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Feed Analysis for the Livestock Producer

Cooperative Extension South Dakota State University

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Website: extension.sdstate.edu
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Email: sdsu.extension@sdstate.edu

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Feed Analysis

for the Livestock Producer

Cooperative Extension Service
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Nancy Thiex, Station Biochemistry,
Gerry Kuhl, Animal Science

Feed analysis can assist many producers to more accurately formulate rations for faster and/or more efficient gains. There are different types of analyses; some are not as useful in a particular situation as are others.

The Proximate Analysis

The proximate analysis (often referred to as a "complete" analysis) determines the amounts of moisture, crude protein, crude fiber, ether extract, ash, and nitrogen free extract in a feed. It is seldom necessary to analyze for all of these components, but some are important in most situations.

Moisture

All feeds contain some moisture. A moisture (dry matter) analysis is less important for low moisture feeds. However, since most nutrients are contained in the dry mater, the moisture (dry matter) content is a very important consideration with high moisture feeds.

For feeds such as silages, moisture may be the single most important determination. For example, a ton of silage containing 60% moisture (40% dry matter) will contain twice as many nutrients as one at 80% moisture (20% dry matter).

It is often necessary to know the moisture (dry matter) content of a feed before using nutrient values from published tables to balance rations. Data published in tables are often expressed on a moisture free (dry) basis. Different feeds should be compared on a dry matter basis only.

Table 1 gives sample calculations for the conversion of feed values from a dry basis to a wet (as-fed) basis and from wet to dry basis.

Crude Protein

Protein is one of the most important constituents of feeds from the standpoint of nutrition. Its determination is generally the most valuable of those included in a proximate analysis.

The protein content of most feeds varies widely, and the crude protein determination appears to be the best single measure of the nutritive value of these feeds.

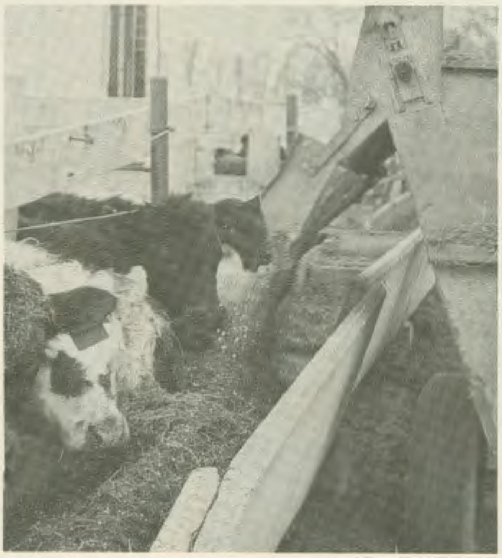
This determination is referred to as "crude" protein because it does not directly measure protein content, but actually measures nitrogen, a component of all proteins. It also measures nitrogen from sources other than true protein which are of variable feed value. Nitrogen content x 6.25 is used to calculate the protein content of most feeds.

The crude protein determination tells nothing of the nutritive value (amino acid composition or digestibility) of the protein in feeds. An index of the nutritional quality of the protein in feeds for non-ruminant animals can be obtained with a lysine analysis, since this essential amino acid is usually the most limiting in common rations for swine and poultry.

When the protein contents of the major feeds available on the farm are known, these feeds can often be used in various combinations to meet a large part, if not all, of the protein needs of cattle, sheep, and horses. In the mixing of complete rations for swine and poultry, the protein content of each ingredient is needed in order to know how much protein supplement to add.

Ether Extract

Fat, oils, and other substances soluble in ether are included in ether extract (sometimes referred to as crude fat). The



Is that ration putting the fastest and most economical weight on your animals? You can find out in short order.

Table 1. Example calculations.

To convert from a moisture free (dry) basis to an as-fed (wet) basis:

$$\text{Dry Value} \times \frac{\text{\% Dry Matter}}{100} = \text{As-fed Value}$$

Example 1: If a corn silage was determined to be 75% moisture by analysis, and the published moisture free (dry) TDN value for well eared corn silage is 70%, you would calculate the % TDN on an as-fed (wet) basis as follows:

$$100\% - 75\% \text{ moisture} = 25\% \text{ dry matter}$$

$$70\% \text{ TDN (dry)} \times \frac{25\%}{100} = 17.5\% \text{ TDN (as-fed)}$$

To calculate a moisture free (dry) value from an as-fed (wet) value:

$$\text{As-fed value} \times \frac{100}{\text{\% Dry Matter}} = \text{Dry Value}$$

Example 2:

$$17.5\% \text{ TDN (as-fed)} \times \frac{100\%}{25\%} = 70\% \text{ TDN (dry)}$$

ether extractable portion of feeds is high in energy when it represents primarily lipids, but this is not always the case.

Since most feeds are rather low in ether extract, a special analysis for it is not often warranted.

Ash

Ash, or mineral matter, is determined by burning a feed sample until the ash is free of carbon. Ash content tells little about nutritive value since it does not indicate the amounts of individual minerals present.

Occasionally, an ash determination may be used to determine if there is a large amount of dirt present or if unusual levels of minerals have been added to a feed.

Crude Fiber

This determination is a "crude" attempt to measure the less digestible portion (cellulose, lignin, and similar fibrous substances) of feeds. Feeds that are high in fiber are less digestible, and therefore less nutritious, than those that are low in fiber.

An analysis for crude fiber is not routinely of much value to the feeder except where roughages are being fed.

Nitrogen Free Extract

Nitrogen free extract (or NFE) is calculated by subtracting the percentages of moisture, protein, ether extract, crude fiber, and ash in a feed from 100%, and therefore requires all of those analyses.

The NFE fraction of feeds is largely composed of starches and sugars and is a major source of energy in feeds. Grains are the primary sources of NFE.

The crude protein determination is often of more value in estimating the quality or feed value of roughages than NFE.

Digestibility of Nutrients

A digestible nutrient is that portion of a feed which may be digested and taken into the body. The proximate analysis tells nothing of the digestibility of the various nutrients.

Send a representative, mixed sample to Station Biochemistry at SDSU. The chemists there can analyze your feeds. Photos from left to right illustrate crude fiber analysis, atomic absorption spectrophotometry for mineral analysis, and a step in crude protein testing. Part of an acid detergent fiber analysis is pictured on the cover. Depending on the tests you want run and the time of year, you can have results back in 7 to 10 days.

This can be determined only by actual digestion trials of long duration with each class of livestock. Such trials have led to the establishment of **digestion coefficients** for each nutrient in a feed.*

Digestible Protein

Digestible protein can be calculated for a feed to be fed to a particular class of livestock by multiplying the percentage of crude protein by the digestion coefficient established for that feed and species of livestock. Digestible protein, therefore, requires a crude protein determination and also requires knowing what feed and what type of animal is being fed.

Digestible protein calculations on unknown feed mixtures should not be requested since the digestion coefficients will not be available. A reasonable estimate can be made if the feed composition of the mixture is known.

* Digestion coefficients are summarized in several books on nutrition. The National Research Council (NRC) values are listed in the *Atlas of Nutritional Data on United States and Canadian Feeds*, published by the National Academy of Sciences, Washington, D.C.

Total Digestible Nutrients

The total digestible nutrients (or TDN) is the sum of all digestible organic nutrients. It can be calculated from the percentages of crude protein, crude fiber, ether extract x 2.25, NFE, and their respective digestion coefficients.

TDN calculations for a particular feed, therefore, require a proximate analysis, identification of the species being fed, and indication of the quality or stage of maturity (forage) of the feed.

Again, since digestion coefficients are available for pure feeds only, TDN cannot be calculated for unknown feed mixtures.

TDN values for most feeds do not vary a great deal, and moisture free values from published tables should generally be used for the formulation of rations. Table 2 lists some frequently requested TDN values.

To calculate the TDN of a feed on a wet (as-fed) basis from a value on a dry (moisture free) basis, a moisture (dry matter) determination is required.

Energy of Feeds

In addition to TDN, various other energy values of feeds (net energy, digestible energy, metabolizable energy) are also used to balance rations. There are no simple chemical analyses to determine these energy values. They must be obtained experimentally and are available in published tables. Sample values are listed in Table 2.

Heat Damaged Forages

If improperly ensiled, forages can quickly spoil. When they become excessively hot, protein digestibility is lowered.

This protein loss is often referred to as "heat damaged" protein. Heat damage is characterized by carmelization and brownish black color development. This is most common in legume and grass silages and is often a problem with alfalfa silage which is put up on the dry side (20-50% moisture).

When in doubt as to the extent of heat damage in a forage, an **acid detergent insoluble nitrogen** determination should be requested in addition to the crude protein determination.

Acid Detergent Insoluble Nitrogen

This determination, usually abbreviated ADIN, gives an estimate of the loss of protein digestibility due to heat damage

by measuring that portion of nitrogen insoluble in acid detergent, which is considered unavailable to the animal.

ADIN can also be calculated as a percent of the total nitrogen (ADIN/%N) in a feed. The higher the ADIN/%N value the greater the heat damage. Values below 10% are considered normal.

Questions

Questions concerning nutrient requirements, the balancing of rations, or what analyses should be made on a particular feed should be directed to your county agent or to livestock specialists in the Animal Science Department (beef, swine, sheep, poultry) or the Dairy Science Department (dairy) at South Dakota State University, Brookings, SD 57007.

For a list of analyses available and their prices, write Station Biochemistry, Animal Science Complex, South Dakota State University, Brookings, SD 57007.

Table 2. Energy values of some common feeds.*

	Dry Matter Basis (moisture-free)					As-fed Basis (90% dry matter)	
	Beef Cattle		Dairy	Sheep	Horses	Poultry	Swine
	TDN	NE_G	NE_L	TDN	TDN	ME	ME
Feedstuff	(%)	(Mcal/lb)	(Mcal/lb)	(%)	(%)	(Kcal/lb)	(Kcal/lb)
Alfalfa meal, dehydrated, 17% protein	62	0.33	0.64	56	56	623	543
Alfalfa hay or haylage, pre bloom	59	0.28	0.72	57	57		
Alfalfa hay or haylage, early bloom	57	0.25	0.66	56	55		
Alfalfa hay or haylage, full bloom	53	0.18	0.55	52	49		
Alfalfa-brome hay or haylage, early bloom	55	0.22	0.57	55	54		
Barley (48 lbs)	83	0.64	0.86	86	82	1200	1275
Corn grain, dent, #2	91	0.67	0.87	94	88	1560	1500
Ground ear corn	80	0.56	0.83	78	74	1260	1200
Corn silage, well-eared	70	0.46	0.71	70			
Corn silage, low grain	66	0.42	0.64	66			
Oats (32 lbs)	76	0.52	0.79	75	76	1160	1100
Oats hay or silage, early dough	60	0.30	0.59	59	47		
Oats straw	48	0.11	0.40	45	40		
Prairie hay, mid bloom	52	0.16	0.45	53	46		
Rye	85	0.62	0.83	85	80		1300
Sorghum (milo)	80	0.56	0.84	86	80	1530	1425
Sorghum silage, grain type	61	0.31	0.64	58			
Sudangrass hay or silage	58	0.28	0.60	55	47		
Sudangrass pasture, mid-bloom	63	0.35	0.64	56	52		
Wheat	88	0.65	0.92	88	87	1400	1500
Wheat straw	46	0.09	0.37	43	34		

* Table values adapted from National Research Council publications on nutrient requirements; beef cattle, 1976; dairy cattle, 1978; sheep, 1975; horses, 1978; poultry, 1977; and swine, 1978.
These booklets make excellent home references and are available (about $4 each) from the Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Ave. NW, Washington, DC 20418.

Abbreviations used:

TDN = Total Digestible Nutrients
NE = Net Energy for Gain (Beef) or Lactation (Dairy)
ME = Metabolizable Energy
Mcal = Megacalorie
Kcal = Kilocalorie
Kcal = Mcal x 1000

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