.35$	$66.24^a \pm 6.87$	$62.44^a \pm 2.40$	$8.78^a \pm 0.93$	$1957.37^a \pm 92.82$	$2392.93^a \pm 137.33$	$406.26^a \pm 14.39$
2	50	$13.46^b \pm 0.28$	$39.60^c \pm 3.35$	$82.80^b \pm 1.78$	$5.82^b \pm 0.71$	$2476.80^{bc} \pm 58.21$	$2820.69^c \pm 91.11$	$384.44^{ab} \pm 14.49$
3	50	$13.90^b \pm 0.32$	$47.72^{bc} \pm 6.47$	$86.95^b \pm 2.05$	$6.12^b \pm 0.77$	$2567.18^c \pm 78.13$	$2866.76^c \pm 115.78$	$366.36^{bc} \pm 12.75$
4	50	$14.20^b \pm 0.39$	$36.48^c \pm 2.70$	$88.40^b \pm 2.55$	$5.40^b \pm 0.41$	$2534.95^{bc} \pm 90.14$	$2801.67^c \pm 110.99$	$377.24^{ab} \pm 11.87$
5	50	$14.02^b \pm 0.41$	$57.98^{ab} \pm 7.20$	$87.64^b \pm 2.76$	$6.42^b \pm 0.86$	$2477.19^{bc} \pm 93.77$	$2741.83^{bc} \pm 123.67$	$359.18^{bc} \pm 12.83$
6	50	$13.57^b \pm 0.42$	$42.82^{bc} \pm 6.14$	$84.27^b \pm 2.86$	$6.70^{ab} \pm 0.74$	$2271.23^b \pm 107.10$	$2421.40^{ab} \pm 120.09$	$336.04^c \pm 11.53$
Overall	300	13.25 ± 0.17	48.47 ± 2.40	82.08 ± 1.11	6.54 ± 0.31	2380.79 ± 37.68	2674.21 ± 48.79	371.59 ± 5.42

DPY/WPY= daily/weekly peak yield, SLMY/TLMY= standard/total lactation milk yield; Means with different superscripts indicate significant differences ($P < 0.01$)

Lactation Curve

The correlation coefficients of milk yield were -0.93 to -0.99 ($P < 0.01$) for both, week and month. Hence, prediction equations were evolved for lactation yield of Gir cows using linear and logarithmic functions. The regression coefficients along with coefficient of determination for milk yield have been furnished in Table 2. Weekly milk yield could be predicted using linear function [$\hat{y} = 79.5139 + (-1.1002 \times X)$] and logarithmic function [$\hat{y} = 1.9378 \times (-0.00965)^X$] with an accuracy of 86 to 95 %. Monthly milk yield could be predicted using linear function [$\hat{y} = 348.52 + (-20.26 \times X)$] and logarithmic function [$\hat{y} = 2.588 \times (-0.042)^X$] with comparatively more precision, R^2 value being 94.01 to 98.05 %. The graphical illustrations of actual and predicted curves of weekly and monthly milk production are presented in Figure 1 and 2, respectively. Savaliya *et al.* (2017) observed the R^2 values for exponential, inverse polynomial parabolic exponential and Gamma-type lactation curve functions in Gir cattle using weekly milk yields accounted for 85.25, 99.76, 95.00 and 99.82% of the variation, respectively. Raja *et al.* (2020) observed the adjusted R^2 values of the lactation curve models in Gir cow using fortnightly test day records ranged from 69.28 (exponential decline function) to 99.36% (parabolic exponential function).

Table 2: Regression coefficients and R² for prediction equations of milk yield in Gir cows

Trait	Function	r- value	Intercept	b- value	F- value	R ² %
Weekly Milk Yield, Lit	Linear	-0.9774	79.51±0.95	-1.1002±0.0367	898.71	95.43
	Logarithmic	-0.9308	1.94± 0.02	-0.0097±0.0006	272.21	86.31
Monthly Milk Yield, Lit	Linear	-0.9912	348.52±6.13	-20.2623±0.9035	502.91	98.05
	Logarithmic	-0.9724	2.59±0.02	-0.0420±0.0033	157.13	94.01

Linear and logarithmic curve indicated that milk yield was linearly related with advancement of lactation period during the descending phase of lactation curve. It neither described the initial increase of milk nor peak production. It only described the declining phase. It can be concluded, therefore, that linear and logarithmic curve has merit to represent only declining phase of lactation curve in Gir cows.

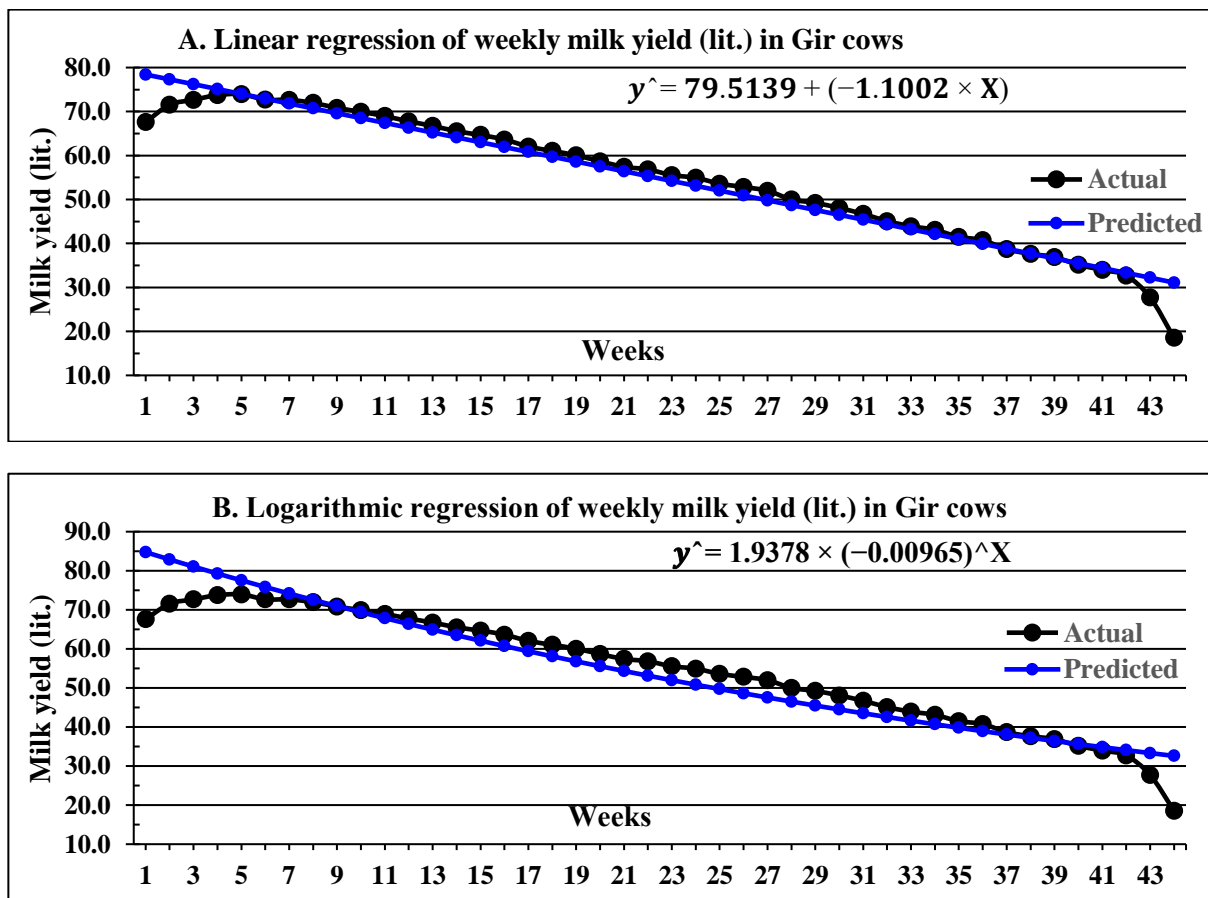
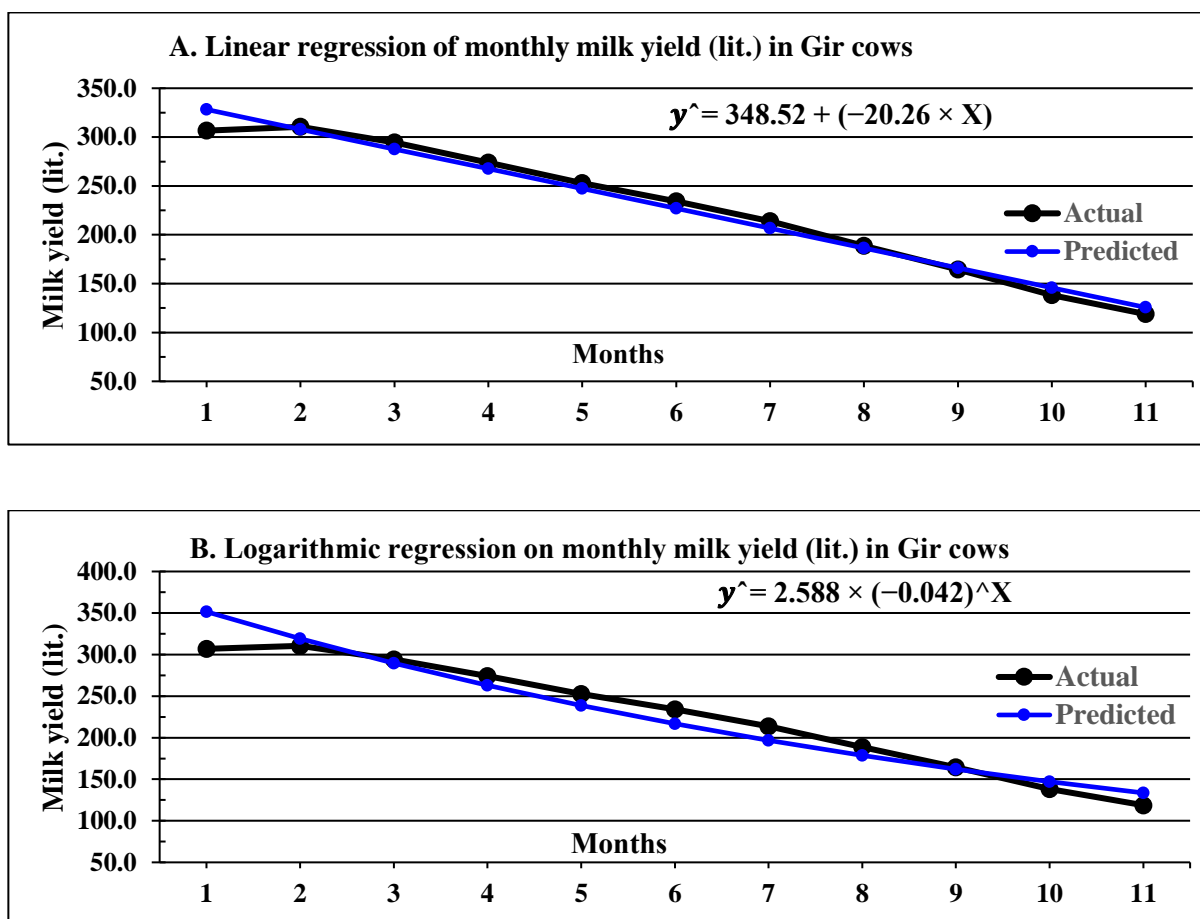
Figure 1: Lactation curve in terms of weekly milk production in Gir cows

Figure 2: Lactation curve in terms of monthly milk production in Gir cows



Persistence

Overall persistency, in terms of weekly milk yield was estimated to be $96.82 \pm 0.13\%$. Thus, overall rate of decline in milk yield was 3.18% per week. Weekly milk production was above 100% till 8th week and further maintained above 95% up to 34th week (Table 3).

Table 3: Persistency (%) of milk yield based on weekly milk production of Gir cows during 44 weeks of lactation

Week	N	Persistency (%)	Week	N	Persistency (%)	Week	N	Persistency (%)
2	300	107.50 ± 0.99	17	300	97.29 ± 0.52	32	294	95.09 ± 0.81
3	300	103.83 ± 1.01	18	299	98.57 ± 0.58	33	291	96.20 ± 0.91
4	300	102.49 ± 0.64	19	299	98.76 ± 0.57	34	288	97.33 ± 1.06
5	300	100.49 ± 0.55	20	299	98.28 ± 0.53	35	286	94.30 ± 0.82
6	300	99.16 ± 0.70	21	299	97.98 ± 0.57	36	281	96.38 ± 0.85
7	300	100.65 ± 0.72	22	299	99.59 ± 0.69	37	280	92.76 ± 1.05
8	300	100.03 ± 0.87	23	299	97.84 ± 0.53	38	274	93.27 ± 1.06
9	300	99.13 ± 0.51	24	299	99.27 ± 0.64	39	267	93.75 ± 1.02
10	300	98.67 ± 0.40	25	299	97.73 ± 0.59	40	263	90.79 ± 1.22
11	300	98.96 ± 0.43	26	298	98.19 ± 0.70	41	255	91.34 ± 1.13
12	300	98.48 ± 0.47	27	297	98.70 ± 0.53	42	249	90.05 ± 1.39
13	300	98.97 ± 0.50	28	298	96.58 ± 0.80	43	235	77.47 ± 1.28
14	300	98.33 ± 0.49	29	297	97.81 ± 0.64	44	232	65.42 ± 0.49
15	300	98.88 ± 0.52	30	296	96.56 ± 0.67			
16	300	98.58 ± 0.58	31	295	96.62 ± 0.65			
					Overall		12468	96.82 ± 0.13

Means with without superscripts indicate non-significant effect ($P > 0.05$)

Singh and Shukla (1986) reported mean persistency of Gir cows based on weekly milk yield was 97.67%. Overall rate of reduction in weekly milk yield of Gir cow from peak yield to 43rd week of lactation was observed to be 0.85 kg/week by Rankja (2004). Patel (2015) observed the overall persistency for weekly milk production in Holstein Friesian cattle up to 42nd week of lactation in first, second, third, fourth and fifth lactations were 84.45, 83.46, 83.40, 83.50 and 83.80%, respectively. In another study (Sharma *et al.*, 2017) the persistency of milk production was measured in Holstein Friesian × Sahiwal cattle up to 42nd week of lactation and overall persistency (%) for weekly milk production in first lactation was found to be 84.22%. Overall persistency, in terms of monthly milk yield was estimated to be 88.77±0.37%, overall rate of decline in milk yield being 11.23% per month. Monthly milk production was found to persist above 90 % till 7th month postpartum (Table 4). The effect of parity on lactation persistency was non-significant (P>0.05).

Table 4: Persistency (%) of milk yield based on monthly milk production of Gir cows

Month	N	Persistency (%)
2	300	102.91 ± 0.96
3	300	95.50 ± 0.66
4	300	92.99 ± 0.51
5	299	92.52 ± 0.64
6	299	92.76 ± 0.77
7	298	90.38 ± 0.77
8	295	85.90 ± 1.02
9	284	82.39 ± 1.23
10	266	75.79 ± 1.66
11	225	70.07 ± 2.06
Over- all	2866	88.77 ± 0.37

Means without superscripts indicate non-significant effect (P>0.05)

The findings of present study tended to indicate that Gir cow is a high and persistent milk producing cattle breed with quite a long lactation length. Linear regression function has been found more accurate than Logarithmic regression function for prediction of weekly and monthly milk production of this cow.

Acknowledgement

We acknowledge the Director of Research, JAU and Cattle Breeding Farm, JAU, Junagadh for providing access to milk production registers for collection of necessary data for the study.

Conflict of Interests

There is no conflict of interest.

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