



Impact of cation-based mineral supplement characteristics on dairy farmer's adoption: Insights from a field trial

SHASHIKANT GOYAL¹, GOPAL SANKHALA^{2✉}, CHANDER DATT², B S MEENA²,
GOUTAM MONDAL², SANJIT MAITI², SENDHIL R³ and CHANDAN KUMAR RAI⁴

ICAR-National Dairy Research Institute, Karnal, Haryana 132 001 India

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ABSTRACT

The attributes of innovation encompass the qualities, traits or characteristics inherent in an object reflecting the relative benefits of a novel idea. Assessing these attributes during the early stages of innovation within farmer management practices can offer valuable insights to the scientific community, enabling the formulation of policies to expedite farmer adoption. This study examined the perceived attributes of Cation-based Mineral Supplement (C-bMS). The research findings indicated that C-bMS demonstrates a moderate relative advantage (82.49%) compared to other mineral supplements in mitigating ruminal acidosis. It is highly compatible (80.84%), easy to comprehend and utilize, readily trialable (73.75%) with observable effects of feeding (78.75%), and predictable benefits (87.92%) for dairy farmers. Feeding C-bMS helps alleviate negative energy balance, increasing feed intake which in turn boosts milk production, ultimately reducing production costs by preventing ruminal acidosis and potentially doubling dairy farmers' income. Raising general awareness among dairy farmers about ruminal acidosis, the consequences of negative energy balance, and the advantages of feeding C-bMS can be achieved through effective extension methods such as demonstrations and exhibitions.

Keywords: Attributes, Cation based mineral supplement, Farmer's income, Milk yield

India's livestock population has grown to 535.78 million, a 4.6% increase since the last census (BAHS 2019). The bovine population, including buffalo, cattle, mithun, and yak, stands at 302.79 million, up by 1%. Cattle numbers are 192.49 million, and female cattle are 145.12 million, showing increases of 0.8% and 18%, respectively. Buffaloes number 109.85 million, a 1.0% rise. From 2014-15 to 2019-20, the dairy sector's compound annual growth rate was 8.15%. The Committee on Doubling Farmers' Income (2018-19) emphasized the need to focus on the dairy sector to boost farmers' income, particularly for small-scale farmers. Developing countries like India have increased their share in global dairy production, primarily by increasing livestock numbers rather than productivity per animal. However, livestock productivity is hindered by poor feeding practices, lack of quality feed, limited market access, inadequate animal health services, and low genetic potential for milk production. Nutrient deficiencies in dairy animal diets can lead to reduced productivity. High-producing dairy animals need a diet high in concentrates, but sudden changes from fodder to concentrates can

cause ruminal acidosis, which negatively impacts milk production. There is a significant gap between available technologies and their adoption by farmers, necessitating the transfer of need-based, demand-driven technology from research institutions to the field.

The cation-based mineral supplement (C-bMS), developed by the Animal Nutrition Division of ICAR-National Dairy Research Institute in Karnal, Haryana, aims to bridge this gap. This supplement improves rumen fermentation, nutrient uptake, feed intake, digestibility, and production efficiency, especially for animals on high fermentable grain or silage diets. It includes antioxidants and ultra-trace minerals like chromium and vanadium, which enhance immune status and milk yield. C-bMS can increase milk yield by 10-15%, improve milk fat content and animal immunity, while reducing ruminal acidosis. Farmers should feed C-bMS to lactating dairy animals at 150 g/day, starting from 15 days after calving (Mani *et al.* 2023). Understanding farmers' perceptions of C-bMS can provide insights into its advantages, compatibility, complexity, trialability, observability, and predictability under field conditions.

MATERIALS AND METHODS

Location of study: The research was conducted in agro-ecological region IV of Haryana state of India. The climate is generally very hot in summer and remarkably cold in

Present address: ¹Gochar Mahavidyalaya, Saharanpur, Uttar Pradesh. ²ICAR-National Dairy Research Institute, Karnal, Haryana. ³Pondicherry University (A Central University), Puducherry. ⁴CCS Machhra, Meerut, Uttar Pradesh.
✉Corresponding author email: gssitaram@gmail.com

winter in Haryana. About 86% of the geographical area is cultivable and about 75% of cultivated area is irrigated (Census of India 2011). This state has been rich in livestock population especially in case of buffalo. Dairy farming forms an essential part of Haryana's rural economy. In Haryana, there are 2901 veterinary institutions operating for health care, breeding work and other activities (Department of Animal Husbandry and Dairying 2022), 71, 26,497 bovine population (Livestock Census 2019) with total annual milk production of 98.09 lakh tones in 2017- 18 (Department of Animal Husbandry and Dairying 2019). The 'Haryanvi' breed of cow and 'Murrah' breed of buffalo are well-known throughout the world. National Dairy Research Institute situated at Karnal and Central Institute for Research on Buffaloes at Hisar are constantly contributing for betterment of livestock, specifically conducting research on cows and buffaloes.

Sampling plan: The Farmer FIRST programme, implemented by ICAR-National Dairy Research Institute, focused on Karnal district, Haryana. This district, chosen purposefully, has around 280,000 high-yielding female bovines, including 110,000 exotic/crossbred cows and 180,000 buffaloes (Government of Haryana 2020). Seven villages—Garhi Gujran, Kamalpur Rodan Churni Jangir, Nagla Rodan, Samora, Chand Samand, and Dabkoli Khurd—were selected for the study. A baseline survey and a complete enumeration of these villages identified 400 dairy farmers with pregnant or recently calved animals. From these, 240 dairy farmers (120 cows and 120 buffaloes) with animals at high risk of ruminal acidosis and peak milk yields over 10 kg/day, not fed cationic diets, and at least one month pre-parturition or up to 15 days post-parturition, were purposefully selected. Farmers received free cation-based mineral supplements (C-bMS). After 110-115 days, data on perceived attributes of C-bMS were collected. Variables affecting these attributes included milk yield, fat content, service period, body condition score, and net return per lactation. Tobit regression was used to identify correlations between productive and reproductive traits and C-bMS attributes. A scale to measure dairy farmers' perceptions of C-bMS was developed using factor analysis, specifically Principal Component Analysis (PCA). Following Edwards' (1969) principles, 47 items were selected for the scale.

A total of 115 dairy farmers were selected randomly from the non-sample villages of Karnal to collect the data. The collected response on a five-point continuum (Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree) was purely an ordinal type of response. Therefore, PCA was run by direct using the data set. 14 statements that could not pass the cut-off (0.80) point were dropped. 33 statements were greater than or equal to the cut-off point (0.80). Therefore, all the 33 statements were retained for further calculation of scale values. Kaiser Normalization was used to identify the initial Eigen values greater than 1. Total 6 Eigen values > 1 were found in the data set and the same numbers of components were extracted by using Varimax

rotational method for each statement. Extracted rotational component matrix was multiplied by the Eigen values and values obtained were added in case of each statement to get final scale values. The Ordinal alpha was used for calculating the reliability of scale. Calculated ordinal alpha were found to be 0.856. Attributes of Innovation is the qualities, traits or characteristics of an object. An innovation has some traits or qualities. There are six key attributes that influence the adoption of innovations:

Relative advantage: This is how much better an innovation is perceived compared to what it replaces. Factors like economic gain, labor-saving benefits, immediate rewards, crisis management effectiveness, and non-economic recognition all contribute to its adoption rate. Low initial cost, perceived risk, and discomfort also play roles.

Compatibility: This measures how consistent an innovation is with existing values, experiences, and needs of potential adopters.

Complexity: The degree to which an innovation is perceived as difficult to understand or use affects its adoption. Simplicity and ease of use are crucial for acceptance.

Trialability: The ability to trial an innovation on a limited basis accelerates its adoption rate, allowing potential adopters to experience it firsthand.

Observability: The extent to which the results of an innovation are visible to others influences its adoption rate. Easily observable benefits encourage adoption. These five attributes explains 49-87% variance in rate of adoption.

Predictability: This attribute refers to the certainty of receiving expected benefits from adopting an innovation.

Data analysis methods such as frequency counts, %, means, standard deviations, correlations, and regressions were employed to derive meaningful conclusions from the study.

RESULTS AND DISCUSSION

Perceived attributes of cation-based mineral supplement

Relative advantage of cation-based mineral supplement: A perusal of Table 2 showed that majority (47.08%) of the dairy farmers perceived that relative advantage of C-bMS is medium whereas, 35.41 and 17.51% of the dairy farmers perceived as high and low relative advantage of the C-bMS. This was probably due to the fact that C-bMS leads to increase in milk production by 13.20% and fat % by 10.20 %. The increased milk yield has directly added in dairy farmer's income. Dairy farmers have also observed increase in dry matter intake, improvement in body condition of their cows and buffaloes.

Relationship between productive and reproductive performance of dairy animals with relative advantage: The Tobit Regression was used in the study to examine the relationship between productive and reproductive characteristics of dairy animals and relative advantage. For the model, relative advantage as response variable have been classified in to low, medium and high level of relative

Table 1. Tobit regression analysis on productive and reproductive performance with relative advantage

Particular	Constant	Δ	T	δT	R ²
Body condition score	2.85 (0.02)	0.04 (0.02)	-.089 (0.04)	0.34** (0.04)	0.32
Daily milk yield (kg/animal)	7.99 (0.83)	0.15 (0.25)	0.041 (0.25)	1.10** (0.36)	0.34
FCM (kg/animal/day)	8.20 (0.32)	0.09 (0.45)	0.03 (0.44)	2.43** (0.62)	0.37
Fat (%)	7.29 (0.04)	-.04 (0.03)	0.03 (0.04)	0.69** (0.04)	0.32
Service period (in days)	125 (0.99)	-.58 (1.39)	-.39 (1.35)	-1.58 (1.89)	0.18
Net returns (₹/animal/lactation)	54494 (2664)	2172 (3750)	578 (3768)	16448** (5304)	0.49

Values in parenthesis indicates standard error; ** & *, significant at 1% and 5% level of significance, respectively. Δ , Treatment; T, Time; ΔT , Interaction effect.

advantage. Strongly agree and agree together constituted to high relative advantage and disagree along with strongly disagree category contributed to low relative advantage. The maximum value of the log-likelihood function for the model was -304.65 giving the likelihood ratio chi-squared statistic $C = 159.44$. It is evident from the Table 1 that for body condition score, milk yield, fat corrected milk yield, fat % and net income was found higher ($P < 0.05$) in supplemented group. Body condition score, milk yield, fat corrected milk yield, fat % and net income were positivity correlated with the relative advantage of C-bMS which might be due that the feeding C-bMS to dairy animals reduced the cases of sub-acute ruminal acidosis, improved the animals body condition score, increased milk yield, fat corrected milk yield and fat %. Service period were not found statistically significant in Tobit regression model. The net returns in pretest and posttest was calculated at ₹42,061 and ₹54,494 respectively.

Compatibility of cation-based mineral supplement: The majority (50.42%) of dairy farmers perceived that the level of compatibility was medium for C-bMS (Table 2). Whereas, 30.42 and 19.16% perceived high and low response, respectively. Compatibility in case of C-bMS indicating that dairy farmers did not observe any side effects of feeding C-bMS on animal's body.

Complexity of cation-based mineral supplement: The majority (52.83%) of the dairy farmers perceived that C-bMS is less complex to understand and use (Table 2) whereas, 26.67 and 21.25% perceived as medium and high complexity. Dairy farmers did not find C-bMS too much complex to use, measure the exact amount (150 g/day), effect of feeding on increase in feed intake, improvement in body weight and increase in milk yield and fat %.

Trialability of cation-based mineral supplement: It is apparent from Table 2 that majority (45.84%) of the dairy farmers perceived that C-bMS is easily trialable on small scale. Whereas, 27.91 and 26.25% perceived high and low trialability of C-bMS. The possible reason might be due to dairy farmers found easy to feed C-bMS for 3 to 4 days and check its effectiveness in increase in feed intake and milk yield.

Observability of cation-based mineral supplement: The majority (46.25%) of the dairy farmers perceived that the effects of C-bMS was easily visible (Table 2), however, 32.50 and 21.25% perceived high and low observability of

Table 2. Perceived attributes of cation-based mineral supplement (n=240)

Particular	Frequency	%
<i>Relative Advantage</i>		
Low (14-39.04)	42	17.51
Medium (39.05-44.57)	113	47.08
High (44.58-49)	85	35.41
<i>Compatibility</i>		
Low (12-21.23)	46	19.16
Medium (21.24-24.89)	121	50.42
High (24.90-30)	73	30.42
<i>Complexity</i>		
Low (4-7.79)	125	52.08
Medium (7.80-15.23)	64	26.67
High (15.24-20)	51	21.25
<i>Trialability</i>		
Low (6-9.89)	63	26.25
Medium (9.10-12.25)	110	45.84
High (12.26-15)	67	27.91
<i>Observability</i>		
Low (10-17.64)	51	21.25
Medium (17.65-20.27)	111	46.25
High (20.28-25)	78	32.50
<i>Predictability</i>		
Low (7-17.44)	29	12.08
Medium (17.45-21.9)	65	27.08
High (22-25)	146	60.84

C-bMS. Dairy farmers found positive effects of C-bMS on milk yield, body condition of dairy animals.

Predictability of cation-based mineral supplement: It is clearly enunciated from the Table 2 (Perceived attributes of Cation-based mineral supplement) that majority (62.26%) of dairy farmers perceived that benefits of feeding C-bMS was easily predictable. While, 26.42 and 11.32% perceived medium and low predictability of effects of C-bMS. The probable reason might be that dairy farmers easily predicted the expected increase in milk yield and increase in income.

Attributes of cation-based mineral supplement perceived by individuals: The pattern of scoring for positive statements was 5, 4, 3, 2, and 1 for Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D) and Strongly Disagree (SD), respectively. Reverses scoring pattern was done in case of negative statements (Table 3).

Table 3. Perceived attributes of cation-based mineral supplement

Particular	Responses					Weighted Mean (%)	Rank
	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)		
Relative advantage	89 (37.08)	100 (41.66)	21 (8.75)	12 (5.00)	18 (7.51)	79.93	1 st
Compatibility	70 (29.17)	90 (37.50)	22 (9.16)	33 (13.75)	25 (10.42)	79.30	2 nd
Complexity	31 (12.91)	38 (15.83)	9 (3.75)	87 (36.25)	75 (31.26)	48.16	6 th
Trialability	59 (24.58)	83 (34.58)	8 (3.33)	51 (21.25)	39 (16.26)	65.63	5 th
Observability	76 (31.66)	96 (40.00)	24 (10.00)	28 (11.66)	16 (6.68)	76.15	3 rd
Predictability	94 (39.16)	101 (42.08)	4 (1.67)	17 (7.08)	24 (10.01)	73.22	4 th

The majority (78.74%) of dairy farmers (41.66% strongly agreed and 37.08% agreed) perceived that feeding C-bMS offers significant advantages over previous mineral mixtures. They ranked it first with a weighted mean score of 79.93 which indicated that farmers recognize tangible benefits such as improved body condition, increased milk production, higher fat content, and reduced service period. This finding aligns with Triveni *et al.*'s (2017) study.

Most (66.67%) dairy farmers (37.50% strongly agree and 29.17% agree) found C-bMS compatible for feeding their animals, giving it a second-ranked weighted mean score of 79.30. Farmers believed C-bMS is safe and free from side effects, although 24.17% (10.42% strongly disagree and 13.75% disagree) expressed some reservations, consistent with findings by Singh (1994) and Datta and Jha (2013).

A majority (67.51%) of dairy farmers (36.25% disagree and 31.26% strongly disagree) found C-bMS easy to understand and use, ranking it fourth with a weighted mean score of 48.16. Despite this, 15.83% and 12.91% of farmers agreed and strongly agreed that it's difficult to comprehend, echoing concerns from Choshaly's (2019) research on complexity and consumer behaviour.

Most (59.16%) dairy farmers (34.58% strongly agreed and 24.58% agreed) believed C-bMS is trialable on a small scale, while 21.25% and 16.26% disagreed and strongly disagreed, respectively. It ranked fifth with a weighted mean score of 65.63, indicating farmers see C-bMS as easily observable in its effects on feed intake, milk yield, and animal condition (Choshaly 2019).

The effects of feeding C-bMS are easily observable according to 71.66% of dairy farmers (40.00% agreed and 31.66% strongly agreed), ranking it third with a weighted mean score of 76.15. This aligns with Sangutha *et al.* (2017) research on perceived benefits in agricultural contexts.

Finally, the majority (81.96%) of dairy farmers (42.08% strongly agreed and 39.16% agreed) believed that the benefits of feeding C-bMS are predictable, while 10.01% and 7.08% disagreed and strongly disagreed, respectively. Predictability in terms of increased feed intake, milk yield, and animal condition is evident, supporting farmers' income expectations.

Feeding C-bMS increased the milk production according to dairy farmers, most perceived it to offer moderate advantages in terms of relative benefits, compatibility, trialability, and observability. This perception may stem

from the fact that C-bMS only slightly increases milk production (100 to 150 ml/day). It is well-suited for animals as no side effects have been reported by farmers, and its effects on productivity and reproductive performance are easily measurable. Livestock rearers find it straightforward to understand and predict its benefits, considering its low complexity and high predictability. Research findings affirm that C-bMS offers significant advantages over other mineral supplements in mitigating ruminal acidosis. It is highly compatible, easy to use and understand, trialable, and its effects are observable. Feeding C-bMS helps in mitigating negative energy balance, increases feed intake, boosts milk production, and reduces production costs by preventing ruminal acidosis, thereby potentially doubling dairy farmer income. To enhance awareness among dairy farmers, effective extension methods such as demonstrations and exhibitions can be utilized to educate them about ruminal acidosis, negative energy balance, and the benefits of feeding C-bMS.

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