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TEST-DAY AND OTHER MILK RECORDING OPTIONS FOR PREDICTION OF LACTATION MILK YIELD IN JAFFARABADI (*BUBALUS BUBALIS*) BUFFALOES

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ABSTRACT

Generally, standard lactation milk yield is predicted based on test-day records collected at monthly intervals. Test-day milk production at different time intervals other than monthly intervals can be used to predict lactation milk yield of field bovines in field conditions. With the same possibility, this study was carried out to predict lactation milk yield in Jaffarabadi buffaloes from various test-day milk yield data retrieved for different time intervals. A total of 1,15,339 daily milk yield records in 176 lactations of 1st to 6th parity of 30 Jaffarabadi buffaloes lactating at the Cattle Breeding Farm, Kamdhenu University, Junagadh, Gujarat over a period of 28 years (1991 to 2018) were used for the study. Single monthly test-day milk yield recorded on 125th, 155th or 185th day *i.e.*, 5th, 6th and 7th monthly test day yield alone provided only 50% reliability in determining the standard lactation milk yield. Daily peak yield alone was also found to be a poor predictor for lactation yield. Prediction equations using combination of consecutive two monthly test day yields from 4th to 10th monthly test day were found reliable source for prediction of lactation milk yield providing accuracy up to 82.19% whereas, daily peak yield in combination with single monthly test day yield at mid and late lactation was also predicted lactation milk yield with accuracies up to 72.23%. Milk production recorded at weekly interval could also be used to approximate milk production using the equation 15.35+6.91 × Sum of all weekly test-day yields, with precision of 98.93% or milk production recorded at fortnightly interval by the equation 18.04+14.65 × Sum of fortnightly test-day yields, with precision of 97.14%.

Keywords: *Bubalus bubalis*, alternate milk recordings, estimation of lactation yield, Jaffarabadi buffalo, peak yield, Test-day milk yield

INTRODUCTION

Exact milk production details of dairy bovines are important for taking managerial decisions as regards to its retention or culling from the dairy farm and at the same time it is also important for running a successful progeny testing programme.

Keeping the milk production records for whole lactation is a difficult and phenomenal task because of several reasons, *viz.*, transfer, sale, death or culling of animals, time required and involved

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labour cost, etc. (Sah *et al*., 2013). In India, only the organized farms under Government or University possess the reliable milk production information of dairy animals. But in the field condition, the lactation milk yield information is not traceable and hence practically it is impossible to determine the production potential of field bovines. Different methodologies have been attempted by various workers (Berry *et al*., 2005; Sah *et al*., 2013; Singh and Tailor, 2013) to calculate the lactation milk yield in bovine animals. Jaffarabadi, the heaviest buffalo breed with unique characteristics of heavy body weight and having perhaps maximum milk fat content among the buffalo breeds of the country (Chaudhari *et al*., 2022). This buffalo has its breeding tract in various districts of Saurashtra region of Gujarat, majorly the areas in and around the Gir forest. There is dearth of such information for Jaffarabadi buffalo. Therefore, this study was carried out to approximate/calculate standard lactation milk yield in Jaffarabadi buffalo from test-day milk records collected at different intervals and from different milk recording option.

MATERIALS AND METHODS

A total of 1, 15, 339 daily morning (M) and evening (E) milk yield records of Jaffarabadi buffaloes lactating at the Cattle Breeding Farm, Kamdhenu University, Junagadh, Gujarat over a period of 28 years (1991 to 2018) were used for the study. A normal 176 lactations from 30 Jaffarabadi buffaloes from 1st to 6th parity having lactation length more than 210 days were shorted out and analyzed for the study. Simple and multiple regression analysis for approximating the lactation milk yield on the basis of test day milk yield records at different time intervals with one or more test-day yields as independent variables was performed as follows:

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

Where, , predicted lactation yield,

$\hat{Y}$, intercept value,

a_i, regression coefficient of lactation milk yield (Y) on yield of considered test-day milk yield option (X), and

x_j, independent variables (milk yield of considered test-day milk yield option)

Following formula was used to calculate coefficient of determination (R^2):

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

Simple regression using one dependent and another independent variable and multiple regression using 2 and 3 independent variables were used to analyse the data (Snedecor and Cochran, 1994) and the findings were drawn accordingly.

RESULTS AND DISCUSSIONS

The lactation performance of the Jaffarabadi buffaloes is detailed in Table 1. Significant (P<0.01) correlation was observed between standard lactation milk yield (SLMY) and variables like daily peak milk production, weekly peak milk production and sum-up of milk yield on various test-days considered in this study. Hence equations to predict lactation milk yield were evolved using regression analysis.

SLMY predicted based on milk yields recorded at various milk recording options

Information on correlation and regression analysis for prediction of SLMY based on test-day milk yields at different time intervals is given in Table 2. Equations using the sum of all milk yield records collected at weekly intervals (all Week) as independent variables accounted for 98.93% variation in SLMY. The equation with sum of all milk yield records collected at fortnightly intervals (all Fortnight) as independent variable covered 97.14% variation. Pundir (2016) predicted standard lactation milk yield with 96.3% accuracy in hill cows of Uttarakhand utilizing the first 12 milk yield records collected at fortnightly intervals. Predicting SLMY using sum of either, all morning or all evening or alternate-M or alternate-E or weekly-M or weekly-E as independent variables gave 61.2 to 63.2% reliability of prediction. Using the sum of either all fortnightly-M or all fortnightly-E variables covered around 58.4 to 59.4% variation. Berry *et al.* (2005) predicted standard lactation milk yield using morning and evening milk yield records and observed higher accuracy of prediction using alternate morning and evening milk yield records at every 4 weeks than that of either all morning or all evening milk yield records. Further, they also found that alternate day morning evening recording at every 4 weeks intervals and at every 8 weeks intervals predicted 305-day milk yield with similar accuracies. Singh and Tailor (2013) reported an increase in the accuracy of prediction of lactation milk yield in Surti buffalo when more number of test-day and part records were considered as independent variables. Sangwan *et al.* (2015) reported that odd and even test-day bimonthly recording had coefficient of determination of 55.57 and 64.02%, respectively in predicting first lactation milk yield in Murrah buffaloes. Further, prediction equations using even test-day milk records provide higher accuracy (R^2 = 64.2%) as compared to odd test-day records (R^2 = 55.57%).

SLMY predicted based on daily and weekly peak milk yield

SLMY of Jaffarabadi buffaloes predicted using daily peak yield (DPY) along-with monthly test-day yield records are detailed in the Table 3. Prediction equations for SLMY based on weekly peak yield (WPY) as independent variable covered more variation than using the DPY (51.08 Vs. 35.85% variation in SLMY). Sah *et al.* (2013) predicted the lactation milk yield in Kankrej cows using only peak milk yield records with an accuracy of 49%. Use of daily peak yield records along with test-day milk yield recorded at monthly intervals *i.e.*, T_5 to T_{275} showed an increasing trend of correlation coefficient of 0.60 to 0.86 along with increasing trend of accuracy (R^2 = 36.37 to 74.23%) in prediction of SLMY. Combining daily peak milk yield records along with monthly test-day milk yields, T_{245} or T_{275} showed an association by r = 0.85 to 0.86 and covered a maximum of 72.34 to 74.23% variation in SLMY.

SLMY predicted based on monthly test day milk yield

Simple regression

SLMY predicted based on single monthly test-day milk production record is detailed in Table 4. Single monthly test-day yield recorded on 125th, 155th or 185th day i.e., 5th, 6th and 7th monthly test day yield alone accounted only 50 percent reliability in determining the standard lactation milk yield. The r value (0.40 to 0.71) and R^2 value (15.74 to 50.66%) increased during ascending and mid-lactation phases of lactation, from initial record of T_5 to T_{185}, *i.e.,* up to 6th month. With the advancement of lactation, the association was reduced (r= 0.68 to 0.25 and R^2 = 45.99 to 5.44%). Kong *et al.* (2018) predicted 305-day milk yield in Holstein cattle more accurately using monthly test-day 6 records than monthly test-day 3 records.

Multiple regression using two or more variables

Multiple regression and correlation analysis using monthly intervals two and three test-day records for prediction of SLMY of Jaffarabadi buffaloes is detailed in Table 5 and 6, respectively. Combining test-day milk yield T_5 with T_{155} or T_{185} or T_{215} or T_{245} showed an association by r = 0.75 to 0.78, resulting in around 56.79 to 61.01% 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} or T_{275} showed correlation coefficient of 0.84 to 0.85 and covered 71.07 to 72.92% variation in predicting SLMY. Equations using test-day milk yield T_{65} with T_{185} or T_{215} or T_{245} or T_{275} showed an association of r=0.82 to 0.84, accounting for 68.0 to 71.79% variation in predicting SLMY. Test-day milk yield T_{95} along with T_{245} or T_{275} showed a higher correlation of 0.89 to 0.91, with precision of 79.13 to 82.19%. Combining test-day milk yield T_{125} with T_{245} or T_{275} showed an association by r = 0.87, covering 75% variation in SLMY. Using test-day milk yield T_{155} along with T_{245} or T_{275} or T_{305} also gave correlation of 0.85 to 0.86 and accuracy of 72.54 to 73.22%. Singh and Tailor (2013) reported 85.50% accuracy for prediction of lactation milk yield in Surti buffaloes using 6^{th}, 10^{th} and 14^{th} fortnightly test-day yield. They also found that when two fortnightly test records were taken, the best multiple regression equations were found to be those utilizing 4^{th} and 10^{th} fortnightly test records under systematic sampling, the accuracy of prediction being 69.70%.

Prediction equation incorporating milk yield of consecutive three test-days at monthly intervals in mid and late lactation, T_{95} to T_{245}, i.e., 3 to 8 months showed a correlation of r = 0.80 to 0.84 with coefficient of determination 63.90 to 69.68% for predicting SLMY. Combining consecutive three test-day milk yield during early phase or very late lactation showed comparatively lower association (r = 0.61 to 0.76) and only covered 36.17 to 58.38% variation. Dass and Sadana (2003) predicted first lactation 305-day lactation milk yield with 89% accuracy (R^2) in Murrah buffaloes using test-day yields taken from 2^{nd}, 4^{th}, 6^{th} and 8^{th} month of lactation and reported that the accuracy increased substantially only up to four test-day yields thereafter increase in accuracy was negligible. Thus, their findings also emphasized the importance of mid and late lactation milk recording, confirming the results of present study. Singh and Rana (2008) reported that the accuracy of prediction (R^2) of 305-day milk yield based on monthly test-day milk yields varied between 42 (TDY- 1^{st}) and 67% (TDY-6^{th}). They also concluded that the third, sixth and ninth test-day milk yield should be pooled for prediction of the 305-day milk yield with accuracy of 91% in Murrah buffaloes. In a study in Kankrej cows, Singh and Tailor (2013) reported that when 3 test records were considered for prediction of lactation milk yield in Surti buffalo, the best equations involved 4^{th}, 10^{th} and 14^{th} fortnightly test records under systematic sampling, accuracy of prediction being 77.50%. Sah *et al.* (2013) observed that prediction of lactation milk yield based on 125^{th}, 155^{th}, 185^{th} and 215^{th} day was quite useful and reliable with more than 66% accuracy.

Thus, findings of present study tended to indicate that (sum up of) all test-day records at weekly interval or at fortnightly interval can be used to estimate SLMY with maximum of 97.14 to 98.93% accuracy. Equations with sum-up of T_5 to T_{305} at monthly intervals produced 95.30% accuracy in prediction of SLMY. Test-day records at mid- and late lactations *i.e.,* 4^{th}, 5^{th} and 6^{th}

Table 1. The overall lactation (n=176) performance of the Jaffarabadi buffaloes.

Sr. No.	Traits	Mean±SE
1	Lactation days	325.90±5.53
2	Total lactation milk yield, lit	2009.31±42.13
3	Standard lactation milk yield, lit	1872.61±32.88
4	Daily peak yield (DPY), lit	11.27±0.20
5	Days to attain DPY	102.00±4.68
6	Weekly peak yield (WPY), lit	64.79±1.09
7	Weeks to attain WPY	13.72±0.64

Table 2. Regression analysis on different milk recording options for prediction of SLMY*.

Trait (variable)	Milk yield			r value	Intercept		b value		R^2 %
	N	Mean	SE		Mean	SE	Mean	SE	
DPY	176	11.27	0.20	0.5988	748.80	116.98	99.73	10.11	35.85
WPY	176	64.79	1.09	0.7147	476.71	106.11	21.55	1.60	51.08
all Morning	176	986.10	20.65	0.7854	639.47	76.45	1.25	0.07	61.69
all Evening	176	885.97	20.99	0.7928	772.16	67.21	1.24	0.07	62.85
alt Morning	176	493.38	10.32	0.7830	642.17	76.89	2.49	0.15	61.31
alt Evening	176	444.89	10.49	0.7952	763.61	67.14	2.49	0.14	63.24
all W M	176	140.96	2.98	0.7823	656.23	76.24	8.63	0.52	61.20
all W E	176	127.99	3.01	0.7897	769.05	68.06	8.62	0.51	62.37
all Week	176	268.95	4.74	0.9946	15.35	15.07	6.91	0.05	98.93
all Fort M	176	66.11	1.41	0.7639	695.28	78.35	17.81	1.14	58.35
all Fort E	176	60.51	1.43	0.7710	800.68	70.34	17.71	1.11	59.44
all Fortnight	176	126.62	2.21	0.9856	18.04	24.78	14.65	0.19	97.14
T5 to T305	93	70.48	1.60	0.9765	65.34	46.09	27.60	0.64	95.30

M/E = morning/evening, W/Fort. = weekly/fortnightly, T = Test-day

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

Table 3. Multiple regression analysis with daily peak yield and test-day yield for prediction of SLMY in Jaffarabadi buffaloes*

Peak yield and test-day (variables)	r value	Intercept		b1 value		b2 value		R^2 %
		Mean	SE	Mean	SE	Mean	SE	
DPY+T_{5}	0.6091	752.74	116.19	88.64	11.70	24.29	13.14	36.37
DPY+T_{35}	0.6198	748.47	114.95	72.42	14.23	40.18	14.99	37.70
DPY+T_{65}	0.6342	718.32	113.58	62.78	14.28	56.87	16.00	39.53
DPY+T_{95}	0.7130	636.85	103.85	40.39	12.07	99.68	13.73	50.27
DPY+T_{125}	0.7517	400.34	103.61	52.23	10.51	116.54	14.01	56.00
DPY+T_{155}	0.7782	417.78	95.82	62.50	9.68	106.94	12.43	60.10
DPY+T_{185}	0.8234	281.34	89.63	75.43	7.96	116.82	10.56	67.42
DPY+T_{215}	0.8306	290.82	87.58	84.28	7.65	111.08	10.30	68.61
DPY+T_{245}	0.8527	380.56	82.99	90.03	7.48	103.32	9.46	72.34
DPY+T_{275}	0.8640	384.68	88.89	105.91	7.53	88.39	9.62	74.23
DPY+T_{305}	0.8352	267.94	124.81	137.77	10.04	55.75	12.99	69.08

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

Table 4. Regression analysis based on test-day milk yield at monthly interval for prediction of SLMY*.

Test-day (variable)	Milk yield			r value	Intercept		b value		R^2 %
	N	Mean	SE		Mean	SE	Mean	SE	
T_{5}	176	4.98	0.18	0.4027	1497.29	71.36	75.33	12.98	15.74
T_{35}	176	7.67	0.19	0.5403	1145.92	90.17	94.79	11.19	28.79
T_{65}	176	7.86	0.18	0.5791	1023.48	94.52	108.08	11.53	33.16
T_{95}	176	7.83	0.17	0.6903	848.32	84.80	130.78	10.39	47.36
T_{125}	175	7.63	0.15	0.7089	669.65	94.18	158.21	11.97	49.97
T_{155}	174	7.13	0.15	0.7138	794.77	84.49	152.36	11.40	50.66
T_{185}	172	6.51	0.15	0.7119	860.87	80.91	157.46	11.92	50.38
T_{215}	169	5.96	0.15	0.6803	991.62	79.04	151.47	12.63	45.96
T_{245}	153	5.27	0.16	0.6807	1176.11	70.12	142.03	12.44	45.99
T_{275}	122	4.74	0.18	0.5703	1432.74	78.74	116.30	15.29	31.97
T_{305}	93	4.14	0.20	0.2544	1774.45	103.83	56.99	22.71	5.44

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

Table 5. Multiple regression analysis using two test-days at monthly intervals for prediction of SLMY in Jaffarabadi buffaloes*.

Test-day (variables)	r value	Intercept		b1 value		b2 value		R^2 %
		Mean	SE	Mean	SE	Mean	SE	
T_5+T_{35}	0.5505	1127.46	90.41	24.36	14.67	81.36	13.76	29.50
T_5+T_{65}	0.5856	1013.70	94.51	19.80	14.06	96.77	14.03	33.53
T_5+T_{95}	0.6996	812.30	85.75	23.57	11.29	120.39	11.43	48.35
T_5+T_{125}	0.7319	598.03	93.51	35.82	10.22	144.19	12.27	53.03
T_5+T_{155}	0.7569	655.06	83.79	47.72	9.47	138.67	11.01	56.79
T_5+T_{185}	0.7840	618.94	79.88	60.40	8.78	148.49	10.64	61.01
T_5+T_{215}	0.7493	780.82	79.51	57.69	9.44	138.91	11.63	55.61
T_5+T_{245}	0.7592	944.90	72.42	61.34	9.70	129.31	11.27	57.07
T_5+T_{275}	0.6937	1137.43	85.13	69.84	11.68	106.65	13.56	47.25
T_5+T_{305}	0.5459	1199.21	138.73	108.01	19.75	70.18	19.93	28.24
$T_{35}+T_{65}$	0.6099	936.96	96.09	46.72	14.71	73.50	15.65	36.47
$T_{35}+T_{95}$	0.7060	766.99	88.37	32.84	11.96	109.02	12.92	49.26
$T_{35}+T_{125}$	0.7530	516.94	93.16	50.94	10.07	127.19	12.77	56.19
$T_{35}+T_{155}$	0.7920	538.76	81.65	68.89	9.37	114.88	11.19	62.30
$T_{35}+T_{185}$	0.8464	408.77	73.64	85.67	7.67	127.33	9.46	71.30
$T_{35}+T_{215}$	0.8555	426.92	71.06	94.38	7.31	126.38	9.16	72.87
$T_{35}+T_{245}$	0.8560	603.70	68.06	95.47	7.76	114.64	9.08	72.92
$T_{35}+T_{275}$	0.8459	691.59	77.47	108.74	8.51	100.78	10.04	71.07
$T_{35}+T_{305}$	0.7547	808.57	117.71	130.06	12.66	55.80	15.50	56.00
$T_{65}+T_{95}$	0.6984	789.89	89.37	29.06	14.98	109.10	15.21	48.18
$T_{65}+T_{125}$	0.7412	548.39	94.36	50.10	11.85	122.60	14.19	54.41
$T_{65}+T_{155}$	0.7778	536.94	85.96	63.90	9.94	118.26	11.55	60.04
$T_{65}+T_{185}$	0.8269	421.63	79.13	80.32	8.26	128.47	10.02	68.00
$T_{65}+T_{215}$	0.8292	461.72	77.50	88.76	8.12	124.07	9.98	68.38
$T_{65}+T_{245}$	0.8495	578.66	71.64	97.71	8.28	112.53	9.33	71.79
$T_{65}+T_{275}$	0.8388	680.72	80.44	111.14	9.02	94.69	10.33	69.86
$T_{65}+T_{305}$	0.7820	654.42	120.12	146.38	13.00	58.61	14.72	60.29

Table 5. Multiple regression analysis using two test-days at monthly intervals for prediction of SLMY in Jaffarabadi buffaloes*. (Continue)

Test-day (variables)	r value	Intercept		b1 value		b2 value		R^2 %
		Mean	SE	Mean	SE	Mean	SE	
$T_{95}+T_{125}$	0.7663	541.25	88.72	74.35	12.52	98.68	14.84	58.23
$T_{95}+T_{155}$	0.7952	508.34	82.56	80.28	10.62	103.85	11.79	62.81
$T_{95}+T_{185}$	0.8379	411.43	76.17	92.03	8.75	115.34	10.11	69.85
$T_{95}+T_{215}$	0.8512	399.93	73.79	101.31	8.07	116.79	9.48	72.11
$T_{95}+T_{245}$	0.9079	377.18	60.78	119.79	6.83	116.31	7.29	82.19
$T_{95}+T_{275}$	0.8915	522.58	70.32	126.10	7.64	100.41	8.52	79.13
$T_{95}+T_{305}$	0.8370	558.12	105.97	148.59	10.75	73.24	12.98	69.40
$T_{125}+T_{155}$	0.7968	462.71	84.97	99.00	12.91	93.08	12.53	63.06
$T_{125}+T_{185}$	0.8245	417.36	80.16	105.49	11.04	101.88	11.25	67.61
$T_{125}+T_{215}$	0.8475	345.43	77.91	118.17	9.63	107.69	9.84	71.49
$T_{125}+T_{245}$	0.8651	417.05	75.58	123.42	9.47	105.38	9.00	74.50
$T_{125}+T_{275}$	0.8675	480.88	81.87	148.05	10.33	76.44	9.71	74.84
$T_{125}+T_{305}$	0.8558	437.74	105.24	181.09	12.08	45.18	12.24	72.65
$T_{155}+T_{185}$	0.7769	636.81	80.68	89.67	13.96	93.50	14.63	59.89
$T_{155}+T_{215}$	0.8030	567.08	79.22	104.46	11.33	96.86	11.88	64.05
$T_{155}+T_{245}$	0.8538	582.24	69.98	120.89	9.97	90.64	9.83	72.54
$T_{155}+T_{275}$	0.8546	597.09	80.03	142.19	10.63	77.88	10.12	72.58
$T_{155}+T_{305}$	0.8591	647.94	92.41	182.41	11.99	14.09	12.41	73.22

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

Table 6. Multiple regression analysis for prediction of SLMY in Jaffarabadi buffaloes*.

Test-day (variables)	r value	Intercept		b1 value		b2 value		b3 value		R^2 %
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	
$T_5+T_{35}+T_{65}$	0.6105	937.88	96.34	6.44	14.55	44.50	15.57	71.46	16.35	36.17
$T_{35}+T_{65}+T_{95}$	0.7073	752.47	90.34	27.96	13.46	13.23	16.69	102.38	15.41	49.15
$T_{65}+T_{95}+T_{125}$	0.7687	518.10	90.46	17.36	13.78	63.43	15.21	95.09	15.08	58.38
$T_{95}+T_{125}+T_{155}$	0.8183	395.58	82.61	51.12	12.09	64.64	14.76	82.77	12.20	66.38
$T_{125}+T_{155}+T_{185}$	0.8380	372.91	78.56	87.84	11.78	47.49	13.39	77.31	12.90	69.68
$T_{155}+T_{185}+T_{215}$	0.8117	542.04	78.47	86.15	13.17	44.91	17.24	73.93	14.62	65.26
$T_{185}+T_{215}+T_{245}$	0.8038	723.49	77.35	96.36	16.14	34.54	16.65	67.02	13.58	63.90
$T_{215}+T_{245}+T_{275}$	0.7437	947.64	90.20	88.58	17.29	76.49	21.26	11.20	19.66	54.18
$T_{245}+T_{275}+T_{305}$	0.6864	1149.04	109.47	131.15	25.64	39.46	30.82	-20.99	21.07	45.33

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

month, alone and 3 to 8 months in combination as consecutive two or three variables and 8th and 9th month test day yield along with peak yield are found important in determining the SLMY.

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