



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Acetic Acid	%DM		A colorless pungent liquid acid (C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> ) that is the chief acid of vinegar.	Often produced if lactic acid production is not rapid enough to inhibit acetic acid production by bacteria. High levels (>3%) suggest inefficient silage fermentation--silage was too wet, loosely packed, or silo filled too slowly. Very high levels (>5%) may decrease dry matter intake in dairy cattle. Use of <i>Lactobacillus buchneri</i> silage inoculant may increase level slightly with minimal effect on intake.
Acid Detergent Fiber	% DM	ADF	Residue remaining after boiling a forage sample in acid detergent solution. ADF contains cellulose, lignin and silica, but not hemicellulose.	Often used in some equations to calculate Energy digestibility, TDN and/or NEI, but newer energy estimates include more complete lab analyses. Contrast with crude fiber and neutral detergent fiber.
Acid Detergent Fiber CP	%DM	ADF-CP	Equals ADIN x 6.25 to convert to crude protein basis. It has a larger error than ADIN since not all protein in this fraction is 16% nitrogen.	The term ADICP is used in NRC, 2001. The Term ADIP (same as ADICP or ADF-CP) is used in CPM.
Acid Detergent Insoluble Nitrogen  Acid Detergent Fiber insoluble nitrogen	%DM preferred; or percent of total N	ADIN	Nitrogen in acid detergent fiber residue. See Acid detergent Fiber CP.	Most feeds naturally contain 5 to 10% of nitrogen (CP) as ADIN, but ADIN greater than 15% of nitrogen is an indicator of heat damage. Formation of ADIN is also called non-enzymatic browning (because the hay or silage turns brown) or Maillard reaction.
Acid Detergent Insoluble Crude Protein		ADIP or ADICP	See Acid Detergent Fiber CP (recommended term).	



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Adjusted Crude Protein	%DM	Adj-CP	A calculated value adjusting total crude protein for heat damaged protein. Sometimes calculated by subtracting ADF-CP from CP. Alternately calculated on a proportional basis depending on ADFCP level ( <a href="http://www.foragetesting.org/labprocedure/appendix/A/AdjustedCP.htm">http://www.foragetesting.org/labprocedure/appendix/A/AdjustedCP.htm</a> ).	Adjusted crude protein estimates the protein available for animal use and should be used for formulating rations when ADFCP is greater than 14% of the total crude protein.
Aflatoxin	ppm or ppb		(C <sub>17</sub> H <sub>10</sub> O <sub>6</sub> ) A polynuclear substance derived from molds; a known carcinogen.	Can pass from feed into milk of dairy animals and result in unsalable milk.
Aluminum	ppm	Al	A trivalent metallic element most abundant in the Earth's crust, but not essential for plant or animal nutrition.	Maximum tolerable concentration for cattle is 1,000 ppm. May be an indication of soil contamination if iron is also high.
Ammonia	%DM or % CP	NH <sub>3</sub>	A pungent colorless gaseous alkaline compound of nitrogen and hydrogen NH <sub>3</sub> that is very soluble in water.	In silage fermentation Ammonia N as % of CP - High levels (>12-15% of CP) indicate that extensive protein degradation has occurred.
Ammonia-N	% DM or % CP	NH <sub>3</sub> -N	Nitrogen content expressed as ammonia. Can be indicator of nitrate toxicity if high.	
Ash	%DM		An estimate of the total mineral content; the residue remaining after burning a sample at 550°C.	Values above 6% for grasses or 8 % for legumes usually indicate soil contamination of forage. Ash, ADF-ash and NDF-ash will be different values because ADF and NDF procedures remove some minerals. Note that this is greater than the sum of minerals since the major component, silica, is not measured in most mineral analysis.
Boron	ppm	B	A trivalent metalloid element, essential to plant and possibly to animal life.	
Butyric Acid	% DM		A colorless pungent liquid (C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> ) that is an indication of fermentation when forage is at too high moisture content.	Presence will reduce feed intake. See Acetic Acid
Bypass Protein	%CP		Protein that escapes degradation in the rumen.	Recommend using the term RUP, see below.



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Calcium	%DM	Ca	A silver-white bivalent alkaline earth metal (mineral element) essential to plants and animals.	
Cation-Anion Balance	meq/100g or meq/kg		The quantity of positively charged ions (cations) less the quantity of negatively charged ions (anions) that a product contains.	Recommend using the term Dietary Cation Anion Difference, see below.
Chloride	%DM	Cl	The chloride ion is formed when the element chlorine picks up one electron to form an anion (negatively-charged ion) Cl <sup>-</sup> .	
Copper	ppm	Cu	A ductile metal element which is an essential trace element to all high plant and animal life.	
Corn Silage Processing Score	% of Starch passing through screen (with stated size).	CSPS	Analysis for corn silage where sample is separated by particle size using sieves and then analyzed for particle size and percent starch calculated in coarse (> 4.7 mm), medium (1.18 to 3.35 mm) and fine particles (0.6 mm or less).	Recommend <30% starch on coarse screen and <25% on fine screen.
Crude Fat, Acid Hydrolysis	%DM	AH	The product is hydrolyzed with hydrochloric acid and filtered. The dried mass containing the fat is extracted with petroleum ether, the solvent evaporated and the residue weighed.	Especially required when calcium salts of fatty acids are involved.
Crude Fat, Ether Extract	% DM	EE	An estimate of the fat content of feeds determined by ether extraction. Crude fat contains true fat (triglycerides) as well as alcohols, waxes, terpenes, steroids, pigments, ester, aldehydes and other lipids. See <i>ether extract</i> and <i>fat</i> .	
Crude Fiber	%DM	CF	The original fiber method using sequential acid and alkali extraction (developed by Henneberg and Sttohmman in 1865).	Crude fiber includes most of the cellulose but only a portion of the lignin and no ash. Therefore it underestimates true fiber, is less than ADF and is seldom used for forage analysis. Contrast with <i>acid detergent fiber</i> and <i>neutral detergent fiber</i> .

# Recommended Terminology and Units for Parameters Used in Lab Reports



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Crude Protein	%DM	CP	6.25 times the nitrogen content for forage or 5.7 times the nitrogen content for grain.	
Degree of Starch Access	%Starch	DSA	An enzymatic analysis that provides an index of the variation in starch access among feeds. Used to estimate total tract starch digestibility	
Dietary Cation-Anion Difference	meq/100g or meq/kg	DCAD	The quantity of positively charged ions (cations) less the quantity of negatively charged ions (anions) that a product contains. DCAD + (Na + K + 0.15Ca + 0.15Mg) = (Cl + 0.25S + 0.5P).	
Digestible Dry Matter	% DM	DDM	The portion of the dry matter in a feed that is digested by animals at a specified level of feed intake. Called <i>in vivo</i> DMD if determined by feeding animals in a digestion trial.	There is no laboratory method for measuring DMD directly and it is often estimated by measuring <i>in vitro</i> digestibility, <i>in situ</i> digestibility, using near infrared reflectance analysis, or calculated from acid detergent fiber. The last is by far the least accurate of the four methods of determination.
Digestible Energy	Mcal/lb or Mcal/Kg	DE	The energy in a forage or feedstuff that is not excreted in feces. Calculated for most feeds for dairy cows at maintenance (NRC 2001): $DE_{IX} \text{ (Mcal/kg)} = (\text{dNFC}/100) \times 4.2 + (\text{dCP}/100) \times 5.6 + (\text{FA}/100) \times 9.4 - 0.3$	Indicate the parameter followed by the method, e.g. DE, NRC Dairy 2001.
Digestible Neutral Detergent Fiber	%DM	dNDF	The portion of the neutral detergent fiber digested by animals at a specified level of feed intake, expressed as a percent of the dry matter.	The dNDF of feeds may be determined by <i>in vivo</i> feeding trials or estimated by lignin analysis, <i>in vitro</i> or <i>in situ</i> digestibility, or by near infrared reflectance analysis. Indicate the time (hours) of digestion, e.g. dNDF, 48h.



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Dry Matter	% as Fed	DM	The percentage weight of the sample that is not water (100% - Moisture).	Indicate the method, temperature and time. Oven DM methods include: AOAC 930.15: Moisture in animal feed, oven drying at 135 °C for 2 h, NIRS determination using in-house calibration equations (reference method = oven dried at 105 °C for 16 h), In-house 2-step NIR: Microwave dried 4 min at 600 watts followed by grinding and NIR determination of residual moisture using NIRS Consortium equations, In-house 2-step oven: Oven dried at 60 °C for 16 h followed by grinding and oven drying at 135 °C for 2 h (AOAC 930.15).
Dry Matter Intake	lb	DMI	The amount of feed dry matter estimated to be eaten usually estimated from NDF content.	
Ethanol	%		A product of heterofermentation of silage. Generally indicator of poor silage fermentation.	Ethanol has no effect on silage pH, is a poor spoilage inhibitor and only partially digested in the rumen.
Heat Damaged Protein-Estimated			Estimate of protein made unavailable by heating. See Acid detergent fiber crude protein.	Recommend the term ADF-CP, see above.
In Vitro Dry Matter Digestibility	%DM	IVDMD or IVDM	Determined by incubation of ground forage sample with rumen fluid in beaker or test tube for 24 to 48 hours, followed by addition of acid and pepsin. See <i>dry matter digestibility</i> .	Should be listed with grind size and rumen incubation time in commas with the parameter, e.g. IVDMD,24h,1mm.
In Vitro True DM Digestibility,	%DM	IVTDM	For in vitro this is generally defined as 48 hour digestion with rumen fluid and buffers followed by NDF. For in vivo analysis this term is defined as total dry matter intake – (fecal dry matter-microbial content).	Should be listed with grind size and rumen incubation time in commas with the parameter, e.g. IVTDM, 24h, 1mm.
Iron	ppm	Fe	A heavy, malleable, magnetic silver-white element essential to plants and animals.	Concentrations > 500 ppm may indicate soil contamination.

# Recommended Terminology and Units for Parameters Used in Lab Reports



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Iso-Butyric Acid	%DM		A colorless pungent liquid acid (C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> ). Possibly, indicator of poor silage fermentation (as butyric acid).	See Acetic Acid
Lactic Acid	% Total Acids, or % DM		A crystalline acid (C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> ) miscible in water or ethanol and is hygroscopic.	See Acetic Acid Greatest silage preservative effect of acids formed in silage fermentation. Should be 65 to 70 % of total acids in good silage.
Lactic: Acetic Ratio			The ration of lactic acid to acetic acid. An indicator of fermentation efficiency.	A low ratio indicates that lactic-acid-producing bacteria did not dominate the fermentation and that lactic acid production may not have been rapid enough, resulting in poor preservation and increased loss of dry matter during ensiling.
Lignin, Acid Detergent	%DM	ADL	Undigestible plant component, giving the plant cell wall giving its strength and water impermeability. Technically, a chain of phenyl propane units.	There are two methods of measuring lignin in acid detergent fiber: sulfuric acid lignin and Permanganate lignin. High levels of lignin also reduce digestibility within a plant species. Permanganate lignin is a larger value than sulfuric lignin for most feeds.
Lignin, Permanganate	%DM		See Lignin, Acid Detergent above.	See above.
Lignin:NDF Ratio			An estimate of forage quality and digestibility that varies with forage type.	
Magnesium	%DM	Mg	An alkaline earth metal essential to plants and animals.	
Manganese	ppm	Mn	A grayish-white hard and brittle metallic element essential to plants and animals.	
Metabolizable Energy	Mcal/lb	ME	The energy in a forage that is not lost in feces, urine, or rumen gases.	
Milk per Ton, milk 2006	lb		An index for comparing forage quality based on milk produced per ton using National Research Council and UW equations.	Put the method in commas with the parameter. i.e. Milk 2000 or Milk 2006.
Moisture	% as Fed		The percent of the sample that is water.	



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Mold Count	CFU/g		Molds are fungi that grow in the form of multicellular filaments (strands) called hyphae. Contrast to yeasts. Technically, a mold count is a mold spore plate count, which is of questionable value as assay for feedstuffs unless levels exceed 100,000 CFU/g.	The mold count does not indicate which molds are present, some are detrimental and some are not.
NDF Digestibility, 48h, 2mm	%NDF	NDFD	In vitro NDF digestibility of forages are evaluated by incubating forage in buffers and live rumen fluid, at body temperature, under anaerobic (no air) conditions. NDFD = (IVTDM)/NDF*100. See Digestible Neutral Detergent Fiber (above).	Put the hour and grind size in commas with the parameter, i.e. NDFD, 48h, 2mm.
Net Energy, Gain	Mcal/Lb	NE <sub>G</sub>	An estimate of the energy value of a feed used for body weight gain above that required for maintenance.	State method of calculation
Net Energy, Lactation	Mcal/Lb	NE <sub>L</sub>	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.	State method of calculation and maintenance level, i.e. NE <sub>L</sub> , 3x, NRC 2001.
Net Energy, Maintenance,	Mcal/Lb	NE <sub>M</sub>	An estimate of the energy value of a feed used to keep an animal in energy equilibrium, i.e., neither gaining nor losing weight.	State method of calculation.
Neutral Detergent Fiber CP, without Na <sub>2</sub> SO <sub>3</sub> with amylase	%DM	NDF-CP	6.25 times the nitrogen in the NDF Residue. Used in CPM model. It has a larger error than NDFN since not all protein in this fraction is 16% nitrogen. See NDICP below.	Put the method in commas with the parameter.
Neutral Detergent Insoluble Crude Protein, with Na <sub>2</sub> SO <sub>3</sub> with amylase	%DM	NDICP	6.25 times the nitrogen in the NDF Residue. Used in NRC model. It has a larger error than NDFN since not all protein in this fraction is 16% nitrogen. See NDF-CP above.	It has been suggested that the NDICP represents the portion of the undegradable protein that is available to the animal.
Neutral Detergent Fiber, with Na <sub>2</sub> SO <sub>3</sub> + amylase	%DM	aNDF	Residue left after boiling sample in neutral detergent solution. If amylase and sodium sulfite are used during the extraction (this is recommended procedure), the fiber fraction should be called amylase-treated NDF (aNDF) to distinguish from original method.	Put the method in commas with the parameter. The NDF in forages represents the indigestible and slowly digestible components in plant cell walls (cellulose, hemicellulose, lignin, and ash). Contrast with <i>crude fiber</i> and <i>acid detergent fiber</i> .

# Recommended Terminology and Units for Parameters Used in Lab Reports



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Neutral Detergent Fiber Nitrogen	%DM	NDFN	Nitrogen in NDF residue.	
Neutral Detergent Residue,	%DM	NDR	NDF with amylase but without Na <sub>2</sub> SO <sub>3</sub>	
Neutral Detergent fiber, ash free	%DM	NDF <sub>om</sub>	NDF with Na <sub>2</sub> SO <sub>3</sub> + amylase and residue ashed with ash value subtracted.	
Nonfibrous Carbohydrate	%DM	NFC	An estimate of the rapidly available carbohydrates (primarily starch and sugars) in a forage. This value is calculated from one of the following equations: $\text{NFC} = 100\% - (\text{CP}\% + \text{NDF}\% + \text{EE}\% + \text{Ash}\%)$ or, if corrected for NDFCP, $\text{NFC}\% = 100\% - [\text{CP}\% + (\text{NDF}\% - \text{NDFCP}\%) + \text{EE}\% + \text{Ash}\%]$	Define how it was calculated, ie corrected for NDFCP or not; was NDF used in the equation defined as aNDF or NDR? Contrast with total nonstructural carbohydrates. Since NFC is calculated by subtraction, the result includes the additive errors of each component and depends on the NDF procedure, mostly.
Nitrate	%DM or ppm	NO <sub>3</sub>	The most common form of nitrogen taken up from soil by plants (NO <sub>3</sub> <sup>-</sup> ).	Can be toxic to animal if it accumulates in plants (for example from over fertilization, High manure, and/or drought)
Nitrate Nitrogen	%DM or ppm	NO <sub>3</sub> -N	The nitrogen concentration expressed as nitrate.	To convert NO <sub>3</sub> -N to ppm Nitrate, multiply results by 4.4.
Nonstructural Carbohydrates	%DM	NSC	An enzymatic method to estimate the sugars, starch, organic acids, and other reserve carbohydrates such as fructans. It is a lower value than nonfibrous carbohydrates because NFC contains compounds other than starch and sugars.	Similar to total nonstructural carbohydrates, except all constituents for NSC are analyzed.
pH			A measure of the acidity of a feedstuff calculated as the negative logarithm of the H ion concentration. Scale ranges from 0 to 14 with 7 being neutral.	
Phosphorus	%DM	P	A multivalent nonmetal of the nitrogen group, essential to all life.	



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Physically Effective NDF	%DM or % NDF	peNDF	An estimate of the coarse portion of the fiber believed effective in stimulating chewing activity and salivary buffer production resulting in increased rumen pH. It is calculated at the proportion of the dry matter retained sieve of some size (no agreement) times the NDF content.	
Potassium	%DM	K	A silver-white, soft, light, univalent metallic element of the alkali metal group, essential to life.	
Propionic Acid	% DM		A colorless, pungent liquid, naturally occurring as an acid (C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> ).	It is produced in the rumen and absorbed by cattle. It is a fungicide and used has a hay and high moisture grain preservative. It is usually produced in silage fermentation only at low levels unless the silage is very wet. See Acetic Acid.
Relative Feed Value		RFV	An index for ranking cool season grass and legume forages based on intake of digestible energy. RFV is calculated from ADF and NDF as follows: $RFV = [(120/NDF) * (0.889 - (0.779 * ADF))] / 1.29$	The higher the RFV, the better the quality. It is used to compare varieties, match hay/silage inventories to animals, and to market hay.
Relative Forage Quality		RFQ	An index for ranking all forages based on intake of TDN calculated by estimating digestible portions of protein, fatty acids, fiber (NDF), and non fibrous carbohydrate. Formulas: RFQ = dIntake potential*dTDN/1.23 Where: dTDN = TDN (defined below) with NDFD. dIntake potential for legumes $=(120/NDF) + (NDFD-45) * 0.374 * 1350 / 100$ dIntake potential for grasses $= -2.318 + 0.442 * CP - 0.0100 * CP^2 - 0.0638 * TDN + 0.000922 * TDN^2 + 0.180 * ADF - 0.00196 * ADF^2 - 0.00529 * CP * ADF$	Digestible fiber should be based on a 48-hr in vitro estimate. The higher the RFQ, the better the quality. It is used to compare varieties, match hay/silage inventories to animals, and to market hay.



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Ruminal Starch Digestibility, 24h	%Starch or % DM	rSTRD	Starch digested in the Rumen, often estimated by gas production in vitro.	Put the hour and grind size in commas with the parameter.
Rumen-Degraded Protein	%CP	RDP	That portion of total protein which is degraded in the rumen.	Same as <i>degraded intake protein</i> . Rumen degraded protein is preferred term.
Rumen-Undegraded Protein	%CP	RUP	That portion of the protein that is not degraded in the rumen.	While sometimes called <i>bypass protein</i> , <i>escape protein</i> or <i>undegraded intake protein</i> , rumen undegraded protein is preferred term.
Salt, Chloride assay backcalculated to NaCl	% DM	NaCl	A dietary mineral composed primarily of sodium chloride that is essential for animal life.	Put the method in commas with the parameter.
Sodium	%DM	Na	A soft, silvery white, highly reactive element and is a member of the alkali metals, and is essential to animals.	
Soluble Crude Protein	%CP	S-CP	The nitrogen fractions extracted by a phosphate solution.	Generally an indicator of protein rapidly digested in the rumen.
Starch	%DM		A polysaccharide consisting of a long chain of glucose units ((C <sub>6</sub> H <sub>10</sub> O <sub>5</sub> ) <sub>n</sub> ). Most starch in plants is 20 to 25% amylose (linear) and 75 to 80% amylopectin (branched).	Starch is digestible by both ruminants and non ruminants; however, physical characteristics of the feedstuff may restrict the amount and rate of starch availability for digestion.
Sugar	%DM		A class of crystalline substances, mainly sucrose, lactose, and fructose. Produced by all plants when growing. Rapidly digested by all animals.	High sugar in diets has been associated with laminitis, a failure of the attachment of the pedal bone and the inner hoof wall.
Sulfur	%DM	S	An abundant multivalent non-metal. Sulfur, in its native form, is a yellow crystalline solid.	
T-2 Toxin	ppm or ppb		A trichothecene toxin produced by a variety of fusarium species, common in soils.	Effects can include no-specific symptoms like weight loss, feed refusal, and diarrhea.
Total Acids	% DM		Sum of all acids in fermented silage.	Indicate which acids are part of total acids in the parameter column.



Parameter	Units*	Abbrev.	Definition <sup>2</sup>	Notes
Total Digestible Nutrients, 1X, NRC 2001	% DM	TDN	Dairy NRC 2001: The sum of digestible crude protein, fat (multiplied by 2.25), non-fibrous carbohydrates, and digestible NDF.  $TDN = [(NFC \cdot 0.98) + (CP \cdot 0.93) + (FA \cdot 0.97 \cdot 2.25) + (NDF \cdot NDFD)] - 7$	Put the method in commas with the parameter. TDN is often estimated by calculation from ADF, but with much greater error. Many different formulas are used for calculating TDN from ADF.
Total Nonstructural Carbohydrate	% DM	TNC	An enzymatic method to estimate the sugars, starch, organic acids, and other reserve carbohydrates such as fructans. It is a lower value than nonfibrous carbohydrates because NFC contains compounds other than starch and sugars.	Similar to <i>nonstructural carbohydrate</i> except TNC is calculated by difference. Contrast with <i>nonfibrous carbohydrate</i> .
Total Tract Starch Digestibility, predicted, 8h, 6mm	%Starch or % DM	†STRD	Total digestion of starch within all stomachs for stated time period. The procedure used defines the analyte so need to define how lab test was done	Put the hour and grind size in commas with the parameter.
Urea	% DM		A white, odorless solid ((NH <sub>2</sub> ) <sub>2</sub> CO) that is used as a non-protein nitrogen supplement for ruminants.	It has been used as a silage additive and hay preservative and will increase forage protein if used as such.
Vomitoxin	ppm or ppb	DON	Also known as deoxynivalenol (DON). This compound is produced primarily by <i>Fusarium</i> spp.	This is relatively mild mycotoxins largely indicative of stress by the plant during growth or silage fermentation.
Yeast Count	CFU/g		Fungal organisms that grow as single cells (contrast to molds).	May cause heating, palatability and other problems in animals, high levels in silage indicate poor fermentation and anaerobic instability.
Zearalenone	ppm or ppb		A mycotoxin produced by <i>Fusarium graminearum</i> (corn ear rot) that can result in reduced animal reproductive performance.	
Zinc	ppm	Zn	A bluish-white crystalline metallic element of low to medium hardness, and essential to life.	



\* Expressed on DM basis unless specified otherwise

<sup>2</sup>Sources:

Undersander, Dan. 2008. Glossary of Forage Quality Terms. National Forage Testing Association.

Barnes, R.F., C.J. Nelson, K.J. Moore, and M. Collins. 2007. Forages, The Science of Grassland Agriculture, 6th Ed. Blackwell Publishing, Ames, IA.

National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

Notes: The definitions often refer to the chemistry methods of analysis which are used to calibrate NIR equations.