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Effect of Challenge Feeding on Milk Production and Peri-parturient Health Problems of Crossbred Cows and Growth Performance of Their Calves

P. Das[1], T.K. Amonge[1], R.J. Deka[1], J. Hussain[1], M. Hazarika[2], R. Deka[3]

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ABSTRACT

Background: Lower level of nutrition during transition period hampers production which will cause more economic loss to the dairy farmers. The present study was conducted with the objectives to study the effect of challenge feeding on production performance of crossbred dairy cows.

Methods: 12 pregnant crossbred cows of 2nd to 4th lactation, which are about to calve after 2 months as per the breeding records available in the farm were utilized in the study. The cows were divided into two groups *viz*., Treatment and Control consisting of six cows in each group**.** All the cows in both the groups were received different pre partum and post partum feeding schedule. The response to different feeding schedule were based on colostrum yield, average weekly milk yield, milk composition, peri-parturient health problems, cost of challenge feeding and growth performance of the calves born.

Result: The cows of challenge feed group produced significantly more colostrum and milk. Challenge feeding of the cows did not significantly affect the fat, protein, lactose and SNF percentage of milk. No pre partum or post partum disease was observed in all the cows. In the challenge feed group there was additional daily income of rupees 51.30 per cow. The birth and subsequent weekly body weights of the calves born from the treatment group was highly significant than the calves of the control group.

Key words: Challenge feeding, Crossbred cows, Milk composition, Milk yield.

INTRODUCTION

The Indian dairy industry holds tremendous potential for value-addition and overall development. Out of 535.78 million numbers of livestock in India, cattle population is 192.49 million accounting to 35.94 per cent of the total livestock population of the country (20th Livestock Census, 2019). The first rank in milk production by India is not because of the higher productivity of the dairy animals but because of the higher bovine population. According to the latest data, milk production in India is 230.58 million tons while per capita availability is 459 gm/day in 2022-23 (Basic Animal husbandry and Fisheries Statistics, 2019). The major causes of low productivity of indigenous cows in India is due to low genetic potential and poor nutrition and feed management. Crossbreeding of low producing indigenous females with high yielding breeds has significant role in improving their genetic potentiality and thus to meet the need of milk production in our country. But without proper feeding, cross breeding will not give optimum result.

Transition period is the most crucial period in annual cycle of a dairy cow. High yielding dairy cows enter a state of negative energy balance (NEB) around calving when the energy demand for maintenance and lactation exceeds that of dietary energy intake (Bauman and Currie, 1980). During the first few weeks after calving the nutritional requirements are at the highest, if the diets does not contain sufficient amount of energy it will be difficult to meet the high demand for milk production. The theory behind challenge feeding is feeding at higher plane of nutrition during dry period and in early post partum period in milch animals (Dann *et al., 2*006). It is essential to encourage provision and utilization of higher amount of concentrates to manage nutrition, negative energy balance and optimal production (Bhat *et al.,* 2000). Supplementation with concentrate is a key aspect for improving productivity in tropical dairy production. Improving nutrition with extra concentrate diet during the late gestation period increases birth weight of the calves and milk production from the dam

[1]Department of Livestock Production and Management, College of Veterinary Science, Khanapara, Guwahati-781 022, Assam, India.
[2]Department of Veterinary Biochemistry, College of Veterinary Science, Khanapara, Guwahati-781 022, Assam, India.
[3]Department of Animal Reproduction, Gynaecology and Obstetrics, College of Veterinary Science, Khanapara, Guwahati-781 022, Assam, India.

Corresponding Author: R. Deka, Department of Animal Reproduction, Gynaecology and Obstetrics, College of Veterinary Science, Khanapara, Guwahati-781 022, Assam, India.
Email: rajudeka110@gmail.com

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(Sanh, 2009; Aschalew *et al.,* 2019; Karuanayaka *et al.,* 2022). Challenge feeding means the cow with high milk production potential are to be fed increase quantity of concentrate to challenge them to produce to the maximum. As the feed intake decreases during pregnancy nutritional requirement should be provided with in the limited quantity feed with nutrients dense concentrate feed. Cows with excessive body tissue mobilization at this stage may take up to 20 weeks to regain a positive energy balance status (Taylor *et al.,* 2003) and there are subsequent effects on fertility that lead to poor conception rates (Wathes *et al.,* 2003). Challenge feeding is an accepted concentrate feeding system to pregnant animals which challenges the animal to maximize energy intake and enables the animal to express the milk production as close to their genetic capability as possible. Scientific investigation on effects of challenge feeding of dairy cows on different production parameters in dairy cattle production system in Assam and other NE states is scanty. Therefore the present investigation was conducted to estimate the effect of challenge feeding on colostrum yield, milk yield, milk composition, peri-parturient health problems of the cows and to find out cost of challenge feeding.

MATERIALS AND METHODS

A total of 12 pregnant healthy crossbred cows of 2nd to 4th lactation were selected from Instructional Livestock cattle farm, College of Veterinary Science, Khnapara, Assam in the present study. The study was conducted for a period of 16 weeks *i.e.* 8 weeks prior to calving (pre-partum) and 8 weeks after calving (post-partum) from September to December, 2023. All the cows were about to calve after 2 months as per the breeding records available in the farm were utilized in the study. The cows were divided into two groups *viz.*, Treatment and Control consisting of six animals in each group. Both the groups were homogenous according to their body weights and previous lactation milk yield. The selected animals were separated from the main herd 10 to 12 days prior to experiment so that the cows can adapt to the new housing environment. Pre partum and post partum feeding schedule of experimental cows are have been depicted in Table 1. Composition of concentrate mixture has been presented in Table 2.

Housing and management

The cows were housed in a well-ventilated, clean and dry concrete floor shelter. The cows were let loose in the paddock during morning hours for a short duration for exercise as well as to facilitate washing, cleaning and drying of the shed. During the experimental period the cows were groomed periodically and the mangers were cleaned regularly. The floor of the sheds was cleaned everyday and disinfected with potassium permanganate solution. Animals were kept in tail to tail position. Both the groups were offered with weighed quantity of feed twice daily at 8:30 AM and 4.00 PM. The concentrates were fed according to the feeding schedule to both the groups and roughages were allowed to feed *ad. libitum.* The left over if any was collected daily in the morning and weighed to determine the feed intake.

Milking management

Hand milking was practiced by massaging and pulling down the teats of the udder, squirting the milk into a bucket. The milking was done under hygienic conditions to ensure clean milk production. Udders were washed and cleaned gently so as not to damage the udder and teat.

Calf management

The experimental calves were housed separately from the other calves. The new born calves must be fed on colostrum for 5 days and thereafter they may be maintained on normal milk. A calf starter was provided from 1 month of age containing 23-26% protein, with at least 18% DCP and 75% TDN (ICAR, 2013). At the same time the calves started eating leguminous fodder.

Table 1: Pre partum and postpartum feeding schedule of experimental cows.

Days prepartum	Control group	Challenge feed group
1-39	Forage= *ad lib*.	Forage *ad lib*.
	Concentrate= 2.5 kg/day	Concentrate= 3.5 kg/day
40-60	Forage= *ad lib*.	Forage= *ad lib*.
	Concentrate= 3.5 kg/day	Concentrate= 3.5 kg +250 gm/day till it reaches1% body weight
Postpartum		
1-14	Forage = ad lib.	Forage= ad lib.
	Concentrate for maintenance = 2 kg/day	Concentrate for maintenance= 2 kg/day
	Concentrate for production = 1 kg/2.5 kg of milk	Concentrate For production=1 kg/2.5 kg of milk + 500 gm concentrate/day
15-60	Forage= ad lib.	Forage= ad lib.
	Concentrate for maintenance= 2 kg/day	Concentrate= Free choice
	Concentrate for production= 1 kg/ 2.5 kg of milk	

Parameters studied

The following parameters were studied during the entire course of the experiment:

a) Cow component

1. Feed intake.
2. Colostrum yield.
3. Milk yield.
4. Milk composition.
5. Peri-parturient health problems.
6. Cost of feeding.

b) Calf component

Birth and weekly body weight of calves.

Feed intake

Weekly feed intake on DM basis was found out by measuring daily feed intake for a week. Daily feed intake was worked out after making correction for feed residue collected in the morning on the following day on as such basis. The daily feed consumption measured on as such basis was calculated out to feed consumption on dry mater (DM) basis using DM values of the respective feed components. For determination of DM of feed, weighed amount of the sample was carefully taken in a petri dish of known weight and kept overnight in hot air oven at 100±1°C. The dried material was then weighed to a constant weight and dry mater of the sample was calculated using the following formula:

$$DM\ (\%) = \frac{\text{Weight of the sample after drying (g)}}{\text{Weight of the sample before drying}} \times 100$$

Colostrum yield

Average daily yield of colostrum in kilogram (kg) in both the experimental groups were recorded for 5 days from first day of calving.

Milk yield

Daily milk yield of individual cow of both the groups were recorded and was expressed as average daily milk yield in Kg. on weekly basis.

Milk composition

Representative milk samples from experimental cow were collected in sterile plastic bottles for analysis of milk composition. Different milk components such as fat, protein, lactose, solid-not-fat (SNF) of the milk samples were analyzed by using automatic milk analyzer.

Table 2: Composition of concentrate mixture.

Ingredients	Proportion (kg)
Maize	47
Wheat bran	12
Rice polish	10
Rice bran	10
Ground nut cake (GNC)	9
Soyabean meal	9
Mineral mixture	2
Common salt	1

*Calculated DCP 16.19% TDN 72.93% (ICAR 2013).

Peri-parturient health problems

a. Utero-vaginal prolapse: Prolapse of the uterus immediately after or within several hours of parturition.

b. Mastitis: Persistent inflammatory reaction of the udder tissue due to physical trauma or microorganisms infections during lactation was considered as udder mastitis.

c. Milk fever: It is a metabolic disorder caused by insufficient calcium, commonly occurring around calving.

d. Retention of placenta: Failure of placenta to be expelled normally at or shortly after parturition. If the placenta is retained longer than 8-12 hours after calving, the condition is considered pathological.

e. Metritis: It is the inflammation of the uterus caused by different bacterial infection following calving.

Cost of feeding

Cost of feeding of the experimental cows and estimated return from sale of their milk were taken into account to analyze the return from milk production on weekly basis. The fixed cost such as housing, depreciation value, cost of maintaining labour *etc.* and other parameters which are common for both the groups were not taken into account. Feed cost was worked out by multiplying feed consumption with price rate of ration. The price of the basal ration was calculated on the basis of the approved feed ingredients price list of the College of veterinary Science, Khanapara. The calculated cost of the basal concentrate ration was Rs. 28.00/kg and the price of mixed green fodder Rs. 2/kg and paddy straw Rs. 4/kg and sale price of milk Rs. 55/kg.

Birth and weekly body weight of calves

The body weight of the calves at birth and subsequent weeks up to 8 weeks of age were taken in weighing machine.

Statistical analysis

The average feed intake, colostrum yield, milk yield, composition of milk and body weight of calves were expressed in mean ± SE (standard error). Means were analyzed using analysis of variance followed by post hoc test to determine significance difference between feed intake, colostrum yield, milk yield, composition of milk and body weight of calves in all the groups, using statistical software package SAS Enterprise Guide 3.4.

RESULTS AND DISCUSSION

Feed intake

The average value of weekly feed intake (kg) on DM basis of the cows in control and treatment groups have been presented in Table 3. The difference in the overall means of weekly dry matter intake of the control and treatment groups supplemented with extra concentrate during experimental period was found to be significant. The higher feed intake in challenge fed group may be due to the

Table 3: Average weekly feed intake (kg) of the cows in control and treatment groups.

Week	Control	Treatment
1st	84.832±2.512^{a}	90.038±2.600^{a}
2nd	86.080±2.982^{a}	89.957±1.880^{a}
3rd	84.865±2.827^{a}	91.247±2.180^{a}
4th	85.908±2.638^{a}	94.795±1.878^{b}
5th	89.390±1.753^{a}	94.087±1.567^{a}
6th	89.415±3.101^{a}	95.922±1.789^{a}
7th	89.953±0.668^{a}	93.107±1.935^{a}
8th	89.328±2.552^{a}	95.197±1.379^{a}
9th	92.973±1.465^{a}	97.147±1.995^{a}
10th	94.240±2.002^{a}	96.080±1.711^{a}
11th	95.948±2.377^{a}	97.058±2.043^{a}
12th	95.082±1.452^{a}	96.280±2.002^{a}
13th	94.913±1.876^{a}	99.197±0.320^{b}
14th	92.885±3.222^{a}	99.925±1.036^{a}
15th	91.572±2.578^{a}	99.278±1.089^{b}
16th	91.033±2.688^{a}	100.077±0.872^{b}
Overall	90.526±2.293^{a}	95.587±1.642^{b}

Means with similar superscripts in a row do not differ significantly p>0.05.

Table 4: Average colostrum yield (kg) of the cows in control and treatment groups.

Group	Control	Treatment
Day 1	3.167±0.167$^{A}{}_{a}$	3.333±0.211$^{A}{}_{a}$
Day 2	3.333±0.211$^{AB}{}_{a}$	3.500±0.224$^{AB}{}_{a}$
Day 3	3.500±0.224$^{AB}{}_{a}$	4.000±0.000$^{BC}{}_{b}$
Day 4	3.500±0.224$^{AB}{}_{a}$	4.333±0.211$^{C}{}_{b}$
Day 5	3.833±0.167$^{B}{}_{a}$	4.333±0.211$^{C}{}_{a}$
Overall mean	3.467±0.093$_{a}$	3.900±0.111$_{b}$

Means with similar superscripts in a column or subscripts in a row do not differ significantly (p>0.01) among themselves.

Table 5: Average milk yield (kg) of the cows in control and treatment groups.

Week	Control	Treatment
1st	46.833±3.535$^{A}{}_{a}$	72.500±13.109$^{A}{}_{b}$
2nd	69.167±6.405$^{B}{}_{a}$	91.667±12.101$^{A}{}_{a}$
3rd	79.667±6.206$^{B}{}_{a}$	103.167±8.619$^{A}{}_{b}$
4th	82.000±5.939$^{B}{}_{a}$	100.000±9.852$^{A}{}_{a}$
5th	82.667±8.781$^{B}{}_{a}$	99.667±10.009$^{A}{}_{a}$
6th	91.167±8.138$^{B}{}_{a}$	94.667±9.340$^{A}{}_{a}$
7th	84.000±7.737$^{B}{}_{a}$	101.500±7.182$^{A}{}_{a}$
8th	75.500±7.478$^{B}{}_{a}$	81.500±16.370$^{A}{}_{a}$
Overall	76.375±2.925$_{a}$	93.083±3.931$_{b}$

Means with similar superscripts in a column or subscripts in a row do not differ significantly (p>0.01) among themselves.

tendency of the cows to take more feed nutrients for supplying more nutrients to the developing calf in pre partum period and utilizing for more milk production during the post partum period. As the milk yield of the cows increased the demand for feed is also increased during postpartum experimental period to replenish the body tissue losses due to high milk production. The results of higher dry matter intake in the present study are in agreement with Vandehaar *et al.* (1999) who reported that average dry matter intake during last two weeks of pre partum period was significantly higher in the cows fed on high energy, high protein group than those fed on low energy, low protein group for the last 4 weeks of gestation (12.5 kg v/s 11.0 kg/day). Similarly, Keady *et al.* (2001) conducted an experiment on cows and found significantly higher DM intake of 11.03 kg/day for the treatment group supplemented with 5 kg concentrate and grass silage basal diet than 9.28 kg/day in the control group.

Colostrum yield

The results presented in Table 4 revealed that the cows of treatment group produced significantly higher amount of colostrum from day 1 to day 5. The extra concentrate fed during prepartum period may have augmented body reserves during dry period which were utilized for colostrum yield in the ensuing lactation. Extra concentrate feeding may have also encouraged development of secretory tissue in mammary glands which later contributed to increased colostrum yield. The additional concentrate feeding also provided extra nutrients to animals to enhance synthesis of colostrum. This positive effect on colostrum yield due to challenge feeding was also reported by Shashi and Yadav, (2016) and observed that steaming-up of cows with 4 kg of concentrate produced 3.07±0.89 kg colostrum per cow compared to 1.78±0.65 kg per cow fed 2 kg of concentrate supplements. Bhat *et al.* (2000) also found higher colostrum yield in two treatment groups cows fed 5 kg (T_1) and 6 kg (T_2) than the control group fed 4 kg concentrate/ day/animal for last 3 weeks pre partum.

Average weekly milk yield

The average weekly milk yield (kg) of the cows in control and treatment groups is presented in Table 5. The average milk yield of the treatment group was significantly higher than the control group. The significant increase in milk yield in the treatment group may be attributed to extra concentrate feeding during the dry period as well as during the course of lactation. The extra concentrate fed during prepartum period may have augmented body reserves during dry period which were utilized for milk production in the ensuing lactation. Extra concentrate feeding may have also encouraged development of secretory tissue in mammary glands which later contributed to increased milk. This positive effect on milk yield due to challenge feeding was also reported by Shashi and Yadav, (2016) and observed that steaming-up of cows with 4 kg of concentrate

Table 6: Average per cent milk composition of cows in control and treatment groups.

Week	Fat		Protein		Lactose		SNF	
	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
1st	4.55±0.22	4.41±0.24	3.58±0.07	3.56±0.08	5.41±0.13	5.41±0.13	9.38±0.23	9.40±0.22
2nd	4.38±0.26	4.63±0.28	3.33±0.18	3.43±0.08	5.18±0.11	5.28±0.09	9.15±0.16	8.96±0.20
3rd	4.66±0.34	4.66±0.28	3.55±0.05	3.55±0.05	5.48±0.10	5.48±0.10	9.48±0.18	9.48±0.18
4th	4.41±0.52	4.46±0.27	3.41±0.04	3.51±0.11	5.43±0.15	5.28±0.09	9.11±0.206	9.48±0.29
5th	4.55±0.39	4.68±0.26	3.43±0.21	3.76±0.12	5.50±0.16	5.517±0.08	9.48±0.18	9.81±0.23
6th	4.61±0.41	4.56±0.30	3.55±0.06	3.61±0.12	5.50±0.16	5.41±0.07	9.38±0.13	9.68±0.19
7th	4.58±0.40	4.56±0.27	3.60±0.09	3.70±0.18	5.65±0.16	5.35±0.15	9.16±0.15	9.66±0.17
8th	4.35±0.43	4.36±0.25	3.60±0.02	3.56±0.17	5.18±0.17	5.16±0.10	9.05±0.17	9.33±0.27
Overall	4.51±0.37	4.54±0.27	3.50±0.09	3.590±0.18	5.41±0.14	5.36±0.10	9.27±0.15	9.47±0.22

Table 7: Average cost of feeding and income from milk in control and treatment group.

Parameters	Control	Treatment
Total cost (Rs.) of feed (Post partum)	23538.08	24557.18
Cost (Rs.) of extra feed (Pre partum)	----	1248.52
Average daily cost (Rs.) of feed	420.32	460.81
Average daily milk yield (kg)	10.91	13.29
Daily return from milk (Rs.)	600.05	730.95
Feed cost (Rs.) per kg of milk production	38.53	34.67
Additional daily income (Rs.)	----	51.30

Table 8: Average body weight (kg) of the calves from birth to 8th week of age in control and treatment groups.

Week	Control	Treatment
Birth	22.000±1.483^{a}	27.333±1.256^{b}
1st	25.000±1.595^{a}	31.157±1.418^{b}
2nd	28.197±1.809^{a}	34.825± 1.486^{b}
3rd	31.402±1.847^{a}	37.723±1.373^{b}
4th	34.943± 2.127^{a}	41.380±1.516^{b}
5th	38.440± 2.343^{a}	44.482±1.498^{a}
6th	41.780± 2.486^{a}	48.192±1.716^{a}
7th	45.463±2.594^{a}	51.417±1.682^{a}
8th	49.400± 2.669^{a}	55.105±1.696^{a}
Overall	35.181±2.106	41.290±1.493

Means with different superscripts in a row differ significantly ($p<0.01$).

produced higher milk as well as fat corrected milk (FCM) yield /cow/day (6.48±2.56 and 7.73 kg) compared to the control group fed 2 kg of concentrate supplements (4.19±0.9 and 5.12 kg). Kamboj *et al.* (2016) and Bhat *et al.* (2000) reported higher daily milk yield in cows with higher plane of nutrition. Many factors may have contributed to the ambiguity of the response, non significant effect of higher nutritional levels on milk yield of cows such as variations in cow parity, body condition score (BCS), basal diet or the genetic potential of the cows.

Milk composition

The average weekly fat percentage, protein percentage, lactose percentage and SNF percentage of milk in control and treatment groups have been presented in Table 6. The milk fat percentage, protein percentage, lactose percentage and SNF percentage of challenge feed group of cows did not differ significantly from the control group of cows. Singh *et al.* (2003) reported non-significant fat, protein and SNF content in milk in both high and low plane of nutrition. On the other hand Bhat *et al.* (2000) in crossbred cows reported significantly higher fat percentage in milk with higher plane of nutrition. Kunz *et al.* (1985) also did not find any significant effect on milk lactose percentage in cows fed ad libitum and control diet.

Peri-parturient health problems

No cow of either control or treatment group during the experiment showed any sign of health problems during pre-partum and post-partum. This may be due to selection of healthy animals for the experiment and optimum managemental cares provided during the entire experimental period were key to keep the cows healthy. The findings of workers like Shashi and Yadav, (2016) and Singh *et al.* (2019) indicated beneficial effect of challenge feeding on productive and reproductive health of animals and avoided the risk and incidence related disorders directly or indirectly.

Cost of feeding

The data of different cost components and return there on during the 8 weeks lactation period in control and treatment group were presented in Table 7. Results revealed cost of extra feed for the challenge feed groups was Rs. 1248.52. Average daily milk yield per cow was 10.91 and 13.29 kg per day for control and treatment group respectively and the daily return from milk Rs. 600.05 for control group and Rs. 730.95 in treatment group and generated an additional income of Rs. 51.30 per day in the treatment group. As such, challenge feeding in the treatment group proved to be more economical than the conventional feeding in the

control group. The present findings are similar to those of Bhat *et al.* (2000) found that challenge fed groups generated extra net benefit of Rs.25.46/day/cow and prove that treatment group cows shows significantly better result and proved to be economical.

Body weight of calf

The average weekly body weight of the calves born in control and treatment groups have been presented in Table 8. The results revealed that the average birth weight of the calves in the treatment group was significantly higher than the control group and maintained this trend of higher body weight up to 4th week of age. In the subsequent weeks from 5th to 8th week of age also, the body weight of the calves in the treatment group was higher than in the control group. The higher birth weight of the calves was due to supplementation of higher plane of nutrition through feeding of extra concentrate in the treatment group during pre partum period and the calves with higher birth weight continued to grow faster in the subsequent weeks. The finding of higher birth weight was supported by findings of Corah *et al.* (1975) reported that heifers that were offered low energy prepartum had lower calf birth weight than heifers that were offered higher energy prepartum. Kale, (1984) reported that the birth weight of Karan-Fries calves delivered from cows fed on 1 kg/day were 27.20 kg, fed on 2 kg/day were 31.89 kg and fed on1 kg/day for 1 month and 3 kg/day for the next month were 31.80 kg and concluded a positive effect on birth weight of calves.

CONCLUSION

The cows performed well in respect of colostrums yield, milk production, maintenance of general health, safeguarded the dairy cows from calving and lactating stress and better growth performance of the new born calves with challenge feeding. The practice of challenge feeding was found to be economical in view of generation of additional daily income of Rs. 51.30 per cow in the challenge feed group by reducing the cost per kg milk production. Hence it can be concluded that challenge feeding is beneficial for crossbred dairy cows and practice of challenge feeding will be helpful to dairy farmers.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions.The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Institutional Animal Ethics Committee and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish or preparation of the manuscript.

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