MEASURE AND MANAGE

Understanding Feed Analysis Terminology

One of the most important steps in developing a ration suitable for dairy animals is feed testing. It is essential to have a starting point in order to formulate a ration to the recommended level for high producing cows. Forages are the most variable of all the feedstuffs tested and because of the large inclusion rate in the rations, require the most attention. The test results are only useful if the recipient can interpret the report.

The following is designed to give some explanation and insight into the various report terminology.

- **AS FED BASIS** - As fed refers to the actual amount of a feed or nutrient fed to livestock and includes the moisture present in the feed.
- **DRY MATTER BASIS** (DM) - Feeds or nutrients listed on a dry matter basis refers to the quantity of feed after the water is removed. i.e. after the sample has been dried to 100% dry matter. This is used as a basis for comparing feeds and estimating intakes.
- **PROTEIN** – Protein is composed of nitrogen, carbon, hydrogen and oxygen and sometimes sulfur or phosphorous. Proteins are made up of complex combinations of various amino acids and are necessary for maintenance, growth, production and reproduction.
- **CRUDE PROTEIN** (C.P.) – Crude protein is represented by the total amount of nitrogen present when analyzed and then multiplied by a conversion factor of 6.25. This is based on the assumption that true protein contains 16% nitrogen. The term crude protein is used because it represents all of the nitrogen that is in the form of nonprotein nitrogen (NPN) such as nitrates, ammonia, urea and single amino acids, as well as the nitrogen present as true protein. As plants mature, the crude protein usually decreases.
- **AVAILABLE PROTEIN** – Available protein is the portion of crude protein that is digestible by the ruminant. It is usually used in describing protein that is ‘available’ in heat damaged haylage or corn silage. Because of the feeding rate and the retention time in the rumen, not all of the protein present has time to be digested. It is usually accepted that only ~70-72% of the protein can be utilized.
- **UNAVAILABLE OR BOUND PROTEIN** – Unavailable or bound protein is the portion of crude protein that is not usable by the ruminant. It is measured by the Acid-Detergent Fiber–Crude Protein (ADF-CP). This is most important in describing heat damaged wet forages, where some of the protein has been rendered unusable due to excessively high temperatures reached during fermentation.
- In conjunction to the available protein, is digestible protein. This figure is not often used in ration formulations. Digestible protein is calculated from the ADF-CP value. Provided that the digestible protein is greater than 60% of the crude protein, no adjustments have to be made.
- An adjusted crude protein value will be included in the report if the bound protein becomes too high. (> 12% of CP) If an adjusted crude protein value is included, this value should be used in ration formulation.
- **SOLUBLE PROTEIN** – Soluble protein is the portion of the available protein that is most readily and completely soluble in the rumen fluid and rapidly attacked by bacteria. It contains both non-protein and true protein nitrogen. Feeds will vary in their degree of

solubility, for example: forages, especially wet forages, have a high percentage of soluble nitrogen in the form of non-protein nitrogen, while urea is 100% soluble.

- **INSOLUBLE AVAILABLE PROTEIN** – insoluble available protein is the portion of available protein that is not soluble in rumen fluid, but is still available to the ruminant. The rate of breakdown will vary depending upon the feed and its physical form. Insoluble available protein, which escapes degradation in the rumen, is almost completely digested in the lower tract and is then referred to as rumen undegraded insoluble protein or **Bypass Protein.**
- **FIBER** - Fiber is the portion of the plant that provides the plant's structural strength and form. Generally, the vegetative parts, especially the stem, have the highest fiber content. Seed hulls and/or coats also often contain fiber. Fiber is composed of several different types of compounds and is the major constituent of plant cell walls. The components of fiber that provide the 'fiber' value are hemicellulose, cellulose and lignin. An adequate amount of digestible fiber is required in the diet of ruminants for efficient production and health. Fiber values in plants are a function of the growing conditions and maturity. As plants mature, the fiber levels increase.
- **ACID-DETERGENT FIBER** (ADF) – ADF is the portion of fiber that is composed of cellulose and lignin. ADF is related to forage digestibility (energy) and is used to calculate forage TDN or NE for hay, haylage and corn silage. Forages lower in ADF are usually higher in energy.
- **NEUTRAL DETERGENT FIBER** (NDF) - NDF is the portion of fiber that is composed of hemicellulose, cellulose and lignin. NDF is related to feed intake or bulk and can be used in ration formulation to predict forage intake and quality. Forages low in NDF are usually of high quality and have high levels of intake.
- **LIGNIN**-Lignin is that portion of the plant structure that forms a crosslink between cellulose and hemicellulose of the plant cell wall. Its purpose is to provide strength and protection to the plant. Lignin is nearly completely indigestible. As plants mature lignin increases. It is more abundant in legume forages than in grasses or corn silage.
- **MINERALS** - Minerals are the inorganic element of animals and plants and are determined by burning off the organic matter and weighing the residue (ASH). It is the ash that represents the minerals. Minerals can be measured in percent (%), grams (g), parts per million (ppm) or milligrams per kilogram (mg/kg).
- **MACRO (OR MAJOR) MINERALS** - Macro minerals, that are required in relatively large amounts by livestock, include: calcium (Ca), phosphorous (P), sodium (Na), potassium (K), magnesium (Mg) and sulfur (S).
- **MICRO (OR TRACE) MINERALS** – Micro minerals, that are required in relatively small amounts by livestock, include: manganese (Mn), iron (Fe), copper (Cu), zinc (Zn) and molybdenum (Mo).
- **NON FIBRE CARBOHYDRATES** (NFC)- Also referred to as nonstructural carbohydrates (NSC), these represent the components of the plant that provide energy to the animal and are stored within the cell. The most common types are sugars and **starch**. The rate and degree of fermentability and digestibility can vary depending on the feed. Some feeds contain large amounts of readily available carbohydrates while others contain significant amounts of more slowly available carbohydrates. The condition of the feed can also contribute to the rate of digestion.
- **ENERGY** - Energy is the 'fuel' that helps the body grow, maintain itself and reproduce. Energy cannot be measured directly in the laboratory like protein, fiber or minerals. Energy is measured in terms of ration dry matter (Mcal/kg).
- **NET ENERGY** (N.E.) - N.E. is the energy used for maintenance, and for productive
- purposes, i.e. growth, gestation and lactation. Net energy is derived from animal studies by measuring the gross energy minus fecal energy, minus energy lost in urine and minus combustible gases and heat loss. Net energy (lactation), however, can also be calculated on a dry matter basis for hay, haylage and corn silage using the forage Acid-Detergent Fiber (ADF) analysis.

- **DIGESTIBLE NUTRIENTS** – Digestible nutrients are the portion of each feed nutrient that is digested or absorbed by the animal.
- **TOTAL DIGESTIBLE NUTRIENTS** (T.D.N.) – T.D.N. is derived from animal studies by measuring the percentage of digestible carbohydrates, digestible protein and digestible fat (x 2.25). T.D.N. values for hay, haylage and corn silage, however, can also be calculated on a dry matter basis using the forage Acid-Detergent Fiber (ADF) analysis.
- **NOTE:** For most common forages, regression equations exist for calculating TDN and net energies. These have been developed for specific areas and several different sets of equations do exist. Depending on which area and laboratory is used for feed testing, the resulting values for these parameters may differ.
- An alternative calculation has been used successfully by Ohio State University to determine TDN for any type of feed. This equation uses true digestibilities for carbohydrates, protein, cell wall fibre and fat to determine TDN. These are prefixed in Agri-Food reports by a capital "w". i.e. WTDN
- **RELATIVE FEED VALUE** (RFV)- This term is useful for comparing forages of the same type. It is calculated as digestible dry matter divided by dry matter intake. Digestible dry matter is a function of ADF, and dry matter intake is a function of NDF. Therefore the fiber components have an integral affect on RFV. The relative feed value for grasses is usually lower than for mixed or legume forages. This is due to the higher fiber values associated with grasses, especially the NDF. It is questionable to compare the relative feed value of different species, for this reason.

Reference: OMAFRA Information Sheet, unpublished, Pioneer Forage Manual, A Nutritional Guide, Pioneer Hi-Bred International Inc. DesMoines, Iowa.