



6) FEEDS FOR DAIRY COWS

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INTRODUCTION

In general, feeds are classified into one of the following categories:

- Forages;
- Concentrates (energy and protein feeds);
- Minerals and vitamins.

This classification is a convenient way to group feeds, but it is somewhat arbitrary. Classifying feeds is not as important as knowing which feeds are available, their nutritive value, and the factors that affect their utilization in a ration.

FORAGES

In general, forages are the vegetative parts of grasses or legume plants containing a high proportion of fiber (more than 30% neutral detergent fiber). They are required in the diet in a coarse physical form (particles with a length of more than 2.5 cm) to help rumen function.

Usually, forages are grown on the farm. They may be grazed directly or harvested and preserved as hay or silage. Depending on the cow's stage of lactation, they should contribute from almost 100% (for non-lactating cows) to no less than 35% (for cows in early lactation) of the ration dry matter. The general characteristics of forages are as follows:

- **Bulky:** Bulkiness puts limits on how much a cow can eat. The energy intake and the milk production of a cow may be limited by too much

forage in a ration. However, bulky feeds are essential to stimulate rumination and maintain the health of the cow.

- **High Fiber and Low Energy:** Forages may contain from 30 to 90% fiber (neutral detergent fiber). In general, the higher the fiber in a forage, the lower the energy content of the forage.
- **Variable in Protein:** Depending on the stage of maturity, legumes may contain 15 to 23% crude protein; grasses typically contain 8 to 18% crude protein (depending on the level of nitrogen fertilization), and crop residues may have only 3 to 4% crude protein (straw).

From a nutritional standpoint, forages may range from very good feeds (lush young grass, legumes at a vegetative stage of maturity) to very poor feeds (straw, browse).

Grasses and Legumes

High quality forage can make up two-thirds of the ration dry matter with cows eating 2.5 to 3% of their body weight as forage dry matter (for example, a cow of 600 kg, can eat 15 to 18 kg dry matter of good quality forage). Cows usually eat more legumes than grasses at similar stages of maturity. However, good quality forages fed in balanced diets will supply much of the protein and energy needed for milk production.

Soil and climate conditions usually determine the type of forage that is most commonly grown in a region. Both grasses (rye-grass, brome grass, bermuda grass, fescue, orchard grass) and legumes (alfalfa, clover, lespedeza, birdsfoot trefoil) are widely spread throughout the world. Grasses need nitrogen fertilizers and moisture conditions to grow well. However, legumes are more resistant to drought. Also, they can add as many as 200 kg of nitrogen/year/hectare in the soil because they live in association with bacteria that convert nitrogen of the air into nitrogen fertilizer.

The feeding value of forages is greatly influenced by the growth stage when harvested or grazed. Growth can be divided in three successive stages:

- 1) Vegetative stage;
- 2) Flowering stage;
- 3) Seed formation stage.

Usually, the feeding value of a forage is the highest during vegetative growth and the lowest during the seed formation stage. With advancing maturity, the concentration in protein, energy, calcium, phosphorus, and digestible dry matter in the plant decreases while the fiber concentration increases. As fiber increases, the lignin content within the fiber also increases. Lignin is indigestible and makes the carbohydrates in the fiber less available to ruminal microbes. As a result the energy value of the forage decreases.

Thus, when forages are grown with the purpose of feeding cattle they should be harvested or grazed at an early stage of maturity. Corn (maize) and sorghum harvested as silage are exceptions because, despite the decrease in nutritive value of the vegetative parts of the plants (stem and leaves) during seed formation, a large amount of highly digestible starch accumulates in the grains.

The maximum yield of digestible dry matter of a forage crop is obtained:

- At the late boot to early head stage of maturity for **grasses**;
- At the mid-to-late bud stage of maturity for **legumes**;
- Before the grains are fully dented for corn and sorghum.

There is little that can be done to prevent the loss of nutritive value of a forage with advanced maturity. For each day of delayed harvest after the optimum stage of maturity, the potential milk production of cows eating the forage will be penalized. However, various strategies can be used to maintain the availability of forage that has good nutritive value:

- 1) Develop a grazing strategy that matches the number of animals in a pasture with the rate of growth of the grass;
- 2) Plant a mixture of grasses and legumes that have different rates of growth and maturity throughout the season;
- 3) Harvest at an early stage of maturity and preserve as either hay or silage;
- 4) Feed lower quality forage to the dry cows or the cows in late lactation and the good quality forage to the cows in early lactation.

Crop residues and industrial by-products of poor feeding value

Crop residues are the parts of the plants that remain in the field after harvesting the primary crop (e.g., corn stover, cereal straw, sugar cane bagasse, peanut hay). Crop residues may be grazed, processed as dry feed, or made into silage. Some general characteristics of most crop residues are:

- Inexpensive bulk feed;
- High in indigestible fiber because of high lignin content (chemical treatments can be used to upgrade their feeding value);
- Poor in crude protein;
- Need to be supplemented properly, especially in protein and minerals;

- Need to be coarsely chopped when harvested or at feeding time;
- Should be included in ration of non-lactating animals with low energy requirements.

CONCENTRATES

There is no good definition for the word concentrate. However, they may be described by their characteristics as feeds and their effect on rumen function. Usually, concentrates have the following characteristics:

- They are **low in fiber and high in energy**.
- They can be either low or high in protein. Cereal grains contain <12% crude protein, but oilseed meals (soybean, cotton, peanut), referred to as **protein feeds**, can contain > 50% crude protein.
- They have a **high palatability** and are usually **eaten rapidly**. As opposed to forage, concentrates are feed that usually have a low volume per unit of weight (high specific gravity).
- As opposed to forages, they **do not stimulate rumination**.
- They usually **ferment faster than forages in the rumen** and they increase the acidity (reduce the pH) of ruminal contents which may impede normal fiber fermentation.
- When they comprise more than 60 to 70% of a ration, they may cause health problems.

Dairy cows with high genetic potential for milk production also have high requirements for energy and protein. Given that cows can eat only a certain amount per day, forage alone cannot supply the required amount of energy and protein. Generally, the purpose of adding concentrates to the ration of dairy cattle is to provide a concentrated source of energy or protein to supplement the forage and meet the animal requirements. Thus,

concentrates are important feeds that allow for formulating diets that will maximize milk production. In general, the maximum amount of concentrates a cow can receive per day should not exceed 12 to 14 kg.

Examples of Concentrates

- **Cereal grains** (barley, corn, sorghum, rice, wheat) are the typical "high energy" feeds for dairy cows, but they are low in protein. Rolled or cracked cereal grains are excellent sources of readily fermentable carbohydrates (starch) which increase the concentration of energy when included in the diet. However, too much cereal grain in the diet (more than 10 to 12 kg/cow/day) reduces chewing activity, proper rumen function, and lowers milk fat percentage.

The various industrial treatments of cereal grain results in numerous **cereal by-products** having extremely variable nutritive value:

- **Corn gluten meal** is obtained from the wet milling of corn starch. It is an excellent source of protein (40 to 60%) and energy. **Corn gluten feed**, another by-product of starch production, contains less protein and more fiber. **Brans** of cereal grains (rice, wheat) add bulk and fiber to a diet and contain from 14 to 17% protein. Wheat bran is a good source of phosphorus and functions as a laxative. **Hulls** are the outer covering of some cereal grains (barley, oats, rice) that contain only 3 to 4% protein but 85 to 90% of highly indigestible fiber.

- **Brewing and distilling by-products** of cereal grains are good sources of slowly digestible carbohydrates and protein (20 to 30%). **Malt sprouts** (radicles from germinating barley) have a bitter taste and are usually mixed with other feeds.

- **Roots and tubers** (carrots, cassava, beets, potatoes, turnips) are usually palatable, good sources of readily fermentable carbohydrates (energy), but low in protein (less than 10%).

- **By-products of the sugar industry** (molasses, sugar beet pulp) are usually high in digestible fiber (beet pulp) or simple sugars (molasses) which make them very palatable feeds.

- Certain plants contain a high concentration of lipids in their seed (**oilseeds**). Many of them grow in the tropics and subtropics (soybean, groundnut, cotton), but some grow in temperate climates (linseed [flax], canola [rapeseed], and sunflower). Intact oilseeds can be used as high energy feeds, but they usually contain anti-nutritional substances. **Oilseed meals** obtained after the extraction of the oil from oilseeds, contain from 30 to 50% protein and are used as typical "protein feeds" for dairy cows (e.g., soybean meal).

- **Seeds of legumes** (beans, chickpeas, cowpeas) contain anti-nutritional substances, but after proper processing, are good energy and protein sources.

- **Proteins of animal origin** (meat and bone meal, feather meal, fish meal) are usually resistant to ruminal degradation, and may be good sources of calcium and phosphorus. They need to be handled properly to avoid the risk of bacterial infections. Whey, a byproduct of dairy processing, contains large amounts of milk sugar (lactose) and some proteins and minerals. However, those nutrients may be very dilute when the whey is not dried.

MINERALS AND VITAMINS

Minerals and vitamins are of great importance in nutrition. For example, milk fever in early lactation is due to an imbalance in calcium metabolism, and phosphorus is essential for high herd

fertility. Deficiencies may result in large economic losses. In lactating dairy cows, the macro-minerals of concern are sodium chloride (NaCl), calcium (Ca), phosphorus (P), and sometimes potassium (K), magnesium (Mg) and sulfur (S). Also, most micro minerals (e.g., iodine, selenium) are required to achieve optimal production and reproduction. The small amount of micro-minerals usually required in a dairy ration is often included as a premix in the concentrates or as fortified salt.

All feeds, except urea and fat, contain at least limited amounts of minerals. Because legumes contain more calcium than grasses, diets based on legumes will require less calcium supplementation. Molasses is rich in calcium and animal protein by-products containing bones are good sources of calcium and phosphorus. Salt (sodium chloride) is a mineral supplement that can be offered free-choice. A mineral mix containing calcium, phosphorus, or both (e.g., dicalcium phosphate) may be required depending on the ingredients in the ration. Green forages usually contain low levels of phosphorus relative to the cow's needs. Corn [maize] silage contains little calcium and phosphorus and both minerals are required in the mineral supplement mix. The amount of mineral mix required in the diet usually ranges from 0 to about 150 g/cow/day.

Vitamin A, D, and E are of concern, with vitamin A the most likely to be deficient in areas with long winters or long dry seasons. Rumen microbes synthesize B complex vitamins, vitamin C, and vitamin K, so these vitamins are not usually required in the diet.