



Concentrate feeding to dairy cattle in India: Practices and implications for Indian dairy industry

PRAKASH KUMAR RATHOD¹ and MAHESH CHANDER²

ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

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ABSTRACT

The shaping of agriculture and allied sectors is possible as a result of research and development (R&D) efforts by offering new ideas, innovations, products and technologies. However, it is also observed that majority of the technologies developed by scientists are irrelevant and inappropriate for field conditions leading to poor diffusion and adoption. This issue is also aggravated by the fact that there is poor linkage of research-extension and farmers. With this theoretical background, the present study has focused on the ground realities or practices, perception of multi-stakeholders viz. dairy farmers, scientists and extensionists about concentrate feeds and has proposed certain policy implications for Indian dairy industry. The study included 360 dairy farmers, 80 research scientists and 40 extensionists in India. The primary data was collected by both qualitative and quantitative method using interview schedule, questionnaire, focus group discussion and observation method. The study revealed that scientists and extension experts were more favourable towards relevance, profitability and sustainability of concentrate feeds, while the perception of farmers was less favourable towards concentrate feeds. The study also observed that there was a wide gap (higher per cent gap) among farmers-scientists and farmers-extensionists with regards to relevance, profitability and sustainability of concentrate feeds, while the gap was very narrow among scientists and extensionists. Hence, the study concluded that scientists have to generate and transfer field relevant, profitable and sustainable dairy innovations for higher diffusion and adoption at field conditions. The study also recommends to involve farmers as the partners of research and extension for effective generation and transfer of dairy innovations leading to higher productivity in Indian dairy sector.

Key words: Concentrate feed, Multi-stakeholders, Profitability, Relevance, Sustainability

In an attempt to increase livestock productivity and improve food security at both national and household level, efforts are underway to generate and disseminate improved livestock technologies among small holder farmers in India. Though various innovations are generated with heavy investments from public and private sources (Moreddu 2013, Sunding and Zilberman 2001, James 1996, Beintema and Stads 2008, Dev 2012), most of the research results and recommended innovations concerning livestock sector have not gone beyond four walls of laboratories and libraries. Thus, the poor productivity as well as the quality of production and products remains a cause of concern in Indian livestock and dairying sector (Chander *et al.* 2010).

Indian dairy sector

Dairying has been one of the livelihood options for many rural poor, especially for landless, marginal and small farmers in India, which indicates that presently over 120

million rural families are engaged in dairying. Dairying is an effective tool for rural development, employment and sustained income and it acts as an insurance against several odds (Prasad 2011). Though, India is blessed with 190.09 million cattle and 108.7 million buffaloes (GOI 2012a), the productivity per animal is very poor. For instance, the average annual milk yield of Indian cattle is 1172 kg which is only about 50 % of the global average (FAOSTAT 2014), and much less than New Zealand (3343 kg), Australia (5,600 kg), UK (7,101 kg), US (9332 kg) and Israel (10,214 kg). Likewise, despite significant increase in dairy production, per capita consumption of milk (69 kg) and meat (3.7 kg) has been much lower against corresponding world averages of 85 and 40 kg, respectively, (GOI 2012b).

Dairy production systems in India

The liberalization of Indian economy, sustained economic and income growth, opportunities for export, etc. have brought about a subtle changes in dairy production systems. The major changes being seen in the recent years as mentioned by GOI (2010) are:

- Shift from resource-driven to demand-driven production systems

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Present address: ¹Assistant Professor (prakashkumarkr@gmail.com), Department of Veterinary and Animal Husbandry Extension, Veterinary College, Bidar, Karnataka State, ²Principal Scientist and Head, Division of Extension Education.

- Shift from extensive subsistence systems to semi intensive / intensive commercial systems
- Many educated youth taking up animal husbandry activities, especially commercial dairy farming as business enterprises.

Dairy production systems are broadly classified as mixed rainfed, mixed irrigated, grassland and landless/industrial (Thornton *et al.* 2003). However, mixed farming systems are undergoing a steady transformation due to increasing pressure to produce more to meet the growing food demand. Since the smallholders are constrained by lack of access to markets, capital, inputs, technology and services, the productivity in dairy sector is low. The reduction of risks for dairy farmers demand for availability of improved breeding services, targeted preventive animal health care, better feeding strategies and easy access to formal credit facilities (Torsten *et al.* 2003). The major input that adds to the cost of dairy production (65–70%) is the feed and in the recent times, the feed costs have risen 2–3 times and hence it becomes necessary to address this issue with greater emphasis. Although, various feed and fodder sources are available, there is a need to study the need based dairy innovations which are relevant, profitable and sustainable at field conditions. Among the various dairy innovations, concentrate feeding has been considered as an emerging dairy innovation of socio-economic importance in Indian dairy industry (Rathod and Chander 2014).

This study has focused on the ground realities or practices, perception of multi-stakeholders about concentrate feeds and has proposed certain policy implications for Indian dairy industry. The paper has briefed the status and issues of animal feeds and feeding in India and has discussed about the perception of multi-stakeholders viz. dairy farmers, scientists and extensionists with regards to relevance, profitability and sustainability of concentrate feeding in dairy industry.

MATERIALS AND METHODS

Keeping in view the objectives of the study, the districts

where the veterinary or animal science universities are situated were selected purposively for data collection (Table 1). Multistage random sampling and snow ball method were followed to select 15 dairy farmers from each village. Totally, six villages per district within a state were selected making a final sample size of 360 farmers from a total of 24 villages in four states as mentioned in Table 1. During the selection of respondents, care was taken to select the farmers who practiced dairy farming as major or subsidiary occupation. The scientists or teaching faculty of the universities were randomly selected considering the fact that they were involved in teaching, research and extension activities of the university. During the selection of respondents, care was taken that among 30 scientists selected, 10 were extensionists from universities or allied KVKs and remaining 20 were involved in research activities of the university.

A judicious mix of both primary and secondary data was used in the study. The data from the dairy farmers was collected either at their farm or home using pretested interview schedule, while that from the scientists and extensionists was collected personally at their offices using questionnaire. Information through observation during interview, group discussion and secondary sources like departmental documents, records, reports and other sources also were collected. Further, a workshop was organized for the scientists and scholars of IVRI, Izatnagar to discuss on the issues and enlist various suggestions for effective generation and transfer of concentrate feeding as dairy innovation (IVRI 2014). The awareness of the farmers was studied with the score of 2 and 1 for 'aware' and 'not aware' about the concentrate feed. The relevance of concentrate feeds was studied using the score of 3, 2 and 1 for 'relevant', 'undecided' and 'irrelevant' at field conditions. The profitability of concentrate feeds was studied on three point continuum as 'profitable', 'undecided' and 'not profitable' with the score of 3, 2 and 1, respectively. The sustainability of concentrate feeds was studied using the sustainability index of Swaminathan (1991) with suitable modifications.

Table 1. Study location

Universities under study (for scientists and extensionists)	Districts under study (for dairy farmers)	States	Geographical location
ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar (http://ivri.nic.in/)	Bareilly	Uttar Pradesh	28.360 N 79.410 E
G.B. Pant University of Agriculture & Technology (GBPUA&T), Pantnagar (http://www.gbpuat.ac.in/)	Udham Singh Nagar	Uttarakhand	28.980 N 79.400 E
ICAR-National Dairy Research Institute (NDRI), Karnal (http://www.ndri.res.in/ndri/Design/Index.html)	Karnal	Haryana	29.690 N 76.980 E
Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana (http://www.gadvasu.in/)	Ludhiana	Punjab	30.910 N 75.850 E

The responses for sustainability were studied in 14 different dimensions and the responses were assigned the score of 3, 2 and 1 for 'agree', 'undecided' and 'disagree', respectively. Further, the innovations were classified into low, medium and high sustainability categories. The data collected from sample respondents were coded, tabulated, analyzed and presented in the form of tables. The statistical tools viz. frequency, percentage, mean and standard deviation were used for analysis of the data. Further, Chi-square test was applied to compare the scenario in different states using SPSS version 20.0 package. The inferences were drawn in light of the results obtained, keeping in view the objectives laid in the study.

RESULTS AND DISCUSSION

Animal feeds and feeding: Status and issues: Adequate supply of feed and fodders is crucial to improve dairy production. Dairying in India is maintained largely on crop residues, by-products and grazing lands. India has remained chronically deficit in feed and fodders. The National Commission on Agriculture (1976) estimated deficit in dry fodder, green fodder and concentrates to the extent of 49, 53 and 43 %, respectively, for the year 1972–73. Feed deficit, however, declined subsequently due to significant increases in production of food–feed crops. However, over the last two decades (1985–86 to 2005–06), availability of various types of feed has increased. Even though availability of feed resources vary from area to area, but during this period, the country as a whole recorded 52 % (240.7 to 365.8 MT), 76.0 % (19.6 to 34.5 MT) and 1.8 % (124.3 to 126.6 MT) increase in crop residues, concentrates and green forages, respectively. As per estimates, the deficit of dry fodder, concentrates and green fodder by 2020 is likely to be 11, 35 and 45 %, respectively, (GOI 2012b). Availability of crop residues and concentrates is linked with the food crop production and since the overall food crop production in the country has shown an increasing trend, the crop residue and concentrate feed ingredients availability has

also shown a commensurate increase.

With dairy farming gaining a commercial importance, the demand for feed has increased greatly. The setting up of compounded feed manufacturing units has become an applicable enterprise leading to increased production of cattle feeds on commercial basis. In addition, the cooperative sector and few private sectors also manufacture the feed (Prasad 2011). But, majority of cattle and buffalo in India are fed homemade feed mixture, concentrates and grazing (Prasad 2011). The private sector produces about 1.2 million tonne and dairy cooperatives produce about 2.5 million tonne of feed and the rest is produced by home mixes in the unorganized sector. About 50 % of India's milk production comes from genetically poor, low yielding indigenous animals and they are mainly provided with home-made mixes (Prasad 2011).

Perception of dairy farmers towards concentrate feeding

The perception of dairy farmers with regards to awareness, relevance, profitability and sustainability is presented in Table 2. The study revealed that 96.38 % of the farmers were aware about concentrate feeds and feeding.

Further, the study indicated that majority of the farmers in pooled data perceived concentrate feeding as relevant by the farmers followed by the response of irrelevant at field conditions. With regards to profitability of concentrate feeding, the study reported that 47.5 % of the farmers in pooled data were in undecided category at field conditions followed by 26.67 % farmers who responded that it was non-profitable in dairying. The sustainability of concentrate feed as perceived by the dairy farmers in terms of their favourability is presented in Table 2. The study indicated that majority of the farmers in pooled data reported medium level of favourability for sustainability of concentrate feed, while 21.94 % respondents perceived high and 13.89 % farmers' perceived low favourability for sustainability of concentrate feeds at field conditions. There was highly significant difference ($P < 0.001$) among the respondents across the states with regards to awareness, relevance,

Table 2. Perception of dairy farmers towards concentrate feeding as dairy innovation

Variables	Categories	States				Pooled	χ^2
		UP	UK	Haryana	Punjab		
Awareness	Not aware	07(7.77)	04(4.44)	02(2.22)	0(0)	13(3.62)	8.53*
	Aware	83(92.23)	86(95.56)	88(97.78)	90(100.0)	347(96.38)	
Relevance	Irrelevant	50(55.56)	45(50.0)	20(22.22)	05(5.55)	120(33.33)	97.8**
	Undecided	27(30.0)	22(24.44)	26(28.89)	16(17.78)	91(25.28)	
Profitability	Relevant	13(14.44)	23(25.56)	44(48.89)	69(76.67)	149(41.39)	86.3**
	Non-profitable	47(52.22)	32(35.56)	12(13.33)	05(5.56)	96(26.67)	
Sustainability	Undecided	34(37.78)	45(50.0)	53(58.89)	39(43.33)	171(47.5)	176.9**
	Profitable	09(10.0)	13(14.44)	25(27.78)	46(51.11)	93(25.83)	
(mean±SD: 28.70±5.09)	Low	32(35.56)	17(18.89)	01(1.11)	0(0)	50(13.89)	176.9**
	Medium	58(64.44)	71(78.89)	69(76.67)	33(36.67)	231(64.17)	
	High	0(0)	02(2.22)	20(22.22)	57(63.33)	79(21.94)	

Figures in the parenthesis indicate percentage.

Table 3. Perception of scientists towards concentrate feeding as dairy innovation

Variables	Categories	Universities				Pooled	χ^2
		IVRI	GBPUAT	NDRI	GADVASU		
Relevance (59)	Irrelevant	02(14.28)	0(0)	01(7.14)	01(6.25)	04(6.77)	2.34
	Undecided	0(0)	0(0)	0(0)	0(0)	0(0)	
	Relevant	12(85.72)	15(100.0)	13(92.86)	15(93.75)	55(93.23)	
Profitability (59)	Non-profitable	03(21.42)	0(0)	0(0)	01(6.25)	04(6.78)	7.57
	Undecided	0(0)	01(6.66)	01(7.14)	01(6.25)	03(5.09)	
	Profitable	11(78.58)	14(93.34)	13(92.86)	14(87.50)	52(88.13)	
Sustainability (31) (mean $\pm$ SD: 36.68 $\pm$ 3.61)	Low	03(33.33)	0(0)	01(14.28)	01(11.11)	05(16.13)	6.3
	Medium	05(55.55)	05(83.33)	04(57.14)	08(88.89)	22(70.97)	
	High	01(11.12)	01(16.67)	02(28.58)	0(0)	04(12.90)	

Figures in the parenthesis indicate percentage.

profitability and sustainability of concentrate feeding which might be due to variation in their socio-economic status, information access and scientific orientation.

Perception of scientists towards concentrate feeding: The perception of scientists towards concentrate feeding with regards to relevance, profitability and sustainability is presented in Table 3. The study revealed that majority of the scientists in pooled data perceived that concentrate feeding was relevant at field conditions while remaining scientists responded that it was irrelevant at field conditions. The study depicted that majority of the scientists in pooled data perceived that it was profitable followed by 6.78 % who responded that it was non-profitable at field conditions. This indicated the fact that still scientists were in dilemma about the profitability of concentrate feeding. The sustainability of concentrate feeding indicated that majority of the scientists in pooled data reported medium favourability for sustainability, followed by high and low favourability for sustainability of concentrate feeding at field conditions. The study indicated that majority of the scientists were doubtful about the sustainable quality of concentrate feeds at field conditions. Few researchers also discussed about the limitations of concentrate feeding for the small and marginal farmers and hence, perceived that

there was a need to modify the innovation as per the suggestions of the farmers.

Perception of extensionists towards concentrate feeding: The perception of extensionists towards concentrate feeding with regards to relevance, profitability and sustainability is presented in Table 4. The study revealed that 87.5 % of the extension experts in pooled data perceived that concentrate feeding was relevant at field conditions while remaining experts responded undecided for the same. The study on profitability of concentrate feed in dairying revealed that majority of the experts in pooled data perceived that it was profitable followed by 17.5% who responded as undecided for the profitability of concentrate feeding. The study also reported that 56.53% of the extension experts in pooled data reported medium favourability for sustainability, while 30.43% and 13.04% respondents perceived high and low favourability for sustainability of concentrate feeds, respectively, at field conditions. This also highlighted the fact that there is a need to transfer only the sustainable dairy innovations to the field conditions rather than promoting all the innovations.

Constraints/problems in feeding concentrate feeds as perceived by dairy farmers: Following are the major constraints or problems perceived by dairy farmers in

Table 4. Perception of extensionists towards concentrate feeding as dairy innovation

Variables	Categories	Universities				Pooled	χ^2
		IVRI	GBPUAT	NDRI	GADVASU		
Relevance (40)	Irrelevant	0(0)	0(0)	0(0)	0(0)	0(0)	0.68
	Undecided	01(10.0)	02(20.0)	01(10.0)	01(10.0)	05(12.5)	
	Relevant	09(90.0)	08(80.0)	09(90.0)	09(90.0)	35(87.5)	
Profitability (40)	Non-profitable	0(0)	0(0)	01(10.0)	0(0)	01(2.5)	3.42
	Undecided	02(20.0)	02(20.0)	01(10.0)	02(20.0)	07(17.5)	
	Profitable	08(80.0)	08(80.0)	08(80.0)	08(80.0)	32(80.0)	
Sustainability (23) (mean $\pm$ SD: 36.48 $\pm$ 5.29)	Low	0(0)	01(16.67)	01(20.0)	01(25.0)	03(13.04)	5.71
	Medium	07(87.5)	02(33.33)	02(40.0)	02(50.0)	13(56.53)	
	High	01(12.5)	03(50.0)	02(40.0)	01(25.0)	07(30.43)	

Figures in the parenthesis indicate percentage.

feeding concentrates to their dairy animals.

- Animals don't relish/non-palatable.
- Highly expensive to purchase concentrate feed from market.
- Costly inputs/raw materials if prepared at home.
- Poor accessibility of inputs/raw materials.
- Lack of knowledge about concentrates feeding.
- Difficult to maintain quality control and balance the ration scientifically.
- Difficult to mix ingredients homogenously if prepared at home.
- Difficult to observe limitations/toxicity of ingredients used in concentrates.
- Cause health problems if too much is fed alone without roughages.
- No immediate benefits from concentrate feeding.
- Poor quality concentrate feeds available in market now-a-days.

The results of the study as a whole revealed that linkages among the three stakeholders viz. farmers, researchers and extensionists were not strong enough which was clear with the constraints or problems faced by the farmers in adopting concentrate feeds as dairy innovation. With regards to technologies related to animal feeding, Walli (2014) reported that the economics of milk production varied with the herd size, the average milk yield and the availability and the cost of feed resources. He also pointed out that there was a need to evolve different sets of feeding models/technologies for landless, small, marginal and for bigger farmers. In a similar context, the Asian Development Bank (ADB 1993) study on policies and strategies for livestock improvement in developing countries concluded that the primary reason for policy failure was the promotion of inappropriate technology. This was reflected in continuing problems experienced in livestock development programmes and projects. However, Rao *et al.* (1995) concluded that rate of adoption was influenced by the farmers' perception of the characteristics of the technology and the required changes in farm management and distribution of family labour.

Modifications/alternatives suggested by dairy farmers for effective generation and transfer of concentrate feeds

The modifications/alternatives suggested by dairy farmers for effective generation and transfer of concentrate feeds as dairy innovation are enlisted below.

- Need to add few components/sweeteners to make concentrate feeds palatable.
- Low cost inputs/raw materials needed to prepare at home.
- Promote easy accessibility of inputs/raw materials.
- A process or mechanism to self evaluate the quality and balance the ration scientifically by farmers must be developed.
- Simple ways to observe toxicity of ingredients used in concentrates are necessary.
- Universities/government institutions can manufacture

feed since the farmers have faith and trust on them.

- The pricing of feeds may be fixed on the quality of feed.
- Need for a strict government mechanism to control illegal and poor quality feed manufacturers.

The results of the study revealed that farmers had various problems with the existing innovations and hence, they demanded for modifications and support from various stakeholders like research and extension institutes, government etc. It is argued that farmers generate and use knowledge, and constantly experiment to manage risks and improve their operations. They should therefore be the natural partners of research (Smith *et al.* 2004) for a mutual exchange and reconciliation of modern and traditional knowledge. Further, on similar lines, Rao *et al.* (1995) also reported that it was essential to appreciate and recognize the perceptions and priorities of the farmers before contemplating development programmes. Only a shared vision among the researchers, extension personnel, farmers and the policy makers can help to evolve suitable strategies for increased production and prosperity. A study conducted by Heffernan and Misurelli (2011) concluded that demand-led research was an option to increase the impact and uptake of livestock research. Across stakeholder groups, the same study demonstrated the large gap between the perceptions of different actors. The results also demonstrated that the importance given to farmer opinions/perceptions varied dramatically between researchers. Moran (2014) also revealed that the biggest constraint to improve the utilisation of by-products was their technology transfer. A more coordinated approach was required, firstly for the 'information disseminators' to document current knowledge in more farmer friendly ways, secondly to seek feedback from the 'information assessors' so that the 'information users' can convert this new knowledge into dollars or rupees.

Per cent gap among multi-stakeholders towards relevance of concentrate feeds: The perception of multi-stakeholders viz. farmers, scientists (researchers) and extensionists towards relevance of concentrate feeds depicted the fact that scientists and extensionists perceived concentrate feeding as more relevant at field conditions compared to dairy farmers. Table 5 depicts that there was a wider per cent gap between farmers-scientists and farmers-extensionists, while the percent gap between scientist-extensionists was very low for relevance of concentrate feeding. This study reaffirmed the fact that there was a weak linkage among the farmers, scientists and extensionists with regard to relevance of concentrate feeding at field conditions. On similar lines, Thomas (2012) also reported that for research to be more relevant to the farmers, there is a need to create a participatory approach that emphasizes research and extension linkage and allows farmers to choose appropriate technologies from research stations, thereby eliminating the perception that extension system is separate from the research system. Rao *et al.* (1995) revealed that there was lack of awareness on the part of the researchers

Table 5. Per cent gap among multi-stakeholders towards concentrate feeding as dairy innovation

Variables	Categories	Per cent gap among the stakeholders		
		Farmers-Scientists	Scientists-Extensionists	Farmers-Extensionists
Relevance	Irrelevant	26.56	6.77	33.33
	Undecided	25.28	12.5	12.78
	Relevant	51.84	5.73	46.11
Profitability	Non-profitable	19.89	4.28	24.17
	Undecided	42.41	12.49	30.0
	Profitable	62.3	8.13	54.17
Sustainability	Low (14–21)	5.0	0	5.0
	Medium (21–28)	38.89	4.34	34.55
	High (28–35)	15.31	13.34	1.97
	Very high (35–42)	59.2	17.68	41.52

and extension agencies regarding the farmers' priorities. This has led the development community to address the wrong problems resulting in technologies which are not suitable or relevant to the farm families for whom they were evolved. In a similar study, Chambers and Ghildyal (1985) also reported that majority of the technologies developed by scientists were irrelevant and inappropriate for field conditions.

Per cent gap among multi-stakeholders towards profitability of concentrate feeds: The perception of multi-stakeholders viz. farmers, scientists (researchers) and extensionists towards profitability of concentrate feed as dairy innovations at field conditions indicated the fact that scientists and extensionists perceived concentrate feeding as more profitable at field conditions compared to dairy farmers. Table 5 depicts that there was a wider percent gap between farmers-scientists and farmers-extensionists, while the percent gap between scientist-extensionists was very low for profitability of concentrate feeding. A study conducted in Iran also revealed that there was insufficient linkage between local agricultural officers and researchers who were working in universities or other research centres. The researcher, therefore, offered recommendations to strengthen the interactions between extension and research institutions (Zamani 2000). Glendenning *et al.* (2010) also reported that these institutes faced the challenges in terms of staff, partnership etc. which would facilitate the joint offering of demonstrations of recent technologies. Further, Moran (2014) also reported that poor acceptance rates by the small farmers for majority of these technologies was attributed to the lack of extension facilities, unavailability of inputs and the time and labour involved under small farm situations. All these previous studies also depict that there is a poor linkage among the stakeholders viz. farmers, scientists and extensionists.

The scientists and extensionists perceived that concentrate feeding was more sustainable at field conditions as compared to dairy farmers. Table 5 depicts that there was a high percent gap between farmers-scientists in very high (59.2) and medium (38.89) sustainable categories, while the per cent gap for farmers-extensionists was 41.52

and 34.55 for very high and medium sustainable categories, respectively. This study highlighted that there was higher per cent gap among the farmers, scientists and extensionists with regard to sustainability of concentrate feeding at field conditions. On the similar lines, Boyazoglu (1998) reported that livestock-related development projects must be efficient and economically sustainable, but also diversified, clean, of high biological added value, and integrated in a healthy, dynamic and renewed agricultural and environmental context. A simpler, robust, cost effective and eco-friendly viable technology would be the key to maximize the gains from dairy cattle. There is a need for a thorough evaluation of extension approaches in order to identify best practices and understand their impact on farming communities and to recognize how extension can be strengthened, particularly to reach smallholder and marginal farmers (Glendenning *et al.* 2010). All these previous studies also depicted a poor linkage among the stakeholders viz. farmers, scientists and extensionists.

Per cent gap among multi-stakeholders towards sustainability of concentrate feeds: The study revealed that perception of scientists and extension experts were more favorable towards relevance, profitability and sustainability of concentrate feeds, while the perception of farmers was less favourable towards concentrate feeds. The study also observed that there was a wide gap (higher per cent gap) among farmers-scientists and farmers-extensionists with regards to relevance, profitability and sustainability of concentrate feeds, while the gap was very narrow among scientists and extensionists. The study concluded that researchers and extension experts need to make farmers more aware about the benefits of concentrate feeds to improve productivity in the dairy sector. Since, majority of the dairy farmers reported various constraints leading to poor adoption, a need based long-run study under field conditions must be undertaken on concentrate feeds to determine the relevance, profitability and sustainability of concentrate feeds and feeding. Further, they demanded for modifications and support from various stakeholders like research and extension institutes, government etc. Hence, the scientists have to generate and transfer field relevant,

profitable and sustainable dairy innovations for higher diffusion and adoption at field conditions. The study also recommends to involve farmers as the partners of research and extension for effective generation and transfer of dairy innovations leading to higher productivity in Indian dairy sector.

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