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Increasing Dairy Cows Productivity through New Balanced Concentrate Feed: A Study in Bihar, India

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ABSTRACT

The present study examined the effect of a new balanced feed on livestock productivity in Bihar in comparison to existing feeding practices. These included supplementing crop residues with either individual concentrate components or with commercial feed. The new balanced feed consisted of crushed grains (37%), cereal brans (30%), pulse husks (10%), oil cakes (20%) and minerals (3%). This resulted in higher ($P<0.05$) levels of metabolizable energy and digestibility compared to other commercial feeds. This new feed was introduced through a combination of participatory trainings on feeding and demonstrations on feed preparation and farm-based feeding trials on 1290 crossbred dairy cows. On an average, farmers were feeding 3.9 kg commercial and/or home-made feed per dairy animal/day adjusted to individual milk yields. After replacing the existing supplements with a reduced amount (3.3 kg) of new feed, average milk yield as well as fat and SNF contents increased ($P<0.05$) by 14, 14 and 4%, respectively. The dairy farmers reduced their cost of milk production and increased their revenue from increased milk sales simultaneously. The new balanced feed also showed better palatability and positive effects on health and reproductive performance in terms of animal appearance and early conception.

Key words: Balanced feed, Experimental trials, Livestock productivity, Milk composition

INTRODUCTION

Dairying is an integral part of small-holder farming systems as well as an important source of subsidiary income for most households in Bihar, India. Since crop production is mostly seasonal, dairy farming is one available option of finding regular employment and income throughout the year for many household members. In Bihar, the share of dairy in the gross value of output from agriculture and allied activities (GVOA) has increased from 13% in 2000-01 to 24% in 2014-15 while at the all India level, the share of dairy in GVOA increased only 2% in the same period. There has been robust growth of the livestock sector in Bihar and its share in GVOA has increased from 23% in 2000-01 to 33% in 2014-15. In comparison, the all India share of livestock in GVOA increased only 3% during the period and stood by 27% in 2013-14 (GOI, 2008, 2017).

Bihar's share of milch cows and buffaloes is about 6.8% and it contributes about 5.3% of the national milk production (GOI, 2017). Bihar figures ninth in milk production in the country. The milk production in the state witnessed tremendous increase in last decade from 2.5 million tonnes in 2000-01 to 8.7 million tonnes in 2016-17, the compounded growth rate of 8.8% being almost double the national average of 4.7% (GOI, 2006, 2017). Nevertheless, the per-capita milk availability in Bihar is still low (228 g/d) compared to India's national average (355 g/d) in 2016-17) which is mainly due to low dairy animal productivity. Low quality feeds and poor feeding practices have been identified as major causes of low productivity driven by the fact that feeding is the major cost of milk production and is, therefore, seen as a prime target for cost reductions (Wolf, 2010). Dependence on residue feeding, non-scientific livestock management, limited farm resources, weak support services and poor knowledge on nutrient requirements of dairy animals are main hurdles in improving livestock productivity in Bihar. The present study was undertaken to see the effect of a balanced concentrate feed on livestock productivity in Bihar in comparison to existing feeding practices.

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MATERIALS AND METHODS

The data for this study were collected from 1290 dairy farmers feeding the new concentrate feed to their lactating cows. The experimental trials were conducted on lactating cows of the households who were the members of Self-Help Groups (SHGs) and Kisan Clubs. One lactating cow from each household was selected. The experimental trials were conducted in six districts of Bihar (Begusarai, Bhojpur, Muzaffarpur, Patna, Samastipur and Vaishali) during 2014-2015. A structured questionnaire was used to collect the data from all farmers which consisted of 3 days control (farmers' feeding practices) and 6 days experimental data on concentrate feed, milk yield, fat content and SNF content following the standard management practices of ILRI-CSISA project.

The current standard feeding practice of dairy farmers consisted of feeding crop residues with commercial cattle feed supplemented or with individual concentrate components such as crushed maize and/or oil cakes. The dairy farmers reported that without supplementation with individual concentrate components, milk yield reduced due to poor quality of commercial concentrates. Keeping this in view, a balanced concentrate feed was formulated with locally available feed ingredients according to the nutritional requirements for lactating cows given by ICAR (2013). To better understand the changes resulting from introducing new balanced feed, this feed and 14 locally available commercial dairy concentrate feeds were analysed for dry matter content, ash, crude protein, neutral detergent fibre, acid detergent fibre, acid detergent lignin, metabolisable energy and *in vitro* digestibility using Near-Infrared Spectroscopy (NIRS). The data were analysed statistically (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

It was observed that dairy farmers were feeding on an average 3.9 kg commercial and/or home-made supplements (crushed maize or in combination with mustard oil cake) per lactating animal/d (Table 1). After replacing the existing concentrate feed with a reduced amount (3.3 kg) of new balanced concentrate feed, average milk yield, fat content and SNF content increased ($P<0.05$) by 14, 14 and 4%, respectively. The results showed that dairy farmers could reduce cost of milk production while increasing their revenue from increased milk sales in terms of higher quantity (yield) and quality (fat and SNF contents). Similar results were reported by FAO (2012) which showed that milk yield and milk fat content increased *(*$P<0.05$) by 0.68 kg/d and 0.55% units in cows and 0.19 kg/d and 0.34% units in buffaloes, respectively in the northern region of India. In southern and central regions of India, milk yield increased ($P<0.05$) by 0.42 kg/d and 0.46% units, respectively in cows after ration balancing. The increase in milk production efficiency after ration balancing resulted in more (<0.05) milk from the same amount of feed. Thus, a decreased cost of the inputs increased profit.

The new balanced concentrate feed also showed

Table 1. Input and output of control and experiment animals

District	Concentrate feed (kg)		Milk yield(L)		Fat (%)		SNF (%)	
	C	E	C	E	C	E	C	E
Begusarai	$3.5^{c}\pm0.10$	$3.1^{b}\pm0.08$	$9.3^{a}\pm0.38$	$10.3^{a}\pm0.40$	$3.7^{b}\pm0.05$	$3.8^{d}\pm0.04$	$8.4^{a}\pm0.02$	$8.5^{a}\pm0.03$
Bhojpur	$2.5^{d}\pm0.13$	$2.5^{d}\pm0.10$	$7.7^{d}\pm0.41$	$8.5^{c}\pm0.43$	$5.3^{a}\pm0.18$	$5.4^{a}\pm0.23$	$7.9^{c}\pm0.11$	$8.2^{c}\pm0.09$
Muzaffarpur	$3.9^{b}\pm0.07$	$3.3^{b}\pm0.06$	$8.2^{d}\pm0.19$	$9.4^{b}\pm0.20$	$3.3^{c}\pm0.01$	$4.0^{c}\pm0.01$	$7.7^{d}\pm0.00$	$8.1^{d}\pm0.01$
Patna	$2.9^{d}\pm0.13$	$2.9^{c}\pm0.09$	$8.6^{c}\pm0.48$	$9.6^{b}\pm0.49$	$4.4^{d}\pm0.15$	$4.8^{b}\pm0.17$	$8.2^{b}\pm0.06$	$8.4^{b}\pm0.05$
Samastipur	$4.1^{a}\pm0.04$	$3.4^{a}\pm0.03$	$8.9^{c}\pm0.11$	$10.2^{a}\pm0.12$	$3.5^{b}\pm0.01$	$4.0^{c}\pm0.01$	$7.8^{d}\pm0.01$	$8.1^{d}\pm0.01$
Vaishali	$4.1^{a}\pm0.19$	$3.3^{b}\pm0.21$	$8.7^{c}\pm0.62$	$9.8^{b}\pm0.67$	$3.7^{b}\pm0.07$	$3.9^{d\pm}0.07$	$8.4^{a}\pm0.02$	$8.6^{a}\pm0.02$
Overall	3.9±0.03	3.3±0.03	8.7±0.09	9.9±0.10	3.5±0.01	4.0±0.01	7.9±0.01	8.2±0.01

^{a,b,c,d}Values bearing different superscripts in a column differ significantly ($P<0.05$); C: control/farmer's feeding and E: experimental feeding trial.

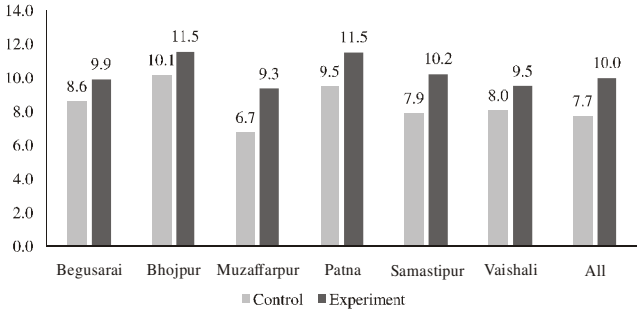

Fig. 1. Fat correct milk (FCM) yield per experiment animal across districts

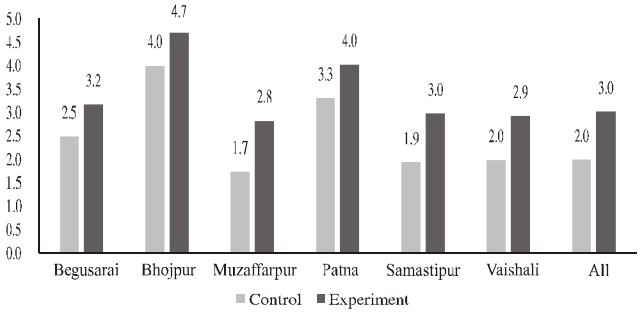

Fig. 2. Fat correct milk (FCM) yield per kg of ILRI-CSISA balanced concentrate feed

better palatability and positive effects on health and reproductive performance in terms of animal appearance, early conception and a lower incidence of ectoparasites. In addition, the new feed did not require cooking which is a common traditional practice in Bihar thus cutting down the cost incurred on fuel and labour.

Several studies have reported the effect of dietary energy on milk quality and animal health (Grieve *et al.,* 1986; Duffield *et al.,* 1997; Heur *et al.,* 2000; Weller *et al.,* 2002). Kennedy *et al.* (2001) revealed that increase in milk yield in response to supplementary concentrate feeding in recent decades stems partly from genetic improvement of cows. High genetic merit cows partition supplementary nutrients towards milk production instead of body reserves at the beginning of lactation. Similarly, Stefanon *et al.* (2002) reported that the milk yield response to concentrate supplementation depended on the overall energy content of the diet.

The farmers reduced their concentrate feed input by 0.6 kg/d/animal while milk yield increased (P<0.05) by 1.2 L/d/animal, fat content by 0.5 points and SNF content by 0.3 points (Table 2). On an average, FCM yield increased by 2.3 L/d/animal (Fig. 1). The lowest FCM yield increase was reported by Begusarai farmers (1.3 L/d/animal) and the highest by Muzaffarpur farmers (2.4 L/d/animal).

On an average, milk yield increased from 2.0 to 3.0 L during the experiment. Whelan *et al.* (2014) observed that milk yield improved with supplementary concentrates rich in protein. Highest output per kg of concentrate was observed in Muzaffarpur and Samastipur districts where milk yield increased by 1.1 L/kg balanced concentrate feed. Andersen *et al.* (2003) studied the effects of high concentrate proportion in diets on milk production and DMI during the first 16 weeks of lactation and DMI was not affected by percentage of concentrate although there was a strong tendency favouring the increase in milk yield with the high concentrate group.

The cost of the new balanced concentrate feed/L milk produced was ₹ 2.1 less than the commercial feed currently used by farmers during the control period

Table 2. Districtwise changes in input and output of experiment animals

District	Concentrate feed (kg)	Milk yield (L)	Fat (%)	SNF (%)
Begusarai	-0.3^{b}±0.05	1.0^{c}±0.04	0.2^{d}±0.02	0.1^{d}±0.02
Bhojpur	-0.1^{a}±0.07	0.8^{d}±0.07	0.2^{d}±0.09	0.3^{b}±0.08
Muzaffarpur	-0.6^{c}±0.06	1.1^{b}±0.04	0.7^{a}±0.01	0.4^{a}±0.01
Patna	-0.1^{a}±0.10	1.0^{c}±0.07	0.4^{c}±0.05	0.2^{c}±0.03
Samastipur	-0.7^{c}±0.04	1.3^{a}±0.02	0.5^{b}±0.01	0.3^{b}±0.01
Vaishali	-0.8^{d}±0.12	1.0^{c}±0.15	0.2^{d}±0.01	0.2^{c}±0.01
Overall	-0.6±0.03	1.2±0.02	0.5±0.01	0.3±0.01

^{a,b,c,d}Values bearing different superscripts in a column differ significantly (P<0.05)

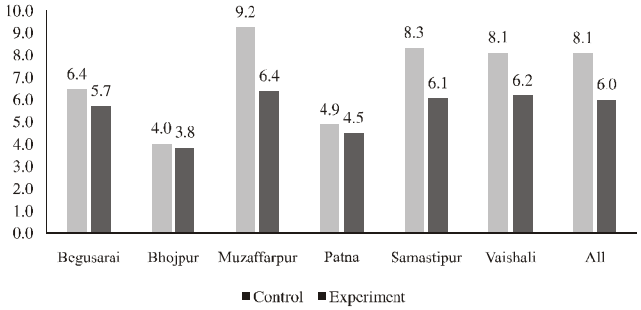

Fig. 3. Cost of balanced concentrate feed per litre of fat corrected milk (FCM) yield

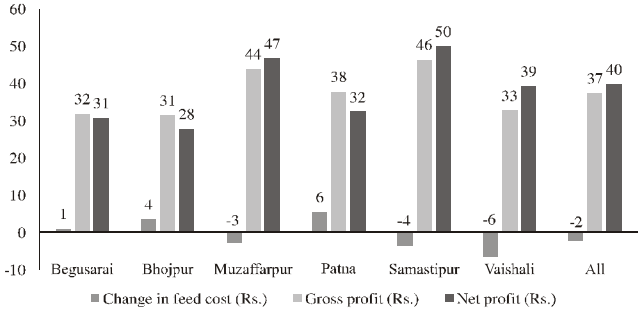

Fig. 4. Economics of ILRI-CSISA balanced concentrate feed (₹ per day/animal)

(Fig. 3). Muzaffarpur district showed the highest price gap (₹ 2.8) in cost of concentrate feed/L of milk between control and experiment while Bhojpur district showed the lowest difference (₹ 0.2). On an average, farmers gained from the new feeding practice *i.e.* they achieved positive net profits estimated at ₹ 40/ d/animal (Fig. 4). The observed variation in levels of benefits between districts was likely due to the variation in the levels of concentrate feed that farmers used during the feeding trials.

In some districts, farmers fed more balanced concentrate feed to obtain more milk while in other districts farmers used less concentrate during the experiment than control periods to reduce costs. The lowest benefit was reported in Bhojpur district where per animal/per day benefit was about ₹ 28 while the highest benefit was in Samastipur district (₹ 50) which was marginally higher than Muzaffarpur district and significantly higher than the other 4 districts. Buza *et al.* (2014) studied the effects of ration composition on profitability in dairy production on existing farms and reported that the lowered share of roughage in the feed ration had a positive effect on financial outcome. They also suggested that utilization of by-products has potential to enhance the dairy farm profitability. The amount of savings in dairy feed cost could have a large positive impact on reducing animal maintenance cost and thus, the profitability of dairy cooperation. Through

Table 3. Laboratory analysis of concentrate feeds (% on DM basis) available for dairy animals

Feed	DM[1]	Ash[2]	CP[3]	NDF[4]	ADF[5]	ADF[6]	ME[7]	IVOMD[8]
ILRI-CSISA Feed	91.0^{d}±0.10	7.4^{d}±0.13	22.5^{a}±0.20	35.9^{b}±0.39	14.2^{d}±0.36	3.3^{d}±0.11	10.3^{a}±0.09	72.7^{a}±0.45
Commercial Feed-1	91.1^{d}±0.16	13.5^{c}±0.34	16.8^{c}±2.31	35.7^{b}±0.84	18.6^{c}±0.36	4.7^{c}±0.23	9.0^{b}±0.11	65.9^{b}±0.61
Commercial Feed-2	94.2^{a}±0.54	18.5^{a}±0.34	21.8^{a}±0.82	23.6^{d}±1.83	22.9^{a}±0.77	5.2^{a}±0.17	7.2^{d}±0.11	57.8^{d}±0.20
Commercial Feed-3	93.0^{a}±0.43	16.0^{b}±0.33	22.6^{a}±0.35	25.8^{d}±1.33	19.7^{c}±0.64	5.0^{b}±0.27	8.1^{c}±0.10	62.3^{b}±0.57
Commercial Feed-4	92.2^{c}±0.47	14.7^{c}±0.94	19.9^{b}±0.80	34.0^{b}±3.60	23.1^{a}±1.38	5.3^{a}±0.27	8.2^{c}±0.38	61.1^{c}±1.81
Commercial Feed-5	92.0^{c}±0.25	16.9^{b}±0.77	19.5^{b}±0.70	32.1^{b}±1.31	22.4^{b}±0.55	5.2^{a}±0.07	8.2^{c}±0.13	61.6^{c}±0.56
Commercial Feed-6	91.8^{a}±0.24	15.4^{b}±0.29	21.6^{a}±0.56	31.5^{c}±0.81	20.1^{b}±0.58	4.7^{c}±0.22	8.4^{c}±0.07	62.7^{b}±0.55
Commercial Feed-7	91.0^{d}±0.17	15.1^{b}±0.43	15.0^{d}±2.25	35.6^{b}±0.94	20.7^{b}±0.55	4.8^{c}±0.24	8.5^{c}±0.11	63.0^{b}±0.65
Commercial Feed-8	90.9^{d}±0.08	12.9^{c}±0.35	19.0^{b}±0.38	40.9^{a}±0.71	22.7^{b}±0.90	5.3^{a}±0.14	9.0^{b}±0.15	64.8^{b}±0.85
Commercial Feed-9	91.6^{c}±0.11	14.0^{c}±0.41	22.7^{a}±0.49	31.7^{c}±0.97	19.3^{c}±0.63	5.1^{b}±0.16	8.7^{b}±0.15	64.5^{b}±0.79
Commercial Feed-10	93.0^{b}±0.51	16.2^{b}±0.68	20.0^{b}±0.57	30.9^{c}±1.51	24.4^{a}±0.95	5.5^{a}±0.18	7.5^{d}±0.24	58.3^{d}±1.19
Commercial Feed-11	92.2^{c}±0.24	17.3^{b}±0.39	21.1^{a}±1.18	28.0^{c}±0.74	21.9^{b}±0.72	5.1^{b}±0.15	7.7^{d}±0.15	59.4^{c}±0.82
Commercial Feed-12	93.67^{b}±0.65	19.7^{a}±0.32	22.5^{a}±0.00	23.1^{d}±0.75	21.4^{b}±0.30	4.4^{c}±0.05	7.3^{d}±0.00	59.1^{c}±0.08
Commercial Feed-13	92.1^{c}±0.37	16.0^{b}±0.81	22.4^{a}±0.92	30.6^{c}±2.07	22.2^{b}±1.14	5.3^{a}±0.21	7.9^{c}±0.35	60.5^{c}±1.71
Commercial Feed-14	91.1^{d}±0.14	12.8^{c}±0.46	20.4^{a}±1.20	38.4^{a}±0.96	21.9^{b}±0.58	5.2^{a}±0.15	8.9^{b}±0.13	65.1^{b}±0.69

^{a,b,c,d}Values bearing different superscripts in a column differ significantly (P<0.05);[1]dry matter, [2]ash, [3]crude protein, [4]neutral detergent fibre, [5]acid detergent fibre, [6]acid detergent lignin, [7]MJ metabolizable energy and [8]*in vitro* organic matter digestibility

the adoption of an optimum ration plan, it was possible to reduce the feed cost while maintaining a balanced diet for the lactating cows through the use of a linear programming model for formulatinga least cost diet (Munford, 1996; Torez, 2000; Djumaera *et al.,* 2009; Griffith, 2010).

The new balanced concentrate feed promoted by ILRI with the CSISA programme was of higher quality in many aspects (*e.g.* metabolizable energy and digestibility) than in any of the other commercial balanced concentrate feeds while only 3 commercial concentrates showed a higher protein value (Table 3). The lignin value of the new feed was lower than all other concentrate feeds which indicated that digestibility and energy content seemed to be more important for improving the feed quality than protein content.

This study was conducted only in 7 districts of Bihar. Therefore, the results applied mainly to this area. However, the type of crossbred dairy cows considered in this study, the feeding practices and the currently available concentrate feeds are similar in large areas of Eastern India. While slight adaptations to the locally appropriate balanced concentrate feed might be required to adjust to variations in dry fodder (*e.g.* wheat straw, paddy straw, maize stalks *etc.*).

CONCLUSIONS

The feeding of a new balanced concentrate feed for dairy animals increased the milk yield of dairy animals by 1.2 L/d/animal. The fat content also increased by 0.5 points while the SNF content increased by 0.3 points. On an average, farmers benefitted from increased net profits of ₹ 40.0/d/animal. New balanced concentrate feed was better than other commercial feeds in terms of protein, metabolizable energy and digestibility.

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