RESEARCH ARTICLE

Prediction of Lactation Milk Yield from Part Yield in Jaffarabadi Buffalo

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Abstract

An attempt was made to predict standard lactation milk yield (SLMY) by simple regression equation from weekly, fortnightly and monthly, individual and cumulative part yield in Jaffarabadi buffalo. A total of 176 normal lactations of Jaffarabadi buffaloes from 1st to 6th parity with lactation length >210 days were analysed. Correlation coefficients between 305-days milk yield (SLMY) and different weekly (1st to 20th week), fortnightly (1st to 5th fortnight) and monthly (1st to 5th month), individual and cumulative part lactations were positive and significant (P < 0.01) and showed increasing trend with advancement of lactation. The reliability of prediction for SLMY was reasonably high, *i.e.,* 63 to 67% for 18th or 19th week, 67 to 68% with 9th or 10th fortnight, and 63 to 67% for 4th or 5th month part lactation yields when used as independent variables. From 20th week, the correlation and accuracy of regression for SLMY reduced. Individual part yields were found to be more reliable than cumulative respective (weekly, fortnightly and monthly) part yields for prediction of SLMY. First 100-days milk yield as part lactation covered only 49% of variation in SLMY in Jaffarabadi buffaloes, which implies that one must be cautious while sire evaluation based on first 100-d yield as part lactation of daughters under progeny testing programmes or determining production potential in terms of LMY based on part lactation of Jaffarabadi buffaloes.

Keywords: Cumulative yield, Jaffarabadi buffalo, Lactation milk yield, Part yield, Prediction.

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Introduction

Estimation of the real performance potential of milch animals is utmost important for taking decision as regards to its own retention or culling in dairy farms and also of daughters of the sires covered under PT programmes. To reduce generation interval, part record, *i.e.,* first 100-days yield of daughters is taken as criterion instead 300-days lactation record. The recording method has to be economical and physically feasible, yet reliable one. To overcome the obstacles of daily milk yield recording, test day records and part yields have been tested for prediction of lactation milk yield in dairy bovines by several researchers (Ranjan *et al.,* 2005; Singh, 2006; Bansal, 2009; Sah *et al.*, 2013; Singh and Tailor, 2013). Jaffarabadi is superior buffalo breed with unique characteristics of heavy body weight and perhaps maximum milk fat content. The breeding tract of these buffaloes lies in Saurashtra region of Gujarat especially areas in and around Gir forest. There is dearth of such study in buffalo. Therefore, an attempt was made to predict standard lactation milk yield from weekly, fortnightly and monthly, individual and cumulative part yield in Jaffarabadi buffalo.

Materials and Methods

The records (n = 1,15,339) on daily morning and evening milk production performance of lactating Jaffarabadi buffaloes at the Cattle Breeding Farm, JAU, Junagadh, Gujarat over a period of 28 years (1991–2018) were used for the study. A total of 176 normal lactations of Jaffarabadi buffaloes (n=30) from 1st to 6th parity with lactation length >210 days were analysed. The data on daily milk production during lactation of each animal were divided into 20 weeks, 10 fortnights and 5 months and used for correlation efficient and regression analysis for prediction of standard lactation milk yield.

Simple regression equation aimed at predicting the standard lactation milk yield (SLMY) based on weekly, fortnightly and monthly, individual and cumulative part yields as independent variables was as follows:

$$\hat{Y} = a + bx$$

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

a, intercept value,

b, regression coefficient of lactation yield (Y) on weekly, fortnightly and monthly, individual or cumulative, part yield (X), and

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x, independent variables (weekly, fortnightly and monthly, individual or cumulative, part yield)

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

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

The data were subjected to simple regression equation taking SLMY as dependent and part yield as independent variable (Snedecor and Cochran, 1994) and the findings were incorporated accordingly.

Results and Discussion

The means ± SE(s) for weekly individual and cumulative milk yields during early- and mid- lactation considered for the study, *i.e.*, for 1st to 20th weeks, as part lactation, are presented, respectively in Table 1 and 2. Average milk yields from 1st to 10th fortnights were 92.90 ± 2.19, 111.57 ± 2.41, 115.07 ± 2.57, 116.36 ± 2.44, 116.75 ± 2.43, 117.28 ± 2.34, 115.57 ± 2.24, 113.38 ± 2.08, 109.64 ± 2.02 and 105.90 ± 1.97 lit., respectively (Table 3), whereas overall monthly milk yield for first 5 months averaged 204.47 ± 4.43, 231.43 ± 4.92, 234.02 ± 4.69, 228.95 ± 4.25 and 215.54 ± 3.90 lit. (Table 5). The standard (305-d) lactation milk yield (SLMY) averaged 1850.50 ± 32.63 lit.

Individual Weekly and Cumulative Weekly Milk Yield for Prediction of SLMY

Regression analysis of weekly milk yield for prediction of standard (305-d) lactation milk yield (SLMY) in Jaffarabadi buffaloes is detailed in Table 1.

The correlation coefficients between SLMY and different weekly (1st to 20th week) part lactations in Jaffarabadi buffalo were significant ($P < 0.01$), positive and ranged from 0.527 for WY1 (1st week) to 0.818 for WY19 (19th week), there after it showed reduced association (r-value) with SLMY. Singh (2006) also reported that association and accuracy of prediction of SLMY based on part milk yields exhibited consistently increasing trend with advancement of lactation. The estimates of phenotypic correlations between SLMY and different weekly part lactations showed a gradually increasing trend from 0.527 for WY1 to 0.818 for WY19. Further, weekly yields, separately till WY8 covered a variation of less than 40% and from WY9 onwards till WY17 covered 61.96% variation in SLMY. The reliability of prediction for SLMY was high, *i.e.*, 66.83% when WY19 part lactation yields were used as independent variable. This could be because part lactation yield in later phase did not vary much and was more correlated with SLMY.

Table 1: Regression analysis of individual weekly milk yield for prediction of SLMY in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	R^2%*
WY1	176	40.28	1.02	0.527	1172.68	87.42	16.83	2.06	27.35
WY2	176	45.74	1.07	0.560	1066.55	92.11	17.14	1.92	30.92
WY3	176	50.21	1.11	0.540	1053.49	98.03	15.87	1.87	28.79
WY4	176	52.92	1.15	0.582	976.19	96.38	16.52	1.75	33.48
WY5	176	53.43	1.21	0.612	968.37	90.13	16.51	1.62	37.14
WY6	176	53.84	1.24	0.570	1040.88	92.40	15.04	1.64	32.14
WY7	176	53.97	1.18	0.632	904.54	91.59	17.53	1.63	39.56
WY8	176	54.36	1.18	0.621	914.01	93.25	17.23	1.65	38.19
WY9	176	54.35	1.17	0.650	864.18	90.77	18.15	1.61	41.98
WY10	176	54.39	1.16	0.660	839.13	90.66	18.60	1.60	43.24
WY11	176	54.87	1.13	0.665	799.27	92.83	19.16	1.63	43.87
WY12	176	54.83	1.08	0.703	685.03	92.34	21.26	1.63	49.14
WY13	176	54.62	1.14	0.726	716.33	84.48	20.76	1.49	52.45
WY14	176	54.27	1.09	0.755	629.40	83.25	22.50	1.48	56.73
WY15	176	53.41	1.03	0.753	577.10	87.08	23.84	1.58	56.45
WY16	176	52.80	1.01	0.779	514.38	83.99	25.30	1.54	60.51
WY17	176	52.99	0.98	0.788	454.68	84.94	26.34	1.56	61.96
WY18	176	52.01	0.98	0.798	470.57	81.55	26.53	1.52	63.40
WY19	176	50.68	0.95	0.819	427.14	77.99	28.08	1.49	66.83
WY20	176	50.05	0.97	0.779	533.15	83.00	26.32	1.61	60.43
WY21	176	49.46	0.92	0.804	443.37	81.13	28.45	1.59	64.52
WY22	176	48.89	0.96	0.806	514.02	76.96	27.34	1.52	64.72

WYi = individual weekly yield in i[th] week,

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

Table 2: Estimates of r and R^2 values for prediction of SLMY based on cumulative weekly milk yield in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	*R^2%**
WY1-2	176	86.02	2.04	0.556	1084.97	90.86	8.90	1.01	30.55
WY1-3	176	136.23	3.06	0.567	1027.04	94.64	6.04	0.67	31.75
WY1-4	176	189.15	4.11	0.585	970.08	96.14	4.65	0.49	33.91
WY1-5	176	242.58	5.22	0.603	935.70	95.43	3.77	0.38	35.98
WY1-6	176	296.43	6.34	0.607	925.20	95.47	3.12	0.31	36.47
WY1-7	176	350.40	7.41	0.620	892.91	95.33	2.73	0.26	38.12
WY1-8	176	404.76	8.45	0.630	866.75	95.45	2.43	0.23	39.30
WY1-9	176	459.10	9.49	0.641	837.75	95.22	2.21	0.20	40.79
WY1-10	176	513.49	10.51	0.652	810.99	94.98	2.02	0.18	42.16
WY1-11	176	568.36	11.52	0.660	787.78	94.95	1.87	0.16	43.23
WY1-12	176	623.19	12.46	0.671	755.95	94.89	1.76	0.15	44.68
WY1-13	176	677.81	13.45	0.683	726.95	94.12	1.66	0.13	46.37
WY1-14	176	732.08	14.39	0.696	695.11	93.37	1.58	0.12	48.14
First 100-d	176	747.35	14.63	0.699	684.82	93.30	1.56	0.12	48.62
WY1-15	176	785.50	15.23	0.708	658.50	92.95	1.52	0.11	49.90
WY1-16	176	838.30	16.04	0.722	619.48	92.33	1.47	0.11	51.81
WY1-17	176	891.30	16.81	0.734	579.81	91.76	1.43	0.10	53.67
WY1-18	176	943.31	17.55	0.748	538.73	90.89	1.39	0.09	55.69
WY1-19	176	993.99	18.27	0.761	498.99	89.83	1.36	0.09	57.70
WY1-20	176	1044.04	18.97	0.773	462.24	88.88	1.33	0.08	59.50

WY1-i = cumulative weekly yield from 1st week till ith week
*Correlation and regression coefficients, significant (P < 0.01)

Table 3: Regression analysis of individual fortnightly milk yield for prediction of SLMY in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	*R^2%**
FNY1	176	92.90	2.19	0.556	1079.81	91.48	8.30	0.94	30.52
FNY2	176	111.57	2.41	0.579	975.91	97.01	7.84	0.84	33.19
FNY3	176	115.07	2.57	0.611	956.17	91.58	7.77	0.76	36.97
FNY4	176	116.36	2.44	0.647	842.27	93.45	8.66	0.77	41.54
FNY5	176	116.75	2.43	0.672	796.65	91.28	9.03	0.75	44.86
FNY6	176	117.28	2.34	0.722	667.65	88.88	10.09	0.73	51.84
FNY7	176	115.57	2.24	0.765	564.50	84.85	11.13	0.71	58.22
FNY8	176	113.38	2.08	0.800	423.94	83.34	12.58	0.71	63.85
FNY9	176	109.64	2.02	0.825	390.26	77.99	13.32	0.69	67.92
FNY10	176	105.90	1.97	0.819	412.47	78.68	13.58	0.72	66.87

FNYi = individual fortnightly yield in ith fortnight,
*Correlation and regression coefficients, P < 0.01

Trend of correlation (r) and coefficient of determination (R^2) values on progressively extended cumulative weekly (part) lactation milk yield in predicting SLMY in Jaffarabadi buffalo is presented in Table 2.

The phenotypic correlations between SLMY and different cumulative weekly part lactation milk yields were positive and ranged from 0.556 for WY1-2 to 0.772 for WY1-20 (P < 0.01). The estimates of phenotypic correlations between SLMY and different weekly part lactations increased from 0.556 to 0.629 from WY1-2 till WY1-8 and almost static 0.641 to 0.696 from WY1-9 to WY1-14 and again increased from 0.708 to 0.772 for W1-20. As addition of weekly yield after 6th week till 14th week did not contribute much towards variability in SLMY, the phenotypic correlation between SLMY and weekly part lactation milk yield from WY1-9 to WY1-14 remains static. Thus, in present study part lactation yield till WY1-12

in Jaffarabadi buffalo could cover 44.68% of variation in the SLMY, whereas WY1-20 showed higher correlation of 0.772 and prediction reliability close to 60% for SLMY.

Thus, it is noteworthy that weekly yield in 18th and 19th week alone was found more reliable and sufficient in predicting SLMY with acceptable R^2 value of 63.40-66.83%, rather than cumulative WY1-19 or WY1-20 (R^2 57.70 to 59.50%).

Individual Fortnightly and Cumulative Fortnightly Milk Yield for Prediction of SLMY

Regression analysis of fortnightly milk yield for prediction of standard lactation milk yield in Jaffarabadi buffaloes is detailed in Table 3.

The coefficients of correlations between SLMY and different fortnightly (1st to 10th fortnight) part lactations in Jaffarabadi buffalo were positive ($p < 0.01$) and varied from 0.556 for FNY1 (1st fortnight) to 0.825 for FNY9 (9th fortnight). The correlation coefficients between SLMY and first fortnight part lactation was 0.556, R^2 value being 30.55% in the present study on Jaffarabadi buffalo, which explained least share of total variation in SLMY. Singh and Tailor (2013) in Surti buffaloes, in relation to part lactation records, also found low R^2 values for prediction of lactation milk yield when first and second fortnight (21.5 to 39%) were used.

The correlation coefficient values between SLMY and different fortnightly part lactations gradually increased with advancement of lactation, the r-values being 0.556 to 0.579 for FNY1 and FNY2, 0.611 to 0.672 for FNY3 and FNY5, 0.721 to 0.764 for FNY6 and FNY7 and 0.80 to 0.825 for FNY8 and FNY9. The SLMY could be estimated with quiet high accuracy of 66.87 to 67.92% by incorporating FNY9 (9th fortnight) and FNY10 (10th fortnight) as independent variable in the prediction equation indicated a greater contribution of FNY9 and FNY10 in total variation in SLMY. Our results support the findings of Nagarcenkar and Basvaiah (1981), who reported that a single part record during 11th fortnight was best predictor for lactation milk yield in Murrah buffaloes. Singh and Tailor (2013) reported quite more accuracy, 52 to 55%, for 6th and 7th fortnight indicating a greater part of total variation in SLMY of Surti buffaloes. Our findings for 6th and 7th fortnight yield (R^2, 51.84 to 58.22%) agreed with these results. Saigaonkar *et al.* (1981) also found the significance of 6th and 8th fortnight, revealing slightly higher accuracy (76%) of prediction of 26 fortnights' milk yield in Sahiwal cattle.

Trend of correlation (r) and coefficient of determination (R^2) values on progressively extended cumulative fortnightly (part) lactation milk yield for prediction of SLMY of Jaffarabadi buffalo is furnished in Table 4.

Correlation coefficients between SLMY and different cumulative fortnightly (part) lactation milk yield were positive ($P < 0.01$) and ranged from 0.589 for FNY1-2 (cumulative first two fortnights) to 0.791 for FNY1-10. The estimates of phenotypic correlations between SLMY and different fortnightly cumulative part lactations increased from 0.589 to 0.636 for FNY1-2 to FNY1-4, 0.658 to 0.736 for FNY1-5 to FNY1-8 and 0.764 to 0.791 for FNY1-9 to FNY1-10. Part lactation yield FNY1-8 (till 8th fortnight) in Jaffarabadi buffalo could cover about 53.97% of variation in the SLMY, whereas FNY1-9 and FNY1-10 showed a higher prediction determination value of 58.17 to 62.37% for SLMY.

It could be noticed from the above results that, part fortnightly yield in 9th and 10th fortnight alone was found more reliable and sufficient in predicting SLMY with acceptable R^2 value of 66.87-67.92%, rather than cumulative FNY1-9 or FNY1-10 (R^2 58.17 to 62.37%)

Individual Monthly and Cumulative Monthly Milk Yield for Prediction of SLMY

Regression analysis of first to fifth monthly (part) lactation milk yield for prediction of SLMY in Jaffarabadi buffaloes is detailed in Table 5. Phenotypic correlations between SLMY and different monthly lactation milk yield were positive ($P < 0.01$). The correlation of SLMY was 0.589 for MTY1 (1st month), accuracy of prediction being only 34.4%, which

Table 4: Estimates of r and R^2 values for prediction of SLMY based on cumulative fortnightly milk yield in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	*R^2%**
FNY1-2	176	204.47	4.43	0.590	962.58	95.90	4.34	0.45	34.40
FNY1-3	176	319.54	6.82	0.613	913.13	95.15	2.93	0.29	37.23
FNY1-4	176	435.90	9.04	0.637	848.49	95.36	2.30	0.21	40.22
FNY1-5	176	552.65	11.23	0.658	793.68	94.91	1.91	0.17	42.99
FNY1-6	176	669.93	13.31	0.682	729.86	94.16	1.67	0.14	46.22
FNY1-7	176	785.50	15.23	0.708	658.50	92.95	1.52	0.11	49.90
FNY1-8	176	898.88	16.91	0.736	573.10	91.68	1.42	0.10	53.97
FNY1-9	176	1008.51	18.48	0.764	489.36	89.60	1.35	0.09	58.17
FNY1-10	176	1114.42	19.89	0.791	403.82	87.12	1.30	0.08	62.37

FNY1-i = cumulative fortnightly milk yield from 1st till ith fortnight,
*Correlation and regression coefficients, significant ($P < 0.01$).

Table 5: Regression analysis of individual monthly milk yield for prediction of SLMY in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	*R^2%**
MTY1	176	204.47	4.43	0.590	962.58	95.90	4.34	0.45	34.40
MTY2	176	231.43	4.92	0.640	867.96	92.99	4.25	0.39	40.57
MTY3	176	234.02	4.69	0.708	696.04	90.21	4.93	0.37	49.89
MTY4	176	228.95	4.25	0.795	450.95	83.30	6.11	0.35	63.02
MTY5	176	215.54	3.90	0.841	334.38	76.07	7.03	0.34	70.54

MTYi = individual monthly yield in i^{th} month,
*Correlation and regression coefficients, $P < 0.01$

Table 6: Estimates of r and R^2 values for prediction of SLMY based on cumulative monthly milk yield in Jaffarabadi buffaloes

	Trait (variable)				*Intercept*		*b value*		
Trait (variable)	*n*	*Mean*	*SE*	*r value**	*Mean*	*SE*	*Mean*	*SE*	*R^2%**
MTY1-2	176	435.90	9.04	0.637	848.49	95.36	2.30	0.21	40.22
MTY1-3	176	669.93	13.31	0.682	729.86	94.16	1.67	0.14	46.22
MTY1-4	176	898.88	16.91	0.736	573.10	91.68	1.42	0.10	53.97
MTY1-5	176	1114.42	19.89	0.791	403.82	87.12	1.30	0.08	62.37

MTY1-i = cumulative monthly yield from 1^{st} to i^{th} month,
*Correlation and regression coefficients, significant ($P < 0.01$).

gradually increased to 0.84 with R^2 value of 70.54% for 5^{th} month. These results on importance of 4^{th} and 5^{th} month of milk yield in estimating SLMY were in accordance with findings of Ranjan *et al.* (2005), who obtained highest R^2 value (58.41%) for 3^{rd} month followed by 5^{th} (57.97%) and 4^{th} (50.48%) month milk yields, while constructing prediction of SLMY in Sahiwal cows. Sah *et al*. (2013) also opined from their study on Kankrej cattle that milk records of 4^{th} and 5^{th} month along with peak yield are helpful for prediction of LY with high accuracy (75.8%).

Trend of correlation (r) and coefficient of determination (R^2) values on cumulative monthly milk yield for prediction of SLMY of Jaffarabadi buffalo is presented in Table 6.

The correlation values of 0.636 to 0.682 with R^2 value of 40.22 to 46.22% were found when MTY1-2 and MTY1-3 were used as independent variables for estimating SLMY. The SLMY could be predicted with reasonably high accuracy of 53.97 and 62.37%, respectively, incorporating MTY1-4 and MTY1-5 as independent variables in the regression equation. Singh (2006) reported that accuracy of prediction of SLMY based on cumulative part milk yields varied from 51% for 30-days to 89% for 270-day and exhibited consistently increasing trend with advancement of lactation of crossbred cattle. Bansal (2009) evolved prediction equations for LMY in Sahiwal cattle and found that actual 300-d milk yields were very close to predicted values based on 120 days milk yield, hence may be used to select sires with good reliability rather than to wait for 300-days or TLMY. Mundhe *et al.,* (2015) predicted first lactation 305-day milk yield in Sahiwal cows using multiple linear regression analysis and artificial neural network method and found that an optimum equation having 3 part lactations (PL) namely PL2, PL5 and PL8 gave 88.80% accuracy of prediction under multiple linear regression analysis, whereas 89.29% accuracy of prediction under artificial neural network. Singh *et al.,* (2020) predicted first lactation 305DMY in Murrah buffaloes using Bayesian Regularization (BR) algorithm in artificial neural network and achieved accuracy of 78.33% accuracy of prediction with RMSE value of 16.89% for input set consisted of four monthly milk yields record, age at first calving and peak yield.

Thus, it is remarkable that MTY4 alone was found to be more reliable than cumulative MTY1-4 (R^2, 63.02 vs 53.97%). Similarly, MTY5 alone gave more accuracy than cumulative MTY1-5 (R^2, 70.54 vs 62.37%). Therefore, instead cumulative MTY1-4 or MTY1-5 (R^2 53.97 to 62.37%), 4^{th} or 5^{th} month yield alone could be used to predict SLMY with acceptable R^2 value of 63.02-70.54%.

Conclusion

From the findings of the present study on Jaffarabadi buffaloes, it could be inferred that, reliability of prediction for standard lactation milk yield (SLMY) was reasonably high, *i.e.,* 63.4 to 66.83% with 18^{th} or 19^{th} week, 66.87 to 67.92% with 9^{th} or 10^{th} fortnight and 63.02 to 70.54% with 4^{th} or 5^{th} month part lactation yields. From 20^{th} week, the correlation and accuracy of regression for SLMY were reduced. Further, individual part yields were found to be more reliable than cumulative respective (weekly, fortnightly and monthly) part yields for prediction of SLMY. Moreover, the results indicated that, since first 100-days milk yield as part lactation covered only 48.62% of variation in SLMY in Jaffarabadi buffaloes, one has to be cautious while sire evaluation based on first 100-d yield /part lactation of daughters in Progeny Testing programmes or determining production potential in terms

of LMY based on part lactation of Jaffarabadi buffaloes. It would be advisable to consider 4th or 5th month yield alone or 120 to 150-days rather than first 100-days milk yield of the buffalo for better reliability of SLMY.

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ANNOUNCEMENT: SVSBT-NS-2022

IX Annual Convention and National Seminar of SVSBT

The ***IX Annual Convention*** and ***National Seminar*** of The Society for Veterinary Science & Biotechnology ***(SVSBT) on "Recent Biotechnological Advances in Health and Management to Augment Productivity of Livestock and Poultry"*** will be **organized at Ramayanpatti, Tirunelveli - 627 358, Tamil Nadu, during September 22-24, 2022** (Thursday, Friday & Saturday) by Veterinary College & Research Institute, Tirunelveli - 627 358, TANUVAS, (TN). The detailed Brochure cum Invitation showing Theme Areas/ Sessions, Registration Fee, Bank Details for online payment and deadlines, etc. has been floated on the Whats Apps and e-mails. Accordingly, the organizing committee of ***SVSBT NS-2022 invites abstracts*** of original and quality research work on theme areas of seminar limited to 250 words by e-mail on svsbttnns2022@gmail.com or mopandian69@gmail.com latest by 30th August, 2022 for inclusion in the Souvenir cum Compendium to be published on the occasion.

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