

# A Crash-Course in Forage Nutritive Value

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# Quality or Nutritive Value?

## Forage Nutritive Value

- ❖ NUTRITIVE VALUE relates to the chemical contents of a forage and measure of digestibility. (i.e., a quantitative measure)
  - Crude protein
  - *In vitro*, *in vivo*, or *in situ* estimates of digestibility
  - Minerals, etc.
- ❖ In other words, what can be measured in the lab...

## Forage Quality

- ❖ Forage quality combines forage nutritive value with animal intake, preference, etc. to express animal performance.
- ❖ Indirect measure of the effect of forage nutritive value and other variables such as palatability, physical processing, etc.

## Why worry about forage nutritive value?

- ❖ Forages are ultimately consumed by livestock.
- ❖ Forage nutritive value affects livestock performance.
  - ADG, weaning weight
  - Milk production
  - Reproduction
- ❖ Forage nutritive value can affect the value of forage sold.

Table 1. Crude protein (CP) and total digestible nutrients (TDN) percentage and mCal of digestible energy per pound of forage dry matter (DM) required in diets of different kinds and classes of grazing livestock.<sup>1</sup>

Animal kind/class	CP	TDN	mCal/lb DM <sup>2</sup>
Growing beef steer			
450 lbs (1.5 lb/day gain)	11-13	65	1.3
650 lbs (1.7 lb/day gain)	10-11	68	1.4
Beef cow			
Lactating	10-12	60	1.2
Dry, pregnant	8-10	50	1.0
Sheep			
Lamb (finishing)	12	70	1.4
Ewe (lactating)	13	65	1.3
Ewe (maintenance)	9	55	1.1
Fallow deer			
Doe (lactating)	14-6	66	1.3
Growing buck	12-14	60-64	1.2-1.3
Meat-type goat			
Doe (lactating)	12	62	1.2
Growing buck	12-13	62-66	1.2-1.3
Horse (maintenance)	10-11	70	1.4

<sup>1</sup> Adapted from *Southern Forages*, 2nd ed., 1998.

<sup>2</sup> mCal of digestible energy per pound of forage dry matter estimated by multiplying TDN x 0.02.

## Fact:

The manager has greater control over forage nutritive value than over forage quality.

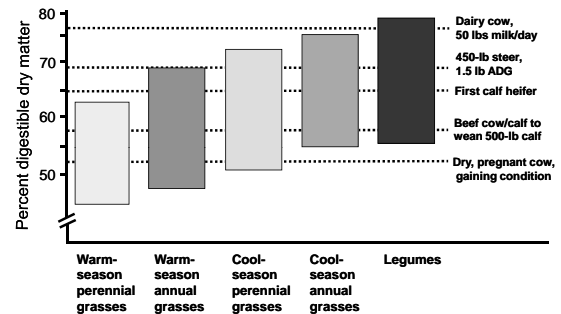
## How do we affect forage nutritive value?

- ❖ Choice of species
- ❖ Soil nutrient status
- ❖ Stage of maturity at harvest

## Species

- ❖ Annual vs. perennial
- ❖ Cool-season vs. warm-season
- ❖ Legume vs. grass

Forage digestibility ranges and their suitability for different classes of livestock.



Adapted from: H. Lippke and M.E. Riewe. 1976. Texas Agric. Exp. Stn. Res. Monograph RMGC:169-206.

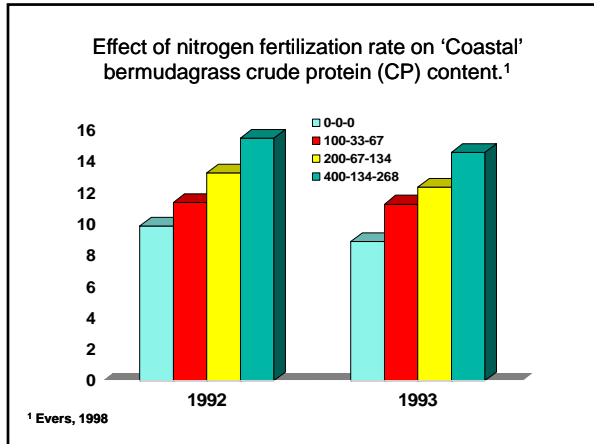
## Forage Nutritive Value Hierarchy



## Soil Nutrient Status

### Nitrogen is important for:

- Growth
  - ✓ N is part of the chlorophyll molecule
  - ✓ N is part of essential amino acids
- Increases crude protein significantly in W-S grasses.

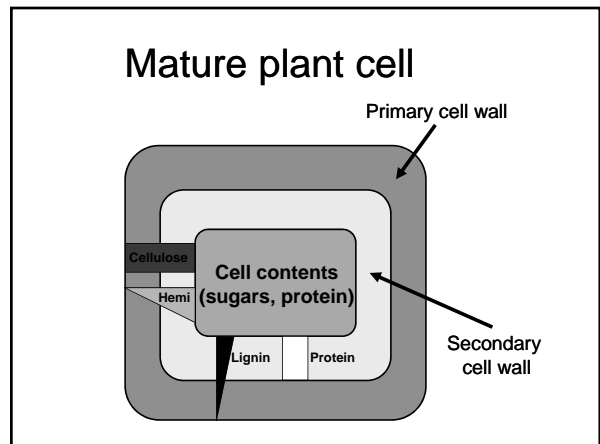
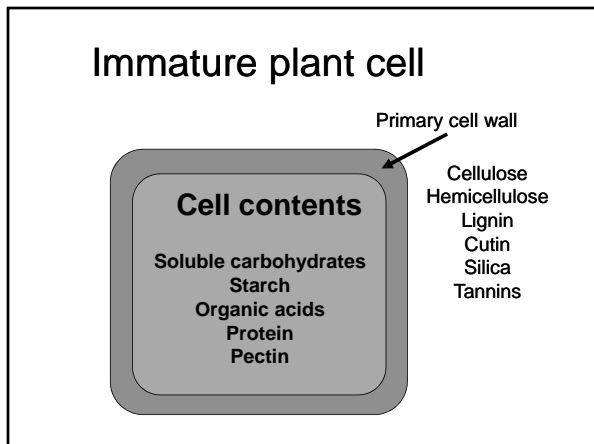
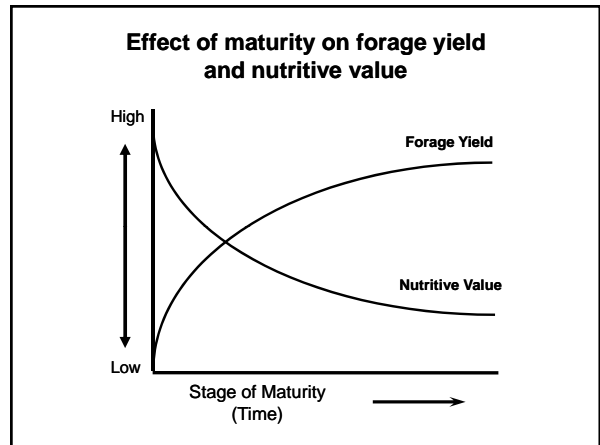


### Nutrient Uptake by Coastal Bermudagrass (2 tons/acre)

	Nutrient	Pounds/Acre
Primary	Nitrogen	100
	Phosphorus	28
	Potassium	96
Secondary	Calcium	15
	Magnesium	6
	Sulfur	8
Micro's	Copper	0.05
	Manganese	0.05
	Zinc	0.10

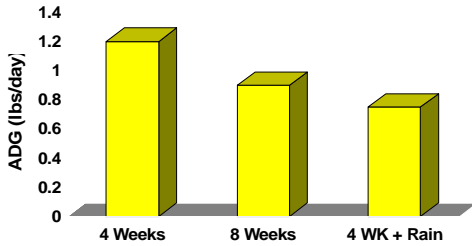
### Stage of Maturity at Harvest

**MATURITY is the eternal enemy of forage nutritive value!!**



### Effect of rain and maturity of hay on animal performance.

McCullough & Burton, 1962



Recommendation is to **WAIT** for better curing weather prior to harvesting hay.

## Hay Storage

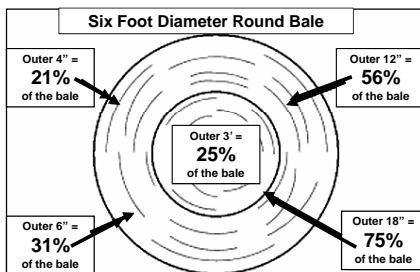


### Effect of storage system on dry matter loss of ryegrass hay stored for 7 months<sup>1</sup>

Storage System	Dry Matter (%)	Animal Refusal (%)	TOTAL (%)
Ground	28	22	50
Gravel	31	17	48
Tires	35	6	41
Rack	26	6	32
Rack with cover	12	2	14
Barn	2	1	3

<sup>1</sup> Nelson et al., 1983

### Hay Losses During Storage



## Hay tarps also work well...

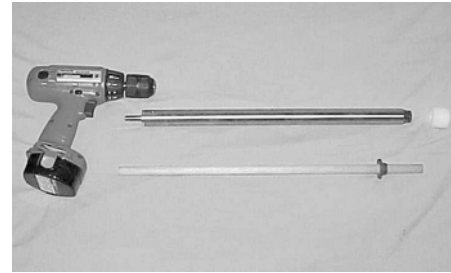


### OUTSIDE HAY STORAGE RECOMMENDATIONS

No objects near hay which are likely to attract lightning  
 Flat ends of bales butted tightly together  
 Bales over run up and down slope with north/south orientation, a southern exposure is best  
 High bales density resists water penetration  
 Tops and sides of bales can be protected from rain with any of a number of different types of covers  
 Bright sunny locations, no trees or other objects near hay to slow drying after rains  
 Storage area located on a gently sloping, well-drained site  
 Hay/soil contact avoided by placing bales on rock, wooden pallets, etc.  
 Rounded sides of bales not touching at least 3 feet of space between rows  
 Fire risk can be reduced by storing hay in more than one location and by maintaining a no-vegetation zone of at least 3 feet in width around the storage area



## Laboratory Analyses



## Forage Report

AgCenter EXTENSION  
 Forage Analysis Report  
 For more information, visit us online at [www.extension.org](http://www.extension.org) or call 1-800-451-5231.

Component	Unit	Value	Range
Crude Protein	%	15.5	7.8 - 21.5
Acid Detergent Fiber	%	32.1	26.7 - 37.5
TDN (Total Digestible Nutrient)	%	66.1	55.0 - 77.0
Net Energy Lactation	Mcal/lb	0.62	0.57 - 0.67
<b>Mineral Analysis</b>			
Phosphorus	%	0.25	0.20 - 0.30
Potassium	%	1.22	1.07 - 1.37
Sulfur	%	0.28	0.20 - 0.36
Magnesium	%	0.20	0.15 - 0.25
Sodium	ppm	414	166.7 - 661.3
Zinc	ppm	85	35 - 135
Copper	ppm	150	70 - 230
Calcium	ppm	8	11 - 15
Manganese	ppm	154	61 - 249

## Forage Nutritive Value

- ❖ Crude Protein (CP)
- ❖ Net Energy (NE)
  - TDN (Total Digestible Nutrient)
  - IVTD (% *in vitro* true digestibility)
- ❖ Minerals, vitamins, etc.

## Nutritive Value – Crude Protein

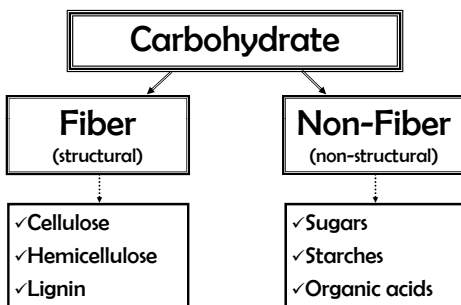
### ❖ Crude Protein (CP)

- An estimate of protein in forage based on the total N in the sample.
- $CP = \%N \times 6.25$  (assumes that forage protein contains 16% N)
  - ◆ Generally, forages harvested at early vegetative stages will have a higher crude protein content.
  - ◆ Warm-season grass CP is greatly influenced by N fertilizer.

## Lab Analysis for Crude Protein

- ❖ Oldest and still the reference value for other techniques is the Kjeldahl method.
- ❖ Newer combustion method
- ❖ Near Infrared Reflectance Spectroscopy (NIRS).
- ❖  $Total\ N \times 6.25 = \text{“crude” protein.}$

## Nutritive Value - Energy



## Nutritive Value - Energy

- ❖ TDN (Total Digestible Nutrient)
  - Traditional measure of energy content.
  - In forages ADF is the primary factor affecting the TDN value.
  - Somewhat vague term in that it is a percentage number based on a calculated value. (No longer based on feeding trials)
  - The higher the number the better (Corn 90% TDN).

## Nutritive Value - Energy

The digestibility of the fiber greatly affects total digestibility and value of the forage as an energy source.

## Lab Analysis for Energy:

***The Detergent System***

Developed by Van Soest @  
Cornell University

- ❖ Designed to replace the old “proximate analysis” method.
- ❖ Based on digestibility or availability to the animal, forage constituents can be broadly divided into 3 classes:
  - > Total availability
  - > Incomplete availability
  - > Total unavailability

Class 1 components  
(Cell Contents)

- ❖ Soluble carbohydrates
- ❖ Starch
- ❖ Organic acids
- ❖ Protein
- ❖ Pectin

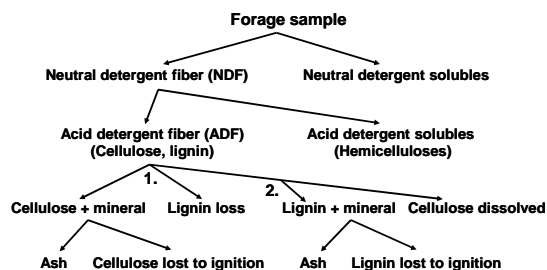
Class 2 components  
(Fiber)

- ❖ Cellulose + Hemicelluloses + Lignin, etc. =  
Neutral Detergent Fiber (NDF)
- ❖ NDF – hemicelluloses =  
Acid Detergent Fiber (ADF)

Class 3 components  
(Lignin + Indigestibles)

- ❖ Lignin (generally indigestible or very slowly digestible in the rumen)
- ❖ Cutin (associated with lignin)
- ❖ Silica (associated with lignin)
- ❖ Tannins, essential oils, and polyphenols
- ❖ NOTE: These compounds are mostly indigestible in the rumen.

Forage analysis for nutritive value  
(Van Soest Detergent System)



Importance of Fiber Analysis

- ❖ **NDF** is associated with dry matter (DM) intake.
  - > Inverse relationship, e.g., the higher the NDF number, the lower the intake.
- ❖ **ADF** is associated with dry matter digestibility.
  - > Inverse relationship, e.g., the higher the ADF number, the lower the digestibility.

