

Haycrop Silage Quality in Vermont, 2005

Sid Bosworth
Extension Forage Agronomist
University of Vermont

The following figures and tables summarize hay crop silage quality data from samples tested at the University of Vermont Agricultural Testing Lab. The data has been broken down by forage type (legume, legume/grass mix, and grass) and by cutting.

Figure 1 shows the relationship of crude protein to NDF levels. NDF, which is a measure of the total cell wall content of the forage, is a good indicator of the maturity of the crop at time of cutting. Generally, as NDF increases, CP decreases. Legumes and legume/grass mixtures had slightly higher crude protein as compared to grass haylage, but time of cut (as assessed by NDF levels) had a greater impact on CP than forage type.

Generally, the best forage quality in terms of high crude protein and energy (NE_L) and low fiber (ADF and NDF) was made in the 3rd and 4th harvests in 2005 (Tables 1, 2, and 3). A large majority of the forage samples representing the first and even second harvest were way beyond what would be considered “ideal” for lactating milk cows. For example the average NDF levels for the first harvest of legume silage was 50%, which is about 10 units greater than the 40% recommended for alfalfa. Grasses should be harvested when NDF reaches 50 to 55% NDF and the average NDF for first cut in 2005 (Table 3) was 62%.

Figure 1. The relationship of crude protein (CP) and neutral detergent fiber (NDF) for legume, legume/grass mixtures, and grass haylage samples (analyzed at the UVM Forage Testing Lab). The vertical dashed lines represent the “target” NDF levels for each respective forage type. Levels at or below the dashed lines would be considered best for a lactating cow diet (if fed as 50% of a TMR).

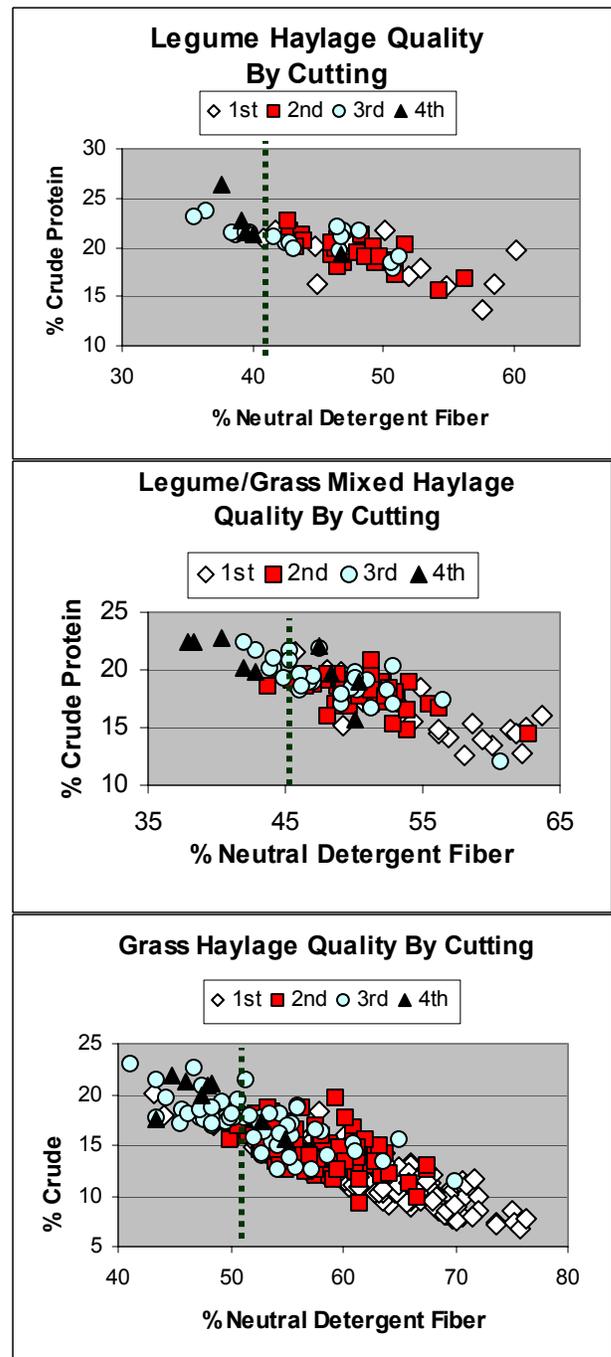


Table 1. Summary of forage quality values of legume haylage samples tested in October and November of 2005 grouped by harvest (The University of Vermont Agricultural Testing Lab).

		Legume Haylage					
Measurement**	unit	1st Harvest Samples		2nd Harvest Samples		3rd and 4th Harvest Samples	
		Mean	Range of Values*	Mean	Range of Values	Mean	Range of Values
Dry Matter	% of total	35.3	30.3 - 40.3	36.7	28.8 - 44.6	40.1	31.7 - 48.5
Crude Protein	% of dm	18.8	16.3 - 21.2	19.5	17.9 - 21.2	21.2	19.4 - 23.0
ADICP	% of dm	1.71	1.10 - 2.31	1.40	1.13 - 1.67	1.29	0.96 - 1.61
Available CP	% of dm	18.1	15.5 - 20.6	19.1	17.3 - 21.0	20.9	19.1 - 22.7
Soluble CP	% of dm	51.5	44.0 - 59.0	46.0	35.2 - 56.7	49.6	41.7 - 57.5
ADF	% of dm	40.2	35.1 - 45.2	36.9	33.7 - 40.1	33.7	29.9 - 37.4
NDF	% of dm	50.0	44.1 - 56.0	47.8	44.3 - 51.2	43.0	38.2 - 47.8
Fat	% of dm	3.1	2.6 - 3.6	3.7	3.2 - 4.1	3.5	3.0 - 4.0
Ash	% of dm	10.0	9.3 - 10.7	10.1	9.5 - 10.7	10.4	9.8 - 11.1
Lignin	% of dm	8.6	7.3 - 10.0	8.0	6.4 - 9.6	7.8	6.4 - 9.3
NEL	% of dm	0.55	0.49 - 0.61	0.59	0.55 - 0.63	0.63	0.58 - 0.68
TDN	% of dm	59.0	55.7 - 62.3	61.1	59.0 - 63.2	63.2	60.8 - 65.7
NFC	% of dm	22.7	18.1 - 27.3	24.2	21.8 - 26.5	27.2	23.6 - 30.8
RFV	none	109	89 - 129	118	105 - 131	138	117 - 159
Calcium	% of dm	1.31	1.18 - 1.43	1.29	1.22 - 1.36	1.38	1.29 - 1.47
Phosphorus	% of dm	0.30	0.26 - 0.34	0.32	0.29 - 0.34	0.33	0.29 - 0.36
Potassium	% of dm	2.6	2.2 - 2.9	2.6	2.4 - 2.9	2.7	2.4 - 3.0
Magnesium	% of dm	0.31	0.29 - 0.32	0.32	0.29 - 0.34	0.33	0.30 - 0.36
Sulfur	% of dm	0.33	0.30 - 0.36	0.34	0.32 - 0.37	0.36	0.33 - 0.38
NDICP	% of dm	4.6	3.8 - 5.5	5.3	4.1 - 6.4	5.3	4.2 - 6.4
Lignin	% of NDF	17.4	14.8 - 20.0	16.7	13.8 - 19.7	18.5	14.6 - 22.3
ADICP	% of CP	9.3	5.8 - 12.7	7.3	5.3 - 9.2	6.3	4.6 - 8.1
NDICP	% of CP	25.0	19.7 - 30.3	27.3	20.2 - 34.4	25.1	19.6 - 30.6
Sugar	% of dm	4.4	3.6 - 5.1	4.7	3.9 - 5.6	5.2	4.3 - 6.2
Starch	% of dm	3.5	2.0 - 5.0	3.2	2.0 - 4.3	2.9	1.4 - 4.3
NSC	% of dm	7.9	6.0 - 9.7	7.6	5.4 - 9.7	7.6	5.2 - 10.0
No. of Samples			15		24		23

* Measurements are in the order as presented on the UVM Forage Lab Results (for a definition, go to the Appendix)

** The range of 1.0 standard deviation that is distributed around the mean, which represents about 2/3's of the total samples

Table 2. Summary of forage quality values of legume/grass haylage samples tested in October and November of 2005 grouped by harvest (The University of Vermont Agricultural Testing Lab).

Measurement**	unit	Legume/Grass Haylage								
		1st Harvest Samples			2nd Harvest Samples			3rd and 4th Harvest Samples		
		Mean	Range of Values*		Mean	Range of Values		Mean	Range of Values	
Dry Matter	% of total	35.5	26.8	- 44.1	36.2	28.1	- 44.4	38.0	28.8	- 47.3
Crude Protein	% of dm	16.5	14.1	- 18.9	18.0	16.6	- 19.4	19.4	17.3	- 21.6
ADICP	% of dm	1.40	0.99	- 1.81	1.30	0.88	- 1.72	1.22	0.84	- 1.61
Available CP	% of dm	16.1	13.5	- 18.7	17.7	16.2	- 19.1	19.2	16.9	- 21.4
Soluble CP	% of dm	48.5	39.7	- 57.3	46.4	39.5	- 53.3	45.5	36.5	- 54.5
ADF	% of dm	39.7	34.9	- 44.5	36.7	33.3	- 40.0	33.7	29.7	- 37.8
NDF	% of dm	54.5	49.2	- 59.7	50.8	47.4	- 54.2	47.3	42.6	- 52.0
Fat	% of dm	3.5	2.8	- 4.1	3.9	3.4	- 4.4	3.9	3.4	- 4.4
Ash	% of dm	9.8	9.1	- 10.6	10.2	9.6	- 10.7	10.3	9.5	- 11.1
Lignin	% of dm	7.8	5.5	- 10.1	7.3	5.8	- 8.8	7.5	5.7	- 9.3
NEL	% of dm	0.52	0.46	- 0.59	0.56	0.52	- 0.61	0.60	0.55	- 0.66
TDN	% of dm	60.2	56.9	- 63.6	62.3	60.0	- 64.6	64.4	61.5	- 67.2
NFC	% of dm	20.2	16.6	- 23.9	22.3	19.4	- 25.1	24.6	21.1	- 28.1
RFV	none	100	85	- 116	111	100	- 123	125	107	- 143
Calcium	% of dm	1.08	0.94	- 1.21	1.12	1.00	- 1.23	1.16	1.04	- 1.29
Phosphorus	% of dm	0.30	0.26	- 0.35	0.33	0.30	- 0.36	0.34	0.31	- 0.37
Potassium	% of dm	2.5	2.1	- 2.8	2.6	2.3	- 2.9	2.7	2.3	- 3.1
Magnesium	% of dm	0.29	0.26	- 0.32	0.31	0.29	- 0.33	0.32	0.30	- 0.35
Sulfur	% of dm	0.25	0.22	- 0.29	0.28	0.25	- 0.30	0.28	0.25	- 0.31
NDICP	% of dm	4.5	3.7	- 5.3	5.2	4.3	- 6.1	5.7	4.6	- 6.7
Lignin	% of NDF	14.2	10.9	- 17.5	14.4	11.7	- 17.0	15.9	12.4	- 19.4
ADICP	% of CP	8.8	5.4	- 12.1	7.3	4.7	- 9.8	6.4	3.9	- 9.0
NDICP	% of CP	27.9	21.2	- 34.6	28.9	23.2	- 34.5	29.6	22.3	- 36.9
Sugar	% of dm	4.5	3.6	- 5.5	4.9	4.0	- 5.8	5.2	4.1	- 6.2
Starch	% of dm	5.0	3.5	- 6.5	4.3	2.8	- 5.8	3.6	1.9	- 5.3
NSC	% of dm	9.5	7.5	- 11.6	9.2	7.1	- 11.3	8.5	5.9	- 11.1
No. of Samples		29			39			37		

* Measurements are in the order as presented on the UVM Forage Lab Results (for a definition, go to the Appendix)

** The range of 1.0 standard deviation that is distributed around the mean, which represents about 2/3's of the total samples

Table 3. Summary of forage quality values grass haylage samples tested in October and November of 2005 grouped by harvest (The University of Vermont Agricultural Testing Lab).

		Grass Haylage								
Measurement**	unit	1st Harvest Samples			2nd Harvest Samples			3rd and 4th Harvest Samples		
		Mean	Range of Values*		Mean	Range of Values		Mean	Range of Values	
Dry Matter	% of total	41.8	28.8	- 54.8	45.9	32.5	- 59.4	42.6	28.4	- 56.8
Crude Protein	% of dm	12.2	9.5	- 15.0	15.1	13.1	- 17.1	17.3	14.8	- 19.8
ADICP	% of dm	1.03	0.67	- 1.39	0.90	0.56	- 1.25	0.77	0.44	- 1.11
Available CP	% of dm	12.1	9.3	- 14.9	15.0	13.0	- 17.0	17.3	14.7	- 19.8
Soluble CP	% of dm	42.9	30.2	- 55.5	39.3	29.2	- 49.4	41.3	32.2	- 50.3
ADF	% of dm	39.8	35.8	- 43.7	35.2	32.1	- 38.2	32.5	28.0	- 37.0
NDF	% of dm	62.6	56.4	- 68.8	56.6	52.4	- 60.8	51.8	46.4	- 57.3
Fat	% of dm	3.5	2.9	- 4.0	4.1	3.7	- 4.5	4.3	3.9	- 4.8
Ash	% of dm	8.5	7.5	- 9.6	9.4	8.6	- 10.2	10.1	9.2	- 11.0
Lignin	% of dm	6.4	4.6	- 8.3	6.3	4.8	- 7.9	5.9	4.1	- 7.7
NEL	% of dm	0.49	0.43	- 0.55	0.56	0.51	- 0.60	0.60	0.53	- 0.66
TDN	% of dm	60.8	57.7	- 64.0	64.5	62.1	- 66.9	66.6	63.0	- 70.2
NFC	% of dm	17.2	13.3	- 21.1	20.3	16.2	- 24.3	22.1	17.6	- 26.5
RFV	none	87	73	- 101	102	91	- 112	116	99	- 133
Calcium	% of dm	0.63	0.48	- 0.79	0.79	0.67	- 0.91	0.89	0.75	- 1.02
Phosphorus	% of dm	0.30	0.25	- 0.34	0.33	0.29	- 0.37	0.35	0.32	- 0.39
Potassium	% of dm	2.2	1.7	- 2.7	2.3	1.9	- 2.8	2.7	2.3	- 3.1
Magnesium	% of dm	0.26	0.23	- 0.30	0.30	0.27	- 0.33	0.32	0.29	- 0.34
Sulfur	% of dm	0.28	0.24	- 0.31	0.32	0.29	- 0.34	0.35	0.32	- 0.38
NDICP	% of dm	4.0	3.1	- 4.9	5.4	4.2	- 6.7	5.6	4.5	- 6.8
Lignin	% of NDF	10.3	7.5	- 13.0	11.2	8.3	- 14.1	11.4	8.3	- 14.5
ADICP	% of CP	9.0	4.8	- 13.2	6.1	3.5	- 8.6	4.7	2.4	- 6.9
NDICP	% of CP	34.3	23.9	- 44.7	36.4	27.5	- 45.3	33.2	24.8	- 41.6
Sugar	% of dm	5.4	4.4	- 6.4	5.7	4.5	- 6.8	5.7	4.4	- 7.0
Starch	% of dm	7.8	5.6	- 10.1	6.4	4.6	- 8.2	5.6	3.8	- 7.4
NSC	% of dm	13.2	10.3	- 16.2	12.0	9.3	- 14.6	11.3	8.6	- 14.0
No. of Samples		173			112			66		

* Measurements are in the order as presented on the UVM Forage Lab Results (for a definition, go to the Appendix)

** The range of 1.0 standard deviation that is distributed around the mean, which represents about 2/3's of the total samples

References

Bosworth, Sid, Felix Jimenez and John Aleong. 2004. Predicting Quality of the First Harvest of Cool Season Grasses and Grass/Alfalfa Mixtures Grown for Hay and Silage. In The Vermont Crops and Soils Home Page, Plant and Soil Sci. Dept., Un. of Vermont
(<http://pss.uvm.edu/vtcrops/?Page=research/PredictingQualityFirstHarvest.html>).

Appendix: Forage Terms and Explanations From the UVM Forage Testing Lab

Dry Matter (DM): 100% minus the moisture in the feed (reported at % of DM)

Crude Protein (CP): Total nitrogen content times 6.25 (reported at % of DM)

Acid Detergent Insoluble Crude Protein (ADICP): Also called Bound Protein. The protein bound to the acid detergent fiber fraction of the feed. Protein that has been heat damaged and is unavailable to the animal. About 1% is naturally occurring in forages. (reported as both % of DM and % of CP)

Available Protein (AV CP): CP minus ADICP (when above 1.0%). (reported as % of DM)

Soluble Protein (SOL PRO): The protein fraction that is rapidly broken down in the rumen. (reported as a % of the CP).

Acid Detergent Fiber (ADF): This value refers to the cell wall portions of the forage that are made up of cellulose & lignin. These values are important because they reflect the ability of an animal to digest the forage. As the ADF increases, digestibility of the forage decreases along with the energy.

Neutral Detergent Fiber (NDF): This value is the total cell wall, which is comprised of the ADF portion plus hemicellulose. These values are important in ration formulation because they reflect the amount of forage the animal can consume.

Ash: Represents the mineral content of the feed on a % of total DM

Lignin: a complex compound that acts as a strengthening material in the cell walls of plants. Lignin reduces the digestibility of plant tissues; as lignin increases, the digestibility of the forage decreases.

Net Energy Lactation (NE_L): The energy value of the feed for milk production, expressed as megacalories (Mcal) per pound of feed. It is calculated from the ADF of the feed. Different forages use different equations to determine NE_L, therefore correctly identifying forages is important (i.e. grass, mixed grass/legume, or legume haylages).

Total Digestible Nutrients (TDN): An older system of estimating the energy value of a feed. Equations also differ depending on type of forage.

Non-Fiber Carbohydrates (NFC): $NFC = 100 - ((CP + (NDF - NDICP) + Fat + Ash))$.

Relative Feed Value (RFV): An index of feed quality relative to feed with an ADF of 41% and NDF of 53% having an RFV of 100%. This term is not used in ration balancing but serves as a simple, yet crude means of forage comparison.

Digestible Energy (DE): The energy value of hay for non-ruminants, expressed as Mcal (megacalories) per pound of feed. The equation determining DE involves CP, NFC, NDF and Fat.

Neutral Detergent Insoluble Crude Protein (NDICP): Nitrogen expressed as protein in the neutral detergent fiber residue. An estimate of the portion of the rumen undegradable protein that is potentially available to the animal.

Non-Structural Carbohydrates (NSC): $NSC = Sugar + Starch$

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. University of Vermont Extension, Burlington, Vermont. University of Vermont Extension and U.S. Department of Agriculture, cooperating, offer education and employment to everyone without regard to race, color, national origin, sex, religion, age, disability, political beliefs, or marital or familial status.

12/05