Concentrate feeding to dairy cattle: Adoption status and factors affecting its adoption in India

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ABSTRACT

An attempt was made to study the adoption status of concentrate feeding and to identify factors affecting its adoption in India through primary data collection from 360 dairy farmers. The study revealed that majority of the respondents had not adopted this practice, followed by full and partial adoption in the study area. Further, the study also pointed out that about 21 per cent farmers adopted concentrate feeding since 3-6 years, while about 19 per cent farmers had adopted the practice from 6-9 years. The adoption status revealed that there was highly significant difference across the states for concentrate feeding in dairying. Multinomial logit model depicted the Chi-square value of 144.84 indicating that the model was highly significant (p<0.001). The study suggested that researchers and extension experts need to make farmers more aware about the benefits of concentrate feeding to improve productivity in the dairy sector. Further, the scientists have to analyse the problems of dairy farmers and find suitable solutions for higher diffusion and adoption at field conditions by participatory technology generation and transfer approach with adequate representation of farmers so that their feedback can be taken into consideration.

Key words: Adoption, Dairy innovation, Livestock technology, Multinomial logit model.

INTRODUCTION

Dairying has been one of the livelihood options for 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, 2012 a), the productivity per se is very poor. For instance, the average annual milk yield of Indian cattle is 1172 kg which is only about 50 per cent of the global average (FAOSTAT, 2014), and much less than New Zealand (3343 kg), Australia (5600 kg), UK (7101 kg), US (9332 kg) and Israel (10214 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, 2012 b). Chander et al. (2010), also pointed out that poor productivity as well as the quality of production and products remains a cause of concern in Indian livestock and dairy sector.

However, the productivity in dairy sector is low, and smallholders are constrained by lack of access to markets, capital, inputs, technology and services. Reduction of production risks faced by rural landless dairy farmers requires the 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. Among the various dairy innovations in feeds and feeding, concentrate feed has been considered as an emerging dairy innovation of socio-economic importance in Indian dairy industry (Rathod and Chander, 2014). Although professionals have pointed out concentrate feeding as an emerging dairy innovation of importance, the ground realities or practices about concentrate feeds is entirely different. With this theoretical background, an attempt was made to study the adoption status of concentrate feeding and also to identify factors affecting adoption of concentrate feeding in India. Further, the study also proposed certain policy implications for Indian dairy industry to improve the diffusion and adoption of concentrate feeding.

MATERIALS AND METHODS

A combination of purposive and multi-stage random sampling was adopted in the study to select the respondents. Four Agricultural / Veterinary Universities and Institutes, which are at the forefront of research in livestock sector, were selected. All the selected Universities / Institutes have carried out researches in feeding of concentrates to the dairy
animals. The districts in which these Veterinary Universities / Institutes are situated were thus selected to ascertain the extent of adoption of concentrate feeding. Table 1 presents the selected Universities / Institutes and the districts in which the study was conducted. A total of 6 villages from each district were selected randomly at the rate of three villages from each block. Fifteen farmers having at least two dairy animals were then selected from each village using random and snow ball method. Thus, the ultimate sample size comprised of 360 dairy farmers from a total of 24 villages in four states of North India.

The primary data from the dairy farmers was collected either at their farm or home using pretested interview schedule by personal interview method. Information through observation during interview and group discussion was also collected. Adoption categories of concentrate feeding was studied using a schedule developed for the purpose with the score of 4, 3, 2 and 1 for ‘adoption’, ‘partial adoption’, ‘discontinuation’ and ‘non adoption’, respectively. Adoption status of concentrate feeding by farmers was enquired to know the total number of years since when this particular practice was introduced in their farm. The responses were categorized into adoption since ‘last 0-3 years’, ‘last 3-6 years’, ‘last 6-9 years’ and ‘more than 9 years’. The data collected from sample respondents were coded, tabulated, analyzed and presented in the form of tables. The statistical tools viz. frequency, percentage, mean, standard deviation and Chi-square test were used for analysis of the data 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.

**Application of Multinomial Logit Model to identify the factors influencing degree of adoption of concentrate feeding:** To identify the factors that influence the respondents’ degree of adoption of concentrate feeding, a multinomial logit model (as used by Pundo and Fraser, 2006) was fitted. The multinomial logit model not only focused on the most important decision (whether the farmer adopts concentrate feeding or not), but also on the degree of adoption of concentrate feeding. In the fitted model, the dependent variable assumed three discrete values, viz. 0 (when the respondent did not adopt concentrate feeding), 1 (when the respondent partially adopted concentrate feeding) and 2 (when the respondent fully adopted concentrate feeding). Given the alternatives before a respondent, the probability that an individual i choose alternative j, therefore, can be expressed by equation:

$$Pr[Y_i=j] = \frac{\exp (\beta' jX_i)}{\sum \exp (\beta' jX_j)}$$

where,

$Pr[Y_i=j] = $ Probability that an individual i belongs to either ‘No adoption’, ‘Partial adoption’ and ‘Full adoption’ category.  
$j = 1, 2, 3$  
$i = 1, 2, 3, \ldots , 360$  
$X_i = $ Vector of the predictor variables, and  
$\beta_j = $ Vector of the estimated parameters

The multinomial logit model determines the effect of independent variable on the probability that a farmer will belong to one of the three categories, viz. non-adopter, partial adopter and full adopter. This model was estimated by keeping the dependent variable 0 (i.e. non-adopter) as the reference category. The $e^{\theta}$ was calculated, which gave the odds ratio (OR) associated with change in the independent variables. The odds mean the ratio of probability of happening of an event to probability of not happening of that event. The odds are expressed as single number to the ratio to 1. The odds of 2 associated with partial adoption, for example, means that the likelihood of partially adopting an innovation is twice that of not adopting. Zero-order correlation matrix was obtained to ensure that multicollinearity did not pose any problem in estimating parameters of the mathematical model. The variables having higher multicollinearity were dropped in the final model to improve the values of the variables. Table 2 depicts the variables used in the model with their expected signs.

**RESULTS AND DISCUSSION**

**Adoption categories of concentrate feeding:** The adoption status of concentrate feeding was studied to know whether the farmers had adopted concentrate feeding or not and the type of adoption followed by the farmers in the study area. The Table 3 indicates that among the pooled data 43.89 per cent of the respondents had not adopted the concentrate feeding, while 28.28 per cent farmers adopted this innovation in their farms. The study also depicted that 21.39 per cent had discontinued adoption of concentrate feeding. This variation in the adoption status might be attributed to poor socio-economic status, low risk and economic

<table>
<thead>
<tr>
<th>Universities identified</th>
<th>Districts under study (for dairy farmers)</th>
<th>States</th>
<th>Geographical location</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar</td>
<td>Bareilly</td>
<td>Uttar Pradesh</td>
<td>28.36° N79.41° E</td>
</tr>
<tr>
<td>G.B. Pant University of Agriculture &amp; Technology (GBPUSA&amp;T), Pantnagar</td>
<td>Udham Singh Nagar</td>
<td>Uttar Pradesh</td>
<td>28.98° N79.40° E</td>
</tr>
<tr>
<td>ICAR-National Dairy Research Institute (NDRI), Karnal</td>
<td>Karnal</td>
<td>Haryana</td>
<td>29.69° N76.98° E</td>
</tr>
<tr>
<td>Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana</td>
<td>Ludhiana</td>
<td>Punjab</td>
<td>30.91° N75.85° E</td>
</tr>
</tbody>
</table>
orientation and also low livestock holding in the states of Uttar Pradesh and Uttarakhand. Further, high adoption in Haryana and Punjab might be the factors contributing for improved dairying in these states. This might be the reason for highly significant difference (p< 0.001) among the respondents across the states with regards to adoption of concentrate feeds in dairying.

In a similar study, Rezvanfar (2007), Singh et al. (2009) and Rathod et al. (2014) also reported similar findings regarding adoption of concentrate feeding. However, Prasad (2011) reported that majority of the dairy farmers in India fed homemade feed mixture and followed grazing practices which might be the reason for partial or non-adoption of concentrate feeding.

Adoption status of concentrate feeding (Years since when it was practiced): An attempt was made to study the total number of years since when concentrate feeding was adopted at the farmers’ field. The study also included the total number of years a farmer adopted this practice before discontinuing, if any. The Table 4 indicates that, among the pooled data, 43.89 per cent of the respondents had not adopted the innovation, while 20.56 per cent farmers adopted the innovation since 3-6 years, whereas, 19.17 per cent respondents were in the 6-9 year category. It was interesting to note that respondents in Haryana and Punjab adopted concentrate feeding to a greater extent as compared to other states which might be contributing for improved dairying status in these states.

This variation in the level of adoption might be due to variation in socio-economic status, risk and economic orientation and also information access in the study areas. This might be the reason for highly significant difference

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition and measurement</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Age of the respondent in years</td>
<td>±</td>
</tr>
<tr>
<td>Family size</td>
<td>Total number of members in a household</td>
<td>±</td>
</tr>
<tr>
<td>land</td>
<td>Size of landholding of household in acres</td>
<td>±</td>
</tr>
<tr>
<td>livestock</td>
<td>Number of livestock owned by the household in units</td>
<td>±</td>
</tr>
<tr>
<td>Distance</td>
<td>Average distance from veterinary institution or animal healthcare centre in kilometres</td>
<td>-</td>
</tr>
<tr>
<td>Information</td>
<td>Information seeking behaviour of the respondent from various sources on three point continuum as ‘frequent’, ‘less frequent’ and ‘never’</td>
<td>±</td>
</tr>
<tr>
<td>Sources</td>
<td>Economic orientation of the respondent on three point continuum as ‘low’, ‘medium’ and ‘high’</td>
<td>±</td>
</tr>
<tr>
<td>Decision</td>
<td>Risk orientation of the respondent on three point continuum as ‘low’, ‘medium’ and ‘high’</td>
<td>±</td>
</tr>
<tr>
<td>Scientific</td>
<td>Scientific orientation of the respondent on three point continuum as ‘low’, ‘medium’ and ‘high’</td>
<td>±</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Variables used in Multinomial Logit Model and their expected signs</th>
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<tbody>
<tr>
<td>Variables</td>
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<tr>
<td>-----------</td>
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<td>Age</td>
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<table>
<thead>
<tr>
<th>Categories</th>
<th>States</th>
<th>Pooled (N=360)</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-adoption</td>
<td>71(78.89)</td>
<td>55(61.11)</td>
<td>29(32.22)</td>
</tr>
<tr>
<td>Discontinuation</td>
<td>07(7.77)</td>
<td>06(6.67)</td>
<td>07(7.78)</td>
</tr>
<tr>
<td>Partial adoption</td>
<td>06(6.67)</td>
<td>16(17.78)</td>
<td>29(32.22)</td>
</tr>
<tr>
<td>Full Adoption</td>
<td>06(6.67)</td>
<td>13(14.44)</td>
<td>25(27.78)</td>
</tr>
</tbody>
</table>

(Figures in the parenthesis indicate percentage)
Reasons for adoption of concentrate feeding: The reasons for adoption of concentrate feed in dairying as perceived by respondents in the study area has been enlisted.

- Provide highly concentrated sources of nutrients to supplement forages.
- Supply valuable starch, sugar and proteins for ruminant digestion.
- Offer a broad choice from individual ingredients to complete balanced supplements.
- Starchy energy from cereals can have a beneficial impact on milk protein production.
- Both cereals and pulses can safety be fed in concentrate ration.
- Providing complete flexibility to fine-tune rations as required.
- Palatable (cattle like to eat them) and easy to digest.
- Can be prepared at home since inputs are available on small scale.
- Immediate benefits in the form of milk yield observed.
- Good quality feeds available at competitive price in market also.
- Properly balanced and contains adequate nutrients and is appetizing.
- Reduced cost of production if prepared at home.
- Good quality feed available due to increased competition among the feed companies.
- Cost of production can be reduced since homemade rations are cheaper than commercial rations.

The above mentioned reasons contributed towards adoption of concentrate feeding in the study area. In a similar context, Kurup (2011) opined that concentrate feeds were used to supplement dry fodder diets in the case of producing working large ruminants. He also pointed out that preparation of homemade concentrates would be more cost effective at field conditions. Prasad (2011) also reported that majority of the dairy farmers in India fed homemade feed mixture and concentrates to their dairy animals. However, Rangnekar (2011) reported that most of the commercial dairy producers in urban areas of western India continued to make feed mixtures and feed animals in the traditional manner contrary to the reports that educated, commercially-oriented and urban livestock producers are early adopters.

Reasons for partial adoption/discontinuation and non-adoption of concentrate feeds: Following are the major reasons for partial adoption/discontinuation or non-adoption of Concentrate feeding to dairy animals.

- Few farmers perceived that animals do not relish since it is non-palatable
- Highly expensive to purchase
- Costly inputs/raw materials to prepare 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 concentrate feed
- Cause health problems if too much is fed alone without roughages
- No immediate benefits from concentrate feeding
- Poor quality concentrate feeds available from market nowadays

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.

Identifying factors influencing degree of concentrate feed adoption: Application of Multinomial Logit Model: To identify the factors that significantly influenced the respondents’ likelihood of belonging to one of the different adopter categories (viz. non-adopter, partial adopter and full adopter), a multinomial logit model was fitted, and the results of this analysis are presented in Table 5. The Chi-square value of 144.84 showed that likelihood ratio statistics are highly significant (p<0.001) suggesting that model was fit for explanation.

The variables significantly associated with the probability that the respondent will be a partial adopter of concentrate feeding were ‘distance to veterinary institution’ or ‘animal healthcare centre’ (P<0.10), ‘information sources’ (P<0.10), ‘scientific orientation’ (P<0.05), and ‘education’ (P<0.05). The signs of regression coefficients for the variables ‘information sources’ and ‘scientific orientation’ were positive, while those for ‘distance to veterinary institution’ and ‘education’ were negative. In case of full adoption also, the above variables emerged as significant determinants of full adoption. In addition to these variables, one more variable, viz. ‘economic orientation’ (P<0.10) significantly and positively influenced the probability of the respondent being a full-adopter.

The negative sign associated with the variable ‘distance to veterinary institution’ in case of both partial adoption and full adoption indicates that, as the distance to the veterinary institution increased, the probability of partial...
and full adoption of concentrate feeds decreased and that of non-adoption increased. Greater distance from veterinary institution implies lesser chance of contact with livestock extension functionaries, which probably explained the negative association of distance from veterinary institution with higher degree of adoption of this innovation. The odds ratio associated with the variable distance to veterinary institution suggests that with one kilometre increase in distance from veterinary institution, the likelihood of full adoption of concentrate feeding decreased by 88.8 per cent. Information seeking behaviour and scientific orientation of the farmers were positively associated with partial and full adoption implying that with the increase in information access and scientific orientation, the farmers moved towards increased adoption level. Economic orientation was significantly and positively associated with full adoption of concentrates feeding, indicating that with the increase in economic orientation, the farmers opted for full adoption of concentrate feeding. The odds of full adoption increases by 15.2 per cent, 40.6 per cent and 21.5 per cent with one unit increase in information access, scientific orientation and economic orientation, respectively.

In earlier studies, it has been reported that number of contacts with extension officers, as a proxy measure for access to agricultural information, positively contributed to awareness and subsequent adoption of new technologies (Abdulai and Huffman, 2005; Menale et al., 2009; Tizale, 2007). The negative association of lower education level with partial and full adoption indicates that with lower education, the probability of adoption of concentrate feeding decreases and the likelihood of the respondent being a non-adopter increase. The odds ratio suggests that when the respondent has lower level of education, the full adoption of concentrate feeding decreased by 18.4 per cent.

**CONCLUSION AND POLICY IMPLICATIONS**

The adoption status of concentrate feeding revealed that majority of the respondents had not adopted concentrate feeding, followed by full and partial adoption of concentrate feeding in the study area. Further, the study also pointed out that about 21 per cent farmers adopted concentrate feeds since 3-6 years, while about 19 per cent farmers had adopted the practice from 6-9 years. The adoption status revealed that there was highly significant difference across the states for concentrate feeds in dairying. Multinomial logit model depicted the Chi-square value of 144.84 indicating that the model was highly significant (p<0.001). The variables significantly associated with the probability that the respondent will be a partial adopter or full adopter of concentrate feeding were ‘distance to veterinary institution’, ‘information sources’, ‘scientific orientation’, and ‘education’. In addition to these variables, ‘economic orientation’ significantly and positively influenced the probability of the respondent being a full-adopter.

The study suggests 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 were in non-adoption and partial adoption category, a need based long-run study under field conditions must be undertaken. The study also revealed that farmers had various problems due to which they did not adopt concentrate feeding in their farms. Hence, the scientists have to analyse these problems and find suitable solutions for higher diffusion and adoption at field conditions. The study recommends for participatory technology generation and transfer approach with adequate...
representation of all categories of farmers i.e. small and marginal, medium and large so that their feedback can be taken into consideration. This can also emphasize on the generation and transfer of dairy innovations based on the socio-economic background of the dairy farmers.

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