

Know Your Feed Terms

When you are talking nutrition and feeds with your feed salesperson, livestock nutritionist, veterinarian or neighbour, it is important that you both speak the same language and understand what the other person means.

You will find this list of common meanings of feed terms helpful when you are talking nutrition, reading articles, feed analysis reports or feed tags.

Acid Detergent Fibre (ADF) – the fibrous, least-digestible portion of roughage. ADF consists of the highly indigestible parts of the forage, including lignin, cellulose, silica and insoluble forms of nitrogen. Roughages high in ADF are lower in digestible energy than roughages that contain low levels of ADF. As ADF levels increase, digestible energy levels decrease.

Acid Detergent Insoluble Nitrogen (ADIN) – a measure of the nitrogen remaining in the acid detergent fibre residue of a feed sample. While some ADIN occurs naturally in all plant material, it is usually considered to be an indicator of heat damage that can occur during storage or processing. Excessive heating of forages and grains causes some of the nitrogen to become irreversibly bound in the fibre. Nitrogen in excessively heated samples is usually indigestible or poorly digested by rumen microbes. It has been estimated that as much as 70 per cent of the protein bound with the fibre is unavailable to the animal. Feed labs may report acid detergent fibre protein (ADF-P%) or acid detergent insoluble protein (ADIP% or ADICP%), which can be expressed as a per cent of total dry matter or as a percentage of total nitrogen/protein.

The concentration of ADIN is used to determine protein availability in heated feeds. Estimates of crude protein (CP) available to the animal can be adjusted by using the following guideline. If ADIN levels are below or equal to 10 per cent, the crude protein level does not require adjustment, as these levels represent naturally occurring ADIN: for example, CP% = 10%

and ADIN = 10%, then CP% = 10%. If reported ADIN is above 10%, then subtract 10% from the ADIN value and use the difference to adjust the crude protein available: for example, if ADIN = 20%, then $20 - 10 = 10\%$ ADIN; $10\% \text{ CP} * (10/100) = 1$, so $10\% \text{ CP} - 1\% = 9\%$ CP available.

Acid Detergent Insoluble Protein (ADIP) or Acid Detergent Insoluble Crude Protein (ADICP) – is the insoluble protein fraction, which is unavailable to the animal due to heat damage. It is expressed as a per cent of total protein. ADIP% may be reported as acid detergent insoluble nitrogen (ADIN %) or acid detergent fibre protein (ADF-P%).

As-fed Basis – represents the sample's moisture level before drying. Most feed reports will have results stated on a wet and a dry basis. The wet basis may be referred to by the terms: As-fed, As-is or As-received.

By-pass Protein – refers to the portion of intake protein in a feed that is not broken down in the rumen but is digested directly in the small intestine. By-pass protein is another name for undegradable intake protein (UIP), rumen undegradable protein (RUP) or escape protein.

Carbohydrates – chemical compounds containing carbon, hydrogen and oxygen. Carbohydrates in plants can be divided into those that serve as storage and energy reserves in plants and are available for metabolism (sugars, starch, pectin and some cellulose, for example barley grain) and those that are structural (for example, fibrous cellulose, hemi-cellulose and lignin, for example, straw). Carbohydrates are a major source of energy in livestock feeds.

Cellulose – one of the major structural materials in the plant cell walls that can be utilized by microorganisms in the rumen.

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Chelated Mineral – are a group of organic minerals that are actually classified as proteinates, chelates and other complexes, depending on the mineral's molecular structure. A chelated mineral is a mineral such as copper or zinc that is bonded by two or more chemical bonds with peptides (small protein molecules) or amino acids. Each has a varying level of absorption and efficacy.

Concentrates – feeds high in energy and low in fibre, for example, barley, oats, wheat, canola meal, soybean meal and molasses.

Conventional Chemical “Wet Chemistry” Analysis – traditional laboratory methods used to analyze feed samples involve various chemical, drying and burning procedures to determine the major chemical components with the feed sample. Wet chemistry procedures are based on sound chemical and biochemical principles and take considerably more time to complete than the newer electronic methods. The analysis results in the sample being destroyed. The wet chemistry analysis is the most exact and the standard that other analyses are compared to. Accurate results depend on good sampling techniques when the samples are gathered, proper handling of samples after collection and good analytical procedures in the laboratory conducting the evaluation.

Crude Fibre – a chemical method used to describe the indigestible portion of plant material. However, some of these substances can be partially digested by microorganisms in the rumen of cattle. The higher the fibre, the lower the energy content of the feed. It is not a very useful value. The practice of analyzing for it in feeds for ruminants is declining, but it is still commonly used for monogastrics (for example, pigs).

Crude Protein – the total amount of protein present as calculated from the total nitrogen present. Unless otherwise stated, protein values given in lab reports, feed tables and feed tags are crude protein. Laboratory analysis measures the total amount of nitrogen present in a feed. The per cent nitrogen is converted to per cent protein by multiplying by 6.25.

Degradable Intake Protein (DIP) – portion of intake protein that is digested or degraded in the rumen by microbes to ammonia and amino acids. DIP is expressed as a percentage of CP. DIP consists of rumen soluble nitrogen, non-protein nitrogen, plus soluble true protein. It may also be referred to as rumen degradable protein (RDP).

Diet – the total amount of feed and drink for an animal.

Digestible Dry Matter (DDM) – is an estimate of digestible fibre in a forage sample. Different laboratories may use different formulas to calculate this value, one common formula is: $\%DDM = 88.9 - (0.779 \times \%ADF \text{ (dry basis)})$.

Digestible Energy (DE) – is the gross intake energy minus the fecal energy ($DE = GE - \text{fecal energy}$). Digestible energy gives an indication of the actual amount of energy the animal has available for use. However, it only partially accounts for energy losses in the process of the utilization of nutrients. It also tends to over-value low quality feeds relative to high quality feeds.

Digestible Protein (DCP) – the amount of crude protein actually absorbed by the animal (crude protein minus the protein lost in feces).

Digestion – refers to all changes that feed undergoes within the digestive tract, with the end result being that the broken down products are absorbed from the digestive tract for use by the animal.

Dry Matter (DM) – total weight of feed minus the weight of water in the feed, expressed as a percentage. May also be referred to as: dry, dry basis, dry result or moisture-free basis. You can convert from As-fed basis or dry matter basis by using the following formulas: $DM \text{ basis} = As\text{-fed basis} \times (\text{Dry Matter } \%/100)$ or $As\text{-fed basis} = DM \text{ basis} \times (\text{Dry Matter } \%/100)$.

Dry Matter Intake (DMI) – all the nutrients contained in the dry portion of the feed consumed by animals. Dry matter intake can be measured in feeding studies by weighing the total ration fed and the amount of feed left by the animal. Feeding studies have shown that as the per cent of neutral detergent fibre (NDF) increases in forages, animals consume less. Therefore, the per cent NDF can be used to estimate dry matter intake (DMI (as a per cent of body weight) equals relative feed value as per cent of body weight divided by per cent NDF). $DMI (\% \text{ of body weight}) = 120/NDF (\% \text{ of DM})$.

Equivalent Crude Protein from Non-protein Sources (ECP from NPS) – the theoretical amount of crude protein value from NPN compounds. For example, urea containing 45 per cent nitrogen contains 281 per cent equivalent crude protein (i.e., $45\% \times 6.25 = 281\%$).

Escape Protein – see By-pass Protein or Undegradable Intake Protein.

Feed Efficiency – the amount of feed required to produce one unit of product, such as pounds (kg) of feed to produce one pound (kg) body weight gain, or one pound (kg) of milk or one dozen eggs.

Gross Energy (GE) – the total energy in a feed. It is determined by measuring the amount of heat produced when a feed is completely oxidized in a bomb calorimeter. It is not a very useful measure since the gross energy in most common feeds is about the same, for example, GE in oat grain = GE in oat straw.

Heat Damage – the result of heating in feeds that essentially binds nitrogen to the fibre portion of the feed making it partially or wholly unavailable. The digestible energy of the feed may also be reduced; the net effect is reduced feed quality or feeding value. See Acid Detergent Insoluble Nitrogen.

Hemi-cellulose – the polysaccharide fraction existing in the cell wall of the plant. It is similar to cellulose but only partially digestible in the rumen.

In Vitro – refers to a feed sample that is digested in test tubes or tested outside the animal. An in vitro digestion study occurs in the laboratory, not in the animal.

In Vivo – refers to a digestion study of a feed that is tested inside the animal's rumen or stomach.

Lignin – a complex indigestible substance that is a major structural component of mature plants. It is contained in the fibrous portion of stems, leaves, cobs and hulls of plants.

Macro-minerals – macro-minerals, also called major minerals, are required in gram (g) quantities if the animal is to live and function. Macro-minerals perform specific roles in the body's structure and functions. The following seven macro-minerals are essential to animals (the mineral names are followed by their chemical symbols): calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg), potassium (K), sulphur (S), chlorine (Cl).

Megacalorie (Mcal) – units used to describe quantities of energy. The energy content of feed can be calculated and expressed in a number of different forms. It is most often calculated for cattle as a unit of heat expressed in megacalories. 1 Megacalorie (Mcal) = 1,000 Kilocalories (Kcal).

Metabolizable Energy (ME) – metabolizable energy is the digestible energy intake minus the energy in the urine minus the energy in the gaseous product of digestion:

ME = DE - (energy in urine) - (energy in gaseous product of digestion). The ME value of individual feeds is rarely measured. Measuring the amounts of energy lost in gaseous form and in the urine is more difficult than measuring digestible energy. Therefore, conversion formulas are often used by nutritionists when ME values are needed. The common formula used to estimate ME in beef feedstuffs is **ME = 0.82 x DE.**

Metabolizable Protein (MP) – metabolizable protein is protein (amino acids) that is actually absorbed from the gut. MP consists of protein in the rumen microorganisms, feed protein and any protein that bypasses digestion in the rumen (undegradable intake protein (UIP)). The concept of protein degradability has led to a new protein system called the metabolizable protein (MP) system. In this system, you balance to meet the requirements of the microbes and the animal, paying attention to the DIP and UIP fractions of the feed.

mg/kg – units of concentration, for example, milligrams in a kilogram. This measure is the same as parts per million (ppm) because 1 kilogram is 1 million milligrams. For example 10 mg/kg = 10 ppm.

Micro-minerals – also called trace minerals, are required in milligram (mg) or microgram (µg) amounts. They are found in animal tissues and feeds in very low concentrations. They often serve as components of enzyme cofactors or hormones. Examples of micro or trace minerals are cobalt, iodine, zinc, copper, manganese and selenium.

Moisture-free Basis – the concentration of a nutrient in the completely dry portion of the feed. Expressing the nutrient content in this way allows you to make comparisons between feeds that have different moisture contents. May also be referred to as dry, dry basis, dry result or dry matter basis. To convert moisture-free (dry basis) values to as-fed values, use the following formula: **Analyzed value (as-fed) = Analyzed value (dry) x 100% moisture /100.**

National Research Council (NRC) Tables – sets of tables published by the National Research Council/ National Academy of Sciences (U.S.) giving the amounts of each nutrient required by an animal for body maintenance, growth and production.

Near Infrared Reflectance Spectroscopy (NIRS) Analysis – near infrared reflectance spectroscopy is a rapid and low-cost computerized method to analyze forage and grain crops for their nutritive value. NIRS uses near infrared light, instead of chemicals as in conventional “wet chemistry” methods, to determine protein, fibre, energy and mineral content. The NIRS method of determining forage nutritional content is about 25 times faster than conventional wet chemistry procedures and less expensive. Accuracy still depends on good sample collection and storage and the consistent drying, grinding and mixing of samples before analysis. The calibration set used must be developed from an adequate number of wet chemistry samples, similar to those being analyzed. Without proper calibration, the NIRS analysis can have serious errors.

Net Energy (NE) – is metabolizable energy minus the heat increment of feeding: $NE = ME - \text{heat increment of feeding}$. The heat increment of feeding is the heat produced when feed is ingested and utilized. The net energy system divides energy requirements into net energy for maintenance (NE_m) and net energy for growth (NE_g) or net energy for lactation (NE_l) in milking cows.

The NE system is more accurate than other energy systems because it gives the net value of each feed after accounting for all the energy losses in the process of feed and nutrient utilization. However, most published NE values for feeds are not measured values but values converted from the DE system, so they are subject to the same errors in estimation of digestibility as the DE system. The NE system is becoming increasingly popular for ration formulation.

Net Energy for Maintenance (NEm) – an estimate of the energy value of a feed used to keep an animal in energy equilibrium, neither gaining weight nor losing weight.

Net Energy for Growth (NEg) – an estimate of the energy value of a feed used for body tissue gain (weight gain) above that required for maintenance.

Net Energy for Lactation (NEl) – an estimate of the energy value of a feed used for maintenance plus milk production during lactation and for maintenance plus the last two months of gestation for dry, pregnant cows.

Neutral Detergent Fibre (NDF) – is commonly called “cell walls.” NDF gives a close estimate of fibre constituents of feedstuffs as it measures cellulose, hemi-cellulose, lignin, silica, tannins and cutins. Neutral detergent fibre has been shown to be negatively correlated with dry matter intake. As the NDF in forages increases, animals will be able to consume less forage. NDF is used in formulas to predict the dry matter intake of cattle (see Dry Matter Intake).

Nitrate per cent ($NO_3\%$) – nitrate is also part of the nitrogen-containing feed fraction; however, it contributes very little to the crude protein percentage. Nitrates can accumulate in a crop that has been subjected to drought, hail, frost or high levels of nitrogen fertilization. Feeds containing high levels of nitrate (greater than 1 per cent) can be toxic to ruminants.

Non-protein Nitrogen (NPN) – nitrogen that comes from other than organic protein sources (e.g. plant or animal) that can be used by ruminants to make animal protein. NPN sources are compounds like urea and ammonia.

Nutrient – an element, compound or group of compounds that can be used as nourishment by an animal.

Organic Matter – the total weight of the feed minus the weight of the mineral matter (or ash) in the feed.

Palatability – taste appeal, the degree of acceptability of a feed to livestock.

Parts per Million (ppm) – 1 milligram per kilogram = 1 ppm = 1 pound per million pounds.

Per cent Moisture (% moisture, or % H_2O) – indicates the proportion of water in the sample, calculated by weighing the sample before and after complete drying. For example, if a sample of silage weighs 100 grams before drying and 35 grams after, it is assumed that 65 grams of water were lost. The original sample was therefore 65 per cent moisture. Conversely, the dry matter per cent of the sample was 35 per cent.

pH – the degree of acidity or alkalinity of a solution: pH levels below 7 are acidic and above 7 are alkaline. As silage ferments, the pH declines from neutral (pH 7). The more fermentation that has occurred in silage, the lower the pH will be. The lower the pH, the greater the acidity. The proper preservation of silage depends largely on the moisture content and pH. With high moisture silage (60 to 75 per cent), the pH should be below 4.5. With low moisture silage (50 per cent), the pH may be higher.

Probiotics – a probiotic can be a live (viable) culture of microbial species, a dead (non-viable) product of microbial fermentation or an extract of plant origin. The function of a probiotic is to improve the growth and development of the normal, desirable microbial population in the gut, allowing them to maintain domination over the undesirable organisms. There is evidence, however, that probiotics do form beneficial temporary colonies that may assist the body in the same functions as the natural flora, while allowing the natural flora time to recover from depletion. The probiotic strains are then progressively replaced by naturally developed gut flora.

Protein – complex compounds containing carbon, hydrogen, oxygen, nitrogen and usually sulphur are composed of one or more chains of amino acids. Proteins are essential in the diet of animals for growth, lactation and reproduction. In ruminants (for example, cattle), the rumen microbes break down about 80 per cent of the protein in the feed to ammonia, carbon dioxide, volatile fatty acids and other carbon compounds. The microbes then use the ammonia to synthesize their own body protein. As feed is passed through the rumen into the rest of the digestive tract, the micro-organisms containing about 65 per cent high quality protein are washed along too. The ruminant obtains most of its required protein by digesting these micro-organisms.

Ration – a 24-hour allotment of feed for an animal.

Relative Feed Value (RFV) – relative feed value has no units but is a way to compare the potential of two or more like forages for energy intake. Relative feed value is an index of forage quality calculated from ADF% and NDF%. Forages with NDF values of 53 per cent and ADF values of 41 per cent represent the value of 100. Forages with values greater than 100 are of higher quality, and forages with a value lower than 100 are of lower quality. Dry matter intake (DMI) and digestible dry matter (DDM) values of forages can be used to calculate RFV or use the formula with ADF and NDF values.

$$\text{RFV} = (\% \text{DDM} \times \% \text{DMI}) / 1.29$$

or

$$\text{RFV} = [(88.9 - 0.78 \times \text{ADF}\%) \times (120/\text{NDF}\%)] / 1.29$$

Rumen – also called the forestomach or paunch. It is the first compartment of four compartments of a ruminant animal's stomach. The rumen serves as the primary site of food fermentation in the entire digestive tract. Protein, non-structural carbohydrates (including starch, sugar and pectin) and structural carbohydrates (including hemicellulose and cellulose) are fermented and digested by ruminal microbes for the duration of their time in the rumen.

Rumen Degradable Protein (RDP) – that portion of the consumed protein digested in the rumen. It may also be referred to as degradable intake protein (DIP).

Rumen Undegradable Protein (RUP) – see Undegradable Intake Protein or By-pass Protein.

Starch – the main carbohydrate component of the dry matter in grain. It contains long chains of glucose molecules, which are easily broken down by rumen microbes.

Soluble Protein – estimates the amount of crude protein that will readily dissolve when the feed enters the rumen. This protein fraction represents the portion of crude protein that is rapidly degraded or digested by rumen microbes. Higher soluble protein levels are often found in silages that are put up very wet (less than 30% dry matter).

Supplement – a product that contains high levels of one or more nutrients and that is fed to correct or prevent deficiencies of these nutrients.

Total Digestible Nutrients (TDN) – the concept of total digestible nutrients comes from the old system of measuring available energy of feeds and energy requirements of animals involving a complex formula of measured nutrients. It is very hard to measure, but is used widely in some parts of the U.S. and Canada. TDN values are usually quoted as percentages for feeds and as amounts per day for requirements. The values are usually calculated on feed analysis reports. The simplest and most commonly used formula for estimating TDN is $\text{TDN} = \text{DE}/0.044$. One kilogram of TDN is equivalent to 4.4 megacalories of DE.

Total Mixed Ration (TMR) – consists of all the feed ingredients mixed together to form the ration allowance for the animal.

Undegradable Intake Protein (UIP) – portion of intake protein that escapes rumen degradation and is digested directly in the small intestine. About 80 to 85 per cent of the microbial bacterial protein and UIP or true protein that flows out of the rumen is digested in the small intestine. UIP is expressed as a percentage of CP. It is also called bypass protein or escaped protein or rumen undegradable protein since it is the amount of feed protein that escapes the rumen to the small intestine.

Factsheet prepared by

Alberta Agriculture and Rural Development

For more information, contact

Alberta Ag-Info Centre
Call toll free 310-FARM (3276)

Website: www.agriculture.alberta.ca