

# Basic Beef Cattle Nutrition

FACTSHEET

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## Table of Contents



## Introduction

The proper nutrition of beef cattle is a key component of a successful production system. Feed

usually accounts for the single largest input cost associated with beef cattle. An understanding of the ruminant digestive process and basic nutrition is required for effective feeding and management.

| Top of Page |

**Digestive System**

Cattle belong to a class of animals called ruminants. This group includes sheep, goats and deer. Ruminants have a digestive system which allows them to utilize roughages (e.g. hay, grass) as a major source of nutrients. These animals have a large (capacity up to 50 gal.), fluid filled digestive organ at the beginning of the digestive tract called the rumen. The rumen contains a large population of microbes (bacteria and protozoa). Much of the initial digestion of feed is done by microbes in the rumen.

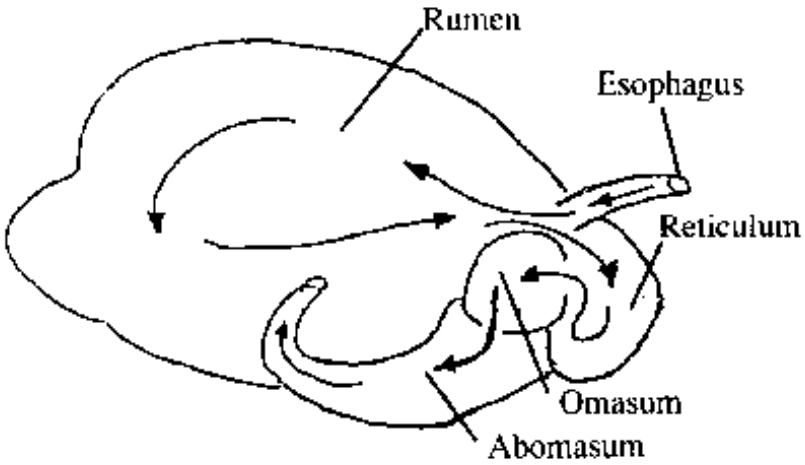


**Figure 1.** Ruminant Stomach
→ Flow of Digesta

These microbes have the ability to break down cellulose and hemicellulose, which are main components of roughages. Rumen microbes also break down other components of the animal's diet such as protein and starch. The reticulum is a smaller organ which acts as a holding area for feed after it passes down the esophagus. The omasum is an organ which absorbs water from the digesta (mixture of feed and fluid) before it flows into the abomasum (true stomach). The animal's own digestive enzymes break down food in the abomasum and small intestine. Absorption of these nutrients occurs mainly through the small intestine

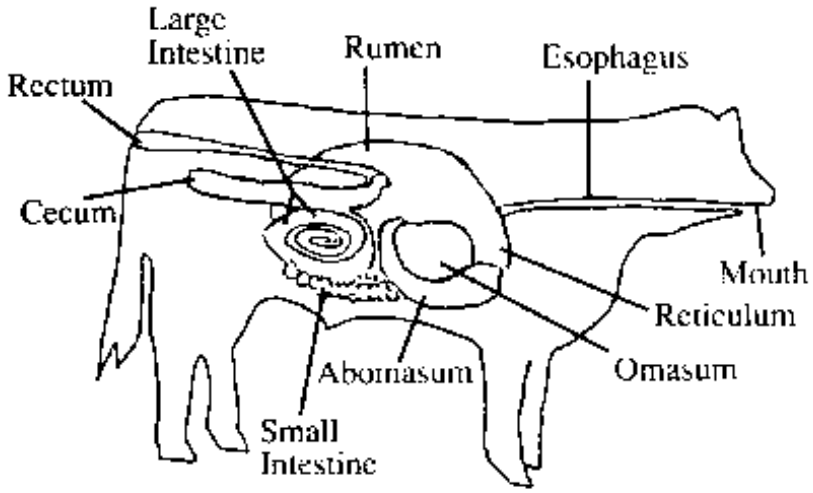


**Figure 2.** Digestive System of the Bovine

Monogastric (non-ruminant) animals (e.g. pigs, dogs, man) are not able to efficiently digest cellulose.

When ruminants consume forages, they take fairly large bites and swallow the material with a minimum of chewing. After eating, they stand or lie down to "chew their cud". This involves regurgitating boluses (masses) of forage up the esophagus and into the mouth, where it is re-chewed and then swallowed. This reduces the size of the forage particles and greatly increases the surface area available for microbial digestion.

| Top of Page |

### Nutrients

Feed requirements are based on the need for specific amounts of various classes of nutrients. Each nutrient fulfills specific roles in growth, production or metabolism. Nutrient classes are defined by their chemical structure or by their function in metabolism.

### Energy

Energy provides the body with the ability to do work. In beef cattle rations energy is usually expressed as % Total Digestible Nutrients (TDN). Work includes growth, lactation, reproduction, movement and feed digestion. Energy is the nutrient required by cattle in the greatest amount. It usually accounts for the largest proportion of feed costs. The primary sources of energy for cattle are cellulose and hemicellulose from roughages and starches from grains. Fats and oils have a high energy content but usually make up only a small part of the diet.

### Protein

Protein is one of the main building blocks of the body. It is usually measured as %4 Crude Protein (CP). It is a major component of muscles, the nervous system and connective tissue. Protein is composed of chains of amino acids. Adequate dietary protein is essential for maintenance, growth, lactation and reproduction. Protein is composed of several fractions which vary in their solubility in the rumen. Rumen soluble protein is digested by microbes in the rumen. Rumen insoluble protein passes intact through the rumen to the lower digestive tract. A portion of this bypass (or escape) protein is digested in the small intestine.

### Minerals

Various minerals are required for growth, bone formation, reproduction and many other body functions. Those that are required in fairly large amounts are called macrominerals. They include sodium (salt), calcium, phosphorous, magnesium and potassium. Those that are required in very small amounts (micro or trace minerals) include iodine, copper, zinc, sulphur and selenium. Mineral content is affected by the type and quality of the feedstuff. Adding supplementary minerals to the ration is usually required to ensure that the proper amounts of these elements are available to the animal. The type of supplementary mineral mix required is determined by the feeds in the ration and the animal's requirements. Problems caused by deficiencies of some minerals are shown in Table 1.

Table 1. Some Symptoms of Mineral Deficiencies

| Mineral | Deficiency Symptons |
|---|---|
| Calcium | - poor growth<br>- bowed leg bones<br>- brittle bones |
| Phosphorous | - poor growth<br>- craving for wood, hair, soil<br>- poor conception rates |
| Magnesium | - muscle tremours<br>- staggering, convulsions<br>(grass tetany) |
| Sodium (salt) | - poor growth<br>- chewing or licking of wood |
| Selenium | - weakness, inability to stand |

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- Resources, Services and Projects
- Alternative Livestock and Aquaculture
- Beef
- Dairy
- Goats
- Horses
- Poultry
- Sheep
- Swine
- Veal
- Animal Health, Care and Handling

**Topics**

- Agriculture
- Food
- Rural
- Research & Innovation
- Food Safety
- Environment
- Programs & Resources
- Agencies, Boards & Commissions

## Vitamins

Vitamins are biological compounds which are active in extremely small amounts. Vitamins of concern in beef cattle nutrition include Vitamin A, Vitamin D and Vitamin E. They are usually reported in International Units (IU's). Fresh forage is a good source of Vitamins A, D and E. Vitamin content of well preserved hay is initially high, but declines over time. Silages usually contain low amounts since the fermentation process destroys most of the vitamins. Grains usually contain relatively low amounts of these vitamins.

Vitamin A is essential for normal growth, reproduction and maintenance. Insufficient Vitamin A is associated with lowered fertility in both bulls and cows. Vitamin D is required for proper development of bone. Vitamin D deficiency in calves results in bowing of the leg bones (rickets). In older animals bones become weak and easily fractured. Vitamin E, along with selenium, is required for proper development of muscle tissue. Lack of Vitamin E and/or selenium causes nutritional muscular dystrophy, commonly called white muscle disease. It is most common in young calves. Prevention of white muscle disease may be achieved by injecting calves with Vitamin E/selenium at birth, injecting pregnant cows with Vitamin E/selenium, or feeding cows supplementary Vitamin E and selenium.

The level of B vitamins in beef cattle diets is not usually of concern, although some special situations exist. The rumen microbes manufacture large amounts of these vitamins, which are then available for absorption by the animal. The B vitamins are of importance in the young calf which has not yet developed a functional rumen. Cattle which have been severely stressed have a depleted rumen microbe population and may benefit from supplemental B vitamins.

- What's New | Top of Page |

**Feedstuffs**

Beef cattle can utilize a wide variety of feedstuffs. Feeds are classified into groups based on their nutrient content and physical form. Most common feeds can be placed in one of the following groups:

1. Roughages

- high in fibre (cellulose and hemicellulose) and usually low to intermediate in energy
- protein content varies widely, depending on the plant species and stage of maturity
- examples are hay, grass, grain hulls, oilseed hulls

2. Grains

- high in energy and relatively low in fibre
- most have a moderate protein content
- examples are corn, barley, oats

3. Oilseeds

- high in protein, usually high in energy
- variable fibre content
- examples are soybeans, canola meal

4. Byproducts

- variable nutrient content
- may contain a high level of moisture
- examples are distillers grains, sweet corn cannery waste, bakery waste, grain screenings, apple pomace

A list of the energy and protein content of some common feeds is contained in Table 2.

Table 2. Energy and Protein Content of Some Common Ontario Feeds*

| Feed | % Dry Matter | % Crude Protein (dry matter basis) | % Estimated TDN (dry matter basis) |
|---|---|---|---|
| **1st cut legume hay** | 86.7 | 15.8 | 58 |
| **1st cut grass hay** | 87.7 | 9.7 | 55 |
| **1st cut mixed hay** | 87.7 | 12.2 | 56 |
| **2nd cut hay** | 86.8 | 17.7 | 59 |
| **legume hay silage** | 46.9 | 17.6 | 59 |
| **grass hay silage** | 38.8 | 13.0 | 57 |
| **mixed hay silage** | 49.4 | 15.8 | 58 |
| **corn silage** | 36.5 | 8.0 | 66 |
| **oats** | 88.5 | 12.1 | 74 |
| **barley** | 88.6 | 12.2 | 82 |
| **wheat** | 89.9 | 13.2 | 88 |
| **mixed grain** | 88.4 | 12.3 | 77 |

| | | | |
|---|---|---|---|
| **grain corn** | 86.6 | 9.6 | 90 |
| **soybean meal 44%** | 89.0 | 47.8 | 81 |

*Source: OMAF Feed Advisory Program

| Top of Page |

### Energy Digestion

In the rumen, microbial digestion of cellulose and hemicellulose (from roughages) and starch (from grains) results in the production of energy rich byproducts called volatile fatty acids (VFA's) which are absorbed by the animal through the rumen wall. This is the major source of energy for the animal. Some starch is not digested in the rumen and is passed on to the true stomach (abomasum) and small intestine where it is broken down by the animal's enzymes and absorbed.

Rumen microbe species are specialized in their ability to break down either starch or cellulose. When the diet is high in roughages, the cellulose (fibre) digesting microbes multiply and dominate. With a high grain diet the number of starch digesting microbes increases. Changes in the composition of a ration should be made gradually to allow time for the rumen microbe population to adapt. About 2 weeks is necessary for making major changes in ration ingredients.

Grains vary in their rate of breakdown in the rumen. This is due to the chemical nature of the starch and the physical structure of the grain. For example, dry corn is degraded in the rumen much more slowly than high moisture corn or dry wheat. This has important implications for the maintenance of rumen health when feeding high grain feedlot rations.

| Top of Page |

### Protein Digestion

Crude protein includes both true protein and non-protein nitrogen (NPN). The digestion of a particular protein depends to a large extent on how easily it dissolves in rumen fluid. Highly soluble protein is more likely to be broken down by rumen microbes than is insoluble protein. Nonprotein nitrogen sources (e.g. urea, ammonia) are 100% soluble in the rumen. The rumen microbes use the nitrogen released in the rumen to form their own microbial protein. Microbes are continually being moved with digesta into the lower digestive tract, where they are digested and absorbed by the animal. Most of the protein which is not soluble in the rumen (bypass or escape protein) passes unchanged to the lower digestive tract. A portion of this protein is broken down by the animal's enzymes and absorbed. Digestible bypass protein is efficiently utilized and is an important component in rations for fast growing beef cattle.

The activity of the rumen microbes in breaking down and reforming dietary protein has important implications for the ruminant:

1. ruminants can thrive on diets containing low quality, low cost protein (relative to monogastrics) since rumen microbes upgrade the protein quality by manufacturing limiting amino acids

2. ruminants can utilize some inexpensive non-protein nitrogen (such as urea) in their diet as a protein substitute.

For optimum performance, a balance of rumen soluble protein (and NPN) and bypass protein is required. Diets with high levels of soluble protein and/or NPN may not supply adequate amounts of protein to the small intestine. Diets with high levels of bypass protein may not supply

adequate amounts of nitrogen to rumen microbes for efficient microbial growth and feed digestion. Optimum diets usually contain 30-40% available bypass protein and 60-70% rumen soluble protein. Less than 30% of total protein should be in the form of NPN.

In order for rumen microbes to utilize NPN, sufficient soluble carbohydrates (e.g. starch) must included in the diet. Without adequate available energy in the diet, the capacity of the microbes to utilize NPN would be overloaded. Excess NPN will be absorbed by the animal as ammonia, and excreted. If NPN levels are high, toxicity will occur (urea poisoning).

| Top of Page |

## Ration Formulation

A properly formulated ration supplies adequate amounts of all nutrients to allow cattle to achieve a desired level of production. Accurate ration formulation requires

1. precise description of the class of cattle (sex, weight, frame size, body condition, desired rate of gain, stage of production)

2. knowledge of management practices utilized (implant usage, feed additives)

3. accurate description of the nutrient content of the available feeds

Laboratory analyses of forages is essential for accurate ration formulation. The nutrient content of forages varies greatly depending on the type, stage of maturity at cutting and how well it is preserved. For more information on lab analysis see OMAF Factsheet, "Feed Sampling and Analysis" Agdex 400/60. Nutrient content of grains is not as variable as forages, but lab analysis is recommended. Help in formulating rations is available from your OMAF county office, feed industry representatives and consultants.

| Top of Page |

## Summary

A knowledge of the basic digestive system of cattle and the role of various nutrients is important to beef producers. Combined with accurate feed analysis, it allows the formulation of balanced rations which will meet production goals in an economic manner. It also enhances the management of the feeding program by providing the background information necessary to prevent or resolve problem situations.

| Top of Page |

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| Top of Page |

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