STANDARDIZING PREGNANCY RATE OF INDIAN MURRAH BUFFALOES FOR HIGHER MILK YIELD

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ABSTRACT

Study revealed that increase in milk production has lead to decline in fertility performances of Murrah buffaloes. Data pertaining to 1224 lactation records of Murrah buffaloes spread over a period 19 years were analyzed in the study. It was observed that pregnancy rate (fertility) depicted negative phenotypic association with 305 days or less milk yield (-0.08±0.04), wet average (-0.12±0.02) and test day five milk yield (-0.09±0.03). It was observed that to achieve around 2000 kg MY, 7.5 kg WA and 7.7 kg in TD 5 MY, the level of pregnancy rate varied between 30-50%. Under the present study an attempt was made to quantify the decline of fertility with the increase of milk production in Murrah buffaloes. The per unit change in fertility with respect to milk yield in Murrah buffaloes, were studied using multiple regression analysis. Increasing one kilogram milk yield in test day five (125^{th} day) pregnancy rate reduced by about 1.3%, and increase in one kilogram milk yield per day in 305 days or hundred kilogram in 305 days of Murrah buffaloes pregnancy rate reduced by 0.9%.

Keywords: Life time, pregnancy rate, production, productivity, standardization

INTRODUCTION

India is among few countries in the world, which has contributed richly to the international livestock biodiversity and improvement of livestock genepool. India contributes about 63 percent of total world buffalo milk and 95 percent of buffalo milk in Asia comes from India. Among the various buffalo breeds in India, Murrah is the important milch breed with superior genetic potential for milk production and constitutes around 19.5% of total buffalo population in the country (FAO, 2012). The breed is versatile and has shown wide adoption for milk production across the length and breadth of the country.

A multitude of studies in dairy cattle have shown that selection for higher milk yield alone is associated with reduced health and fertility (Pryce *et al.,* 1999). Fertility is economically important as it brings buffalo into lactation, reduces reproductive disorders and maximizes the profitability by in time calf crop. Most of the developed countries have already developed a national genetic evaluation for female fertility along with the production traits and they have used fertility traits like Pregnancy Rate (PR) and Service Period (SP) for genetic evaluation of dairy cattle (VanRaden, 2004; De Vries, 2010 and Cabrera, 2011). Pregnancy rate (PR) measures the

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percentage of non-pregnant animals that become pregnant during each estrous cycle, because each estrous cycle represents only one chance for an animal to become pregnant. A comparison of pregnancy rate with other fertility traits from 14 countries has been conducted by Interbull, 2007 and the result indicated that pregnancy rate is highly correlated with other fertility traits. These correlations indicate that pregnancy rate can be expected to improve fertility in animals (Jorjani, 2007).

Conventional selection for milk has made buffaloes more profitable producers in the country and continuous selection for increased milk production has led to long service period in buffalo result in reduced pregnancy rate and decrease in calf crop and milk yield on lifetime basis. Until recently under Buffalo Improvement programme in India, no efforts have been made in using genetic selection of fertility to improve performances of buffaloes. The increase in milk production causes how much apparent decline in fertility in each lactation as well as in life time production has not been explored in Murrah buffaloes. The objective of the study was standardization of level of fertility with respect to milk production and quantifies the decline of fertility with the increase of milk production in Murrah buffaloes.

MATERIALS AND METHODS

Data Size: The breeding information of 522 Murrah buffaloes scattered over a period of 19 years from January 1993 to October 2011, maintained at Dairy Cattle Breeding Division and Livestock Research Station, National Dairy Research Institute, Karnal were collected. The basic information of Murrah buffaloes, reproduction and production traits were recorded. The reproduction traits included pregnancy rate (PR) and life time pregnancy rate (LTPR). The production traits included 305 days or less milk yield (MY), wet average (WA), test day five milk yield (TD 5 MY), life time 305 days or less milk yield (LTMY), life time wet average (LTWA) and life time test day five milk yield (LT TD 5 MY).

In the present study, the normal lactation was considered as the period of milk production by a buffalo for at least 100 days or a minimum of 500 kg milk produced and the animal calved, dried under normal physiological conditions. The information of 1224 lactation records of 522 Murrah buffaloes were subjected to standardization and normalization of traits, and subsequently 853 lactation records were obtained (distributed as 404, 230, 138 and 81 completed first, second, third and fourth lactations) for production traits and 748 records (distributed as 340, 204, 126 and 78 completed first, second, third and fourth parity) for fertility traits.

Statistical analysis

The genetic parameters for fertility and production traits were estimated by REML using Wombat software (Meyer, 2010) applying a repeatability animal model, $Y_{ijklm} = \mu + A_i + S_j + P_k + Pa_l + AG_m + e_{ijklm}$ where, Y_{ijklm}, ijklmth observation of fertility and production traits; m, population mean; A_i, Animal random effect; S_j, Fixed effect of jth season of calving (winter, summer, rainy and autumn); P_k, Fixed effect of kth period of calving (1 to 8); Pa_l, Fixed effect of lth parity(1 to 4), AG_m, Fixed effect of mth age group of calving(<37 months, 37-51 months, >51 months); and e_{ijklm}, Random error is normally and independently distributed with mean zero and variance (σ^2_e).

Estimation of Pregnancy Rate of Murrah buffaloes

The Voluntary Waiting Period (VWP) is the period after calving during which no inseminations occur, voluntarily left by the management for better pregnancy rate. VWP in Indian Murrah buffaloes has been standardized as 63 days (Patil *et al.,* 2013). Pregnancy rate in each lactation was estimated as PR = 21 / (Service Period – Voluntary Waiting Period + 11). The constant factors 11 centralize the measure of possible conception within each 21 days time period.

Estimation of life time traits

An empirical estimation suggests that in buffaloes about 90.27 % was produced up to fourth lactation and thereafter milk production started to decline. Therefore, each life time performance trait was estimated as average of four parity /lactations. Life time pregnancy rate (LTPR) was estimated as average pregnancy rate of buffaloes completed four parity. Life time production or productivity was estimated as average production or productivity of buffaloes completed four lactations.

Standardization of level of fertility for optimum milk production / productivity

Standardization of fertility and production/ productivity were done parity wise, overall and life time (Table 1). For standardizing the level of fertility with milk production and productivity, the pregnancy rate was classified into seven classes with the increment of 10% in all parities, overall and life time. The number of buffaloes scattered in different classes of pregnancy rate were identified and their corresponding average pregnancy rate in relation to MY, WA and TD5 MY were estimated.

To explore the per unit change in fertility with respect to milk production/ productivity in Murrah buffaloes, regression analysis was done in the study using the General Linear Model (GLM) procedure of SAS (SAS Institute 2009), presented in Table 3. Following model was used: $Y_i = a + b_1X_1 + e_i$ where Y_i is pregnancy rate (PR), a is intercept, b_1 is regression coefficient estimated, X_1 is MY/ WA/TD 5 MY and e_{ij} is Random error ~NID (0, σ^2_e). The relation of change in life time pregnancy rate with respect to per month milk yield in life time was analyzed using the regression model: $Y_i = a + b_1X_1 + e_i$ where Y_i is life time pregnancy rate (LTPR), a is intercept, b_1 is regression coefficient estimated, X_1 is per month milk yield and e_{ij} is Random error ~NID (0, σ^2_e).

RESULTS AND DISCUSSION

Fertility traits of Murrah buffaloes were found influenced by period and season of calving, parity and age group of calving, while production traits were mainly influenced by period of calving and parity. Least-squares means of SP, LL and MY were estimated as 28±5.58 days, 286.06±1.72 days and 2078.20±31.21 kg, respectively. By keeping days to first service or VWP as 63 days, the average pregnancy rate (PR) and life time pregnancy rate (LTPR) of Murrah buffaloes were estimated as 0.36±0.013 and 0.38±0.03, respectively. Wet average (WA) of Murrah buffaloes was estimated as 7.29±0.06 kg. On analysis of test day milk, it was observed that TD 5 (125th day) MY had the highest phenotypic association (0.79±0.31) with MY out of eleven test day milk yields in Murrah buffaloes. The average LTMY, LTWA and LT TD 5 MY were estimated as 2188.00±41.50 kg, 7.54±0.12 kg and 8.52±0.15 kg respectively. The fertility traits were more influenced by environment and management of the herd, as pregnancy rate

encompasses buffalo's ability to return to normal reproductive status after calving, to display visible signs of estrus, to conceive when inseminated and to maintain the pregnancy.

The heritability of PR, MY, WA and TD 5 MY were estimated as 0.02±0.005, 0.17±0.04, 0.15±0.03 and 0.12±0.04. The pregnancy rate had low but negative phenotypic associations with MY (-0.08±0.04), WA (-0.12±0.02) and TD 5 MY (-0.09±0.03).The association of pregnancy rate with life time was 0.15±0.03. The buffalo fertility had negative correlation with milk yield but is a major component of longevity, as pregnancy rate had positive association with life time.

Level of fertility (PR) with milk production (MY) and productivity (WA/TD 5 MY) in different parities

The pregnancy rate of Murrah buffaloes varied from less than 10% to more than 90% in each of the four parity (Table 1). The average pregnancy rate ranged from 30% to 50%. In the first parity, it was observed that with the increase of average pregnancy rate of Murrah buffaloes from 34% to 45%, the level of average production was found decreased from 2040.46 kg to 1993.32 kg, 7.15 kg to 6.58 kg in WA and 8.52 kg to 6.59 kg when TD 5 MY was considered. Almost similar trend were observed in other parities also. In the second parity, it was observed that with the increase of 35% to 46% pregnancy rate, MY reduced from 2113.40 kg to 2034.48 kg, where WA declined from 7.45 kg to 7.32 kg and TD 5 MY declined from 7.95 kg to 7.81 kg. In the third parity, with the increase of 36% to 47% pregnancy rate, MY, WA and TD 5 MY from 2008.02 kg to 1906.31 kg,7.29 kg to 7.19 kg and 7.85 kg to 7.52 kg, respectively. In the fourth parity, though the increase of pregnancy rate was from 33% to 46%, milk yield reduced from 2118.66 kg to 1994.96 kg, however the decline of productivity was found less i.e. from 7.11 kg to 7.04 kg and 8.52 kg to 8.45 kg in WA and TD 5 MY.

Level of fertility with milk production and productivity in overall and life time

In overall lactations, with the increase of pregnancy rate from 34% to 45%, the corresponding production declined from 2053.98 kg to1946.64 kg, productivity declined from 7.50 kg to 7.33 kg in WA, 7.82 kg to 7.63 kg in TD 5 MY depicted in Figure 1, 2 and 3. However, with the increase of same pregnancy rate in life time, the productivity of life time reduced from 7.12 kg to 7.00 kg and 7.60 kg to 7.33 kg in WA and TD 5 MY, respectively. The life time milk yield reduced from 2249.56 kg to 2089.65 kg, as depicted in Figure 4, 5 and 6.

From the perusal of data from different parities, overall and life time, pregnancy rate of Murrah buffaloes had been classified into three classes, i.e. the buffaloes with less than 30% pregnancy rate, 31-50% pregnancy rate and more than 50% pregnancy rate. Average milk productivity and production corresponding to three ranges of pregnancy rate in different parities as well as in over all parities has been presented in Table 2. Therefore, under Murrah Buffalo Improvement breeding programme in India, once the target is to obtain 2000 kg MY, 7.4 kg WA and 7.7 kg TD 5 MY, the level of pregnancy rate should be in between 30-50%.

Linear evaluation of fertility and productivity / production in Murrah buffaloes

The percent change in of fertility with the corresponding unit increase of milk productivity and production was studied in different lactations, overall and life time in Murrah buffaloes (Table 3).

The change in per unit (percent) of fertility with the corresponding increase of per month milk production in life time of Murrah buffaloes was also analyzed using simple regression model. In Murrah buffaloes, average life time was estimated as 4.10 years, average life time milk yield and average per month milk yield in life time were estimated as 2188.00 kg and 151.44 kg, respectively. The results revealed that by increasing hundred kilograms of per month milk yield in life time, the pregnancy rate will reduce by about 13% in life time.

Scanty reports were available about the literature reviewing the standardization of fertility with milk yield. According to De Vries (2010) one month life time is worth 112 lbs (approx. 50.80 kg) milk in a lactation and 1.5% daughter pregnancy rate in Holstein dairy cattle. He also reported that one percent daughter pregnancy rate is worth 73 lbs (approx. 33.11kg) milk in 305-day lactation. Cabrera (2011) reported that improving pregnancy rate by 5% would increase economic gain of milk production by 21.41 kg per year, while De Vries (2010) reported that improving pregnancy rate by 1% will increase the milk production 7.13 kg per year, by 2.85 kg per year (Rogers and Cooper, 2011), while Hansen (2007) reported an increase of 4.26 kg per year in cattle. In India, economic estimates of percent increase of pregnancy rate with milk yield have not been explored. In present study, fertility had low negative association with milk yield. The present study quantifies the decline of pregnancy rate with increase of lactation milk yield in Indian Murrah buffaloes. However, in the absence of any direct selection pressure on pregnancy rate of Murrah buffaloes due to low heritability (h^2 0.02), there has been downward trend in fertility associated with the selection for milk yield. The study emphasis the importance of fertility (pregnancy rate) along with milk yield in the genetic evaluation of Indian Murrah buffaloes and a sustainable level of fertility should be maintained for further improvement in milk yield of buffaloes.

CONCLUSION

In the present study, fertility had found negatively associated with production traits of Murrah buffaloes. The increase in milk production or productivity causes how much apparent decline in fertility in each lactation as well as in life time production has been revealed in the study. It was found that to achieve around 2000 kg milk yield in 305 days, 7.5 kg wet average and 7.7 kg in test day 5 (125^{th} day) milk yield, level of fertility (pregnancy rate) should be in between 30-50%. Increasing one kilogram milk yield in test day five (125^{th} day) pregnancy rate reduced by about 1.3%, and increase in one kilogram milk yield per day in 305 days or hundred kilogram in 305 days of Murrah buffaloes pregnancy rate reduced by 0.9%. By increasing hundred kilograms of per month milk yield in life time, the pregnancy rate reduced by about 13% in life time. In the present study, fertility had positive correlation with life time or productive life, which indicated that selection of buffaloes for fertility along with milk production increases their life time and profitability of herd. The study quantifies the decline of fertility (pregnancy rate) with the increase of milk production / productivity in Indian Murrah buffaloes. The findings of the study clearly depicts that importance should be given to fertility traits like pregnancy rate along with production traits for improving milk yield of buffaloes, thereby increasing the economic efficiency of herd.

Table 1. Parity wise, Overall and life time level of fertility (PR) with milk productivity (TD 5 MY / WA) and production (MY) in Murrah buffaloes.

Range of PR (%)	First parity					Second parity				
	N	PR (%)	MY (kg)	WA (kg)	TD 5 MY (kg)	N	PR (%)	MY (kg)	WA (kg)	TD5 MY (kg)
<10	33	9	2137.95	7.39	8.52	32	9	2255.46	8.00	8.37
11-20	88	14	2239.26	7.12	8.28	43	15	2036.66	7.63	8.12
21-30	58	25	2095.98	7.33	8.23	22	25	2234.58	7.70	8.08
31-40	26	34	2040.46	7.15	7.97	38	35	2113.40	7.45	7.95
41-50	13	45	1993.32	6.58	7.42	14	46	2034.08	7.32	7.81
51-60	12	55	1961.78	6.55	7.40	9	57	1986.27	7.25	7.84
>60	36	98	1821.37	6.44	6.59	33	100	1915.96	6.97	7.63
	Third parity					Fourth parity				
<10	15	9	2201.45	7.79	8.53	11	9	2594.79	8.03	10.25
11-20	34	15	2025.76	7.68	8.03	20	15	2199.22	7.56	8.52
21-30	15	25	2082.18	7.68	8.23	11	27	2150.68	7.34	8.61
31-40	19	36	2008.02	7.29	7.85	4	33	2118.66	7.11	8.52
41-50	6	47	1906.31	7.19	7.52	5	46	1994.96	7.04	8.45
51-60	6	54	1877.91	6.77	7.48	3	54	1989.39	6.97	7.52
>60	13	95	1772.31	6.38	7.30	10	97	1847.84	6.70	7.25
	Overall					Lifetime				
<10	82	9	2239.7	8.60	7.62	-	-	-	-	-
11-20	19	14	2144.4	7.95	7.65	13	15	2393.5	8.00	8.00
21-30	11	25	2104.2	8.10	7.58	15	26	2280.6	7.72	7.43
31-40	74	34	2053.9	7.82	7.50	10	34	2249.5	7.60	7.12
41-50	45	45	1946.6	7.63	7.33	12	45	2089.6	7.33	7.00
51-60	30	55	1923.2	7.26	7.16	14	71	2014.2	7.05	6.98
>60	12	95	1914.3	6.90	7.02	-	-	-	-	-

PR, Pregnancy Rate; TD 5 MY, Test day five milk yield; WA, Wet Average MY, 305 Days or less Milk Yield.

Table 2. Average milk production and productivity corresponding to pregnancy rate.

Range of PR (%)	305 Days or less Milk Yield (kg)				
	Overall	**First parity**	**Second parity**	**Third parity**	**Fourth parity**
<30	2162.78 (119)	2124.95(39)	2431.05 (49)	2189.91(25)	2314.90(9)
30-50	2000.31 (388)	2024.75(179)	2165.12 (81)	1983.61(64)	2056.81 (42)
>50	1918.81 (122)	1856.47(48)	1931.03 (57)	1805.54(19)	1981.62(13)
	Wet Average (kg)				
	Overall	**First parity**	**Second parity**	**Third parity**	**Fourth parity**
<30	7.63 (119)	7.24 (39)	7.90(49)	7.71(25)	7.27 (9)
30-50	7.44 (388)	6.98 (179)	7.41 (81)	7.25 (64)	7.04 (42)
>50	7.05 (122)	6.46 (48)	7.03 (157)	6.50 (19)	6.77 (13)
	Test Day 5 Milk yield (kg)				
	Overall	**First parity**	**Second parity**	**Third parity**	**Fourth parity**
<30	8.13 (119)	8.03(39)	8.19 (49)	8.35 (25)	8.99 (9)
30-50	7.75 (388)	7.69 (179)	7.76 (81)	7.95(64)	8.32 (42)
>50	7.37 (122)	6.76 (48)	7.34(157)	7.67 (19)	7.75 (13)

Table 3. Parity wise regression of productivity and production on fertility (Pregnancy Rate) in Murrah buffaloes.

Parity	Models	Intercept	MY	WA	TD 5MY	R^2(%)	Average error
			b	b	b		
First	I	0.2646	-	-	-0.008	0.30	0.13
	II	0.3061	-	-0.017	-	2.47	0.15
	III	0.4112	-0.00003	-	-	0.70	0.08
Second	I	0.4606	-	-	-0.011	0.70	0.02
	II	0.4634	-	-0.024	-	1.41	0.11
	III	0.5520	-0.00007	-	-	1.90	-0.04
Third	I	0.4151	-	-	-0.011	0.70	0.02
	II	0.4956	-	-0.042	-	8.89	0.16
	III	0.5180	-0.00009	-	-	9.47	-0.01
Fourth	I	0.3959	-	-	-0.017	2.47	0.13
	II	0.5802	-	-0.044	-	6.41	0.07
	III	0.6721	-0.00014			0.14	0.07
Overall	I	0.3647	-	-	-0.013	0.7	0.09
	II	0.4192	-	-0.009	-	0.2	0.0002
	III	0.5047	-0.00009	-	-	1.47	0.14
Lifetime	I	0.5829			-0.0002	1.88	-0.04
	II	0.6358	-	-0.034	-	4.88	-0.02
	III	0.8718	-0.023	-	-	15.0	-0.01

MY, 305 Days or less Milk Yield; WA, Wet Average; TD 5 MY, Test day five milk yield; b, regression co-efficient estimated; R^2, coefficient of determination.

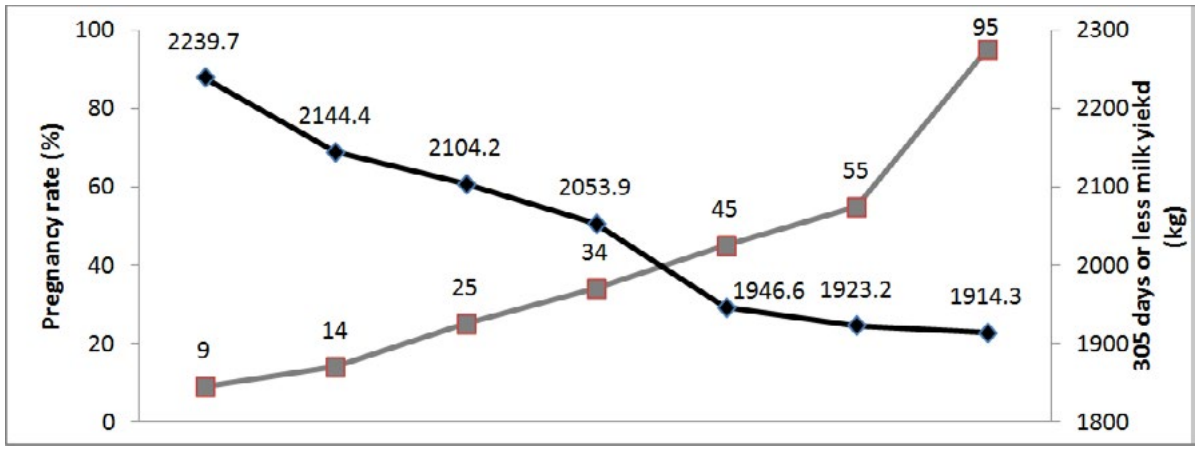

Figure 1. Level of fertility (pregnancy rate) and milk yield upto four lactations of Murrah buffaloes.

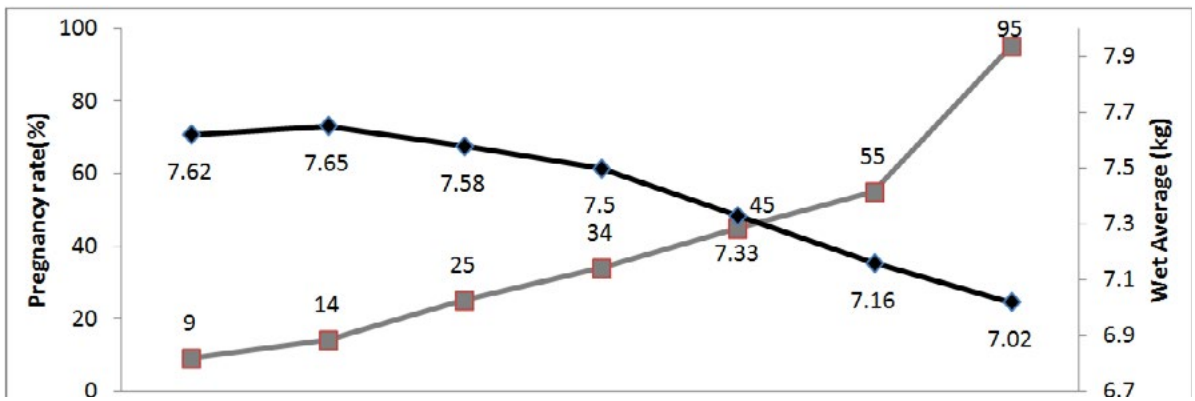

Figure 2. Level of fertility (pregnancy rate) and wet average upto four lactations of Murrah buffaloes.

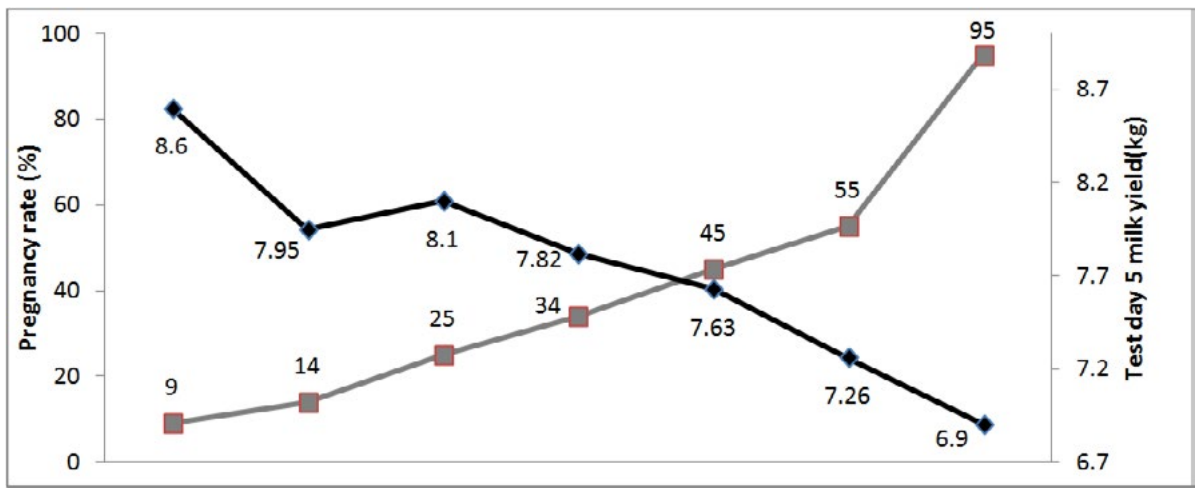

Figure 3. Level of fertility (pregnancy rate) and test day five milk yield upto four lactations of Murrah buffaloes.

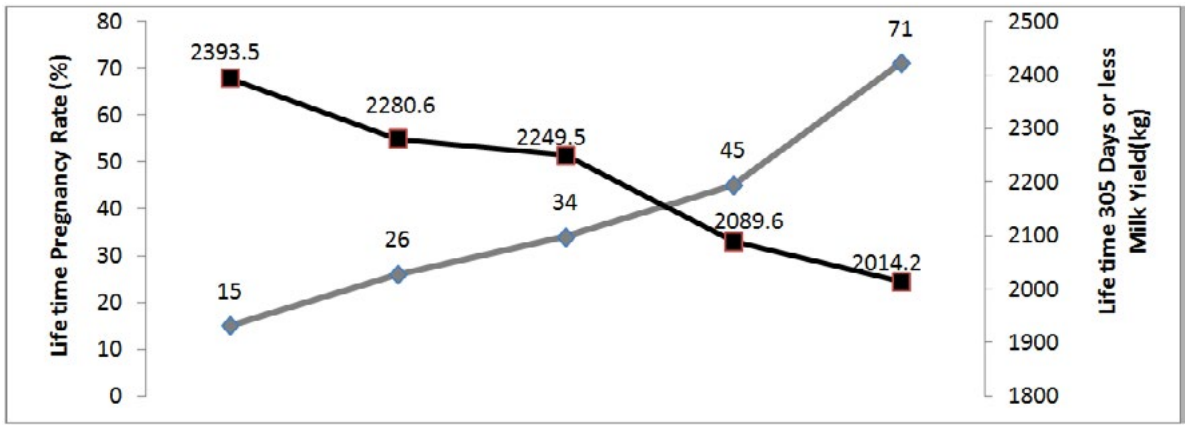

Figure 4. Level of life time fertility (pregnancy rate) and life time milk yield in Murrah buffaloes.

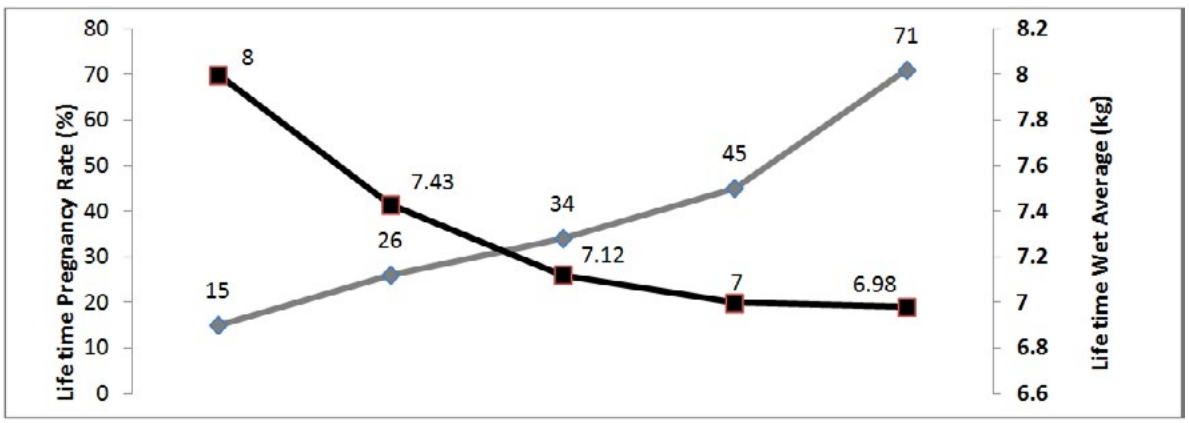

Figure 5. Level of life time fertility (pregnancy rate) and life time wet average in Murrah buffaloes.

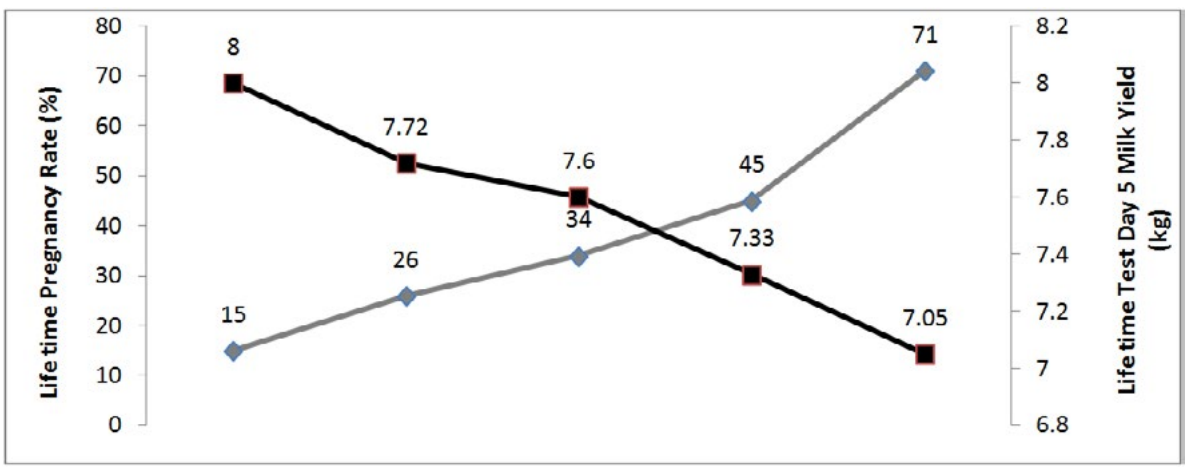

Figure 6. Level of life time fertility (pregnancy rate) and life time test day 5 milk yield in Murrah buffaloes.

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