Numerically, the livestock wealth of India is highly impressive. In 1972, according to the eleventh livestock census, there were about 178 million cattle and 58 million buffaloes. But, when one takes a realistic look, the picture is rather gloomy. For instance, the average annual milk yield of the Indian cow is 157 kg and that of the buffalo 504 kg. Whereas, the improved cows in Denmark, the U.S.A., the U.K., Switzerland and Israel produce milk more than 20 times that of the Indian cow and over 7 times that of the buffalo (Bhattacharya, 1976). The production of milk is estimated to have gone up to 23.2 million tonnes in 1973-74 as compared to 20.4 million tonnes in 1961. However, because of the rise in human population, the production level is not catching up with the demand. As such, the present availability of milk per person per day calculates to be only 108 g as against the minimum requirement of 250 g.

The situation is partly due to the low genetic potential and partly due to the malnutrition of our bovine population. Coupled with this is the problem of food shortage for the ever-increasing human mouths (12 million per year). This is evident from the per year availability of only 2.6 kg of vegetable-oils as against 20 kg, recommended by the Indian Council of Medical Research, and the per capita per day consumption of only 56 g of protein as compared to 93 g in the United States of America, 87 g in the United Kingdom and 70 g in Japan. The problem becomes more serious when we consider the quality of protein in the Indian diet.
Thus, the situation calls for an improvement in the nutritional status of our human population on one hand and that of the bovine population on the other hand. Although, the problem of alleviating the food shortage seems to be a difficult proposition, yet the solution probably lies in sparing the protein and oil-rich materials for human consumption.

In India, there is a common belief amongst the farmers, especially in the cotton producing States of Gujarat and Maharashtra, that the cotton seed is a much superior feed than the various oil-cakes, and that its feeding to cattle and buffaloes yields more milk of higher butter-fat content. As such, cotton seed is extensively fed to these animals in almost all parts of this country. On the contrary, cotton seed meal is the most widely used protein supplement for dairy cows in the other developed countries of the West. This is on account of the value of oil, and the protein content which is almost double than that in the cotton seed, and because cotton seed meal usually gives better results as a livestock feed (Morrison, 1959). Moreover, animals fed with too large amounts of cotton seed may scour badly on account of the high content of oil.

The available literature in India and abroad presents different opinions as to the beneficial use of feeding cotton seed to cattle and buffaloes (Lush and Gelpi, 1932; Bal and Misra, 1939; Miller and Wise, 1941; Davis and Harland, 1946; Patel and Ray, 1948-49; Ramsey and Miles, 1953; Kehar et al., 1956; Anon., 1965-66; Tandon, 1974). In most
of the above mentioned studies, either the protein or the energy equivalence of the rations has not been taken care of. Also the work so far reported (in India) has been conducted mostly on buffaloes. Moreover, the work on cattle as well as buffaloes is not exhaustive as to the utilization of various nutrients and their effects on the chemical composition of milk.

According to Rao and Pavate (1973), 60 to 70 per cent of the available cotton seed is fed to the cattle and buffaloes. In contrast to this, 80 per cent of the cotton seed produced in the United States is crushed to obtain oil and other by-products. Moreover, when oil supply under the PL-480 project has been stopped (Anon., 1974) and efforts are being made to extract more and more oil even from the unconventional agricultural by-products, like rice bran (Yearbook, 1976) to meet the deficiency of oil for human consumption, the feeding to cattle with 70 per cent of the whole cotton seed (containing about 20 per cent oil) is a mere national wastage (Rao and Pavate, 1973).

From ruminant nutrition point of view, the oil present in the cotton seed may not be of much value, whereas the same oil after extraction from the seed can be utilized for human needs and for other industrial purposes. To meet the shortage of groundnut oil, the Government of India has instructed the Vanaspati Industry to increase the compulsory minimum level of the usage of cotton seed oil from 10 per cent to 15 per cent (Yearbook, 1974/75). The surplus cotton seed cake can earn the much needed foreign exchange too. Very
recently (Anon., 1976b) the World Bank has sponsored an integrated "Cotton Development Project" worth $18 million for the States of Haryana, Punjab and Maharashtra with additional ginneries to be set up, which is a further step in making more and more cotton seed cake available for the ruminant and non-ruminant feeding and also meeting the oil shortage for human consumption. The latest recommendation (Yearbook, 1976a) of the Government of India is also that the use of cotton seed for directly feeding to cattle must be discouraged, because the cattle need only 1 per cent of the oil which is available even after recovery of the oil through solvent extraction. The State of Maharashtra has already taken a decision to this effect (Rao and Pavate, 1973).

Another important aspect is the protein malnutrition in India, which is affecting a significant part of our human population leading to diseases like Kwashiorkar and Marasmus. It is evident from the fact that protein provides merely 9 per cent of the calories, out of which only 25 per cent is contributed by the animal protein (Razdan et al., 1974). Also, the per capita consumption in India of all food items in terms of calories compares as follows:

<table>
<thead>
<tr>
<th>Country</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>3300</td>
</tr>
<tr>
<td>Canada</td>
<td>3200</td>
</tr>
<tr>
<td>UK</td>
<td>3170</td>
</tr>
<tr>
<td>Japan</td>
<td>2470</td>
</tr>
<tr>
<td>India</td>
<td>1990</td>
</tr>
</tbody>
</table>

Yearbook, 1976a
The situation seems to be more critical when we compare the average milk yield of our cows and buffaloes with those of the developed countries, which is as follows:

<table>
<thead>
<tr>
<th>Country</th>
<th>Cattle/Buffalo</th>
<th>Yield per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>Cattle</td>
<td>4154 kg</td>
</tr>
<tr>
<td>UK</td>
<td>Cattle</td>
<td>3950 &quot;</td>
</tr>
<tr>
<td>Denmark</td>
<td>Cattle</td>
<td>3902 &quot;</td>
</tr>
<tr>
<td>India</td>
<td>(Cattle</td>
<td>157 &quot;</td>
</tr>
<tr>
<td></td>
<td>(Buffalo)</td>
<td>504 &quot;</td>
</tr>
</tbody>
</table>

Thus, under the prevailing circumstances of food shortage, there is a scope to work out suitable methods for the efficient and economical utilization of NPN compounds by the ruminants. It is known that the ruminants by virtue of their inherent physiological and biochemical capabilities, due to the presence of a complex microbial population in the rumen are capable of hydrolysing protein and non-protein nitrogenous (NPN) compounds to NH₃ and converting it to microbial proteins, which are digested and absorbed in the latter parts of the gastrointestinal tract in a manner analogous to that in the monogastric animals.

For the efficient and proper utilization of NPN compounds, the presence of a readily available carbohydrate source (McNaught and Smith, 1947-1968; Locson, 1958; Rekib et al., 1970) and the adaptation time (Mc Laren et al., 1965; Oltgen and Putnam, 1966; Clifford
and Tillman, 1968) are of great importance. Urea to the extent of one per cent of the concentrate ration has been recommended for ruminants by the Indian Standards Institution, but up to 2 to 3 per cent has generally been tried by many workers (Bartlett and Cotton, 1938; Collovos et al., 1963; Huber et al., 1967; Mudgal and Sampath, 1969; Von Horn and Mudd, 1971; Sharma et al., 1973; Dutrow et al., 1974; Khajuria and Mudgal, 1975).

Of all the commonly tried NPN compounds, urea is probably the commonest compound by choice as a protein replacer in the ruminant rations (Henderickx, 1967). This is evident from the presence in the rumen of \( \frac{1}{4} \) strains of bacteria, 80 per cent of which require \( \text{NH}_3 \) as the sole source of nitrogen (Bryant, 1961). Therefore, it seems that the true value of urea and other NPN compounds in the ruminant feeding requires further assessment and it may remain a challenging field of research for many more years. Urea has been fed to the ruminants in various combinations and in the form of compounded feeds which have, beyond any doubt, formed the maintenance ration; but the data on feeding high levels of urea-based rations to lactating cows and buffaloes are very few.

Looking to the importance of the investigations, the All India Cotton Seed Crushers' Association, Bombay, sponsored the research project at the National Dairy Research Institute, Karnal (Haryana). Thus, the first phase of the present work was taken up as a sponsored project to determine the nutritive value of the cotton seed cakes as
compared to the whole cotton seed. Later on, the work was extended
to study the effect of cotton seed and its cakes as also of groundnut
cake, in complete rations, on the quality and quantity of milk produced.
This part of the investigation was, therefore, undertaken to critically
evaluate the nutritive values of different types of cotton seed cakes
as compared to the cotton seed itself, and to ascertain whether the
feeding of cotton seed to cattle had any marked effect over its by­
products so far as the quality and quantity of milk production was
concerned. This was followed by an effort to replace even a major
portion of the feed protein by urea for the milking cows.

The present work was, therefore, undertaken with the following
objectives:-

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 (undecorticated and decorticated)
and groundnut 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.

The information collected from these investigations will be of
great help in finding out whether it is necessary to feed the cotton
seed, and thus much economy could be achieved in the feeding of ruminants by saving the much needed vegetable-oil for human consump-
tion. The data will also give the information whether the molasses-
bound urea can serve a better purpose in the utilization of NPN compounds by the milk producing cows.