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Impact assessment of mineral mixture feeding on the productive and reproductive performance of dairy animals

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Abstract
The present experiment was carried out to assess the effect of mineral mixture supplementation on productive and reproductive performance of dairy animals in Chittorgarh district of Rajasthan. The data was collected through personal interviews conducted using a pre-tested, well-structured interview schedule, from 180 dairy farmers. Dairy farmers were divided into two groups *viz*., beneficiary respondents (n=90) and non-beneficiary respondents (n=90). Animals from beneficiary respondents group were supplemented with the mineral mixture, while animal from non-beneficiary respondents group were not supplemented with the mineral mixture. The study revealed that mean value of productive traits of beneficiary respondents dairy cattle *viz*., lactation length (279.69 days), total lactation milk yield (1542.26 lit.) and average milk yield/day (5.52 lit.) were found significantly ($p \leq 0.01$) higher than non-beneficiary respondents dairy cattle and no significant differences in milk fat and milk SNF % between the beneficiary and non-beneficiary respondents dairy cattle. Similarly mean value of productive traits of beneficiary respondents dairy buffaloes *viz*., lactation length (289.85 days), total lactation milk yield (2087.39 lit.) and average milk yield/day (7.20 lit.), peak yield (8.17 lit.) were also found significantly higher ($p \leq 0.01$) as compared to non-beneficiary respondents dairy buffaloes. Reproductive traits of beneficiary respondents dairy cattle *viz*., service period (113.87 days), dry period (124.92 days) and postpartum estrus days (95.15 days) were found significantly ($p \leq 0.01$) lower and conception rate (66.34%), heat period (23.39 Hrs.) higher than the non-beneficiary respondents dairy cattle. Mean value of reproductive measures of beneficiary respondents dairy buffaloes *viz*., service period (125.95 days), dry period (128.17 days) and postpartum estrus days (97.56 days) were also found significantly ($p \leq 0.01$) lower and conception rate (61.88%), heat period (21.09 Hrs.) higher as compared to non-beneficiary respondents dairy buffaloes.

Keywords: Mineral mixture, significant at 1% level, SNF, fat %, beneficiary, non-beneficiary, respondents

Introduction
The livestock industry has been a significant contributor to the Indian economy, providing the public with nutrient-dense food high in animal protein, bolstering family incomes, and creating gainful employment opportunities in rural areas, especially for women, landless people, and small, marginal farmers. In the emerging agriculture scenario, raising livestock in general and dairying in particular helps to increase small farmers' income by lowering unemployment among the landless. The total number of livestock in India is 535.8 million, showing an increase of about 4.6% from the 2012 livestock census. With 192.5 million cattle overall, the nation's cattle population has increased by 0.8% since the last Census. The number of buffaloes in the nation is 109.9 million, up 1.1% from the previous Census (20th livestock Census, G.O.I - 2019) [1]. With a 20.17 percent share of the global milk production, India has emerged as the leading milk producer. The amount of milk produced in 2020–2021 and 2020–2022 is 210.0 million tonnes and 221.1 million tonnes, respectively, indicating a 5.29 percent annual growth (DAHD, 2021-22). However, the India has very low animal productivity, primarily as a result of dairy animals' poor nutritional status and poor genetic makeup, which can lead to a variety of metabolic disorders and ineffective reproductive problems like anestrous, repeat breeding, and infertility. Hence, balanced nutrition is very essential for maintaining a healthy body condition score (3 to 3.5) and improving the productivity and reproductive efficiency of dairy animals. The primary reason dairy animals grow slowly, have weakened immune systems, produce less milk, and have a variety of reproductive issues is

because they lack certain minerals. During the past decade, significant research has been conducted for understanding the effect of macro/micro mineral supplements on the production efficiency in dairy animals (Griffiths *et al.* 2007, Garg *et al.* 2008) [7, 5]. So, mineral mixture supplementation is essential for animal health because it increases growth rates, feed utilisation efficiency, milk production, reproductive efficiency, resistance to infectious diseases, lowers the incidence of certain metabolic diseases, and reduces the time between inter-calving interval.

Materials and Methods

The present experiment was conducted in the Chittorgarh district of Rajasthan. Three tehsils namely Dungla, Badi Sadri, Chittorgarh was selected purposively and from each tehsil two villages were selected and from each selected village 30 respondents who possess minimum five dairy animals were selected. The data was collected through personal interviews conducted using a pre-tested, well-structured interview schedule, from 180 dairy farmers. Dairy farmers were divided into two groups *viz*., beneficiary respondents (n=90) and non-beneficiary respondents (n=90). Animals from beneficiary respondents group were supplemented with the mineral mixture, while animal from non-beneficiary respondents group were not fed mineral mixture. The collected data were analysed by using simple statistical methods like mean, standard deviation and Two sample Z-test as follows:

Mean

Mean is nothing but the average of the given set of values. It denotes the equal distribution of values for a given data set.

$$\text{Mean} = \frac{\text{Sum of productive or reproductive economic trait of animals individually}}{\text{Total no. of dairy animals in given tehsil}}$$

Standard deviation (S.D)

The standard deviation measures the absolute dispersion of variability of distribution. Here mean and standard deviation were used for categorization of respondents in different categories.

$$s = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1}}$$

Where:
S = Standard deviation
n = Sample size
$\sum Xi$ = Sum of total scores in sample
$\sum Xi^2$ = Sum of squares of score of each respondent in sample

'Z' test (Standard Normal Deviate test)

The test was used to observe to significance difference between two sample mean for large sample (i.e., n>30). Formula for 'Z' test is under

$$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{{\sigma_1}^2}{n_1} + \frac{{\sigma_2}^2}{n_2}}}$$

Where:

- x_1, x_2: sample means
- σ_1, σ_2: population standard deviations
- n_1, n_2: sample sizes

Results and Discussion

Productive and reproductive performance of dairy animals

Productive performance of dairy animals

Results pertaining to productive performance of dairy cattle and buffalos are presented separately in subsequent sub heads.

Productive performance of dairy cattle

It was observed from Table 1 that average milk yield was found significant ($p \leq 0.01$) higher in beneficiary respondents cattle (5.52 lit.) than the non-beneficiary respondents cattle (5.02 lit.). Besides this, beneficiary respondents cattle (1542.26 lit.) were produced significantly ($p \leq 0.01$) higher total lactation milk yield than the non-beneficiary respondents cattle (1334.28 lit.). Peak milk yield production was also found significantly ($p \leq 0.01$) higher in beneficiary respondents cattle (6.08 lit.), however lactation length was found significantly ($p \leq 0.01$) higher in beneficiary respondents cattle (279.69 days) than the non-beneficiary respondents cattle (265.80 days). Time laps to achieve peak production was found significant higher in non-beneficiary respondents cattle (53.26 days). These finding were in agreement with the results by Srivara (2019) [22], Meher *et al.* (2017) [10] and Gupta *et al.* (2017) [8] in crossbred cattle. Pandey *et al.* (2017) [15] and Nocek *et al.* (2006) [13] also reported increase in milk yield due to supplementation of area specific mineral mixture in dairy cattle. Mohsina *et al.* (2017) [12] and Tiwari *et al.* (2013) [24] reported feeding of area specific mineral mixture increased milk yield 25% in field trials. However, the impact of dietary mineral mixture supplementation has on the smooth muscle alpha-actin (ACTA2) in the udder during lactation may be the reason behind the results that show enhanced milk production potential in cattle. Moreover, the synergistic interaction of micro and micro elements improves the efficiency with which memory cell's function. These findings were in accordance with Ghosh *et al.* (2016) [6] and Rohilla *et al.* (2007) [18]. The difference in average percentage of milk fat was found non-significant between beneficiary respondents cattle (4.17%) and non-beneficiary respondents cattle (3.98%). The percentage of SNF followed the same trend as the fat there is no significant difference between beneficiary and non-beneficiary respondents cattle. The findings are supported by the results of Rabiee *et al.* (2010) [16] and Mohsina *et al.* (2017) [12] found that the milk fat and SNF% of the animals in the supplemented and non-supplemented groups did not differ significantly.

Table 1: Productive performance non-beneficiary and beneficiary respondents cattle

S. No	Particulars	Cattle				'Z' value
		Non-Beneficiary (n=70)		Beneficiary (n=71)		
		Mean	S.D.	Mean	S.D.	
1.	Lactation length (days)	265.80	4.57	279.69	3.90	19.41**
2.	Total lactation milk yield (lit.)	1334.28	128.07	1542.26	86.78	11.27**
3.	Average milk yield/day (lit.)	5.02	0.46	5.52	0.30	7.63**
4.	Days to attain peak yield	53.26	2.10	41.44	3.06	26.76**
5.	Peak yield (lit.)	5.65	0.76	6.08	0.67	3.56**
6.	Average milk fat (%)	3.98	0.25	4.17	0.68	2.16 NS
7.	Average milk SNF (%)	8.55	0.06	8.58	0.12	1.68 NS

** Significant at 1 percent level of significance, NS= Non-Significant, n= No. of cattle

Productive performance of dairy buffaloes

To find out the difference in the productive performance of the dairy buffaloes of non-beneficiary and beneficiary respondents, 'Z' test was applied. The data pertaining to productive performance of dairy buffaloes of non-beneficiary and beneficiary respondents are presented in Table 2.

Data depicted in Table 2 indicates that there was highly significant difference in production performance between non-beneficiary and beneficiary respondent's buffaloes. But in case of average milk fat and SNF% there was no significant difference between beneficiary and non-beneficiary respondents buffaloes. The mean value of lactation length was found to be higher in beneficiary respondents (289.85 days) buffaloes than the non-beneficiary respondents (271.86 days) buffaloes. Data concerning to average milk yield of non-beneficiary respondent's buffaloes (6.57 lit./day) found lower than the beneficiary respondents buffaloes (7.20 lit.). Data in Table 2 shows that peak yield (lit) of beneficiary respondents buffaloes were higher (8.17 lit.) than the non-beneficiary respondents (7.67 lit.) buffaloes. Average fat percentage of non-beneficiary and beneficiary respondent's buffaloes were found non-significant with 6.33% and 6.61% respectively. SNF of non-beneficiary and beneficiary respondents buffaloes were also found non-significant with 8.64 and 8.68 SNF. According tabulated data of Table 2 lactation length, peak yield (lit), average milk yield and days attain to peak yield are highly significant because Z value of these parameters are greater than Z tabulated value at 1 percent level of significance.

Table 2: Productive performance of non-beneficiary and beneficiary respondents buffaloes

S. No	Particulars	Buffalo				'Z' value
		Non-Beneficiary (n=76)		Beneficiary (n=81)		
		Mean	S.D.	Mean	S.D.	
1.	Lactation length (days)	271.86	5.29	289.85	5.63	20.72**
2.	Total lactation milk yield (lit.)	1785.93	123.25	2087.39	108.17	16.25**
3.	Average milk yield/day (lit.)	6.57	0.42	7.20	0.39	9.82**
4.	Days to attain peak yield	50.01	3.98	39.33	3.57	17.64**
5.	Peak yield (lit.)	7.67	0.27	8.17	0.88	4.82**
6.	Average milk fat (%)	6.33	0.85	6.61	0.66	2.30 NS
7.	Average milk SNF (%)	8.64	0.08	8.68	0.17	1.75 NS

** Significant at 1 percent level of significance, NS= Non-Significant, n= No. of buffalo

Reproductive performance of dairy animals

Results pertaining to reproductive performance of dairy cattle and buffalos are presented separately in subsequent sub heads.

Reproductive performance of dairy cattle

In relation to the reproductive performance of dairy cattle in non-beneficiary and beneficiary respondents of Chittorgarh district. To find out the variation in the reproductive performance of the dairy cattle, 'Z' test was applied.

Data depicted in Table 3 indicates that there was highly significant difference in reproductive performance between non-beneficiary and beneficiary respondents cattle. The mean value of service period (136.60 days) was found to be higher in non-beneficiary respondents cattle and 113.87 days was found in beneficiary respondents cattle. Similarly mean value of dry period (139.58 days) of non-beneficiary respondents cattle found higher than beneficiary respondents cattle dry period (124.92 days). Data of Table 3 revealed that mean value of heat period was higher in the beneficiary respondents cattle than non-beneficiary respondents cattle with 23.39 hours and 20.1 hours respectively. Conception rate of non-beneficiary respondents cattle 46.30 percent was found lower than beneficiary respondents cattle 66.34 percent. Data presented in Table 3 shows that 42 dairy cattle of non-beneficiary respondents were suffering from the prolapse of uterus while only, 8 cattle of beneficiary respondents cattle were suffering from prolapse of uterus problem.

Table 3: Reproductive performance of non-beneficiary and beneficiary respondents cattle

S. No	Particulars	Cattle				Z' value
		Non-Beneficiary respondents (n=70)		Beneficiary respondents (n=71)		
		Mean	S.D.	Mean	S.D.	
1.	Service period(days)	136.60	6.25	113.87	6.37	21.39**
2.	Conception rate (%)	46.30	7.28	66.34	7.02	16.63**
3.	Dry period (days)	139.58	14.71	124.92	14.04	6.08**
4.	Heat period (Hrs.)	20.01	1.94	23.39	1.10	12.67**
5.	Postpartum estrus (days)	117.19	15.59	95.15	3.12	11.91**
6.	Prolapse of uterus	42		8		

** Significant at 1 percent level of significance, n= No. of cattle

Reproductive performance of dairy buffaloes

In relation to the reproductive performance of dairy buffaloes in non-beneficiary and beneficiary respondents of Chittorgarh district. To find out the variation in the reproductive performance of the dairy buffaloes, 'Z' test was applied.

It was concluded from Table 4 that the average post-partum estrous period was lower (97.56 days) in beneficiary respondents buffaloes as compare to non-beneficiary respondents buffaloes (125.08 days), which shows significant difference ($p \leq 0.01$). These findings are in accordance of Mohapatra *et al*. (2012) who also noticed that the group supplied with mineral mixture had lower post-partum estrous days than the control group. The average service period was observed 125.95 days in beneficiary respondents buffaloes and 145.22 days in non-beneficiary respondents buffaloes. It was found significantly ($p \leq 0.01$) lower in buffaloes fed with mineral mixture as compare to non-supplemented buffaloes. Similar findings were also reported by Singh *et al*. (2020) [19], Kumar *et al*. (2020) [9], Tanwar *et al*. (2019) [23] and Gupta *et al*. (2017) [8], there was a significant difference observed in the post-partum estrous days and service period between dairy animals in the group supplemented with mineral mixture and the non-supplemented group. The average dry period was observed 128.17 days in beneficiary respondents buffaloes and 147.93 days in non-beneficiary respondents buffaloes. It was found significantly ($p \leq 0.01$) lower in beneficiary respondents buffaloes supplemented with mineral mixture as compare to non-beneficiary respondents buffaloes. Heat period (21.09 hrs.) of buffaloes in beneficiary respondents was significantly higher ($p \leq 0.01$) as compared to non-beneficiary respondents buffaloes. Conception rate (61.88%) was found significantly ($p \leq 0.01$) higher in beneficiary respondents buffaloes supplemented with mineral mixture as compare to non-beneficiary respondents buffaloes. There are lower number (9) of buffaloes of beneficiary respondents were suffering from prolapse of uterus as compared to non-beneficiary respondents buffaloes (30) due to supplementation of mineral mixture, it reduce the risk of prolapse of uterus problem. Conception rate was found 20% higher in beneficiary respondents buffaloes supplemented with mineral mixture. Behera *et al.* (2012) [3] also found comparable results as it improved conception rate in mineral supplemented heifers.

Table 4: Reproductive performance non-beneficiary and beneficiary respondents buffaloes

S. No	Particulars	Buffalo				'Z' value
		Non-Beneficiary respondents (n=76)		Beneficiary respondents (n=81)		
		Mean	S.D.	Mean	S.D.	
1.	Service period(days)	145.22	5.29	125.95	4.96	23.51**
2.	Conception rate (%)	44.80	6.43	61.88	6.38	16.52**
3.	Dry period (days)	147.93	10.23	128.17	12.34	10.93**
4.	Heat period (days)	17.88	1.99	21.09	2.68	8.53**
5.	Postpartum estrous (days)	125.08	9.40	97.56	6.32	21.38**
6.	Prolapse of uterus	30		9		

** Significant at 1 percent level of significance, n= No. of buffaloes

Conclusion

From the present study, it was concluded that mean value of productive traits *viz*., lactation length (days), total lactation milk yield (lit.), average milk yield/day (lit.), peak yield (lit.) and reproductive traits *viz*., conception rate (%), heat period (hrs.) found significantly higher in beneficiary respondents dairy cattle and buffaloes. There is no significant difference in milk fat and milk SNF % between the beneficiary and non-beneficiary respondents dairy cattle and buffaloes. When dairy animals are given a mineral mixture supplement, their capacity for reproduction and production is increased. Therefore, farmers can profit more from their dairy animals by using its supplementation.

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