RESEARCH ARTICLE

Test-Day and Other Milk Recording Options for Prediction of Lactation Milk Yield in Gir (*Bos indicus*) Cows

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Abstract

In the field condition, various milk recording options or test-day recording can be a useful tool to approximate/predict the production potential of field bovines. Therefore, a study was carried out to approximate/predict standard lactation milk yield in Gir (*Bos indicus*) cows from different milk recording options and test-day milk yield. A total of 2,24,748 daily morning and evening milk production performance records in 300 lactations of 50 Gir cows lactating at the Cattle Breeding Farm, JAU, Junagadh (Gujarat) over a period of 31 years (1986-2016) were used for the study. Test day records, 125, 155, and 185th at mid-and late lactations, *i.e.,* 4, 5, and 6th month, alone or combining consecutive two or three variables and even test day records 155th to 275th, *i.e.,* from 5th to 9th month along with daily peak yield were found important in determining the SLMY. Sum-up of morning and evening milk yield at weekly intervals till the cow dries could be used to estimate lactation milk yield by the equation 0.59+6.97×Sum or sum-up of morning and evening milk yield records at the fortnightly interval by the equation 21.23+14.73×Sum, with a precision of 99%.

Keywords: Gir (*Bos indicus*) cow, Milk recording options, Peak yield, Prediction of lactation yield, Test-day milk yield.

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Introduction

Milk recording is one of the essential criteria for efficient herd management, selection of animals with higher genetic potential, and for culling of low-producing animals. Complete record keeping is a difficult and phenomenal task because of several reasons, *viz.,* time and labour consumed, transfer, sale, death or culling of animals etc. (Sah *et al.,* 2013). Reliable information on production potential in terms of lactation milk yield is available only on organized Government or University farms. In the field condition, exact information on lactation characteristics is not available, and hence it is practically impossible to have exact information on the production potential of milch bovines. Various workers (Berry *et al.*, 2005; Sah *et al.,* 2013; Singh and Tailor, 2013) have attempted to estimate the lactation yield of dairy animals through different methodologies. There is a dearth of such information in Gir (*Bos indicus*) cattle. Therefore, a study was carried out to approximate/predict standard lactation milk yield in Gir cows from different milk recording options and monthly test-day milk yield.

Materials and Methods

The records (N= 2,24,748) on a daily morning (M) and evening (E) milk production performance of Gir (*Bos indicus*) cows lactating at the Cattle Breeding Farm, JAU, Junagadh, Gujarat over 31 years (1986-2016) were used for the study. A total of 300 normal lactations of 50 Gir cows from 1st to 6th parity with lactation length >210 days were analyzed.

Simple and multiple regression equation aimed at predicting the lactation yield based on various milk recording options or one or more test day yields as independent variables was as follows:

$$\hat{Y} = a + \Sigma b_i x_j$$

Where, $\hat{Y}$ predicted lactation yield,

a, intercept value,

b_i, the regression coefficient of lactation yield (Y) on milk recording options/test day/peak yield (X), and

x_j, independent variables (milk recording options, test day, or peak yield).

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

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

(Snedecor and Cochran, 1994)

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The data were subjected to a simple regression equation taking one dependent and another independent variable, and multiple regression equations also were obtained by using 2, and 3 independent variables (Snedecor and Cochran, 1994), and the findings were incorporated accordingly. The data were analyzed using excel analysis tool pack 2016.

Results and Discussion

Overall lactation length (LL), total lactation milk yield (TLMY) and standard lactation milk yield (SLMY) of the Gir cows were 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 of the Gir cows averaged 82.08±1.11 lit/week and 6.54±0.31 weeks, respectively.

Prediction of SLMY based on Different Milk Recording Options

Correlation and regression coefficients of daily peak yield, weekly peak yield, and sum-up of various milk recording options considered in the study were significant ($p < 0.01$) on SLMY; hence prediction equations were evolved. Information on correlation and regression analysis for the prediction of SLMY is presented in Table 1. Prediction equations with a sum of either all weekly interval morning and evening milk yield records (all W M+E) or all fortnightly interval morning and evening milk yield records (all Fort M+E) as independent variables accounted for 99.2 to 99.7% variation in SLMY. Pundir (2016) predicted 305-day lactation milk yield based on cumulative first 12 morning and evening milk yield records collected at fortnightly intervals in Hill cows of Uttarakhand with 96.3% accuracy of prediction. Another study (Berry *et al.*, 2005) also revealed five or more test day weekly recording intervals predicted 305-day yield with higher accuracy. Predicting SLMY using the sum of either all E or alternate E or weekly E covered around 95% variation of SLMY trait. Using the sum of fortnightly E was found to be more accurate than fortnightly M in predicting SLMY (R^2 value being 94.96 vs. 90.74%). Equations for SLMY with a sum of either all M or alternate M or weekly M as independent variable gave around 92% prediction reliability. Berry *et al.* (2005) reported that alternating between AM and PM sampling every 4 weeks predicted 305 days yield with higher accuracy than either all AM or PM sampling. Further, alternate AM-PM recording every 4 weeks and AM+PM recording every 8 weeks produced similar accuracy in predicting 305 days yield than with AM+PM recording every 4 weeks interval.

Prediction of SLMY based on Daily and Weekly Peak Yield

Prediction equations for SLMY based on DPY or WPY accounted for 65.3 to 68.0% variation. Sah *et al.* (2013) found that the lactation milk yield could be predicted using peak yield alone with slightly less accuracy (49%) in Kankrej cattle. Prediction of SLMY of Gir cattle combining daily peak along-with monthly test-day records is detailed in Table 2. Use of daily peak yield along with test-day milk yield at monthly interval T_5 to T_{95} showed a correlation coefficient of 0.808 to 0.866 with an increasing trend of accuracy (R^2 = 65 to 75%) of prediction of SLMY. Combining daily peak along with test day milk yields, T_{155} or T_{185} or T_{215} or T_{245} or T_{275} showed an association by r=0.927 to 0.945, covered 86 to 89% variation in SLMY.

Table 1: Regression analysis on different milk recording options for prediction of SLMY*

Trait (variable)	*Trait (variable)*				*Intercept*		*b value*		
	N	*Mean*	*SE*	*r value*	*Mean*	*SE*	*Mean*	*SE*	*R^2 %*
DPY	300	13.25	0.17	0.808	-52.29	105.02	183.52	7.74	65.33
WPY	300	82.08	1.11	0.825	86.70	93.58	27.94	1.11	68.01
all M	300	1134.11	16.78	0.964	-72.78	40.67	2.16	0.03	92.86
all E	300	1245.99	21.96	0.979	287.69	26.43	1.68	0.02	95.83
all Alt M	300	568.07	8.42	0.963	-67.70	41.09	4.31	0.07	92.70
all Alt E	300	624.19	11.00	0.979	288.81	26.41	3.35	0.04	95.83
all W M	300	162.41	2.42	0.962	-50.35	41.20	14.97	0.25	92.57
all W E	300	178.96	3.13	0.976	279.81	28.11	11.74	0.15	95.34
all W M+E	300	341.37	5.40	0.999	0.59	7.29	6.97	0.02	99.74
all Fort M	300	75.95	1.15	0.953	0.49	45.51	31.33	0.58	90.74
all Fort E	300	84.23	1.48	0.975	296.07	29.07	24.74	0.33	94.96
all Fort M+E	300	160.18	2.55	0.996	21.23	12.97	14.73	0.08	99.17
all T5 to T305	221	88.53	1.41	0.988	59.13	26.30	27.46	0.29	97.62

N = No. of lactations, DPY/WPY= daily/weekly peak yield, M/E = morning/evening, W/Fort –weekly/fortnightly, T = Test-day, *Correlation, and regression coefficients were significant ($p < 0.01$).

Table 2: Multiple regression analysis with daily peak yield and test day yield for prediction of SLMY in Gir cows*

DPY and Test day yield	*r value*	*Intercept*		*b1 value*		*b2 value*		
		Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	R^2 %
DPY + T_5	0.811	-18.46	106.04	166.92	11.60	20.84	10.89	65.52
DPY + T_{35}	0.808	-49.20	106.44	181.35	13.79	2.42	12.72	65.10
DPY + T_{65}	0.851	98.56	95.38	89.87	12.75	108.61	12.42	72.24
DPY + T_{95}	0.866	12.17	89.66	89.18	11.04	123.97	11.63	74.76
DPY + T_{125}	0.904	104.38	76.23	75.94	9.00	145.85	9.53	81.65
DPY + T_{155}	0.927	-46.42	66.53	88.39	6.91	155.69	7.91	85.76
DPY + T_{185}	0.941	-11.99	59.72	96.70	5.75	148.94	6.38	88.46
DPY + T_{215}	0.945	-55.57	57.42	116.81	5.06	134.23	5.65	89.23
DPY + T_{245}	0.939	-125.13	60.93	136.35	4.93	121.74	5.70	88.17
DPY + T_{275}	0.932	-172.29	67.43	155.86	5.25	104.02	6.26	86.77
DPY + T_{305}	0.908	-173.59	84.70	175.54	6.08	71.94	7.34	82.34

* Correlation and regression coefficients were significant ($p < 0.01$).

Table 3: Regression analysis based on monthly test-day milk yield for prediction of SLMY*

Test day Yield	*Trait (variable)*				*Intercept*		*b value*		
	N	*Mean*	*SE*	*r value*	*Mean*	*SE*	*Mean*	*SE*	R^2 %
T_5	300	8.93	0.18	0.647	1148.12	88.82	137.90	9.41	41.70
T_{35}	300	10.60	0.18	0.672	888.34	99.26	140.74	8.99	44.97
T_{65}	300	10.04	0.17	0.824	551.29	76.05	182.15	7.27	67.71
T_{95}	300	9.57	0.16	0.833	473.60	76.22	199.30	7.66	69.31
T_{125}	299	8.74	0.16	0.880	558.71	60.01	208.99	6.56	77.31
T_{155}	299	8.10	0.15	0.883	547.91	59.24	226.92	6.99	77.96
T_{185}	298	7.52	0.15	0.881	751.29	54.20	217.98	6.82	77.48
T_{215}	295	6.75	0.15	0.835	1010.96	57.22	205.84	7.92	69.67
T_{245}	285	6.04	0.15	0.751	1281.71	64.70	189.52	9.92	56.19
T_{275}	262	5.40	0.14	0.650	1546.87	72.14	169.22	12.27	42.04
T_{305}	221	4.83	0.15	0.395	2000.59	84.93	101.29	15.92	15.22

N = No. of lactations, *Correlation and regression coefficients were significant ($p < 0.01$).

Prediction of SLMY based on Monthly Test Day Yield

Simple Regression

Prediction equations for SLMY based on a single monthly test-day milk yield are presented in Table 3. Equations with a sum-up of T_5 to T_{305} at monthly interval covered 97.62% variation. The r-value (0.647 to 0.883) and R^2 value (42 to 78%) increased in ascending and mid-lactation phase, from initial record of T_5 to T_{185}, *i.e.,* up to the 6 months. Then-after, with advancement of lactation, the association reduced (r= 0.881 to 0.395) and R^2 =78 to 15 %). Thus, test day recording at 4, 5, and 6th months (T_{125}, T_{155}, and T_{185}) accounted for 77 to 78 % variation in SLMY. Kong *et al.* (2018) observed that 6 test day monthly records were more accurate than 3 test day monthly records for predicting 305-day milk yield in Holstein cattle.

Multiple Regression using Two or More Variables

Information on correlation and multiple regression analysis with monthly two and three test days for prediction of SLMY of Gir cattle are detailed in Table 4 and 5, respectively. Combining test day milk yield T_5 with T_{155} or T_{185} showed an association by r=0.914, resulting in around 83% coefficient of determination for prediction of SLMY. Use of test day milk yield T_{35} along with T_{185} or T_{215} or T_{245} showed a correlation coefficient of 0.924 and covered 84 to 85% variation in SLMY. An equation involving test day milk yield T_{65} with T_{185} or T_{215} or T_{245} showed an association of r=0.938 to 0.943, accounting for 88 to 90% variation in SLMY. Use of test day milk yield T_{95} along with T_{155} or T_{185} or T_{215} or T_{245} or T_{275} also gave a correlation of 0.920 to 0.940, but slightly lower accuracy of 84 to 88%. Combining test day milk yield T_{125} with T_{185} or T_{215} or T_{245} or T_{275} showed r-value of around 0.948, covering 87 to 90% variation in SLMY. Use of test day milk yield T_{155} along with T_{185} or T_{215} or T_{245} or T_{275} also gave a correlation of .915 to 0.925, but slightly lower accuracy of 84 to 85%.

Regression with milk yield of first three consecutive test days (T_5+T_{35} + T_{65}) or T_{35} + T_{65} + T_{95} showed an association

Table 4: Multiple regression analysis using two test days for prediction of SLMY in Gir cows*

Test day Yield	*r value*	*Intercept*		*b1 value*		*b2 value*		
		Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	R^2 %
T_5+T_{35}	0.723	738.54	95.49	76.28	11.49	90.58	11.30	51.91
T_5+T_{65}	0.834	476.01	76.28	37.82	9.14	156.00	9.49	69.37
T_5+T_{95}	0.849	375.46	75.33	44.22	8.37	168.26	9.40	71.85
T_5+T_{125}	0.894	424.88	60.74	41.47	6.79	181.83	7.62	79.78
T_5+T_{155}	0.910	340.89	57.48	53.57	5.98	193.27	7.25	82.60
T_5+T_{185}	0.914	476.13	53.75	58.62	5.71	184.66	6.70	83.36
T_5+T_{215}	0.885	648.30	59.32	68.39	6.41	168.62	7.58	78.10
T_5+T_{245}	0.860	670.19	66.80	91.30	6.61	154.19	8.09	73.79
T_5+T_{275}	0.816	793.52	77.73	104.37	7.61	134.81	9.68	66.30
T_5+T_{305}	0.755	925.28	95.96	125.53	8.67	92.83	11.41	56.59
$T_{35}+T_{65}$	0.825	520.27	80.07	13.67	11.12	170.81	11.74	67.77
$T_{35}+T_{95}$	0.840	385.89	79.35	31.85	9.48	173.18	10.83	70.34
$T_{35}+T_{125}$	0.888	430.55	64.84	33.70	7.53	182.81	8.64	78.67
$T_{35}+T_{155}$	0.902	332.28	61.92	48.11	6.54	190.61	8.11	81.31
$T_{35}+T_{185}$	0.924	345.22	54.27	66.73	5.28	177.87	6.35	85.34
$T_{35}+T_{215}$	0.921	377.92	55.27	85.96	5.08	164.45	6.14	84.64
$T_{35}+T_{245}$	0.919	314.97	57.93	108.86	4.84	157.78	6.11	84.25
$T_{35}+T_{275}$	0.889	393.87	69.49	121.98	5.73	144.10	7.50	78.85
$T_{35}+T_{305}$	0.833	451.34	94.48	140.44	7.19	118.79	9.66	69.03
$T_{65}+T_{95}$	0.867	334.99	70.92	94.03	11.42	115.10	12.35	74.93
$T_{65}+T_{125}$	0.904	359.52	58.93	74.46	8.83	146.07	9.51	81.64
$T_{65}+T_{155}$	0.922	271.84	54.22	84.30	7.14	156.27	8.31	84.97
$T_{65}+T_{185}$	0.938	322.62	48.09	93.45	5.87	149.68	6.60	87.84
$T_{65}+T_{215}$	0.943	330.96	45.97	113.80	5.05	136.29	5.70	88.87
$T_{65}+T_{245}$	0.948	309.09	44.64	135.29	4.43	124.00	5.25	89.78
$T_{65}+T_{275}$	0.928	378.69	54.09	149.38	5.22	106.08	6.42	86.00
$T_{65}+T_{305}$	0.901	417.62	70.24	167.98	6.11	78.75	7.59	80.95
$T_{95}+T_{125}$	0.895	394.22	62.10	72.81	11.50	147.95	11.44	79.95
$T_{95}+T_{155}$	0.920	264.35	55.74	91.86	8.18	153.19	8.80	84.49
$T_{95}+T_{185}$	0.932	337.02	50.57	100.93	7.01	144.33	7.31	86.74
$T_{95}+T_{215}$	0.940	331.11	47.43	124.94	5.78	128.86	6.07	88.31
$T_{95}+T_{245}$	0.938	312.60	49.12	144.90	5.31	118.36	5.82	87.93
$T_{95}+T_{275}$	0.934	280.13	54.02	167.58	5.55	103.76	6.18	87.12
$T_{95}+T_{305}$	0.906	296.05	71.81	187.19	6.60	77.90	7.41	81.84
$T_{125}+T_{155}$	0.918	398.93	52.09	110.72	10.23	125.80	11.07	84.15
$T_{125}+T_{185}$	0.936	438.64	45.32	117.50	7.65	122.81	8.02	87.44
$T_{125}+T_{215}$	0.941	470.32	42.90	139.35	6.34	105.03	6.68	88.54
$T_{125}+T_{245}$	0.948	458.70	41.28	156.95	5.14	96.64	5.67	89.78
$T_{125}+T_{275}$	0.939	494.66	46.54	171.41	5.40	83.09	6.18	88.11
$T_{125}+T_{305}$	0.918	515.69	60.58	188.74	6.12	61.23	7.01	84.12
$T_{155}+T_{185}$	0.918	497.89	50.75	124.15	11.06	117.59	10.62	84.16
$T_{155}+T_{215}$	0.925	472.75	49.74	154.21	8.63	98.88	8.11	85.47
$T_{155}+T_{245}$	0.924	456.12	51.21	175.86	7.43	86.44	7.21	85.28
$T_{155}+T_{275}$	0.919	471.22	56.88	193.74	7.55	71.03	7.57	83.56
$T_{155}+T_{305}$	0.893	419.86	73.11	217.67	8.27	51.86	8.03	79.60

* Correlation and regression coefficients were significant ($p < 0.01$)

Table 5: Multiple regression analysis for prediction of SLMY in Gir cows*

		Intercept		*b1 value*		*b2 value*		*b3 value*		R^2 %
Test day yield	*r value*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	
$T_5 + T_{35} + T_{65}$	0.834	476.92	78.96	37.96	9.65	-0.52	11.44	156.34	12.04	69.26
$T_{35} + T_{65} + T_{95}$	0.867	342.77	73.29	-4.30	10.01	96.79	13.12	116.16	12.61	74.86
$T_{65} + T_{95} + T_{125}$	0.907	316.05	60.12	60.28	10.01	36.03	12.47	127.84	11.32	82.08
$T_{95} + T_{125} + T_{155}$	0.928	273.68	53.16	59.79	9.71	66.63	12.01	118.07	10.51	85.91
$T_{125} + T_{155} + T_{185}$	0.940	391.16	44.83	92.69	9.02	55.61	11.61	97.94	9.32	88.31
$T_{155} + T_{185} + T_{215}$	0.933	449.64	47.31	117.08	10.36	69.38	11.88	69.27	9.21	86.95
$T_{185} + T_{215} + T_{245}$	0.909	649.53	51.34	145.29	10.98	65.23	12.62	35.62	10.51	82.44
$T_{215} + T_{245} + T_{275}$	0.856	894.75	61.96	152.27	13.73	72.80	16.83	6.94	13.58	73.02
$T_{245} + T_{275} + T_{305}$	0.790	1111.12	78.45	167.15	17.81	116.82	22.42	-81.49	16.41	61.96

* Correlation and regression coefficients were significant ($p < 0.01$)

by r=0.834 to 0.867, covered 69 to 75% variation in SLMY. An equation involving milk yield of three consecutive monthly test days, at mid-and late lactations (starting at T_{95} to T_{215}), showed a correlation of r=0.928 to 0.940 with a coefficient of 86 to 88% for predicting SLMY. Singh and Tailor (2013) reported accuracy of prediction of lactation milk yield of 85.50% using 6th, 10th, and 14th fortnightly part yield. Thus, their findings also emphasized the importance of milk recording during mid and late lactation, confirming the present study results. In a study in Kankrej cattle, Sah *et al.* (2013) observed that prediction of lactation milk yield based on 125, 155, 185, and 215th days was quite useful and reliable with more than 66% accuracy.

Conclusions

The present study's findings tended to indicate that (sum up of) all weekly interval M and E or all fortnightly interval M and E recordings can be used to estimate SLMY with a maximum of 99.2 to 99.7% precision. Equations with a sum-up of T_5 to T_{305} at monthly intervals produced 97.62% accuracy in the prediction of SLMY. Test day records at mid-and late lactations, *i.e.,* 4, 5, and 6th month, alone or combining consecutive two or three variables and even test day records from 5th to 9th month with daily peak yield are important in determining the SLMY, emphasizing the significance of persistency of lactation.

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