FEED RESOURCES AND MAIN ASPECTS OF NUTRITION AND FEEDING OF LIVESTOCK IN INDIA

P. George Kunju John*

The Republic of India has a human population of 684 million according to the 1981 census. There are 181 million cattle, 63 million buffaloes, 159 million poultry and 86 million other livestock (Table 1). Unlike the West, where dairying has been evolved as a more specialised and commercial enterprise, animal husbandry in India is subsidiary to crop production. The pattern of livestock kept on landholdings is dominated by draught animals and milch cattle.

Table 1. Livestock population of India (millions)

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>1977</th>
<th>1972</th>
<th>1966</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Males</td>
<td>74.76</td>
<td>74.46</td>
<td>73.38</td>
</tr>
<tr>
<td>b.</td>
<td>Females</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>In milk</td>
<td>23.21</td>
<td>22.03</td>
<td>20.97</td>
</tr>
<tr>
<td>ii.</td>
<td>Dry</td>
<td>26.51</td>
<td>26.33</td>
<td>25.80</td>
</tr>
<tr>
<td>iii.</td>
<td>Others</td>
<td>8.11</td>
<td>8.03</td>
<td>7.60</td>
</tr>
<tr>
<td>c.</td>
<td>Young stock</td>
<td>47.39</td>
<td>47.48</td>
<td>48.07</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>179.98</td>
<td>178.33</td>
<td>175.82</td>
</tr>
<tr>
<td>2.</td>
<td>Buffaloes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Males</td>
<td>8.4</td>
<td>8.11</td>
<td>8.20</td>
</tr>
<tr>
<td>b.</td>
<td>Females</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>In milk</td>
<td>17.00</td>
<td>15.07</td>
<td>12.92</td>
</tr>
<tr>
<td>c.</td>
<td>Young stock</td>
<td>21.70</td>
<td>20.11</td>
<td>18.59</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>61.90</td>
<td>57.42</td>
<td>52.95</td>
</tr>
<tr>
<td>3.</td>
<td>Sheep</td>
<td>40.87</td>
<td>39.99</td>
<td>42.01</td>
</tr>
<tr>
<td>4.</td>
<td>Goats</td>
<td>75.36</td>
<td>67.52</td>
<td>64.59</td>
</tr>
<tr>
<td>5.</td>
<td>Horses &amp; ponies</td>
<td>0.89</td>
<td>0.94</td>
<td>1.15</td>
</tr>
<tr>
<td>6.</td>
<td>Pigs</td>
<td>7.70</td>
<td>6.90</td>
<td>5.04</td>
</tr>
</tbody>
</table>


India has a land mass of 3.28 million (km)$^2$ stretching 2977 km between its East-west points and 3219 km from North to South. This land mass comprises 2.4 percent of the world's land mass area but has 15.5 percent of the World's human population. According to the 1981-82 Fertilizer Association Economic Survey, the total geographical area for land utilization is 329, million ha, out of which the net area sown is 14.3 million ha. The utilisation of the land for major crop cultivation is rice 23 percent, wheat 12.5 percent, jowar 9.4 percent bajra 6.4 percent and groundnut 3.4 percent (Tables 2 and 3).

The 1981 census indicated that 76 percent of the population live in rural areas. Out of these, 30 percent are landless agricultural labourers and 19 percent have non-agricultural occupations.

Indian agriculture is dominated by the influence of the Himalayas to the North, from which the major rivers originate and the seasonality of monsoon rains which come from the South-west in the middle of the year followed by a second monsoon from the North-east (Nov.—Jan.). Al-

* National Dairy Development Board, Gujerat (India)
Table 2. Land utilization pattern and production (1980-81)

<table>
<thead>
<tr>
<th>Geographical area*</th>
<th>(000' ha)</th>
<th>(000' tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net area sown*</td>
<td>328,778</td>
<td></td>
</tr>
<tr>
<td>Gross area sown*</td>
<td>142,606</td>
<td></td>
</tr>
<tr>
<td>Cereals</td>
<td>172,306</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>103,160</td>
<td>118,700</td>
</tr>
<tr>
<td>Wheat</td>
<td>39,770</td>
<td>53,230</td>
</tr>
<tr>
<td>Jowar</td>
<td>22,100</td>
<td>36,460</td>
</tr>
<tr>
<td>Pulses</td>
<td>15,610</td>
<td>10,500</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>2,650</td>
<td>11,170</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15,400**</td>
</tr>
<tr>
<td>Net area irrigated*</td>
<td></td>
<td>36,665</td>
</tr>
<tr>
<td>Gross area irrigated*</td>
<td></td>
<td>45,910</td>
</tr>
</tbody>
</table>

* 1977-78
** In terms of Gur


In general, the agricultural crops are divided into four categories i.e., food crops, oil seeds, fodder and non-fodder crops (Fig. 1).

CROP BY-PRODUCTS AND AGRO-INDUSTRIAL BY-PRODUCTS AVAILABLE FOR LIVESTOCK

The food and export crops leave residues (straws) and by-products (oil cakes and brans). Straw, forage crops and natural herbage and tree leaves comprise the roughage portion of the livestock feed whereas oil cakes, other by-products (from cotton and cereals) and non-conventional feeds constitute the concentrate component. The predicted availability of the different feed resources for livestock for the year 1985 is given in Table 4. A report of the committee on Livestock Feeds and Fodder (1974) showed that there was a deficit of 8.5 million tonnes of concentrates, 40 million tonnes of dry fodder and 29 million tonnes of green fodder. The requirements of feeds and fodder were calculated as per the different feeding standards. The national awareness for increasing

Table 3. Yields and cropping patterns — regional examples and national averages

<table>
<thead>
<tr>
<th>Region</th>
<th>Rice (kg/ha)</th>
<th>Wheat (kg/ha)</th>
<th>Jowar (kg/ha)</th>
<th>Bajra (kg/ha)</th>
<th>Potato (kg/ha)</th>
<th>Groundnut (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>2,583</td>
<td>2,432</td>
<td>NA*</td>
<td>924</td>
<td>21,481</td>
<td>915</td>
</tr>
<tr>
<td>South</td>
<td>1,846</td>
<td>NA</td>
<td>942</td>
<td>1,010</td>
<td>11,839</td>
<td>882</td>
</tr>
<tr>
<td>East-west</td>
<td>1,143</td>
<td>2,040</td>
<td>NA</td>
<td>NA</td>
<td>14,410</td>
<td>—</td>
</tr>
<tr>
<td>West</td>
<td>1,218</td>
<td>1,475</td>
<td>556</td>
<td>808</td>
<td>30,382</td>
<td>1,006</td>
</tr>
<tr>
<td>National</td>
<td>1,088</td>
<td>1,387</td>
<td>667</td>
<td>554</td>
<td>11,573</td>
<td>747</td>
</tr>
<tr>
<td>Average</td>
<td>(23.0)**</td>
<td>(12.5)**</td>
<td>(9.4)</td>
<td>(6.4)</td>
<td>(NA)</td>
<td>(4.2)</td>
</tr>
</tbody>
</table>

* NA : Not available.
** Figures in parenthesis is % of cultivated land used for crop.


PRODUCTION OF CEREALS AND OTHER CROPS

The yields and cropping pattern of cereals and other crops are given in Table 3. During the year 1980-81, production of rice was 53.2, wheat 36.4, jowar 10.5, pulses 11.2 and sugarcane 15.4 million tonnes. The national average yields (kg/ha) were 1,088, 1,387, 667, 554, 11,600 and 747 for rice, wheat, jowar, bajra, potato and groundnut respectively.

Though a majority of the people are vegetarians there are still a large number of people who eat meat and eggs. Milk is the main source of animal protein for the vegetarians. The per capita consumption of milk is 131 g per day. Despite the large cattle population, there is a religious ban on cow slaughter. However, buffalo meat is popularly used.

milk production in India urged the animal nutritionists to explore the possibilities of identifying non-conventional feed stuffs for livestock. The various centres of the Indian Council of Agricultural Research at Bhubaneswar, Trichur, Bangalore,
Fig: 1 Model of resources

Agricultural crops

Food crops

Crops residues (dry Fodder)

Roughages

Unconventional Feeds

Concentrates

Oil seeds

Oil cakes & By-products

Green

Natural herbage

Tree Leaves

Fodder

Cotton seed cakes & By-products

Non-Food crops (fibre)
Anand etc., and also the Indian Veterinary Research Institute, have identified more than 100 non-conventional items for feeding livestock. Anti-metabolites and toxic principles have been found in many of them. The major anti-metabolites in these plants are incorporating 60 to 70 percent agro-industrial by-products and unconventional feeds, thus minimising the utilisation of expensive oil cakes. Apart from these plants, there are 134 other feed plants in public and private sectors.

Table 4. Estimated availability of feeds and fodder (1985) (million tonnes)

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Total quantity</th>
<th>Protein</th>
<th>By-pass protein</th>
<th>Met. energy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>((10^6)) tonnes</td>
<td></td>
<td>((10^6)) MJ</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Concentrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.  Oil cakes</td>
<td>15.3</td>
<td>6.12</td>
<td>2.40</td>
<td>198900</td>
</tr>
<tr>
<td></td>
<td>ii. Soybean meal</td>
<td>1.4</td>
<td>0.70</td>
<td>0.56</td>
<td>25480</td>
</tr>
<tr>
<td></td>
<td>iii. Brans and churis</td>
<td>9.7</td>
<td>1.70</td>
<td></td>
<td>87300</td>
</tr>
<tr>
<td></td>
<td>iv. Pulse by-products</td>
<td>2.5</td>
<td>0.50</td>
<td></td>
<td>27500</td>
</tr>
<tr>
<td></td>
<td>v.  Unconventional feeds</td>
<td>7.7</td>
<td>1.90</td>
<td></td>
<td>731500</td>
</tr>
<tr>
<td></td>
<td>vi. Coarse grain</td>
<td>7.0</td>
<td>0.70</td>
<td></td>
<td>91000</td>
</tr>
<tr>
<td></td>
<td>vii. Molasses</td>
<td>3.0</td>
<td></td>
<td></td>
<td>28500</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>46.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Green Fodder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.  Cultivated green</td>
<td>351</td>
<td>8.41</td>
<td></td>
<td>631800</td>
</tr>
<tr>
<td></td>
<td>ii. Natural herbage and tree leaves</td>
<td>430</td>
<td>5.16</td>
<td></td>
<td>688000</td>
</tr>
<tr>
<td>3.</td>
<td>Dry Fodder</td>
<td>316</td>
<td>12.64</td>
<td></td>
<td>1580000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>37.83</td>
<td>2.96</td>
<td></td>
<td>4089980</td>
</tr>
</tbody>
</table>

are tannins, trypsin inhibitors, hydrocyanic acid, nimbidin, saponin and crysophenic acid. The names, nutritive value, the levels of incorporation in livestock feeds and the anti-metabolites present are given in Table 5.

FEED INDUSTRY

The prospects for the livestock feed industry in the country are considered bright although the industry is still in its infancy. In 1978, the production of compounded cattle and poultry feeds was 0.66 million tonnes. In 1981, it rose to 1.7 million tonnes. The feed mill industry provides a nutritionally balanced feed which is less expensive than the oil cakes and meals. Under the Operation Flood Programme in India, a total of 34 plants have been envisaged to produce around 4,000 tonnes balanced cattle feed in a day. These feed plants are BALANCED LIVESTOCK FEED

The animal nutritionists' definition of a balanced livestock feed, is a correct mixture of protein, energy, minerals and vitamins. However, the food mill industry defines it as one which is balanced in different aspects of feed milling technology such as nutrition purchase and production. This is a practical approach to produce nutritionally balanced feed at the least cost. Many times the formulation may not take care of the availability constraints of raw material and the production constraints of feed milling. The quality control specifies the standards for the nutrition value of the feed, raw material specifications, production specifications and also checks the various operations. This will enable the feed miller to produce and distribute balanced feeds at a reasonable price to the farmers (Fig. 2).
Fig. 2. Balanced livestock feed
<table>
<thead>
<tr>
<th>No.</th>
<th>Unconventional seed/cake</th>
<th>Chemical composition &amp; nutritive value (% on dry matter basis)</th>
<th>Level of incorporation (%)</th>
<th>Antimetabolite present, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CP</td>
<td>EE</td>
<td>CF</td>
</tr>
<tr>
<td>Fruit and Vegetable Canning Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mango seed kernels</td>
<td>8.5</td>
<td>8.5</td>
<td>2.8</td>
</tr>
<tr>
<td>2.</td>
<td>Cashew apple waste</td>
<td>9.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3.</td>
<td>Tomato pomace and citrus peel</td>
<td>26.7</td>
<td>21.0</td>
<td>21.4</td>
</tr>
<tr>
<td>Sugar Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Molasses</td>
<td>2.4</td>
<td>5.3</td>
<td>—</td>
</tr>
<tr>
<td>Meat Processing Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Fish meal</td>
<td>60.0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Meat meal.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Offals</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Carcasses</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>7.</td>
<td>Blood meal</td>
<td>80.0</td>
<td>0.8</td>
<td>—</td>
</tr>
<tr>
<td>8.</td>
<td>Frog meal/waste</td>
<td>60.0</td>
<td>6.0</td>
<td>3.5</td>
</tr>
<tr>
<td>9.</td>
<td>Silk worm pupae meal</td>
<td>60.65</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Warai bran (panicam milliaceum)</td>
<td>8.0</td>
<td>3.5</td>
<td>25.0</td>
</tr>
<tr>
<td>11.</td>
<td>Guar meal</td>
<td>44.0</td>
<td>5.8</td>
<td>7.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Tapioca starch waste</td>
<td>5.0</td>
<td>1.0</td>
<td>19.0</td>
</tr>
<tr>
<td>13.</td>
<td>Cashew bran (Anacardium accidentale)</td>
<td>16.9</td>
<td>29.0</td>
<td>6.5</td>
</tr>
<tr>
<td>Agricultural By-products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Cereals and other dry roughages</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Rice husk</td>
<td>2.4</td>
<td>1.0</td>
<td>40.0</td>
</tr>
<tr>
<td>16.</td>
<td>Bagasse</td>
<td>3.5</td>
<td>1.2</td>
<td>36.0</td>
</tr>
<tr>
<td>17.</td>
<td>Sugarcane tops</td>
<td>3.5</td>
<td>1.7</td>
<td>29.0</td>
</tr>
<tr>
<td>18.</td>
<td>Tapioca (Manihot utilissima)</td>
<td>15.2</td>
<td>3.7</td>
<td>9.8</td>
</tr>
<tr>
<td>19.</td>
<td>Tapioca leaf meal</td>
<td>15.4</td>
<td>12.2</td>
<td>22.0</td>
</tr>
<tr>
<td>20.</td>
<td>Coffee husk</td>
<td>7.7</td>
<td>2.5</td>
<td>25.5</td>
</tr>
<tr>
<td>No.</td>
<td>Unconventional seed/cake</td>
<td>Chemical composition &amp; nutritive value (% on dry matter basis)</td>
<td>Level of incorporation (%)</td>
<td>Antimetabolite present, if any</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CP</td>
<td>EE</td>
<td>CF</td>
</tr>
<tr>
<td>21</td>
<td>Tea waste</td>
<td>28.0</td>
<td>3.0</td>
<td>18.0</td>
</tr>
<tr>
<td>22</td>
<td>Coconut pith (<em>Cocos nucifera</em>)</td>
<td>1.8</td>
<td>2.4</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Availability and Utilization of Agro-Industrial By-Products in Cattle Feed

23. Salseed (*Shorea robusta*)

<table>
<thead>
<tr>
<th>No.</th>
<th>Unconventional seed/cake</th>
<th>Chemical composition &amp; nutritive value (% on dry matter basis)</th>
<th>Level of incorporation (%)</th>
<th>Antimetabolite present, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CP</td>
<td>EE</td>
<td>CF</td>
</tr>
<tr>
<td>23</td>
<td>Salseed (<em>Shorea robusta</em>)</td>
<td>6.5-9.0</td>
<td>1.0</td>
<td>2.35</td>
</tr>
<tr>
<td>24</td>
<td>Neem seed (<em>Azadirachta indica</em>)</td>
<td>11.0-25.0</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Availability and Utilization of Agro-Industrial By-Products in Cattle Feed

25. Mahua seed (*Madhuca indica*)

<table>
<thead>
<tr>
<th>No.</th>
<th>Unconventional seed/cake</th>
<th>Chemical composition &amp; nutritive value (% on dry matter basis)</th>
<th>Level of incorporation (%)</th>
<th>Antimetabolite present, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Mahua seed (<em>Madhuca indica</em>)</td>
<td>19.0</td>
<td>12.0</td>
<td>—</td>
</tr>
<tr>
<td>26</td>
<td>Babul seed</td>
<td>10.0-14.0</td>
<td>1.0</td>
<td>13.8</td>
</tr>
<tr>
<td>27</td>
<td>Rain tree pods (<em>Enterolobium samon</em>)</td>
<td>15.9</td>
<td>1.5</td>
<td>11.8</td>
</tr>
<tr>
<td>28</td>
<td>Powad seed (<em>Cassia tora</em>)</td>
<td>21.0</td>
<td>7.7</td>
<td>—</td>
</tr>
<tr>
<td>29</td>
<td>Tamarind seed</td>
<td>15.4</td>
<td>3.89</td>
<td>—</td>
</tr>
<tr>
<td>30</td>
<td>Date stones</td>
<td>5.99</td>
<td>6.89</td>
<td>10.5</td>
</tr>
<tr>
<td>31</td>
<td>Sunhemp seeds (<em>Crotalaria juncea</em>)</td>
<td>35.0</td>
<td>3.7</td>
<td>10.0</td>
</tr>
<tr>
<td>32</td>
<td>Sheria (<em>Ambadi cake</em>)</td>
<td>30.0</td>
<td>7.0</td>
<td>18.0</td>
</tr>
<tr>
<td>33</td>
<td>Dhupa seed (<em>Vateria indica</em>)</td>
<td>6.3</td>
<td>9.8</td>
<td>7.0</td>
</tr>
<tr>
<td>34</td>
<td>Rubber seed (<em>Hevea Brasiliensis</em>)</td>
<td>25.0</td>
<td>11.0</td>
<td>4.0</td>
</tr>
<tr>
<td>35</td>
<td>Tobacco seed/cake</td>
<td>29.9</td>
<td>10.3</td>
<td>22.3</td>
</tr>
<tr>
<td>36</td>
<td>Safflower seed/cake</td>
<td>Seed</td>
<td>19.0</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>Cake</td>
<td>38.0</td>
<td>20.0</td>
<td>12.0</td>
</tr>
<tr>
<td>37</td>
<td>Silk cotton seed cake</td>
<td>24.0</td>
<td>10.0</td>
<td>17.0</td>
</tr>
<tr>
<td>38</td>
<td>Raple seed (<em>Sataria etalica</em>)</td>
<td>10.0</td>
<td>2.5</td>
<td>8.5</td>
</tr>
<tr>
<td>No.</td>
<td>Unconventional seed/cake</td>
<td>Chemical composition &amp; nutritive value (% on dry matter basis)</td>
<td>Level of incorporation (%)</td>
<td>Antimetabolite present, if any</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CP</td>
<td>EE</td>
<td>CF</td>
</tr>
<tr>
<td>39</td>
<td>Kokam cake (Garainia indica)</td>
<td>13.0</td>
<td>2.7</td>
<td>4.2</td>
</tr>
<tr>
<td>40</td>
<td>Raramira cake (Eruca sativa)</td>
<td>32.0</td>
<td>9.0</td>
<td>7.0</td>
</tr>
<tr>
<td>41</td>
<td>Prosopis juli flora</td>
<td>14.3</td>
<td>4.1</td>
<td>15.8</td>
</tr>
<tr>
<td>42</td>
<td>Karanj cake</td>
<td>27.2</td>
<td>9.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

**FEED FORMULATION**

The important step in feed formulation is to decide on the product specification (Fig. 3). According to the nutrient requirement of the livestock, the nutritional composition of different feeds have been worked out (Tables 6 and 7). The feeds are manufactured in different forms such as; mash, pellets, cubes and blocks. Different raw materials are selected to produce a particular feed with the specified nutritional composition. These raw materials vary in their nutritional composition, and this determines the quality specifications. These specifications should be genuine and practicable. It may help the buyer to know what is being purchased and the supplier to know what should be supplied. Any dispute regarding the quality of the material can be solved once the specifications are available. The Indian Standards Institute has worked out specifications for various raw materials available in the country. Along with the quality specifications, processing specifications such as degree of grinding of the ingredients, molasses percentage, steaming, percentage of “fines” in pellets and also the moisture content and density of the final product, are also worked out. For cattle feed formulations linear programming is used to derive the least cost formula. The data sheet generally used is shown in Table 8.

**PURCHASE OF RAW MATERIALS**

The purchase of raw materials is based on quality specifications. Since large quantities of different by-products are being purchased, there is a possibility of variation in the chemical composition. Generally, the specifications laid down are for moisture, protein, ether extract, fibre, total ash, silica and various minerals. The toxic elements such as fluorine, aflatoxin and ergotoxin are also controlled by specifications. If the raw material is found to be unadulterated and free from harmful elements to livestock this could be accepted with certain rebate conditions. The rebates are being worked out for different nutritional motives for their excess on maximum limit as well as deficiency on minimum limit in between the rejection limits. However, the quality standards on the final product are not sacrificed for short-term economic gain.

**PRODUCTION**

The processes involved in feed milling are cleaning, grinding, mixing, molassing, pelleting, cooling and packaging. Strict plant production control is exercised to maintain the quality of the finished product, to increase production and decrease the cost. Idle operations are discouraged. Weighing and conveying is done under strict supervision.

**QUALITY CONTROL**

The most important function in a feed plant is the quality control operation. The quality
Fig. 3: Specification and quality control in feedmill operations

Product specification

Nutritional characteristics

Physical characteristics

Performance specification

Complaints field report

Action marketing

Raw materials specification

Formulation

Buying specification

Acceptance specification

Action purchase

Action production

Auction production

Physical

Chemical

Deviation from standard

Review quality standards

Review raw materials specification
Table 6. Nutritive value of different types of feeds manufactured in India

<table>
<thead>
<tr>
<th>No.</th>
<th>Analysis</th>
<th>Cattle feed-I</th>
<th>Cattle feed-II</th>
<th>Calf starter*</th>
<th>Layer</th>
<th>Grower</th>
<th>Broiler Starter</th>
<th>Finisher</th>
<th>Chick feed</th>
<th>Breeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Crude protein</td>
<td>22</td>
<td>20</td>
<td>22</td>
<td>18</td>
<td>16</td>
<td>22</td>
<td>19</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>3.</td>
<td>Ether extract</td>
<td>3.5</td>
<td>2.5</td>
<td>4.5</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4.</td>
<td>Crude fibre</td>
<td>7</td>
<td>12</td>
<td>6.0</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Acid insoluble ash</td>
<td>3.0</td>
<td>4.0</td>
<td>2.5</td>
<td>4.0</td>
<td>4.0</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>6.</td>
<td>Calcium</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>2.75</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.74</td>
</tr>
<tr>
<td>7.</td>
<td>Phosphorus</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>8.</td>
<td>Jrea</td>
<td>1</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>9.</td>
<td>Vitamin A+D3 IU/kg</td>
<td>5000</td>
<td>5000</td>
<td>8000</td>
<td>8000</td>
<td>4000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>4000</td>
</tr>
<tr>
<td>10.</td>
<td>Common salt</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
</tbody>
</table>

* Kaira district cooperative milk producers union Ltd. (by author)


Table 7. Requirements for chicken feeds to be declared

<table>
<thead>
<tr>
<th>No.</th>
<th>Items</th>
<th>Broiler starter</th>
<th>Broiler finisher</th>
<th>Chick</th>
<th>Growing chicken</th>
<th>Layers</th>
<th>Breeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lysine (percent)</td>
<td>0.9</td>
<td>0.9</td>
<td>1.0</td>
<td>0.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>2.</td>
<td>Methionine (percent)</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>3.</td>
<td>Metabolisable energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Kcal/kg</td>
<td>2900</td>
<td>3000</td>
<td>2700</td>
<td>2700</td>
<td>2700</td>
<td>2800</td>
</tr>
<tr>
<td>5.</td>
<td>Manganese, mg/kg</td>
<td>60</td>
<td>60</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>6.</td>
<td>Iodine, mg/kg</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Iron, mg/kg</td>
<td>40</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>8.</td>
<td>Copper, mg/kg</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>Zinc, mg/kg</td>
<td>50</td>
<td>50</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>10.</td>
<td>Vitamin D, AOAC chick units/kg</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>11.</td>
<td>Thiamine, mg/kg</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>12.</td>
<td>Riboflavin, mg/kg</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>13.</td>
<td>Pantothenic acid, mg/kg</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>14.</td>
<td>Nicotinic acid mg/kg</td>
<td>40</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>15.</td>
<td>Vitamin B₁₂ mg/kg</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>16.</td>
<td>Biotin mg/kg</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>17.</td>
<td>Alpha tocopherol</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>18.</td>
<td>Linoleic acid, g/100g</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.00</td>
</tr>
<tr>
<td>19.</td>
<td>Sulfur amino acids g/100g</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>20.</td>
<td>Choline chloride</td>
<td>1400</td>
<td>1400</td>
<td>1300</td>
<td>—</td>
<td>—</td>
<td>1300</td>
</tr>
</tbody>
</table>

Table 8. Data sheet for least cost formulation

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>CP</th>
<th>DCP</th>
<th>TDN</th>
<th>Fat</th>
<th>Fibre</th>
<th>Silica</th>
<th>Cost</th>
<th>Individual constrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Maize</td>
<td>10</td>
<td>6</td>
<td>80</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1400</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Jowar</td>
<td>9</td>
<td>5</td>
<td>79</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1200</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>Bajra</td>
<td>11</td>
<td>6</td>
<td>74</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1300</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Tapioca chips</td>
<td>2</td>
<td>-</td>
<td>75</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1000</td>
<td>UB 7</td>
</tr>
<tr>
<td>5.</td>
<td>Coconut cake ext.</td>
<td>27</td>
<td>18</td>
<td>75</td>
<td>1.2</td>
<td>9</td>
<td>2</td>
<td>1200</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Guar meal</td>
<td>56</td>
<td>50</td>
<td>75</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>1200</td>
<td>UB 14</td>
</tr>
<tr>
<td>7.</td>
<td>Salseed ext.</td>
<td>10</td>
<td>-</td>
<td>40</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>500</td>
<td>UB 5</td>
</tr>
<tr>
<td>8.</td>
<td>Groundnut ext.</td>
<td>45</td>
<td>42</td>
<td>75</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>1300</td>
<td>-</td>
</tr>
<tr>
<td>9.</td>
<td>Soybean ext.</td>
<td>54</td>
<td>50</td>
<td>75</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>1700</td>
<td>-</td>
</tr>
<tr>
<td>10.</td>
<td>Groundnut cake</td>
<td>37</td>
<td>35</td>
<td>75</td>
<td>7</td>
<td>12</td>
<td>2</td>
<td>1400</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Sunflower cake</td>
<td>32</td>
<td>21</td>
<td>51</td>
<td>1</td>
<td>18</td>
<td>2</td>
<td>1000</td>
<td>UB 7</td>
</tr>
<tr>
<td>12.</td>
<td>Safflower cake</td>
<td>20</td>
<td>15</td>
<td>51</td>
<td>1</td>
<td>36</td>
<td>2</td>
<td>700</td>
<td>UB 7</td>
</tr>
<tr>
<td>13.</td>
<td>Rice bran ext.</td>
<td>16</td>
<td>10</td>
<td>55</td>
<td>1</td>
<td>14</td>
<td>6</td>
<td>560</td>
<td>UB 40</td>
</tr>
<tr>
<td>14.</td>
<td>Wheat bran</td>
<td>15</td>
<td>12</td>
<td>65</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>1000</td>
<td>UB 12</td>
</tr>
<tr>
<td>15.</td>
<td>Maize bran</td>
<td>12</td>
<td>10</td>
<td>55</td>
<td>2</td>
<td>10</td>
<td>-</td>
<td>750</td>
<td>UB 16</td>
</tr>
<tr>
<td>16.</td>
<td>Rice polish</td>
<td>13</td>
<td>10</td>
<td>80</td>
<td>16</td>
<td>7</td>
<td>5</td>
<td>1200</td>
<td>UB 16</td>
</tr>
<tr>
<td>17.</td>
<td>Cotton seed ext.</td>
<td>40</td>
<td>38</td>
<td>75</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>1600</td>
<td>UB 10</td>
</tr>
<tr>
<td>18.</td>
<td>Cotton seed bran</td>
<td>4</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>36</td>
<td>2</td>
<td>400</td>
<td>UB 7</td>
</tr>
<tr>
<td>19.</td>
<td>Groundnut shells</td>
<td>5</td>
<td>-</td>
<td>40</td>
<td>-</td>
<td>55</td>
<td>4</td>
<td>250</td>
<td>UB 5</td>
</tr>
<tr>
<td>20.</td>
<td>Molasses</td>
<td>-</td>
<td>-</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>UB 11</td>
</tr>
<tr>
<td>21.</td>
<td>Calcite powder</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>200</td>
<td>UB 2</td>
</tr>
<tr>
<td>22.</td>
<td>Mineral mixture</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2000</td>
<td>LB/UB 1</td>
</tr>
<tr>
<td>23.</td>
<td>Salt</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>200</td>
<td>UB 1</td>
</tr>
</tbody>
</table>

Formula Specification:

- \( CP = 20 \text{ percent minimum} \)
- \( DCP = 14 \text{ percent minimum} \)
- \( FAT = 3 \text{ percent minimum} \)
- \( Fibre = 10 \text{ percent maximum} \)
- \( Silica = 3 \text{ percent maximum} \)
- \( TDN = 65 \text{ percent minimum} \)

control helps in the purchase of good quality raw materials, provides the required nutrients in the feed, controls the production cost and maintains the quality of the stored products (Fig. 2).

Purchase

The raw materials are samples properly analysed before acceptance. The materials with tolerable limit are accepted with rebate but sub-standard materials are rejected outright.

Production

The variation in the usage of different raw materials is controlled. Timely advice regarding the quality of the finished product helps to avoid re-processing. The finished products are analysed to check the quality.

Storage

To prevent spoilage of the stored materials, different measures have been taken such as cleaning, proper stacking, insecticide spray, fumigation and rodent control. Occasional checking of raw materials for moisture, rancidity and infestation will avoid possible spoilage and losses.

In any case the quality control guarantees the...
Table 9. Indian Standard Institute specification for raw materials and livestock feeds

1. Oil Cake
   iv) IS : 1934 – 1961 Specification for sesamum (Til) oil cake as livestock feed.
   x) IS : 3441 – 1966 Specification for solvent extracted groundnut cake as livestock feed.
   xi) IS : 3591 – 1968 Specification for solvent extracted coconut oil cake as livestock feed.
   xii) IS : 3592 – 1968 Specification for solvent extracted cotton seed oil cake as livestock feed.
   xiv) IS : 5862 – 1970 Specification for solvent extracted niger seed oil cake as livestock feed.
   xvii) IS : 1714 – 1960 Methods of sampling and test for oil cakes as livestock feed.

2. Grain By-Products

3. Animal Waste and Other Agricultural/Industrial By-Products

Source: Indian Standard Institute, New Delhi.

In India the feed control laws are not enforced. However, the Indian Standards for different raw materials and finished products are available. The Indian Standards Institute (ISI) has formed Animal Feed Sub-committee, comprising scientists, practitioners, technologists, feed manufacturers and farmers. Generally, the products sold in the market with the certification of ISI are...
trusted for quality. The different ISI standards are given in Table 9.

EXPORT OF FOOD AND FEEDS

The export of oilseeds, oil cakes and food materials for the period April, 1978 – March, 1979, is given in Table 10. 18,000 tonnes of oilseeds, 14 million tonnes of oil cakes and 7,000 tonnes of food materials were exported during 1978-79. India does not import feed stuffs from other countries. However, there are imports of oilseeds, rice and wheat.

MAIN FEEDING SYSTEMS

The need for draught power is a pivotal element in the farming operations and determines priorities in feeding. During the seventies, along with the “Operation Flood” programme, the milk stock were also given priorities. The co-operative infrastructure created by the project in the rural milkshed area gave a new hope for the milk producers, especially the landless and small farmers. India’s non-descript cows (Bos indicus) which are randomly bred can survive on a low plane of nutrition and can produce calves (and limited quantity of milk), while consuming mainly coarse roughages of high fibre content such as straw/stover.

The Indian buffaloes can make better use of roughages than cattle and produce more milk fat. The disadvantages are that even if fed scientifically the non-descript cow uses 44 percent of intake, and the buffalo 60 percent of intake, for milk production whereas an exotic cow utilises 65 to 70 percent of the intake for milk production.

The feeding of Bovines in India is directly dependent on the economic return. Various scientific feeding regimens have been suggested. e.g. the Sen and Ray Feeding Standard of India, which is similar to the Morrison standards Mullick and Kehar (1952) and Mudgal (1969) suggested that Indian cattle require 20 percent less nutrients than other breeds, but this is not valid. Recent results (Ranjan et al. 1975, Katiyar 1971; Patle and Mudgal 1976) indicated that lactating cows require the same amount of ME, or even more than what is recommended by NRC.

<table>
<thead>
<tr>
<th>Feeding requirements (theoretical approach)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cow</td>
</tr>
<tr>
<td>Buffalo</td>
</tr>
</tbody>
</table>

*1 kg FCM=750 Kcal

It is observed that when the nutritional requirements of body maintenance are satisfied, the additional nutrients are converted into milk yield. It is theoretical to believe that the increase of milk production is linear to the incremental feeding. In fact, the response of milk production increases till it reaches the genetic potential. It is clear from Fig. 4 that the increase of milk production after 9 litres is not as steep as below 9 litres. Hence the maximum profit return for the farmer could be that point.

ECONOMIC FEEDING REGIMEN (FUTURE APPROACH)

About 55 to 60 percent of the cost of milk production is for feed. The most expensive component is the concentrate. The economics of milk production depends on the degree to which the quantity of concentrates can be reduced without affecting the milk yield. Fig. 4 represents the economic feeding rate. AB represents the conventional feeding rate as per the scientific principles and CD the response by reducing 40 percent of the concentrates increasing the crop residue intake. The net profit in the case of CD is much greater. In India, where a majority of the milch animals are low producers and the economy of milk production depends on the crop residue feeding, a new approach which maximises the crop residue utilisation will be desirable. The ideal way for that is by manipulation of rumen fermentation.

MANIPULATION OF RUMEN FERMENTATION

Leng (1981) proposed that the nutritional
Fig. 4: Milk production response
Table 10. Exports of oil seeds and oil cakes from India (April 1978–March 1979)

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Quantity (Tonnes)</th>
<th>Value (Rupees Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Copra</td>
<td>566</td>
<td>1.73</td>
</tr>
<tr>
<td>2</td>
<td>Groundnut kernel H.P.S.</td>
<td>4,055</td>
<td>26.4</td>
</tr>
<tr>
<td>3</td>
<td>Groundnut shell H.P.S.</td>
<td>4,445</td>
<td>28.8</td>
</tr>
<tr>
<td>4</td>
<td>Cotton seed</td>
<td>312</td>
<td>0.27</td>
</tr>
<tr>
<td>5</td>
<td>Mustard seed</td>
<td>2</td>
<td>0.002</td>
</tr>
<tr>
<td>6</td>
<td>Sesame seed</td>
<td>2,725</td>
<td>18.4</td>
</tr>
<tr>
<td>7</td>
<td>Niger seed</td>
<td>5,915</td>
<td>61.8</td>
</tr>
<tr>
<td>8</td>
<td>Safflower seed</td>
<td>1.5</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

18,021.5

Oil Cakes

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Quantity (Tonnes)</th>
<th>Value (Rupees Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soybean extraction</td>
<td>52,500</td>
<td>87.1</td>
</tr>
<tr>
<td>2</td>
<td>Groundnut extraction</td>
<td>538,493</td>
<td>740.9</td>
</tr>
<tr>
<td>3</td>
<td>Decorticated cotton seed expeller</td>
<td>55,038</td>
<td>66.4</td>
</tr>
<tr>
<td>4</td>
<td>Decorticated cotton seed extraction</td>
<td>115,077</td>
<td>180.4</td>
</tr>
<tr>
<td>5</td>
<td>Linseed oilcake expeller</td>
<td>1,696</td>
<td>0.24</td>
</tr>
<tr>
<td>6</td>
<td>Linseed oil cake extraction</td>
<td>25,111</td>
<td>36.38</td>
</tr>
<tr>
<td>7</td>
<td>Sunflower seed extraction</td>
<td>973</td>
<td>0.70</td>
</tr>
<tr>
<td>8</td>
<td>Rape mustard extraction</td>
<td>11,192</td>
<td>11.10</td>
</tr>
<tr>
<td>9</td>
<td>Copra oilcake expeller</td>
<td>301</td>
<td>0.24</td>
</tr>
<tr>
<td>10</td>
<td>Copra oilcake extraction</td>
<td>4,856</td>
<td>0.38</td>
</tr>
<tr>
<td>11</td>
<td>Mowza oilcake expeller</td>
<td>396</td>
<td>0.22</td>
</tr>
<tr>
<td>12</td>
<td>Kardi oilcake extraction</td>
<td>14,106</td>
<td>8.75</td>
</tr>
<tr>
<td>13</td>
<td>Sesame seed extraction</td>
<td>5,541</td>
<td>7.97</td>
</tr>
<tr>
<td>14</td>
<td>Sesame seed expeller</td>
<td>674</td>
<td>0.99</td>
</tr>
<tr>
<td>15</td>
<td>Mango kernel extraction</td>
<td>3,979</td>
<td>1.79</td>
</tr>
<tr>
<td>16</td>
<td>Sal oil cake extraction</td>
<td>13,473</td>
<td>0.84</td>
</tr>
<tr>
<td>17</td>
<td>Other oilcake expeller</td>
<td>755</td>
<td>0.26</td>
</tr>
<tr>
<td>18</td>
<td>Other oilcake extraction</td>
<td>315</td>
<td>84.99</td>
</tr>
<tr>
<td>19</td>
<td>Compounded animal feed</td>
<td>61,363</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Rice bran extraction</td>
<td>478,826</td>
<td>196.16</td>
</tr>
</tbody>
</table>

13.84 million

Food

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Quantity</th>
<th>Value (Rupees Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fish</td>
<td>78</td>
<td>2282.6</td>
</tr>
<tr>
<td>2</td>
<td>Cashew kernal</td>
<td>27</td>
<td>802.3</td>
</tr>
<tr>
<td>3</td>
<td>Sugar</td>
<td>731319.2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Coffee</td>
<td>6,630</td>
<td>1440.6</td>
</tr>
<tr>
<td>5</td>
<td>Tea</td>
<td>172</td>
<td>3404.5</td>
</tr>
<tr>
<td>6</td>
<td>Spices</td>
<td>97</td>
<td>1480.5</td>
</tr>
</tbody>
</table>

70,11.3

Requirements of ruminents in India are best understood by considering first the need for an efficient rumen fermentation which may increase the efficiency of low cost feed utilisation to increase the productivity of the animal. A highly efficient rumen fermentation can be achieved by:

* Increasing the feed intake.
* Increasing the microbial population.

Intake

The intake of feed is controlled by (a) distension of rumen (b) VFA concentration (c) regulation of energy balance (d) amino acid absorption apart from the factors such as palatability, climatic effects and the physiological status of the animal. The low rate of fermentation of straw may not provide enough substrate for cellulolytic organisms. Addition of readily and totally fermentable energy sources to the diet may possibly increase the availability of substrate for the colonisation by cellulolytic organisms. This may increase the rumen turn-over reducing the distension and increasing the intake. Feeding of urea along with bypass protein has increased the feed intake (Kempton and Leng 1979; Orskov et al., 1973).

Increasing Microbial Population

The major factors that affect microbial protein synthesis in the rumen on straw-based diets are:

a) availability of potentially fermentable feed.

b) availability of precursors of microbes such as glucose, amino acids, ammonia and minerals.

c) Maintenance of ATP requirements of the micro-organisms.

d) Microbial turnover and lysis

When the objective of the feeding strategy is the production of meat, milk and wool then any manipulation of rumen fermentation must be aimed at maximising microbial protein output. Any manipulation which maintains a large pool of organisms in the rumen will increase the rate of colonisation and degradation of straw particles (Nielsen 1983).

For maximum cell production, rumen ammo-
nia level, should not be less than 5–8 mg/100 (Sattar and Slyter 1974). A number of studies have emphasized the need for a continuous supply of NH₃ in the rumen in order to maintain higher intake and digestibility of fibrous diets (Romero et al., 1970; Campling et al., 1962).

When the fermentation of roughages is maximised, the degradation of dietary protein has to be minimised. If 100 g dietary amino acid is fermented in the rumen, the availability of microbial protein is about 9 g only, out of which the productive protein is only 4 g (Leng, 1981) which is a waste as far as the feeding economics is concerned. However, the nitrogen requirement of the microbes has to be fulfilled. The empirical evaluation of dietary nitrogen as DCP does not take full account of the effect of ruminal fermentation, nor of the close relationship between energy availability and N requirements and cannot predict with sufficient accuracy the true availability of protein for production in the body (Verite et al. 1979; ARC 1981). In India, where concentrates (oil cakes, meals and cereals) are quite expensive, supplying soluble N from cheap sources such as NPN and unconventional feeds; energy from roughages after efficient fermentation in rumen; and the extra productive protein from bypass protein is quite imperative. This can be done on a straw based diet by supplying fermentable N and fermentable energy constantly using a urea = molasses animal lick, and also concentrates with certain amount of bypass protein.

FEEDING OF POULTRY

Rearing of poultry on kitchen wastes in the backyard has been practised for generations in India. Recently, improved poultry husbandry methods have been started. In practice, birds are fed ad libitum and, therefore, the necessity for having a requirement for energy and protein is probably an academic exercise. On ad libitum feeding, birds will normally tend to adjust intake voluntarily to their individual requirements for nutrients which can vary with factors such as environment, breed, liveweight, balance of nutrients in the diet, and for layers, on the rate of egg production. The requirement of energy is expressed in terms of Metabolisable Energy (ME). The protein requirements are assured by amino acid analysis of rapid growing chickens at say, weekly intervals determining by difference in composition of new tissue added, during growth. The protein level in starting rations for chickens is about 20 percent, but it is lowered as the chickens increase in weight.

For layers it has been worked out according to the nutrient content of the egg. An egg weighing two ounces will contain about 7.5 g protein, 2 g calcium and about 95 calories of gross energy. The basal heat production of an adult hen is about 2.75 calories/kg BW per hour. The requirement of energy and protein of hens is worked out after calculating their basal heat production, activity requirements and nutrients stored in eggs.

In general, when lower feed intake is noticed then the concentration in nutrients is increased.

FEEDING OTHER LIVESTOCK

Goats: There are different breeds of goats in India and their milk production varies from 60 to 250 litres for 120 days of lactation. A majority of goats prefer browsing rather than grazing. Goats can well utilise the coarse fibrous feed but for efficient production the energy losses in heat production and digestion process have to be minimised to get a maximum return in the form of edible products.

Sheep: Sheep prefer pastures and ranges as their natural habitat. In India the maximum concentration of wool-yielding sheep is in the arid region of the northern plains comprising Rajasthan, Kutch, Saurastoa and North Gujarat. The sheep in India generally live on grazing wild grasses, herbs and farm waste products.

Pigs: Commercial hog industry has not yet been developed like wool and poultry industry because (1) pork is not eaten by a majority of meat eaters in India (2) pigs compete directly with humans for the cereals. Therefore the common village hog in India is a scrub animal and lives on kitchen waste and night soil. However, in recent times a number of piggeries have been established where hogs are reared on scientific principles.
SUMMARY

India has a large livestock population. Feeding the draught animals as well as milch animals is the priority for rationing the available feed stuffs. The available feed stuffs are mainly crop residues, agro-industrial by-products and unconventional feed stuffs. The compound feed industry is still in its infancy. However, a rapid increase in the near future is expected. Feed formulation, compounding and quality control are done on scientific principles. There is an export of oilseeds, oil cakes and food material from India. The import of feed materials is negligible. The feeding of bovines is not practised on scientific principles. An approach to the utilisation of crop residues for better conversion efficiency is proposed. The net return could be increased by giving urea-molasses licks and by-pass protein from crop residues. The feeding of poultry and other livestock is also discussed.

REFERENCES

5. Operation flood II documents NDDB publication.
8. Twelfth all India census 1977.
10. ICAR schemes all India coordinated research project for investigation on agricultural by-products and industrial waste materials for evolving economic ration for livestock.