Feeding Management volume 1 is the fourth of a series of management manuals published by Veepro Holland and the first of two volumes on feeding management. Though these manuals Veepro Holland aims at providing you with useful management information. Dairy cattle worldwide need to be managed well to utilize their potential to full extent.

No single booklet can cover every subject as diverse and complex as dairying. Nor can everyone associated with dairying agree on all points covered in one publication. But we of Veepro Holland believe the combination of this manual and other publications on the subject may broaden your knowledge on dairy cattle feeding and subsequently contribute to a healthy and highly productive herd.

Veepro Holland is indebted to those who contributed to this manual, particularly, ir Bob Subnel of the Research Station for Cattle, Sheep and Horse Husbandry at Lelystad and ir Wilfried van Straalen of the CLO Institute for Animal Nutrition “De Schothorst” at Lelystad, for their constructive criticism.

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Veepro Holland
INTRODUCTION

Animal nutrition has great influence on the profitability of the dairy farm. Cows should be fed well-balanced rations as a prerequisite for optimal milk production. With good nutrition, dairy cows can demonstrate their full genetic potential whilst maintaining their good health. The ration should meet the cow’s energy and protein requirements for maintenance, milk production, growth and reproduction. A successful ration should be nutritionally complete, with adequate amounts of minerals and vitamins.

Two feeding manuals have been written to assist you in feeding your cows correctly. This first discusses the composition of feedstuffs and gives a description of feeds used in dairy cattle feeding. The second describes the balancing of rations and tells how to feed cows during the various stages of the lactation period.

The availability of the different kinds of feed and their composition as well as the nutritional requirements of dairy cows differ considerably on a worldwide basis. Influencing factors include the climate, the level of milk production and the genetic potential of the cows. Therefore, it is difficult to give figures and examples that are applicable to all circumstances. In this manual average values of the nutritional composition for quality feeds are given, but it is advisable to have feed samples analyzed to ensure the desired composition.

THE COMPOSITION OF FEEDSTUFFS

In order to get a better insight into animal nutrition one should have a basic knowledge of how feedstuffs are allocated to the various nutritional groups and how they contribute to animal nutrition. Figure 1 gives a schematic view of how feeds are divided into their nutritional components.
Figure 1: The composition of feedstuffs

Water
Water is an essential dietary component for dairy cattle, since it makes up about 55-60% of a cow’s bodyweight. Water is needed for maintaining body fluid levels, digesting and metabolizing nutrients, the production of milk and so on. Furthermore the intake of water depends on the dry matter content of feeds, the level of milk production and climatic conditions. Forages have a relatively high water/dry matter ratio, whereas cereals and their by-products have a relatively low water content. Water should always be fresh and freely available. At high ambient temperatures, a high-yielding cow may require over 100 litres of fresh water per day.

The water quality must be good and without any flavour. The total soluble salts content of the water should be below 2,000 ppm, as otherwise it will affect health and milk production.

Dry matter
Dry matter (DM) is the material remaining after the water has been extracted from feeds. The daily DM intake for high-yielding dairy cows is about 3-4% of their live weight. Cows regulate dry matter intake and water consumption independently. The dry matter intake depends, amongst others, on the DM percentage of the ration, the milk production and climate. These may be divided into animal factors and feed factors (see table 1).

Dry matter can be divided into organic matter and inorganic matter. The organic matter contains nutrients such as protein, fat, carbohydrates and vitamins.

Healthy cows take in as much as dry matter as necessary to satisfy their appetite.
High-producing dairy cows need much energy and protein to make their production possible.

The inorganic matter consists of macro and micro elements (see fig. 1). The energy requirements for maintenance, milk production, growth and reproduction are derived from the organic matter in the ration.

**Protein**
The proteins and their structural units, amino acids, are essential dietary components. The crude protein (CP) refers to all nitrogenous compounds in a feed and consists of true protein and non-protein nitrogen (NPN). It is the total nitrogen (N) converted to a protein basis by multiplying the nitrogen content by 6.25. The average N content in crude protein is 16% (100 divided by 16 equals 6.25).

A further distinction can be made between degraded and undegraded protein. Degraded intake protein (DIP) is protein which is broken down in the cow’s rumen. Undegraded protein escapes (by-passes) rumen fermentation. It is partially absorbed in the lower digestive tract and is called undegraded intake protein (UIP).

High-yielding cows need a substantial amount of protein that escapes the rumen (undegraded protein) to be absorbed in the small intestinal tract. Table 2 lists feeds with their ruminal undegraded protein.

In the Netherlands the DVE system was developed to calculate the amount of protein available for digestion in the small intestine. It consists of the undegraded intake protein (UIP) in a ration, together with microbial protein produced in the rumen. The DVE system was discussed in Veepro magazines 16 and 17.

**Carbohydrates**
The dairy cow derives her energy mainly from carbohydrates. They consist of carbohydrates that are rapidly absorbed, such as
soluble sugars, easily degraded and undegraded starch, and crude fibre carbohydrate, which is degraded more slowly (although most of it passes through the intestine unchanged), such as cellulose and hemicellulose. The carbohydrates are to a large extent digested by microbes in the cow’s rumen. Ruminants need sufficient amounts of fibre for proper functioning of the rumen. Crude fibre slows down the passage of feed in the rumen and thus the rumen attains a more neutral pH and microbes function at their optimum. This leads to better utilization of the feed.

Usually soluble sugars have a positive influence on the butterfat percentage and undegradable starch has a favourable influence on milk production, but too much of these components will lead to a large amount of lactic acid within the rumen. This will result in less crude fibre being degraded. In other words, high levels of easily digestible carbohydrates will disrupt rumen fermentation.

**Fat**

Fat has the highest energy content per unit mass. It is the main source of energy reserve for animals. Furthermore, it acts as a carrier for other feed components such as fatsoluble vitamins. Several essential unsaturated fatty acids should be supplied with the ration to guarantee high milk production and good fertility. A ration containing at most 50 grammes vegetable fat per kg DM for freshly calved cows and 40 grammes per kg DM for end of lactation cows usually meets these requirements.

Minerals and vitamins are essential for the cow’s overall health

Notably undegraded starch may have a positive effect either on milk or protein production. It is broken down into glucose in the small intestine and is a very important energy source for milk production. A large amount of undegraded starch at the beginning of lactation will lead to better utilization of amino acids from the small intestine for milk protein production. If the lactating cow gets an insufficient supply of energy from undegraded starch, these amino acids may be used as an alternative source of energy.

Minerals are needed for strengthening of skeleton and all sorts of vital functions. They also serve as the constituents of organic compounds which are required for the formation of body tissue and enzymes.
They can be divided into two groups, notably macro and micro (trace) minerals. Minerals needed in larger amounts are the macro minerals: Sodium (Na), Chlorine (Cl), Calcium (Ca), Phosphorus (P), Potassium (K), Magnesium (Mg) and Sulphur (S). Minerals needed in smaller amounts, the micro minerals, include: Iron (Fe), Copper (Cu), Cobalt (Co), Manganese (Mn), Zinc (Zn), Iodine (I), Molybdenum (Mo) and Selenium (Se). These minerals are essential for the cow’s health. Overdosing of some minerals (e.g. Cu, Mo and Se) may lead to toxic effects.

Dairy cows exposed to high ambient temperatures require more minerals (cattle salt) than those exposed to moderate temperatures. High-yielding cows lose considerable amounts of certain minerals during their lactation period. Therefore, a mineral mixture with adequate amounts of Sodium, Chlorine, Calcium, Phosphorus, Magnesium, and limited amounts of Selenium and Iodine should be available ad libitum to high-yielding cows.

Vitamins
Vitamins are either fat-soluble or water-soluble. Fat-soluble vitamins (A, D, E, K) are necessary for optimal functioning of specific structures within the cow’s tissues. Water-soluble vitamins (B, C) act as components or activators of enzymes at a biochemical level. Vitamins in small amounts are essential for overall health, maintenance of body structures, milk production, growth, and reproduction. Vitamins A and D are the only two vitamins that cannot be made by the cow itself and have to be supplemented in the ration. Additional other vitamins are often supplied in commercially available concentrate mixtures.

NUTRIENT COMPOSITION OF FEEDS
The nutritional composition of feedstuffs is influenced by many factors. These include the quality and the degree of fertilization of soil, the stage of growth at harvesting or grazing and climatic conditions. The average composition of commonly used quality farm feed per kg fresh product is shown in tables 3 en 4 (see pages 8 and 9).

These figures represent a good practical guide, although they may be substituted for preferred values.

In the Feeding Management manuals the terms Total Digestible Nutrients (TDN) and Net Energy for Lactation (NEL) are used since these terms are most often used internationally. The energy determination within the Total Digestible Nutrients is calculated by adding the feed levels of digestible crude protein, crude fibre, nitrogen free extract (soluble starch) and fat. The fat percentage is multiplied by 2.25 to allow for the energy content of fat.

A clear insight into the composition of feeds is essential for feeding the cow to her requirements.

Net Energy for Lactation (NEL) is the amount of feed energy needed for milk production and body maintenance. On a dry matter basis, feeds are usually similar in total energy content, but vary widely in the proportion of the total energy available for milk production and maintenance. The remainder of the energy in a feed is lost in faces, urine, gas (methylene) belched form the rumen and excess heat.
production by the cow. Net energy is also required to support the growth of the foetus. Each kilogramme of milk produced requires a known amount of net energy (Feeding Management, Volume 2).

As regards the difference in prices among different feeds, one unit of crude protein (CP) or energy (TDN) should be compared on a 100% DM basis. This will indicate which feed has the best quality-to-price ratio.

DESCRIPTION OF FEEDSTUFFS

ROUGHAGES

Good-quality roughages are the best sources of fibre for optimal functioning of the rumen. This relates to their influence on the rumen flora. In order to maximize the nutrient value of forages, it is important to harvest (graze) at the right stage of maturity. Nearly all forages have their highest nutrient content before the flowering stage. The nutrient value as well as digestibility declines after this stage. Maize/sorghum to be ensiled should be harvested at the dough stage of the grain to obtain the highest nutrient value.

Wet brewers’ grains is a by-product of the brewing industry. It is a medium-protein and medium-energy feed. It is very palatable and is best fed at a rate of 5 to 10 kg per dairy cow per day. It must be fed fresh or obtained from ensiled storage. If ensiled, the wet brewers’ grains take

<table>
<thead>
<tr>
<th>Name</th>
<th>DM (g)</th>
<th>CF (g)</th>
<th>TDN (g)</th>
<th>NEL (Mcal)</th>
<th>CP (g)</th>
<th>CA (g)</th>
<th>P (g)</th>
<th>max. kg in rations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa fresh</td>
<td>200</td>
<td>50</td>
<td>210</td>
<td>0.30</td>
<td>45</td>
<td>4.40</td>
<td>0.70</td>
<td>-</td>
</tr>
<tr>
<td>Napier grass</td>
<td>200</td>
<td>65</td>
<td>110</td>
<td>0.25</td>
<td>18</td>
<td>1.20</td>
<td>0.50</td>
<td>-</td>
</tr>
<tr>
<td>Rhodes grass</td>
<td>200</td>
<td>75</td>
<td>150</td>
<td>0.30</td>
<td>20</td>
<td>1.30</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>180</td>
<td>45</td>
<td>110</td>
<td>0.25</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sorghum forage</td>
<td>240</td>
<td>55</td>
<td>140</td>
<td>0.35</td>
<td>25</td>
<td>0.90</td>
<td>0.40</td>
<td>-</td>
</tr>
<tr>
<td>Brewers grains (wet)</td>
<td>220</td>
<td>30</td>
<td>150</td>
<td>0.35</td>
<td>55</td>
<td>0.60</td>
<td>1.20</td>
<td>10</td>
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<td>Grass silage (Dutch)</td>
<td>450</td>
<td>100</td>
<td>280</td>
<td>0.60</td>
<td>75</td>
<td>2.50</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Maize silage</td>
<td>300</td>
<td>75</td>
<td>180</td>
<td>0.35</td>
<td>20</td>
<td>0.80</td>
<td>0.70</td>
<td>-</td>
</tr>
<tr>
<td>Sorghum silage</td>
<td>300</td>
<td>80</td>
<td>170</td>
<td>0.40</td>
<td>20</td>
<td>0.70</td>
<td>0.50</td>
<td>-</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>900</td>
<td>200</td>
<td>540</td>
<td>1.30</td>
<td>200</td>
<td>13.40</td>
<td>3.00</td>
<td>-</td>
</tr>
<tr>
<td>Alfalfa pellets</td>
<td>920</td>
<td>240</td>
<td>550</td>
<td>1.25</td>
<td>175</td>
<td>14.00</td>
<td>2.30</td>
<td>10</td>
</tr>
<tr>
<td>Rhodes grass hay</td>
<td>900</td>
<td>240</td>
<td>510</td>
<td>1.15</td>
<td>70</td>
<td>4.50</td>
<td>3.50</td>
<td>-</td>
</tr>
<tr>
<td>Ryegrass hay</td>
<td>880</td>
<td>250</td>
<td>530</td>
<td>1.20</td>
<td>75</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Barley straw</td>
<td>910</td>
<td>380</td>
<td>430</td>
<td>0.90</td>
<td>40</td>
<td>2.70</td>
<td>0.70</td>
<td>-</td>
</tr>
<tr>
<td>Maize stover</td>
<td>860</td>
<td>300</td>
<td>510</td>
<td>1.15</td>
<td>50</td>
<td>4.90</td>
<td>0.80</td>
<td>-</td>
</tr>
<tr>
<td>Oats straw</td>
<td>920</td>
<td>375</td>
<td>460</td>
<td>1.05</td>
<td>40</td>
<td>-</td>
<td>0.60</td>
<td>-</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>900</td>
<td>375</td>
<td>400</td>
<td>0.85</td>
<td>30</td>
<td>1.60</td>
<td>0.50</td>
<td>-</td>
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</table>
Table 4  Examples of feeds rich in energy and/or protein and their nutritional composition per kg fresh product (g/kg)

<table>
<thead>
<tr>
<th>Name</th>
<th>ST g</th>
<th>SV g</th>
<th>TDN g</th>
<th>NEL Mcal</th>
<th>CP g</th>
<th>CA g</th>
<th>P g</th>
<th>Max. % u koncentratima</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy-rich feeds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>900</td>
<td>50</td>
<td>750</td>
<td>1.80</td>
<td>115</td>
<td>0.50</td>
<td>3.40</td>
<td>70</td>
</tr>
<tr>
<td>Maize</td>
<td>900</td>
<td>25</td>
<td>800</td>
<td>1.80</td>
<td>95</td>
<td>0.50</td>
<td>3.40</td>
<td>50</td>
</tr>
<tr>
<td>Oats</td>
<td>900</td>
<td>105</td>
<td>600</td>
<td>1.55</td>
<td>120</td>
<td>0.80</td>
<td>3.40</td>
<td>25</td>
</tr>
<tr>
<td>Sorghum</td>
<td>900</td>
<td>25</td>
<td>670</td>
<td>1.20</td>
<td>115</td>
<td>0.50</td>
<td>3.200</td>
<td>25</td>
</tr>
<tr>
<td>Corn and cob meal</td>
<td>900</td>
<td>85</td>
<td>720</td>
<td>1.70</td>
<td>80</td>
<td>0.60</td>
<td>2.50</td>
<td>20 (obroku)</td>
</tr>
<tr>
<td>Hominy feed</td>
<td>900</td>
<td>55</td>
<td>840</td>
<td>2.00</td>
<td>100</td>
<td>0.50</td>
<td>5.00</td>
<td>50</td>
</tr>
<tr>
<td>Rice bran</td>
<td>900</td>
<td>120</td>
<td>640</td>
<td>1.20</td>
<td>130</td>
<td>0.70</td>
<td>14.40</td>
<td>25</td>
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<tr>
<td>Wheat bran</td>
<td>900</td>
<td>100</td>
<td>630</td>
<td>1.40</td>
<td>155</td>
<td>1.30</td>
<td>11.60</td>
<td>25</td>
</tr>
<tr>
<td>Sugarbeet pulp</td>
<td>900</td>
<td>160</td>
<td>700</td>
<td>1.55</td>
<td>90</td>
<td>5.60</td>
<td>0.90</td>
<td>15 (ubroku)</td>
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<tr>
<td>Tapioca meal</td>
<td>900</td>
<td>30</td>
<td>740</td>
<td>1.65</td>
<td>20</td>
<td>1.80</td>
<td>1.80</td>
<td>25</td>
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<tr>
<td>Cane molasses</td>
<td>750</td>
<td>-</td>
<td>540</td>
<td>1.20</td>
<td>30</td>
<td>8.00</td>
<td>0.80</td>
<td>10</td>
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<tr>
<td><strong>Protein and energy-rich feeds:</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brewers grains</td>
<td>920</td>
<td>130</td>
<td>650</td>
<td>1.50</td>
<td>275</td>
<td>3.00</td>
<td>5.00</td>
<td>10</td>
</tr>
<tr>
<td>Cottonseed, delinted</td>
<td>910</td>
<td>195</td>
<td>870</td>
<td>2.00</td>
<td>215</td>
<td>1.40</td>
<td>6.90</td>
<td>10 (ubroku)</td>
</tr>
<tr>
<td>Cottonseed cake</td>
<td>910</td>
<td>120</td>
<td>680</td>
<td>1.60</td>
<td>410</td>
<td>1.70</td>
<td>11.00</td>
<td>15</td>
</tr>
<tr>
<td>Soybean seeds</td>
<td>920</td>
<td>55</td>
<td>840</td>
<td>1.90</td>
<td>380</td>
<td>2.50</td>
<td>6.00</td>
<td>20</td>
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<tr>
<td>Soybean cake</td>
<td>900</td>
<td>60</td>
<td>760</td>
<td>1.65</td>
<td>440</td>
<td>3.50</td>
<td>6.40</td>
<td>-</td>
</tr>
<tr>
<td>Sunflower cake, dehulled</td>
<td>920</td>
<td>110</td>
<td>700</td>
<td>1.60</td>
<td>450</td>
<td>3.80</td>
<td>10.00</td>
<td>20</td>
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<td>Sunflower cake, with hulls</td>
<td>920</td>
<td>240</td>
<td>450</td>
<td>1.00</td>
<td>290</td>
<td>3.80</td>
<td>9.70</td>
<td>20</td>
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<td><strong>Animal protein feeds and by-products:</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Blood meal</td>
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<td>10</td>
<td>610</td>
<td>1.35</td>
<td>800</td>
<td>2.90</td>
<td>2.50</td>
<td>2.5</td>
</tr>
<tr>
<td>Fat (tallow)</td>
<td>900</td>
<td>-</td>
<td>1750</td>
<td>5.75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fish meal</td>
<td>910</td>
<td>10</td>
<td>730</td>
<td>1.65</td>
<td>650</td>
<td>4.00</td>
<td>28.50</td>
<td>2.5</td>
</tr>
<tr>
<td>Meat and bone meal</td>
<td>900</td>
<td>20</td>
<td>630</td>
<td>1.85</td>
<td>460</td>
<td>110.00</td>
<td>54.00</td>
<td>2,5</td>
</tr>
<tr>
<td><strong>Common mineral supplements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone meal (steamed)</td>
<td>970</td>
<td>20</td>
<td>155</td>
<td>0.40</td>
<td>120</td>
<td>240.00</td>
<td>120.00</td>
<td>5</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>970</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>165.00</td>
<td>120.00</td>
<td>-</td>
</tr>
<tr>
<td>Limestone (ground)</td>
<td>1000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>370.00</td>
<td>2.10</td>
<td>-</td>
</tr>
<tr>
<td>Limestone (dolomite)</td>
<td>1000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>200.00</td>
<td>-</td>
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</tr>
</tbody>
</table>

It is important that the silage clamp has proper drainage to prevent the feed from rotting.

**ENERGY-RICH FEEDS**
Cereals have a high energy and low protein content. See table 4 for the maximum amount to be used in concentrate mixtures.

**Barley**
Barley should be milled moderately fine or rolled for maximum utilization by dairy cows; otherwise it will pass through the digestive tract partly undigested. It has about 95% of the energy value of maize and is very palatable and an ideal feed for cattle.

**Maize**
Maize is highly palatable and supplies a large amount of energy economically. However, it is low in protein, crude fibre and minerals. Maize may be used as the main source of energy. In order to use the high energy content of maize efficiently it should be properly balanced with other ingredients. It should be used milled or rolled or be fed as a high moisture ensilaged grain. Maize meal on its own should not be stored too long as it easily becomes rancid and its carotene content will decrease considerably. The advantage of maize is the high amount of undegraded starch.
Maize can be used as the main source of energy in the cow's ration.

Oats
Oats are very rich in crude fibre; therefore it is advisable to mix oats with other cereals in rolled form for maximum utilization. Oats have a positive effect on milk and butterfat production. The rolled form is a very good feed for calves. The high crude fibre content contributes to early rumen development.

Sorghum
Sorghum grain is an excellent feed for livestock when supplemented with other palatable ingredients. It should be milled moderately fine, since too finely ground sorghum results in reduced consumption. It is important to remember that the red sorghum varieties have a high tannin content and lack carotene. Tannin is a toxic substance if eaten in large quantities.

Corn and cob meal
Corn and cob meal are the complete milled maize cobs (includes grains, spills and husks). Corn and cob are much lower in TDN and crude protein than maize itself, but is known for its easily digestible high crude fibre content.

Hominy feed (maize germ and bran meal)
This is a by-product of the dry maize milling industry and consists of the bran coating and maize germs. Hominy feed is very palatable and its nutrient content is nearly the same as that of maize grain. However, it contains more oil when the germs are included.

Rice bran
Rice bran is a by-product of the rice-milling industry. It is made up of the bran layer, rice germs and pieces of broken rice. Rice bran is similar to oats as regards crude protein, energy, oil and crude fibre content, but contains more phosphorus.

Wheat bran
This is a by-product of flour wheat milling and is highly palatable. It is poor in calcium, but tends to be higher in phosphorus than most other cereals and their by-products. It is a bulky feed, rich in crude fibre and has a laxative effect.

Sugar beet pulp
Dried sugar beet is available in pellets. It is an ideal energy source for dairy cows producing large amounts of milk since it contains a high percentage (45%) of undegraded protein. Molasses may occasionally be added to increase its palatability. The crude fibre is very digestible and the sugar beet pulp can be fed to milking cows at a rate of up to 3 kg per day.
**Tapioca**
Tapioca is produced in tropical and sub-tropical zones. It is the substance that remains after starch has been extracted from the roots. Tapioca is quite palatable and relatively inexpensive. It is high in TDN content but low in protein. Its starch is highly digestible and quickly degraded.

**Cane molasses**
Cane molasses make feed more palatable and serve as a dust-settler and binder in dry feed. It is an inexpensive and excellent source of energy. Up to 10% by weight may be used in mixtures.

**PROTEIN/ENERGY-RICH FEEDS**
The majority of the protein-rich feeds are derived from oilseeds. They consist of the residues remaining after oil has been extracted. Whole oilseeds may also be used as feed.

**Alfalfa pellets**
Alfalfa pellets are produced in dehydration plants from standing alfalfa. The protein of alfalfa pellets is less degraded in the rumen than the protein of alfalfa hay, so alfalfa pellets are a good source of escape (by-pass) protein.

**Dried brewers’ grains**
The protein of dried brewers’ grains is degraded at a relatively slow rate in the rumen. Up to 2 kg per cow per day can be fed to milking cows. It contains about 49% of undegraded protein.

**Cottonseed (fuzzy)**
The whole kernel of cottonseed without the lint (fuzzy cotton) may be used as a good feedstuff for mature cattle. This feed is often used in tropical and sub-tropical regions. It is rich in protein, oil, crude fibre and energy. An amount of up to 2.5 kg per day for high-yielding cows may be fed in early lactation. It has a positive effect on the butterfat percentage of milk and is known for its enduring effect on milk production.

**Cottonseed cake**
Cottonseed cake (meal) is an excellent protein supplement for dairy cattle. It is important to avoid overfeeding because the cottonseed cake may contain a toxic substance called gossypol. Gossypol has an inhibitive effect on digestive enzymes in the cow’s intestine. Heating to above 100° C alters the chemical composition of gossypol and removes its toxicity.
Soybeans
Soybeans are rich in protein, oil and energy. The beans should be milled or crushed and not be stored longer than one week. Milled or crushed soybeans will rapidly become rancid owing to their lipase content. Furthermore, soybeans contain an enzyme called urease, which convert urea into ammonia and may have an adverse effect on the cow’s digestive system. Lipase and urease are inactivated by heating. Dairy cows fed with heat-treated (flaked) soybeans produce more milk than cows fed on raw soybeans.

Soybean cake
Soybean cake (meal) is one of the most valuable source of vegetable protein and energy available. It is very palatable and may be used as the main protein source in dairy rations without restriction.

Sunflower cake
Sunflower cake (meal) is the by-product remaining after most of the oil has been extracted from sunflower seeds. The national composition varies widely owing to differences in the amount of hulls (fibres) present. Decorticated cake is a most useful protein source for dairy cows.

ANIMAL PROTEIN FEEDS AND BY-PRODUCTS
These products are very rich in protein and are the by-products of slaughterhouses and seafood industries. Some products are very low in palatability and they should be used in limited amounts as mentioned in the tables. Caution is recommended because of the risk of salmonella contamination by some of these products.

COMMON MINERAL SUPPLEMENTS
These supplements are used mainly for balancing the required mineral composition of the ration and should be used according to its specifications.

Proper feeding is a prerequisite for profitable milk production.
Proper understanding of the basic principles of dairy cattle nutrition is essential for optimizing milk production and maintaining good animal health. Basic knowledge of the characteristics of various feeds and of the nutritional requirements of dairy cow during lactation are essential prerequisites for profitable milk production. Feeding Management volume 2 will deal in greater detail with the composition of well-balanced rations for dairy cows and concentrate mixtures.

REFERENCE FOR FURTHER READING

- An introduction to Animal Nutrition, Lecture notes Dairy Training Centre ‘Frieland’.
- Cattle Feeding, Lecture notes Dairy Training Centre ‘Friesland’
- Principles and Practice of Feeding Dairy Cows, Broster, Phipps and Johnson, NIRD (1986).

Earlier publications:
- Reproduction Management
- Young Stock Management
- Foot Care
Dairy Training Centre Friesland (DTC-Friesland) is established by various Dutch farmers’ organizations and controlled by the Ministry of Agriculture. The Centre conducts a variety of international training-programmes and courses. We also provide consultancy and management services.

All courses have a strong practice-oriented character based on the training concept of learning by doing. The practical training is very intensive; one instructor deals with groups of six students and for subjects like milking even with three students only.

DTC-Friesland offers training in the following subjects:

- **Dairy Husbandry**
  * machine- and handmilking, milking machines, milk hygiene
  * feeding, ration-calculation, feedplants, quality of feedstuffs
  * fertility management, heat detection
  * Breeding, use of A.I., culling, body conformation
  * housing, tying/cubicle systems, hygiene
  * health, mastitis control, hoofcare
  * calf rearing
  * farm economics
  * farm administration

- **Forage production**
  * pasture management
  * fodder crops
  * silage making
  * farm machinery

- **Milk processing**
  * manufacture of cheese, butter, yoghurt, ice-cream, etc.
  * milk collection and payment systems
  * marketing
  * management of a dairy unit

- **Sheep husbandry**
- **Dairy goat husbandry**
- **Intensive beef-production**
- **Horse-keeping and animal traction**
- **Teaching-methodology**

Visits to farmers organizations, A.I.-stations, Health and Extension service etc. are integrated in the courses to provide a good picture of the dairy sector in the Netherlands.
AD HOC COURSES

Our major activity is the organization of ad hoc courses on request, preferably for groups of a multiple of six participants. These training programmes are tailor-made and completely designed according to the requirements of the client. The courses deal with one or more of the earlier mentioned subjects. Duration of the courses varies from 1 week to several months.

The courses are conducted in English. For some special subjects training can be provided in French, Spanish or German as well.

If facilities are available locally, our staff is prepared to conduct courses abroad as well.

SIX-WEEKS COURSE: MODERN DAIRY FARM MANAGEMENT

This course is especially designed for persons in charge of a large-scale dairy enterprise, and includes all aspects involved in managing a dairy herd. The course offers a good opportunity to refresh one’s knowledge and learn about recent developments in dairy-farm management. The course is conducted annually in September/October.

However, for groups of least six persons it can be organized at any time during the year.

TRAINING FACILITIES AND STAFF

The center has four farms, each with a different management system. One farm is especially equipped for international courses. The total stock at the four farms includes 250 dairy cows, 50 fattening-bulls, 45 dairy-goats, 85 sheep and 12 Friesian horses. Additionally, the centre maintains close relations with twenty neighbouring farms which are used for practical training.

Our staff consist of fifty dedicated and well-qualified trainers. All have up-to-date knowledge of modern dairy-farm management and over 70 man-years experience is present in various dairy development projects throughout the world.

ACCOMMODATION

A newly constructed hostel provides full board and lodging in single or double bedrooms. The hostel provides an international kitchen, and many recreational facilities. Social excursions are organized during the weekends to enable the students to get acquainted with the Dutch culture.

For more information on our activities, please contact:

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