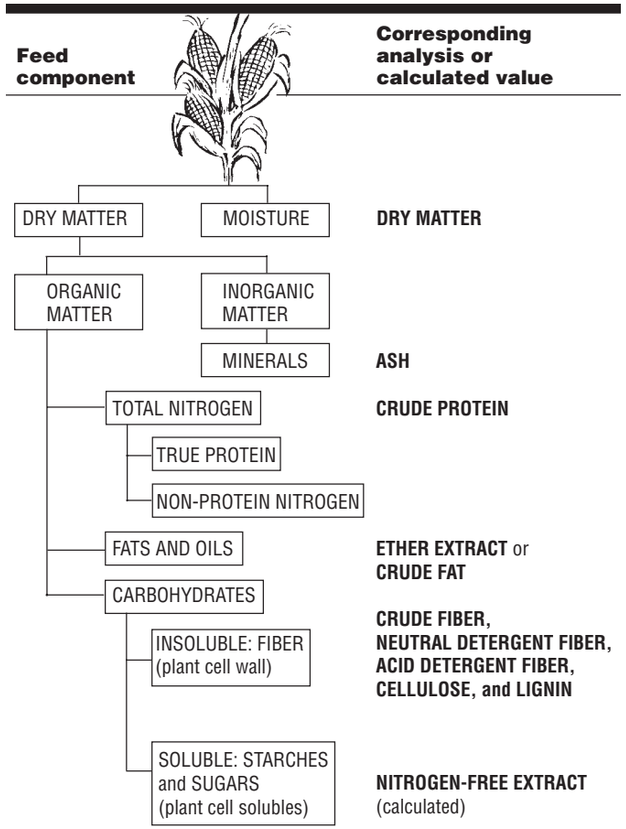

This chart shows how the various nutrient components of a livestock forage or feedstuff are related to the values obtained from a livestock feed analysis. Some of the terms are defined on the back panel of this publication, and the components are described on the inside page.

Livestock feed analysis services are available from the CTAHR Agricultural Diagnostic Service Center through your local Cooperative Extension Service office, or from other commercial laboratories.

Glossary

antioxidant: a feed additive that inhibits one of the chemical reactions (oxidation) in fats that occur in the presence of oxygen, heat, or light and cause rancidity.

macrominerals: those minerals found in an animal's body in concentrations higher than 100 ppm—they are calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), chlorine (Cl), sodium (Na), and sulfur (S), and are usually expressed as percent of dry matter.

microminerals: those minerals found in an animal's body in concentrations less than 100 ppm; just as important as macrominerals in maintaining health—they are copper (Cu), iron (Fe), zinc (Zn), selenium (Se), fluorine (Fl), manganese (Mn), cobalt (Co), iodine (I), molybdenum (Mo), nickel (Ni), and silicon (Si).

monogastric: a type of digestive system consisting of "one stomach"—includes humans, swine, poultry, horses, rabbits, dogs, and cats; monogastrics have limited ability to digest fiber and non-protein nitrogen sources; dietary starch and amino acids are essential.

ruminant: a type of digestive system consisting of a multicompartmental stomach including a forestomach (rumen, reticulum, and omasum) and an abomasum (true stomach)—includes cattle, sheep, goats, buffalo, and deer. Ruminants' ability to digest fiber and use non-protein nitrogen sources is excellent.

non-protein nitrogen (NPN): compared to true protein, this fraction of the "crude protein" value refers to any nitrogen (N) which is not in the form of chains of amino acids—includes ammonia, ammonium phosphate, urea, and dietary nucleic acids. NPN is most effectively used by ruminants with a functioning rumen (i.e., not those suckling milk) and requires the presence of a readily available dietary carbohydrate source, such as molasses or grain.

true protein: compared to non-protein nitrogen, this fraction of the crude protein consists of long chains of amino acids linked together; essential for diets of monogastrics.

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Charles W. Laughlin, Director and Dean, Cooperative Extension Service, CTAHR, University of Hawaii at Manoa, Honolulu, Hawaii 96822. An Equal Opportunity / Affirmative Action Institution providing programs and services to the people of Hawaii without regard to race, sex, age, religion, color, national origin, ancestry, disability, marital status, arrest and court record, sexual orientation, or veteran status.

Cooperative Extension Service
C/T/A/H/R
College of Tropical Agriculture & Human Resources
University of Hawaii at Manoa

Livestock Feed Analysis

How to Interpret the Results

Livestock are most productive when fed a ration that meets their nutritional needs. Laboratory analysis of feeds is the best indicator for predicting animal performance on a ration before it is fed. This publication has been developed to help livestock producers interpret feed analysis results, which can help them in planning rations. Livestock feed analyses provide producers with useful data that can help to

- determine the nutrient content of a mixed feed or a particular ration component
- decrease feed costs through lower-cost rations and more efficient utilization
- evaluate forage production practices such as plant species selections, fertilizer schedules, and time of harvest (age of regrowth)
- set and monitor nutrient standards for local and imported feeds and feed by-products for marketing purposes

The results of the analysis can only be useful when the sample tested truly represents the lot of feed that the animals will eat. Poor sampling technique results in misleading feed analysis values, which may lead to increased feed costs, reduced animal performance, and economic loss. For further assistance in using livestock feed analysis results to maximum benefit, contact your local Cooperative Extension Service livestock agent.

Michael W. DuPonte
Cooperative Extension Service, Hilo

DM = Dry Matter DM is the percentage of the feed that is not water (moisture). Fresh grass has higher moisture content and lower DM content compared to hay.	DM increases with plant age when harvested. The lower the DM, the more moisture is present, and the lower is the nutrient density in the fresh feed. Also, high moisture may decrease the keeping quality of a feed (through molding) unless it is made into silage.	Expressing nutrients on a dry-matter basis allows comparison among feeds by correcting for "as-fed" moisture. Diets are formulated on DM basis, but ingredients are weighed out or mixed on an as-fed basis. When fresh forages and grasses make up the bulk of the diet, a large amount of water is consumed, which could limit intake of energy and protein sources.
Ash = total inorganic matter Ash is a measure of the total mineral content of the feed, but it does not tell us how much of each mineral is present.	Ash is not digestible by animals. High ash content of feeds may dilute the amount of nutrients available to the animal. Bone content of feeds of animal origin can contribute to ash content. If a plant feed is high in ash content, it may be due to soil contamination during harvest of the plant material.	Although minerals are not digested by animals, some are essential to their health. In order to determine the individual mineral content, such as calcium and phosphorus, you must order mineral analysis of the sample (usually includes all macrominerals and some microminerals).
CP = Crude Protein CP is an estimate of the level of protein in the feed based on the amount of nitrogen present. Since some, but not all, of the nitrogen is in the form of true protein , it is termed "crude" protein. CP also does not give individual amino acid profiles.	CP content of plants peaks at about 4–6 weeks of age, then begins to decline quickly. Legumes such as alfalfa, *koa haole*, and clovers are generally higher in protein than grasses and other forages. Seed oil meals have higher CP values than whole grains. The protein quality of grasses declines more rapidly than that of legumes with plant age, and tropical forages decline more rapidly with plant age than temperate forages.	CP includes both true protein and non-protein nitrogen (which can be used most effectively by ruminant animals). Because feeds high in protein are generally more expensive, compare feed costs on the basis of cost per pound of CP rather than per pound of DM. For swine, poultry and other monogastrics, knowing the amount of each essential amino acid in the feed is critical. Some protein fractions are more digestible than others, but in general the higher the protein level, the more digestible is the feed. Laboratories can analyze for amino acids (lysine, methionine, etc.) and protein fractions (soluble, insoluble).
EE = Ether Extract EE, also termed crude fat, is the amount of fat and fat-soluble components in a feed. In addition to fats and oils, it includes plant pigments (chlorophyll, xanthophylls, carotene) and fat-souble vitamins (A, D, E, K), but it does not tell us how much of each vitamin or fatty acid is present.	EE is usually higher in meat and fish byproducts and whole seeds. If a feed is high in fat, it may be susceptible to rancidity, which causes off-flavors, low palatability, and potential toxic effects. Usually an antioxidant such as Vitamin E is added to prevent a feed from becoming rancid.	Because fat has 2.25 times more energy per unit of weight compared to carbohydrates, feeds with high fat content are more energy-dense and are added to diets to increase calories, provide essential fatty acids, and (in some cases) improve palatability. Fat is also helpful in lubricating and maintaining feed mixing equipment.
CF = Crude Fiber CF is the insoluble carbohydrate remaining in the feed analysis process after the sample is boiled in weak acid and alkali.	Crude fiber is the poorly digested component of a feed. It is made up of plant structural carbohydrates such as cellulose and hemicellulose; it also contains some lignin.	CF analysis has been replaced by NDF and ADF analysis for ruminant feedstuffs, but it is still used by the feed industry as a measure of fiber content for monogastrics.
NDF = Neutral Detergent Fiber The NDF value is the percent of total fiber in the feed. NDF is the plant cell wall components: cellulose, hemicellulose, lignin, silica, insoluble CP, and ash. Analysis for NDF, along with ADF, cellulose, and lignin, is replacing the older, more variable crude fiber analysis.	NDF content increases as plants mature. Although feeds from animal tissue (fish meal, meat and bone meal, milk, etc.) do not contain fiber, they may contain small amounts of NDF due to ash and other insoluble components.	NDF, or total fiber, influences level of intake. High levels will limit intake, but minimum levels are necessary to prevent fattening during pregnancy, and also to maintain a healthy rumen in ruminants. It is the fiber in the diet that stimulates rumination, chewing, and saliva production.
ADF = Acid Detergent Fiber The ADF value is the percent of the least digestible parts of cell walls: cellulose, lignin, silica, insoluble CP, and ash.	ADF content increases as the plant matures and is generally higher in legumes than grasses of the same age. For any given sample, ADF will be lower than NDF content and the difference between the two reflects the amount of hemicellulose present.	ADF, or the least digestible portion of fiber, affects a feed's digestibility - the lower the ADF content, the higher the digestibility. It is used in calculating energy estimates, such as TDN (total digestible nutrients) or NE (net energy).
Cellulose Cellulose is the principal constituent of plant cell walls.	Feeds high in fiber generally have high cellulose contents. Cellulose generally has low digestibility in nonruminants, and high levels may reduce the digestibility of other nutrients in a ration.	Cellulose is digested well by ruminants, moderately by horses and rabbits, and poorly by swine and poultry.
Lignin Lignin is not true carbohydrate; it is a protective coating on the cellulose-hemicellulose structure of plant tissues, which apparently protects them from bacterial attack.	Lignin is found in straws, hulls, and overmature hays. It is essentially indigestible by all livestock.	Lignin has no known nutritive value, except as a bulk factor. At high levels, it reduces digestibility of other nutrients in a ration.
NFE = Nitrogen free extract NFE is a calculated value: the original sample weight minus the sum of weights of water, ether extract, crude protein, crude fiber, and ash.	NFE is made up primarily of readily available carbohydrates, such as sugars and starches; this fraction may also contain sulubilized hemicellulose and lignin.	The NFE fraction in grain can be readily utilized as a nutrient by nearly all livestock species, but in forages and roughage it is less available to the animal.