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Effect of dietary supplementation of mineral mixture on production and economic performance for small holder dairy farming in Kolasib district of Mizoram

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Abstract
The present study was conducted on lactating crossbred dairy cows with the objectives of evaluating the effect of mineral mixture supplementation on production performance and economics of small holder dairy farming under sub-humid ecosystem of Kolasib district of Mizoram. Experimental dairy cow's was selected on mid phase of 2nd stage of lactation for a period of 120 days. A total of sixty dairy cow's (n=60) were divided into two groups viz., treatment (T_2-supplement of 50gm mineral mixture/cattle/day) and control (T_1-no supplementation) in a completely randomized designed. Analysis of data revealed that increased in milk yield (19.68%) by 1.23 litre day^{-1} and number of insemination per conception leading to increased conception rate. However, significantly (p<0.05) reduce post partum estrus period and service period. The benefit-cost (B: C) ratio was recorded as 2.37 and 1.78 in the present study under intensive farmer management practices. Thus, supplementation of mineral mixture are beneficial and improved better results in augmenting milk yield and reproductive efficiency in crossbred dairy cow's for enhancing more profitability, productivity and economically viable among smallholders' dairy farmers in hilly regions.

Keywords: Mineral mixture, milk yield, reproductive efficiency, crossbred

Introduction
For the last two decades, India has been the world's largest milk producer, with a 22.67 percent share of global dairy production (Singh *et al.,* 2020) [1], achieving an annual output of 187.7 million tonnes (2018-19) as compared to 176.3 million tonnes (2017-18) recording an annual growth of 6.5 percent (BAHS, 2019) [2]. Around 70 million Indian households are projected to be active in dairy production vis-à-vis 150 million households worldwide (FAO, 2020) [3]. Per capital availability has also increased from 233 gm per day during 2004-05 to 394 gm per day in 2018-19. However, the milk production has increased from 25 thousand tonnes in 2017-18 to 25.78 thousand tonnes in 2018-19 registering a growth of 3.05%. However, milk production is steadily growing in Mizoram, the per capita availability of milk per day in 2018-2019 worked out at 66 gm is far below the Indian Council of Medical Research recommendation (ICMR) of 300gm of milk per day per individual (Government of Mizoram, Economic Survey, 2019-20) [4].

In Mizoram, cattle farming plays as multifarious role (milk, meat, dung as manure) in the life of the agrarian society which contribute significantly to poverty alleviation of a major section of socio- economically weaker, landless, small marginal and smallholder tribal dairy farmers. Dairy sector is constrained by many farmers such as poor-quality feed, shortage of feed resources, high cost of raw feed ingredients (65-70%), shortages of skilled and committed labours (28-32.5%), transportation charges were found to be major bottle-necks in these regions (Singh *et al*., 2020) [1]. Dairy cattle are more prone to mineral deficiency due to their increased requirement for maintenance and lactation (McDowell *et al*., 2003) [5]. Another factor is due to soil mineral status keeps on changing due to pressure on land for maximum crop production, fertilizer application and natural calamities, thus altering the mineral contents of fodders and feeds and hence their inability to supply to the animals resulting in poor milk production, reproduction, and productivity. As far as Mizoram is concerned, a significant number of animals in the state suffer from micro-mineral imbalance in terms of macronutrients and micronutrients (Kumaresan *et al*., 2010) [6] and till now no scientific knowledge of mineral mixture supplement is adopted by Mizo's dairy farmer so far. In hilly regions, dairy cattle are largely dependent on grazing and crop residue with little or no additional concentrate or

mineral mixture except common salt (Garg *et al*., 2005) [7]. Keeping these facts in view and findings, an attempt was made to assess the effect of dietary supplementation of mineral mixture on milk yield, reproduction efficiency and economic analysis of dairy cow's under field condition of sub-humid ecosystem in Kolasib district of Mizoram.

Materials and Methods

The experiment was carried out in lactating crossbred dairy cow's at Kolasib district of Mizoram, India. Selection of five villages (Vengthar, Rengtekawn, Thingdawl, Kawnpui and Bualpui) by simple random sampling techniques was used for the study where dairy cattle population is more. The study site is located between 24013'48"N latitude and 92040'48"E longitudes with an altitude of 888 meters above the mean sea level. The area experiences sub-tropical and humid mild climate zone with temperature varies from 8.03 °C to 14.73 °C during winter and 21.31 °C to 33.03 °C during summer and an annual rainfall was 2703 mm. All the animals were selected on mid phase of 2nd stage of lactation, milk yield and parity. A total of sixty lactating crossbred dairy cow's (n=60) were divided into two groups (n=30 milch cows/ groups) viz., control (T_1) and treatment (T_2), respectively. All the animals were managed under intensive system of farmer's own management practices. The feeding of dairy cow's (kg/day/animal) in both the groups consisting of 30-35 kg green fodder, 5-6 kg dry fodder and commercial concentrate feed (3-3.5 kg/day; 18% CP).The composition of the commercial concentrate feed for both groups was similar. In treatment group (T_2) were fed mineral mixture at the rate of 50 gram/cattle/day are presented in table 1, whereas cattle from the control group were not given any supplementation. The concentrate was offered two times a day just before milking in morning and evening. Water was offered *ad libitum* throughout the experimental period. The feeding trial lasted for a period of 120 days. Milk yield was recorded daily, twice both in morning and evening at 6:00 and 17:00 hours by the farmers and at weekly interval by the researcher. Data on reproductive traits viz. post-partum estrus, service period and number of artificial inseminations required for conception were recorded on the basis of dairy cow owner's response. The benefit cost ratio for all the groups were calculated. A skill based training programme was conducted for the farmers before starting the experiment to educate them for feeding and correct method of data recording on different parameters in the adopted villages.

Table 1: Composition of mineral mixture Kg^{-1}

Composition	Content Kg $^{-1}$
Vitamin A	7,00,000 IU
Vitamin D_3	70, 000 IU
Zinc	9600 mg
Magnesium	6000 mg
Manganese	1500 mg
Iron	1500 mg
Copper	1200 mg
Nicotinamide	1000 mg
Iodine	325 mg
Vitamin E	250 mg
DL-Methionine	1000 mg
Cobalt	150 mg
Potassium	100 mg
Sodium	5.9 mg
Calcium	25.5%
Phosphorus	12.75%
Sulphur	0.72%

Source: Manufactured by Kamadhenu Nutrients Pvt. Ltd, Gujarat-394116 and Marketed by Virbac Animal Health India Pvt. Ltd, Maharastra-400066

The recorded data was analyzed statistically as per Snedecor and Cochran (1994) [8] and student's t-test of significance (2-way split analysis of variance) between groups was performed using SPSS for Windows (version 17.0 Microsoft) [9].

Results and Discussion

Effects on Milk yield

The experiments were performed with dietary supplementation of mineral mixture to find out whether it will have any effect or any change on milk yield, reproductive performance, and benefit cost ratio in crossbred dairy cattle in this hilly region. The observations on milk production are presented in table 2. The average milk yield in treated group (T_2) was found significantly higher ($p<0.05$) as compared to the milk yield observed in control group (T_1). These finding agreed with the results reported by Gupta *et al*., 2017 [10]; Srivara and Bhuvaneswari, 2019 [11] and Singh *et al*., 2020 [1] in crossbred cattle. Saxena *et al*., 2008 [12] and Sharma *et al*., 2009 [13] also reported increase in milk yield due to supplementation of area specific mineral mixture in dairy cattle. Tiwari *et al*., 2012 [14] and Mushtaq *et al*., 2017 [15] reported feeding of area specific mineral mixture increased milk yield 25% in field trials. Similar to the present findings, Hackbart *et al*., 2010 [16] observed increase in milk production at 14-weeks supplementation of organic trace minerals to cattle. This finding was in line with Akila *et al*., 2013 [17] and Senthilkumar *et al*., 2016 [18] who were reported that supplementation of TANUVAS – mineral mixture to dairy cattle resulted in increase in milk yield by 1.46± 0.14 and one litre per day in cow, respectively. Sawant *et al*., 2013 [19]; Singh *et al*., 2016 [20] and Madke *et al*., 2018 [21] observed significantly higher ($p<0.05$) milk production in supplemented animal with mineral mixture. However, result indicating that dietary mineral mixture supplementation attributes improved milk production potential of cattle could be due to having impact on the mammary myoepithials cells-

smooth muscle alpha-actin (ACTA2) in the udder during lactation periods. Further, synergistic effect of micro and micro elements contributes to the working of memory cells to enhance their milk production. This finding was in accordance with the observations of Rohilla *et al*., 2007 [22]. In support to the present findings, Wu *et al*., 2001 [23]; Begum *et al*., 2010 [24] and Rabiee *et al*., 2010 [25] observed no significant difference in milk fat percent and milk SNF percent between the supplemented and non-supplemented groups of animals.

Table 2: Economics impact of mineral mixture supplementation on milk yield

Parameters Milk yield (litre day^{-1})	T_1 (N=30)	T_2 (N=30)	SEM	t-value	Level of significance
Initial (0 day)	6.16	6.15	1.08	1.78	NS
Final average (30-120 days)	6.25^a	7.48^b	0.14	1.25	p<0.01
Change in milk production (%)	-	19.68	-	-	-
Average milk Fat%	3.64	4.68	0.21	3.67	NS
Average milk SNF%	8.58	8.62	0.11	2.03	NS

Numbers of observations are given in parentheses. Means bearing different superscript within a row differ statistically significant as p<0.05; T_1-Control group; T_2-treatment group

Effects on reproductive performance

Reproductive traits i.e., onset of first Post-partum estrus after calving, service period and number of inseminations per conception were also recorded as shown in table 3. These reproductive traits significantly (P≤0.05) differed in the treatment group as compared to control group.

Table 3: Economics impact of mineral mixture supplementation on reproductive performance

Parameters	T_1 (N=30)	T_2 (N=30)	SEM	t-value	Level of significance
Onset of first post-partum estrus (days) after calving	58.21^a	45.37^b	6.83	24.16	p<0.05
Service period (days)	88.63^a	61.03^b	7.89	28.74	p<0.05
Number of insemination/conception	2.82^a	1.73^b	0.65	5.82	p<0.05

Numbers of observations are given in parentheses. Means bearing different superscript within a row differ statistically significant as p<0.05; T_1-Control group; T_2-treatment group

The supplemented group of animals voluntary waiting period (45.37 days) was observed slightly lower than the control group (58.21 days). On average onset of first postpartum estrus was observed to occur 12.84 days earlier in the supplement animals as compared to control group. Moreover, the mineral mixture supplemented group with a service period (61.03 days) was also found significantly (P≤0.05) lower than the control group (88.63 days). Similar findings were also reported by Mohapatra *et al*., 2012 [26]; Gupta *et al*., 2017 [10]; Sahoo *et al*., 2017 [27]; Sivara and Bhuvaneswari, 2019 [11] and Singh *et al*., 2020 [1] in crossbred cattle. Significant effect of service period and number of insemination required for conception was evident from the present study. The present results support the findings of Prasad *et al*., 2005 [28] and Devasenat *et al*., 2010 [29] regarding improvement in general health score condition of the cows after area specific mineral mixture supplementation. The improvement in reproductive efficiency in cattle could be attributed due to mineral supplementation as compared to the performance of un-supplemented group was noticeably clear in this study

Cost of milk production and Benefit Cost ratio (BCR)

The economic analysis of the data revealed that dietary supplementation of mineral mixture enhances the milk yield by 1.23 Litre per day in treated group. It could be inferred from table 4 that benefit cost ratio was higher (p<0.05) in supplement animals as compared to control group.

Table 4: Benefit cost ratio (B:C ratio) analysis of tribal small holder dairy cow's farmer

Parameters	T_1 (N=30)	T_2 (N=30)	SEM	t-value	Level of significance
Average maintenance Cost of feeding /cow/day* (INR)	210^a	219^b	0.52	2.18	p<0.02
Average feed cost per litre of milk production (INR)	33.60^a	25.23^b	6.62	24.23	p<0.05
Gross return from sale of milk (INR 60 L^{-1})	375.00^a	520.80^b	3.57	12.66	p<0.05
Net profit per day (INR)	165.00^a	301.80^b	2.68	11.46	p<0.05
Net profit per litre of milk (INR)	26.40^a	34.77^b	7.63	26.83	p<0.05
Benefit: cost ratio	1.78^a	2.37^b	0.61	5.62	p<0.001

Numbers of observations are given in parentheses. Means bearing the different superscript within a row differ statistically significant as 0.05; * price is varies in hilly region*Net profit per litre of milk (INR)= (Net profit per day x Rs/litre)/Gross return from sale of milk; Benefit: cost=gross return/gross cost; ; T_1-Control group;T_2-treatment group

The feeding cost of per litre of milk was lower (INR 25.23) in treatment group as compared to control group (INR 33.60). Gross return from sale of milk (INR 520.80 vs 375.00) and net profit litre of milk was found higher in treatment group (INR 34.77) than control group (INR26.40). The BCR was also found higher in treatment group as compared to control (2.37 vs 1.78). Similar result to the present finding was in accordance with Lalrinsangpuii *et al*., 2016 [30]; Sivara and Bhuvaneswari, 2019 [11] and Singh *et al*., 2020 [1] in milch cattle.

Conclusions

It can be concluded from the present study that dietary supplementation of mineral mixture to the lactating crossbred dairy cattle under field conditions not only increases the milk yield, but also reduces the cost per litre of milk production

and increases reproductive efficiency and can earn more farm profit from their milch cattle by smallholders' dairy farmer in hilly region.

Conflict of Interest

Authors declare that they have no conflict of interests arising from this study.

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