CHAPTER V

SUMMARY AND CONCLUSIONS
The common belief with the Indian small farmers (contributing a major portion to the overall milk production in the country) that the feeding of cotton seed to milch animals produces more milk of richer fat content, has led to the liberal use of this valuable oil-seed for feeding to cattle and buffaloes especially in the States of Gujarat and Maharashtra, and thus curtailing the availability of oil for the manufacture of hydrogenated oil and other industrial commodities. A few references spread over a period of about 30 years are available in the literature, where results have been reported mostly in favour of discontinuation of the use of this valuable oil-bearing seed which could otherwise be used for the industrial purposes, leading to the huge saving of foreign exchange being spent for the import of oil from other countries. The by-product, cotton seed cake/meal, instead of making it an item of export, can be profitably used as a rich plant protein source for feeding to the Indian milch cattle and buffaloes.

In the present investigation, therefore, an effort has been made to compare the effects of feeding cotton seed and its cakes (decorticated and undecorticated) on the utilization of feed nutrients on one hand, and the milk production, milk composition, feed conversion efficiency and the economics of milk production, on the other hand, in the Zebu cattle (Sahiwal cows). Furthermore, looking to the scarcity of protein rich concentrates in India and the limited scope of increasing the production of good quality green fodders, it was further
proposed to explore the possibility of replacing the cotton seed cake portion of the concentrate mixture by the NPN compounds, like urea, in the ration of lactating dairy cattle. Thus, the present investigation on the project "Effect of Feeding Cotton Seed Cake With and Without Molasses-Bound NPN Compounds on Nitrogen Utilization and Milk Production in Ruminants" was so designed as to cover the following aspects:

1. To compare the effect of feeding cotton seed and cotton seed cakes on the utilization of feed nutrients.

2. To study the effect of different rations containing cotton seed, cotton seed cakes (decorticated and undecorticated) as also the G.N. cake, on the quality and quantity of milk produced.

3. To compare the nitrogen utilization and milk production of rations containing cotton seed cake with and without molasses-bound NPN compounds as the principal source of nitrogen.

Phase I

A completely randomised design with 4 animals in each group was followed to compare the utilization of feed nutrients from cotton seed (A), undecorticated cotton seed cake (B), and decorticated cotton seed cake (C) in the non-producing mature cows of the Sahiwal breed. In addition to meeting the total protein requirement through either
of the feeds, 5 kg of cereal green fodder along with an appropriate dose of minerals was given to each animal under experiment. The rations were computed as per the NRC (1971) standards.

1.1 The chemical composition of various feeds (cotton seed and two types of its cakes) showed that the cotton seed which is a rich source of oil (20.11 per cent) contained the least percentage of crude protein (23.75 per cent) as against 37.74 per cent in the decorticated cotton seed cake followed by the undecorticated cotton seed cake (27.96 per cent). Contrary to the above findings, the crude fibre content was almost double in the cotton seed as well as the undecorticated cotton seed cake.

1.2 The dry matter intake per 100 kg body weight and per kg $W^{0.75}$ by the different groups was statistically nonsignificant. Further, the ratio of water to dry matter intake was also observed to be nonsignificant amongst the various groups.

1.3 Except for crude fibre and ether extract, the apparent digestibility coefficients for all other organic nutrients as also of dry matter were found to be nonsignificant for the three treatments. The digestibility coefficient of crude fibre was highly significant ($P \leq 0.01$) for the decorticated cotton seed cake fed group, whereas that of the ether extract was highly significant ($P \leq 0.01$) for the cotton seed fed group. However, the decorticated cotton seed cake fed group digested the crude protein better by 3 units over the other two groups.
1.4 The intake of nitrogen, its outgo and the balance was also quite comparable in the three treatment groups and was nonsignificant on per unit and per kg \( W^{0.75} \) basis. Apparently, the balance was 3 to 5 g more in the decorticated cotton seed cake fed group as compared to groups A and B.

1.5 The feeding of cotton seed or its cakes had no effect on the calcium utilisation, whereas the phosphorus balances were negative in all the groups and the variation was found to be highly significant \( (P < 0.01) \) for the various treatments. The cotton seed fed group utilized phosphorus of the ration in a better way as compared to the cake fed groups.

1.6 The DCP intake by the decorticated cotton seed cake fed group was highly significant \( (P < 0.01) \) over the group A by 18 per cent and over the group B by about 12 per cent. However, the TDN intake by the different groups of animals was very similar. Whereas, the DCP intake by the different groups as compared to NRC (1971) standards was higher (maximum in the decorticated cotton seed cake fed group), the figures for the intake of TDN were quite comparable to the NRC standards.

1.7 All groups of animals irrespective of the type of treatment maintained their live weights throughout the study period.

Phase II

In this phase a 4 x 3 Latin-square design with 3 animals in each group \((3 \times 4 = 12 \text{ in the four periods})\) was followed to study the effect
of isonitrogenous and isocaloric concentrate mixtures on nitrogen utilisation, the quantity and quality of milk produced, the feed conversion efficiency and the economics of milk production. Fifty per cent of the DCP requirement for maintenance and milk production was met by the concentrates, and the rest was met through the feeding of green fodder. The four concentrate mixtures contained either groundnut cake, cotton seed, undecorticated cotton seed cake, or decorticated cotton seed cake as the major protein supplement.

2.1 As in phase I, the crude fibre content of the concentrate mixtures containing the cotton seed and undecorticated cotton seed cake was almost double as compared to those containing the groundnut cake or the decorticated cotton seed cake. Ether extract was comparable in all the concentrate mixtures except that containing the cotton seed (B group), where it was about 3 times more as compared to groups A (groundnut cake), C (undecorticated cotton seed) and D (decorticated cotton seed).

2.2 It was interesting to note that the intake of water and dry matter on per 100 kg body weight and per kg W^0.75 basis, as also the ratio of water to dry matter intake was apparently as well as statistically nonsignificant by all the animals of 4 groups, irrespective of the treatment. However, with respect to the results obtained in phase I (dry cows), the values of intake of water and dry matter as well as the ratio between the two was much higher (milch cows) in this phase of the study.
2.3 It was an important point to note that the dry matter intake per 100 kg body weight was about 0.3 to 0.4 kg less during the metabolism trial period. This was probably due to the stress and strain conditions exerted by the harness applied to the animals during the metabolites collection period.

2.4 Again, it was interesting to note that, whereas the crude protein digestibility coefficient was significant \( (P \leq 0.05) \) for the groundnut cake fed group (A), the crude fibre utilization on the contrary was significant \( (P \leq 0.05) \) for the other three treatment groups, i.e. B (cotton seed), C (undecorticated cotton seed cake), and D (decorticated cotton seed cake). The digestibility coefficient for ether extract was highly significant \( (P \leq 0.01) \) for cotton seed and undecorticated cotton seed cake fed groups. Whereas, the utilization of NFE was significantly \( (P \leq 0.05) \) higher in the decorticated cotton seed cake and groundnut cake fed groups.

2.5 The intake of nitrogen, its outgo through urine, faeces and milk and the balance thereof were quite comparable in all the 4 groups. Statistically no significant difference was found to be present within the 4 groups of animals. However, only marginal positive balance was observed in this phase.

2.6 The intake of DCP as well as TDN by the various groups of animals was also very similar. However, as compared to the NRC (1971) standards, the consumption of DCP was much higher, whereas the TDN consumption was only slightly higher. The maximum difference in
the DGP intake was present in the groundnut cake fed group. The other three groups, i.e. cotton seed and two types of cotton seed cake fed groups, were similar in the intake of DGP with respect to NRC standards.

2.7 As in phase I, here also, on an average the animals of various treatment groups well maintained their live weights, and there was a gain of 2 to 4 kg during the entire study period.

2.8 The production of whole milk as well as 1% per cent fat-corrected milk (FCM) during the 84 days of treatment period as well as during the metabolism trials of 14 periods was found to be statistically nonsignificant. However, apparently, the cotton seed and undecorticated cotton seed cake fed groups showed somewhat higher values for the 1% per cent fat-corrected milk.

2.9 The figures on per cent chemical composition of milk with respect to total solids, protein and solids-not-fat (SNF) were quite comparable in all the groups, and were statistically nonsignificant. However, the value for fat percentage was observed to be significantly higher (P < 0.01) in the cotton seed fed group. This group also showed higher milk production per day as compared to the groundnut cake fed group but was similar in production when compared to cotton seed cake fed groups. As such the variation amongst groups was found to be nonsignificant.

2.10 The milk production efficiency in the various groups, based on TDN intake per kg of 1% per cent FCM varied from about 25 to 28 per cent.
2.11 The intake of DCP and TDN for each kg of FCM was calculated on the basis of total intake minus the maintenance requirement as per NRC (1971) standards, divided by the quantity of milk. It was observed that both DCP as well as TDN per kg of 4 per cent FCM were similar in all the groups and the small differences from group to group were found to be statistically nonsignificant. The average values for DCP and TDN intake were 0.073 and 0.364 kg/kg of fat-corrected milk.

2.12 The feed cost per kg of 4 per cent FCM was calculated to be maximum for the cotton seed fed group followed by the groundnut cake fed group, whereas the values were minimum and similar for the cotton seed cake fed groups. The feed cost of milk production was much higher (10 to 12 paisa) in the cotton seed fed group. The higher milk production cost was probably due to the high price of cotton seed in the ration of the particular group.

Phase III

In this phase a 6x3 Randomised block design with 6 cows in each of the three treatments was followed. The major ingredient as a protein source in the three concentrate mixtures was either cotton seed cake, free urea or molasses-bound urea, and the groups receiving
these treatments were designated as, A (decorticated cotton seed cake), B (free urea) and C (molasses-bound urea). On the basis of the results obtained on the utilisation of nutrients and the feed cost in phase I and II, only the ration based on the decorticated cotton seed cake was compared with free urea and molasses-bound urea containing rations. According to the NEC (1971) feeding standards, 80 per cent of the total DCP requirement for maintenance and milk production was met through the feeding of isonitrogenous and isocaloric concentrate mixtures and the rest was presumed to be met through the feeding of 10 to 15 kg of green depending on its quality. In addition, wheat straw was provided ad libitum to meet the dry matter and energy requirements.

3.1 The per cent values of crude fibre and ether extract were somewhat higher in the concentrate mixture containing the cotton seed cake as compared to the free urea and molasses-bound urea containing concentrate mixtures. Conversely, the NFE content was more in the urea containing concentrate mixtures as compared to one containing the cotton seed cake.

3.2 It was quite interesting to note that, in contrast to the results of phase I and II with regard to the intake of water as well as dry matter, the intake of these, in phase III was significantly higher (P < 0.05) in group A, fed with the cotton seed cake containing concentrate mixture. However, there was no significant difference in the ratio of water to dry matter intake. It was of further interest to note that the ratio between water and dry matter intake in this
phase was also similar to that obtained in the previous phase (II). However, when compared to the results of phase I, the values were much higher.

3.3 It was observed that the digestibility coefficient for ether extract was significantly higher ($P < 0.01$) in the cake fed group (A) followed by the molasses-bound urea fed group (C), whereas the value was minimum in the free urea fed group (B). Further, it was interesting to see that the variation in the digestibility coefficients of all other organic nutrients as also of dry matter were statistically nonsignificant amongst various groups. However, it was of particular value to note that the figures for the digestibility coefficients of all the organic nutrients except the ether extract, were apparently higher for the molasses-bound urea fed group of cows.

3.4 The total intake of nitrogen and its total outgo per unit as well as per kg $w^{0.75}$ was much more and significantly higher ($P < 0.05$) in case of cake fed group as compared to the free as well as molasses-bound urea fed groups. It was further observed that the excretion of nitrogen through urine was similar in all the groups irrespective of the treatment; whereas, the excretion through faeces, and secretion in milk was significantly more ($P < 0.05$) in the cake fed group, as compared to the urea fed groups, which led to the similar nitrogen balance in all the groups, irrespective of the treatment. It was of interest to note that all the groups showed a negative nitrogen balance in this phase. The probable reasons have been discussed in the text.
3.5  The DCP intake was found to be similar in all the groups whereas, the intake of TDN was significantly higher ($P \leq 0.05$) in cotton seed cake fed group (A) as compared to the free urea (B) and molasses-bound urea fed (C) groups. It was noteworthy to point out that in phase III, whereas the DCP intake was about 20 per cent less, the intake of TDN was similar as compared to the requirements given in the NRC (1971) standards. In contrast to this, in phase II the DCP as well as TDN intake by the different groups was more as compared to the NRC standards. This was probably due to the difference in the quality of the roughage available in the two phases.

3.6  The average per day milk production during the 10 weeks of experimental period was not significantly different in the various treatment groups on the basis of 4 per cent fat-corrected milk. However, apparently, the milk production level of the cake fed group was higher as compared to the urea fed groups.

3.7  The per cent values of various milk constituents were quite similar with respect to total solids, SNF and protein, whereas the percentage of butter-fat was more in both the urea fed groups. However, these differences were found to be within the normal range of variation and were not statistically significant.

3.8  The milk production efficiency, which was calculated on the basis of TDN intake per kg of milk produced, was found to be insignificantly different in the three groups. The variation was from 31 to
3.4 per cent, the value being maximum in the cake fed group. However, both the urea fed groups exhibited a very similar milk production efficiency. As compared to the results of phase II, the values were somewhat higher. This might be due to that the intake of TDN per unit body weight in this phase was less.

3.9 As mentioned under phase II, the DCP and TDN intake for milk production was based on the total intake of these minus the maintenance requirement as per NRC (1971) standards. It was observed that for each kg of 4 per cent FCM, the consumption of DCP as well as TDN was similar in all the groups, i.e. A (cotton seed cake), B (free urea) and C (molasses-bound urea). However, the value of DCP was more in the urea fed groups, whereas the TDN intake/kg of milk production was more in the cake fed group. The average values for DCP and TDN intake were 0.032 and 0.272 kg/kg respectively, of the fat-corrected milk. However, as compared to phase II, the values were much less.

3.10 The feed cost of milk production in all the groups was similar, i.e. 40 to 43 paise/kg of 4 per cent FCM. However, on the whole milk basis, the cost was somewhat more in the urea fed groups, maximum being in the free urea fed group. As compared to the milk production cost in phase II, the average value was about 10 paise less in phase III.

3.11 The milk was also analysed at fortnightly intervals for major constituents and for various nitrogen fractions as also the pH, to examine the effect of adaptation to urea feeding. Upto 45 days of treatment period, the fat and total solids continued to rise under the
urea feeding. The effect was more pronounced in the free urea fed group (B). The cake fed group did show a rise in the fat level, but only up to 15 days. Thereafter, there was a sharp fall in the fat percentage in the cake fed group. In all the groups, a sharp fall was observed in the total solids after the 15 days of treatment period. The levels of SNF and protein did not show any variation from treatment to treatment.

3.12 The observations on the nitrogen fractions (total, NPN, TCA, urea) showed that the rate of conversion of NPN into protein of the milk was maximum after the 15 days of adaptation to urea feeding and the effect was more pronounced in the molasses-bound urea fed group. Further, the urea level of milk showed that the adaptation period to NPN feeding lay between 15 and 30 days of the treatment period. The pH of milk at fortnightly intervals did not show any particular trend.

3.13 The blood of the experimental cows was also analysed for total-N, NPN, TCA-N, Urea-N and NH₃-N. Except for urea-N, all other nitrogen fractions, i.e., total, TCA, NPN, NH₃, presented a similar trend. However, the values of NH₃-N and urea-N were minimum for the molasses-bound urea fed group. Further, all nitrogen fractions in the cake and molasses-bound urea fed groups showed the peak values at 4 hours of concentrate feeding, whereas in the free urea fed group, the level of total-N, TCA-N, urea-N as well as NH₃-N continued to show a rise even after 4 hours of feeding.
CONCLUSIONS

The following conclusions could be drawn on the basis of the results obtained during the tenure of the present investigation.

1. The decorticated cotton seed cake fed group of cows showed a definite superiority as per the DCP and TNH intake. The overall feed utilization was also the best in the animals fed with the decorticated cotton seed cake. Thus, the decorticated cotton seed cake can replace the whole cotton seed from the ration of dairy cattle.

2. It was further concluded that the cows fed with the ration containing the whole cotton seed, secreted maximum fat into the milk, but it was in no way superior to the cotton seed cake or the groundnut cake, either in milk production or in the utilization of feed nutrients, or in the feed conversion efficiency. On the other hand, the feed cost of milk production was found to be higher by 10 to 12 paise per kg of milk in the cotton seed fed group.

3. There was a nonsignificant decrease in the FCM production in both the urea fed groups (free urea and molasses-bound urea). Further, a close similarity was observed in the composition of milk, the feed conversion efficiency and the cost of milk production, as compared to the cake fed group.

4. The molasses-bound urea fed group was particularly better than the free urea as well as the cake fed groups in the utilization of
crude protein and crude fibre of the ration, and also better in the conversion of NPN into the protein of the milk. Thus, the molasses-bound urea can probably provide a better source of protein supplement for cattle as compared to the feeding of free urea.

5. The data also indicate that in order to compensate the lower biological value of urea-N (especially at high levels of urea feeding) as compared to the plant protein nitrogen, the milch animals under the molasses-bound urea feeding will have to be given an extra allowance of nitrogen.

Further Approach

It is suggested that probably more studies on the feeding of molasses-bound urea, under different feed combinations and with various species of ruminants, are needed to fully establish the utility of the urea-molasses complex in the ration of dairy cattle for milk production.