FORAGE LAB AUSTRALIA

Powered by Cumberland Valley Analytical Services USA

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Interpreting your Forage Lab Australia results

The introduction of FORAGE LAB AUSTRALIA (powered by CVAS USA) has seen a wonderful improvement in the detail now available to characterize a feed stuff accurately, in a fast turnaround time.

This document provides a brief, practical summary of a range of the more important nutrient specifications within the broader set of numbers that Forage Lab Australia is capable of generating, and the benefits this can bring in a nutritional sense.

AN IMPORTANT NOTE ON ENERGY VALUES FROM FORAGE LAB AUSTRALIA vs SOME OTHER LABS: THE LAB TO USE WHEN YOU WANT A REALISTIC NUMBER AS A NUTRITIONIST

The values for ME (MJ/kgDM) are a calculation (not a measurement as such), and the numbers generated by Forage Lab Australia are often more conservative on some feedstuffs (especially some forages) then those generated by some other labs.

These numbers are far more accurate and reflective of the reality "in the paddock".

The wide range of experienced and respected nutritionists who have embraced Forage Lab Australia give us confidence that our energy calculations are numbers you can trust, to give outcomes you can predict.

MOISTURE/DRY MATTER

These add to 100%, and are the inverse of each other.

Importantly, specs on a ruminant feed assay, and in ruminant nutrition generally, are quoted on a *dry matter* basis, not an *as is* basis. Because of this it is important to understand the moisture level of a feed stuff so you can understand what you are feeding out in as is terms. Moisture levels in pasture, silage, hay and other products vary greatly. Grains, legumes and protein meals are more consistent.

PROTEINS

Protein has long been used as the first parameter looked at in feed assays. This is probably because as a plant tissue matures, protein declines. Protein can thus be a very basic proxy for plant maturity and the decline in energy, increase in fibre and decline in overall nutrient value that follows as a plant matures.

More protein is typically seen as better. This broad statement has many flaws however, and we need more details to allow us to understand protein better.

CRUDE PROTEIN: This is the traditional nutrient quoted. It is simply a measure of Nitrogen content (%) X 6.25 = Crude Protein%. While still useful, it gives us no ideas on the nature of the protein content and how it is digested.

SOLUBLE PROTEIN: Within the Rumen Degradable fraction of protein we have proportions that break down fast within the rumen, and portions that break down slowly (but are still degradable in the rumen). Soluble Protein is the proportion that releases fast. It is made up of both simple Non Protein Nitrogen source, and also True Protein sources. In both cases the release rate is the key thing defining Soluble Protein.

AMMONIA (CPE): This is one important Non Protein Nitrogen form. It's typical that in some poorly produced silages some better quality True Protein (made up of Amino Acids) is broken down to simple Nitrogen in the form of Ammonia. This high Ammonia is not a desirable thing, so we want to know how much Ammonia is in the feed, as it

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still tests as Crude Protein, but is of differential quality for productive milk or weight gain. High Ammonia content is also a good indicator of silage/wet product spoilage, and can suggest we look for problems in other areas as well. We don't want more than 1% ammonia in silage, and less is always better.

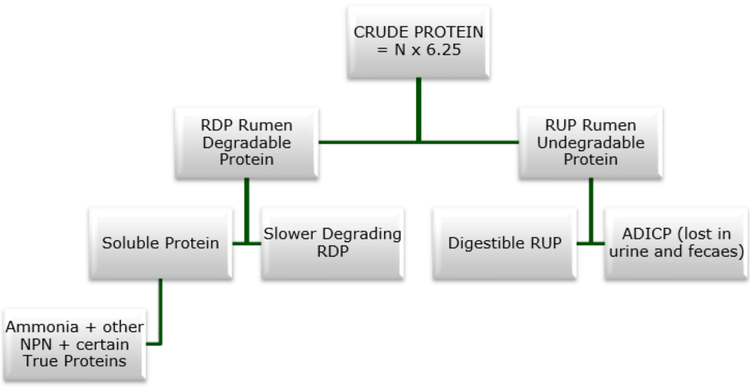
ADF PROTEIN (ADICP): Acid Detergent Insoluble Crude Protein- for Australian conditions, this is probably a more important indicator than NDF. It measures the protein bound into the ADF fraction of carbohydrates as measured by the Van Soest system. It measures the amount of protein insoluble or bound up in the more highly indigestible ADF fraction. It is an indicator of the protein that will simply be unavailable to the animal in spite of it showing up as part of the simple crude protein %. ADICP is especially a good and useful guide to how much protein has been created as unavailable by heating of silage and hay. A rough rule of thumb is to discount the Crude Protein minus the ADICP to get an idea of the protein that is "really there" for the animal.

NDF PROTEIN (NDICP): Neutral Detergent Insoluble Crude Protein - This is the portion of Crude Protein held in a matrix within the total fibre fraction. Some of this protein will be available to the animal, some of it will not. It is measured as the protein held insoluble within the NDF component using the Van Soest system of carbohydrate fractions. NDICP is an important input into energy predictions on a feedstuff.

RUMEN DEGR. PROTEIN (RDP): Within the Crude Protein we can broadly break up protein as that which will degrade in the rumen, and that which will escape or bypass the rumen and is known as **Rumen Undegradable Protein (RUP).** This number gives a guide to what the rumen degradable component will be. It is quoted as both % of Dry Matter and as a % of the Crude Protein.

By difference we can calculate the amount of **Rumen Undegradable Protein** (Crude Protein - RDP = RUP).

These numbers are generated or predicated for a given rumen passage rate (typically about 6%/hour), so in real world terms no ingredient has a RDP or UDP that is set in stone. It will vary somewhat with passage rate and rumen dynamics. These specs are valuable indicators nevertheless.



FIBER

By and large, fibre fractions increase with plant maturity and aging. Simple sugars and carbohydrates that are highly digestible and exist within the cell itself, are converted into less digestible structural carbohydrates that measure as fibre, exist in the cell wall as it thickens, and are of less nutritive value to the animal.

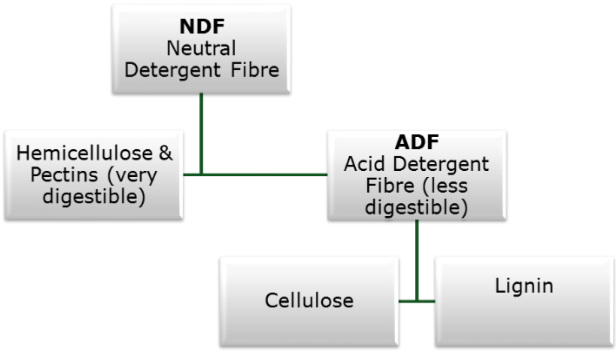
With these fibre fractions, less is typically better and produces better nutrient content.

ADF ACID DETERGENT FIBRE: This is a portion of the total fibre (NDF), and is the less digestible components of Lignin + cellulose. It has been used as a guide to total digestibility of a feed stuff, and indirectly as an energy indicator.

aNDF NEUTRAL DETERGENT FIBRE: This is a measure of the total fibre in the feedstuff. It's predicted using the Van Soest system. It consists of both digestible and indigestible fibre fractions. IE it captures bad and good fibre as it were. Ranging from lignin, cellulose, hemicellulose and some pectins.

NDF ON ORGANIC MATTER BASIS (aNDFom): Is the NDF component of the organic matter, i.e. we discount the ash component and give the NDF on the organic matter portion. This is often pretty similar to the aNDF, but in high ash materials or in hay or silage with soil contamination we can see bigger differences, which is why we have a guide to both. A big difference can suggest we need to go looking for contamination issues, or account for high ash content in our energy considerations.

LIGNIN: Is the completely indigestible fraction that is part of both NDF and ADF. It has no nutrient value, and in fact acts to bind up and render unavailable nutrients that would otherwise be available to the animal. This is some of the fibre and protein (and thus energy) that we may assume is there for the animal, but is not in practical terms.



NDF DIGESTIBILITY (NDF – D): These are numbers for 12/24/30/48/240 hours. They predict the proportion of fibre as NDF that would be digested at various dwell times within a rumen. The longer the dwell time the greater the digestibility, but as time increases the digestibility won't increase at the same rate. The time that is applicable to consider depends on rumen passage rate. Faster passage rate decreases dwell time in the rumen and makes a shorter hours more relevant. Most nutritionists look at the 24 and 30 hour numbers mainly as a guide to real digestibility outcomes. The 240 hour number is really just a theoretical guide to the ultimate end point digestibility that may occur if a feedstuff stayed in the rumen indefinitely (in this case 10 days) which is not real in a practical sense.

uNDF INDIGESTIBLE NDF: Indigestible NDF. Measured at 30/12/240. These are somewhat the converse of NDF digestibility. They are useful in certain dairy models to predict rumen dynamics in terms of rumen dwell times, likely build up or other wise of rumen mats and as a result rumen stability. uNDF and the term indigestible NDF (iNDF) are interchangeable.

uNDF is seen as a function of lignin content, but the factor of lignin content that is uNDF will not be constant, and has moved on from lignin X 2.4 as it was commonly quoted in the past.

CARBOHYDRATES

These are non-fibre fractions of carbohydrates. They are normally the simpler carb fractions, and often when we have more of these we have less mature plant tissue.

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We also have our fat information presented in this area of the report, though fats are clearly not carbohydrates.

SILAGE ACIDS: These are presented only on silages typically (or wet fermented co-products if requested). It gives an idea of the proportion of the carbohydrates that are not fibre, but are already fermented to acids, and thus can't contribute to fermentation energy in the rumen to grow microbial protein.

High silage acids in silage can still be a positive, indicating good silage fermentation process. Lower acid levels may indicate less complete ensiling and possibly more spoilage risk. Wetter silages normally have more silage acids. Dry silages less silage acids. We like to see at least 5% silage acids in silage to indicate good fermentation. More details occur under **QUALITATIVE** specification heading.

ETHANOL SOLUBLE CARBOHYDRATE (SUGAR): ESC - a measure of simple sugars capturing monosaccharides, disaccharides, oligosaccharides and some of the fructans.

WATER SOLUBLE CARBOHYDRATES: As per ESC this is a measure of sugars, but captures more of the fructans within feeds. As a consequence, may be slightly higher than ESC, though often the numbers are quite similar.

STARCH: An intra cellular carbohydrate (found inside the cells), Starch is the chief storage carbohydrate compound in plants. It is found mainly in seeds or as root tubers. It is made up of sugars linked together in complex chains. If the chains are branched the starch is Amylopectin. If the chains are not branched the starch is called amylose. Starch varies a great deal in how it behaves in nutritional terms based on the ratios of the amylose to amylopectin, and to how the starch interacts with protein fractions.

SOLUBLE FIBRE: is the fibre fraction that is soluble in neutral detergent solution and are not recovered in the NDF fraction. It includes pectins and gums. Citrus, apple and fruit pulp contains plenty of pectin as does immature legumes. Gums are high in certain confectionary coproducts. Typically, soluble fibre will ferment readily to VFA in the rumen and support microbial growth, but is poorly digested intestinally.

STARCH Dig.: Measured at a 4mm grind, over 7 hours. This spec is not offered unless the starch content of the ingredient is high enough. It tells you what % of the starch will be broken down within 7 hours at a specific particle size.

FATTY ACIDS, TOTAL: these are the true fats that are in well-structured chain lengths (normally c16 or C18 in plants) that are highly digestible and provide good energy sources to the animal. They typically provide about twice the energy to the animal as carbohydrates or proteins once absorbed. In plants Fatty acids are usually about EE - 1% eg if EE = 5% of dry matter, fatty acids = 4% of Dry matter. The differences are in non-digestible wax's etc.

FATTY ACIDS AS % OF TOTAL FAT: gives a guide to the proportion of the Crude Fat that is in fact digestible fatty acids. More is better of course.

CRUDE FAT: This is lipid content measured as ether extract. It contains a range of lipids, most will be true fats and thus quite digestible, but some including wax's will not be digestible.

MINERALS

It's important to start with that we state that mineral analysis is best generated via Wet Chemistry rather than NIR analysis. NIR operates by reflected light off organic bonds within a feed stuff. Minerals are by definition not organic, so they are less suited to NIR then organic protein, carbohydrate and fat fractions.

Nevertheless, with enough repetitions built into a calibration (and CVAS has many many thousands of samples in its calibrations), NIR can generate mineral numbers that we suggest are used simply as a useful guide rather than a defining specification output.

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This is especially so for DCAB mineral numbers that are carried out for pre-calving rations designed to prevent or control specific metabolic disorders. **DCAB should only be generated via wet chemistry.**

ASH: Is generated by burning the sample at a very high temperature for a long period to remove all organic matter. This leaves only the pure inorganic residue that can't be combusted.

MACRO MINERALS: Calcium, Phosphorous, Magnesium, Potassium, Sulphur, Sodium and Chloride. These are at the top of the mineral list. They are all reported at % terms, and are required by the animal in greater amounts then those minerals known as micro or trace minerals. NIR will generate a small number of these for guidance purposes only. Wet chem is preferred methodology for accurate outcomes.

MICRO OR TRACE MINERALS: these are reported at parts per million (ppm) which is the same as mg/kg or g/t. These trace minerals are lower on the list of minerals, from Iron to Molybdenum on the CVAS report page. The animal requires them in far smaller amounts, but they are important in a great range of metabolic processes.

QUALITATIVE

These set of numbers relate specifically to silages and fermented feeds that have undergone a fermentation process to preserve them. Achieving a good silage outcome is dependent on what the plant quality was like going into the ensiling process, and also on the success of the preservation via fermentation that will see plant sugars converted to organic acids to preserve the plant mass and exclude spoilage organisms. These numbers give indications as to the effectiveness of the fermentation process.

TOTAL VFA: is a measure of all the organic acids (known as Volatile Fatty Acids) in the fermented silage. Is normally a very similar number to the "silage acids" listed in Carbohydrates. We like to see above 5% VFA in silages to indicate good fermentation of sugar to acids for preservation.

LACTIC ACID: is generally seen as the preferred silage acid in silage. Produces the sweet yet tangy aroma associated with good quality silage. We like to see Lactic Acid making up the majority of our VFA content. Good lactic acid levels indicate low spoilage organisms, and a sound anaerobic fermentation (no oxygen present) which is ideal for quality outcomes.

ACETIC ACID: is another silage acid. We are happy to accept smaller amounts of acetic acid in our silage. We don't want an acetic dominated fermentation as it reduces palatability. Acetic Acid produces a vinegar aroma. Small amounts of acetic do seem to improve aerobic stability and shelf life of silage once exposed to air, however 1-2% Acetic Acid is OK. More is not so good.

BUTYRIC ACID: is the chief VFA produced by spoilage organisms that proliferate when air is not excluded during the silage process. The wrong microbes grow, and convert plant nutrients into spoilage compounds. Butyrate smells like vomit/spew. It makes silage unpalatable, and is also an indicator of other potential issues around spoilage like moulds and toxins. We do not want any butyrate, but certainly no more than 0.2% of DM.

ENERGY & INDEX CALCULATIONS

Included in this area are important energy predications. Also in this area are several "index" numbers that are of themselves not required nutrients for animals, rather they are numerical indicators of RELATIVE QUALITY FOR COMPARISON PURPOSES. For both energy and the indicators, more is typically better… a bigger number indicates a better feed.

Be aware that energy values are themselves just predications. Total Digestible Nutrients, Metabolisable Energy and Net Energy are all predicted using a range of other nutrient content values. These are Crude Protein, Fatty Acids, Neutral Detergent Fibre, Neutral Detergent Fibre Digestibility, Non Fibre Carbohydrate, Neutral Detergent Insoluble

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Crude Protein. These energy predictors are as suggested by USA NRC committee and in addition the work of Professor Bill Weiss from The Ohio State University.

pH: a measure of hydrogen ion concentration. Numbers below pH 7 are acidic. Above pH 7 are alkaline. Silages and fermented products should be on the acidic scale. It is a logarithmic scale, so each unit drop is 10 times more acidic then the previous unit. E.g. pH5 is 10X as acidic as pH6 and 100X as acidic as pH7. In Australia, fully fermented silages of maize or higher moisture pasture can have pH levels in range from pH 4.0-5.0. Less fermented pasture or legumes normally range from pH 5-5.7. Higher dry matter, less fermented haylage style samples range from 5.7 and up.

TDN (TOTAL DIGESTIBLE NUTRIENTS): This is an energy predictor that has its origins in simple and inaccurate basis around simple ADF values. More recent NRC equations have far more input values (see above) and are more robust and accurate.

ME (mj/kg DM): Metabolisable Energy per kg of Dry Matter. Whilst most of the world runs on **NET ENERGY** system (see below), Australia and New Zealand a few other areas run on ME.

ME = Gross Energy – energy lost in faeces - Energy lost in urine- energy lost in gases.

It does not account for energy lost in heat increment generated by the consumption and digestion of the feed stuff (which is accounted for in Net energy). Heat increment can be quite considerable in fibrous feeds, so ME tends to have a smaller gap between forages and concentrates. whereas that energy difference gap is larger in the Net Energy system that accounts for heat increment and thus discount likely energy levels of fibrous feeds to a greater degree.

ME will always be quite a bit larger number then NE numbers, because of the heat increment differential.

NET ENERGY (NE): Because we have accounted for heat increment, NE is the best indicator of the amount of energy actually available to the animal for maintenance, growth and milk production.

NE is partitioned in this manner (as either NE-M (Maintenance), NE-G (Gain), or NE-L (Lactation)) because energy from the same feedstuff is used with different efficiencies for each metabolic process. Maintenance being more efficient use then Lactation, which is in turn more efficient use than Growth. One ingredient thus has 3 net energy values listed.

NDF Dig. Rate (Kd, %/Hr): This could well sit in the fibre area as it lays out the amount of NDF that is predicted to break down per hour. It describes the rate of disappearance of the NDF fraction in digestion. Less lignified, less mature plant tissue breaks up faster. More lignified tissue breaks down slower. There are two numbers. One relates to a measure based on lignin X2.4. The second based on uNDF. Numbers for both these are inevitably below 10% per hour, and the uNDF/ iNDF number is preferable as an accurate indicator. The Lignin X2.4 is offered for historical value.

Starch Dig. Rate (Kd, %/Hr): This could well sit in the carbohydrate area. It describes the rate of breakdown of the starch component. Simple starch sources have a faster breakdown rate than slower sources. A high rate of breakdown will see more energy released ruminally, and potentially in a block post ingestion. This can have negative impacts on rumen stability. A slow rate of starch breakdown coupled with a high rate of ruminal passage flow will see more starch escape the rumen.

NON FIBRE CARBOHYDRATE (NFC): Could again sit within the Carbohydrate section. This is mathematical calculation to generate the carbohydrate fractions that are not fibrous, and as such are more readily fermentable in the rumen.

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NFC = 100% - (CP% + (NDF%-NDICP%) + Crude Fat% + Ash%)

NON-STRUCTURAL CARBOHYDRATES (NSC): This produces a wet chem outcome that in some cases is similar to NFC. NSC is a measure of all the components of the feed that disappear when the feed is boiled in a neutral detergent solution. This includes starch, sugars, pectins, silage acids. They are all non-cell wall carbohydrates. The mathematical number NFC typically shows a higher value than the wet chem NSC number. In grains and some other ingredients however, the numbers are nearly identical because starch and sugars make up the bulk of both

RELATIVE FEED VALUE: this is an index only, and basically a ranking system. This also applies to RFQ (below). Both are based on relativity to a full bloom Lucerne crop with an ADF = 41% and a NDF= 53%. Such a crop is allocated a score of 100, and other feedstuffs are ranked according to relative merit versus that score of 100. RFV is the older of the two. It accounts for NDF and ADF as follows:

RFV = DDM (% OF DM) x DMI (%BW) ÷ 1.29

Where, DDM (Digestible Dry Matter) and DMI (Dry Matter Intake) can be calculated from ADF and NDF as:

- DDM (% of DM) = 88.9 – 0.78 x ADF (% of DM)
- DMI (% of BW) = 120 ÷NDF (% of DM)

One of the limitations of RFV is that it relies in ADF alone as an indicator of digestible dry matter (DDM). This is not ideal and is one of the reasons that RFQ has superseded RFV as an index.

RELATIVE FEED QUALITY: is an updated version of RFV. It shares most of the attributes of RFV. It is also based on a 100 score for full bloom Lucerne. Importantly, RFQ uses TDN as a replacement for DDM, so it brings in a range of parameters in place of a simple ADF basis. It also accounts more for protein, fibre digestibility, fat content etc.

RFQ = DMI (% of BW) x (TDN (% of DM) ÷ 1.23

The use of TDN and its greater range of input factors make RFQ a better indicator than RFV.