



# UNDERSTANDING FORAGE QUALITY

Jennifer J. Tucker, Ph.D  
Assistant Professor  
Department of Animal and Dairy Sciences  
University of Georgia – Tifton



- **Overview of forage quality**
- **Taking a Forage Sample**
- **Reading a forage quality analysis**

# Forage Quality has High Value Now

## Supplementing a Lactating Beef Cow

Crop	Maturity
Bermudagrass	4 weeks
	6 weeks
	8 weeks
Tall Fescue	Late boot
	Early head
	Dough

Assuming 50:50 corn gluten:soy hulls supplementation for forage quality on low end of the range.

Approximate prices for Oct. 2013 (\$230/ton).

# Maturity Matters

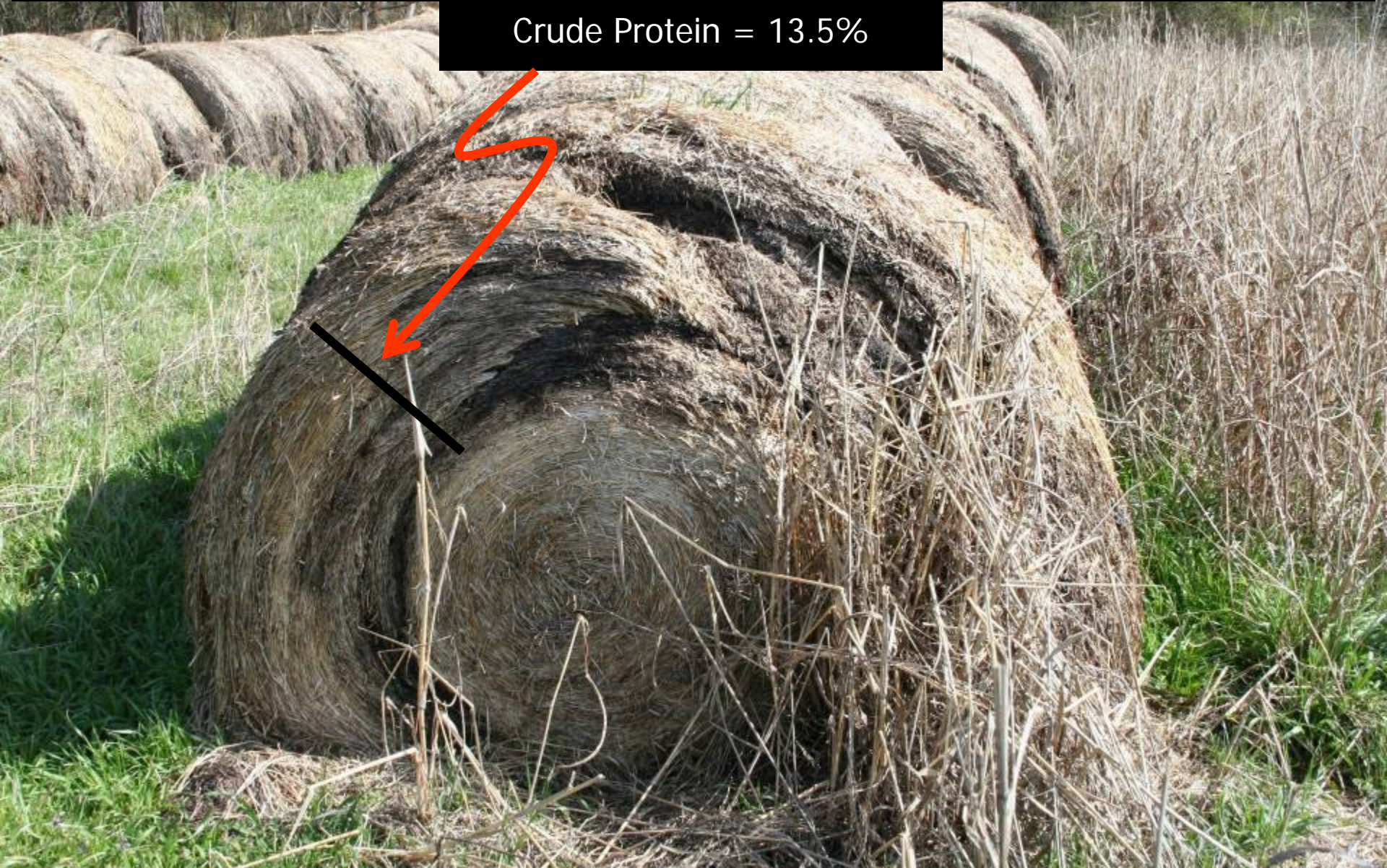
Forage Quality Parameters for Selected Forage Crops

Crop	Maturity	CP	TDN	NDF	ADF
Bermudagrass	4 weeks old	10-12	52-58	33-38	63-68
	8 weeks old	6-8	45-50	40-45	70-75
Alfalfa	Bud	22-26	64-67	28-32	38-47
	Early Flower	18-22	64-64	32-36	42-50
	Mid Bloom	14-18	58-61	36-40	46-55
	Full Bloom	9-13	50-57	41-43	56-60
Ryegrass	Vegetative – Boot	12-16	63-68	27-33	47-53
	Boot – Head	8-12	59-63	33-39	53-59
Red Clover	Early-Flower	14-16	64-67	28-32	38-42
	Late Flower	12-14	59-64	32-38	42-50

Source: Adapted from J.C. Henning and G.D. Lacefield, University of Kentucky

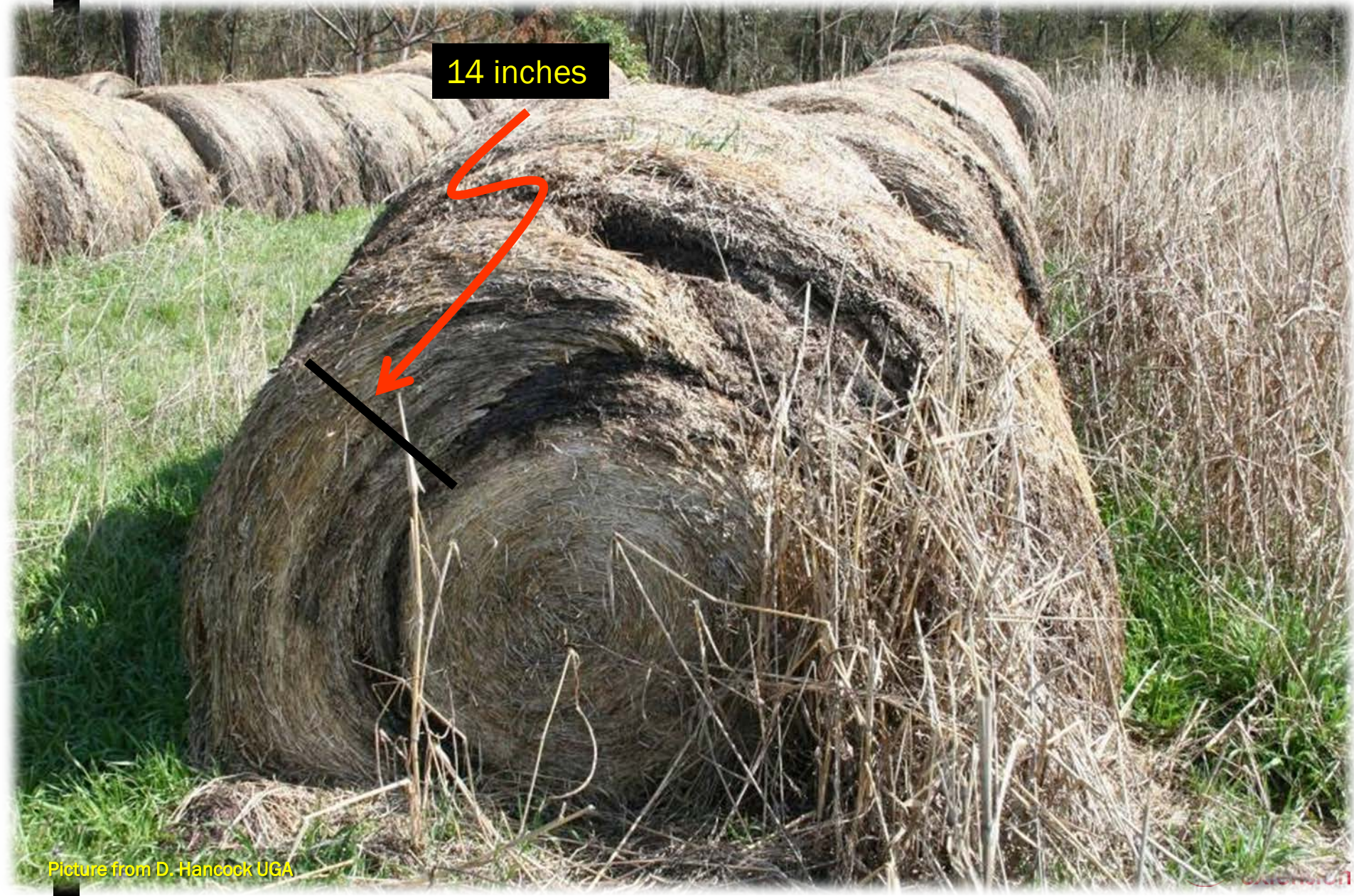
# How good is this hay?

Crude Protein = 13.5%



# 74% of the bale LOST!

14 inches





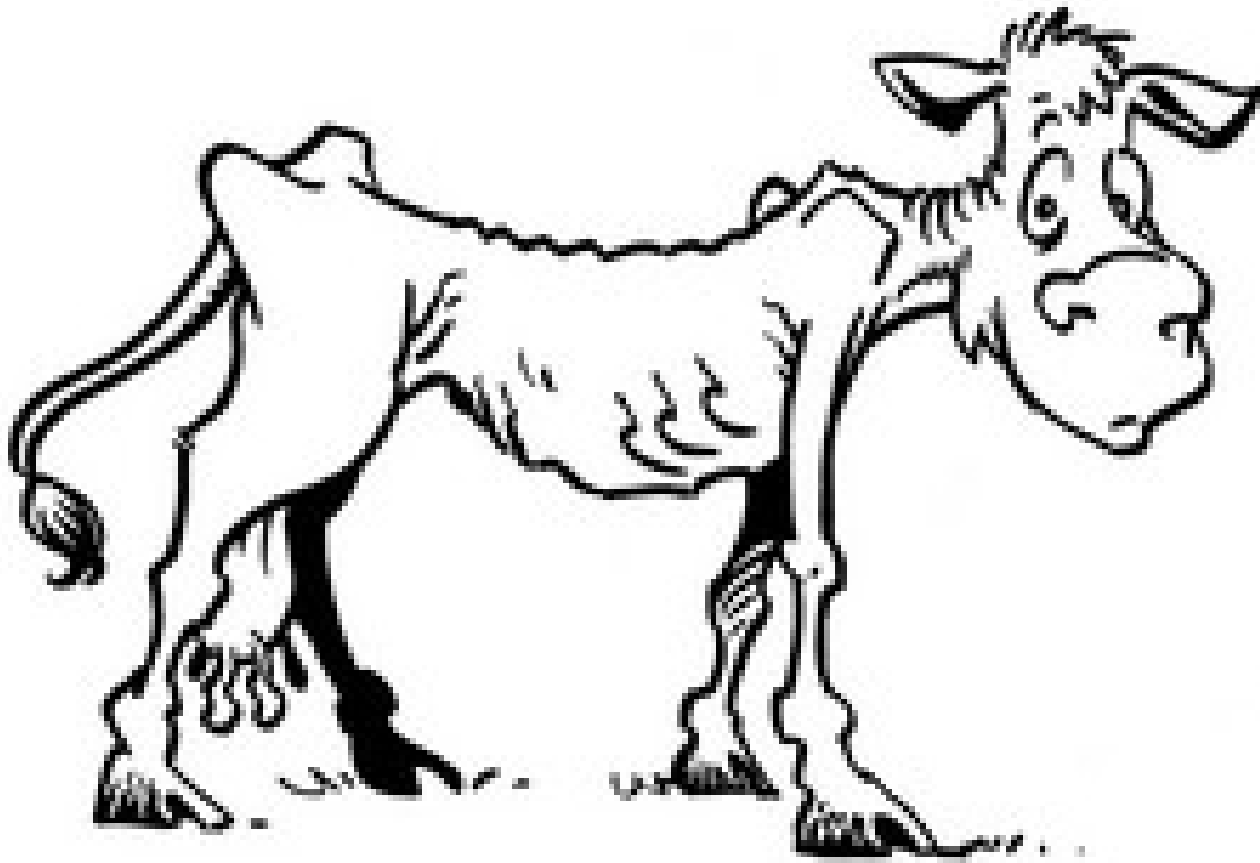
# Crude Protein and Hay Quality

- CP is the most overrated measure of quality!
  - $Total\ N \times 6.25 = CP, \%$
- Tells you nothing about the form nitrogen is in
  - *Protein (AA), Bound Protein, Nitrates etc.*
- Protein requirements are (typically) easily met
- Somewhat related to maturity

Tells you very little about energy content

- Important- just overemphasized

**“Low Carb, High Fat” –**



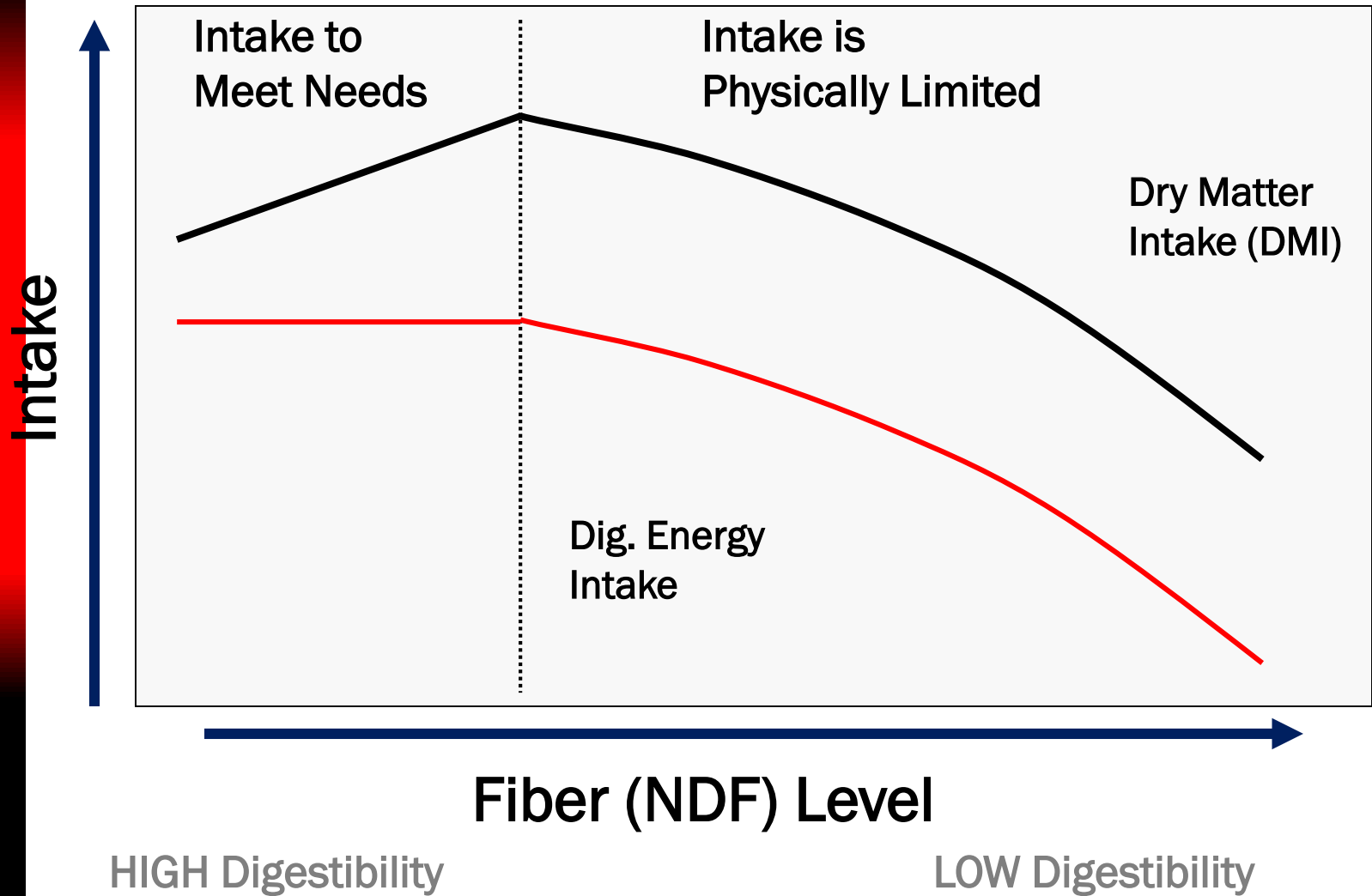
**do our cattle want that?**



# How do we get enough energy in the animal?

- The animal eats more forage.
  - *What is the physical limit?*
  - *Can a cow eat enough straw to meet her energy needs?*
- What forage the animal eats must be high in energy.
  - *High digestibility -> High energy*
- Bottomline: Every bite has to count!

# The Relationship between Fiber (NDF) and Dry Matter Intake (DMI)



Source: D Hancock, UGA

# What is “High Quality Forage”?

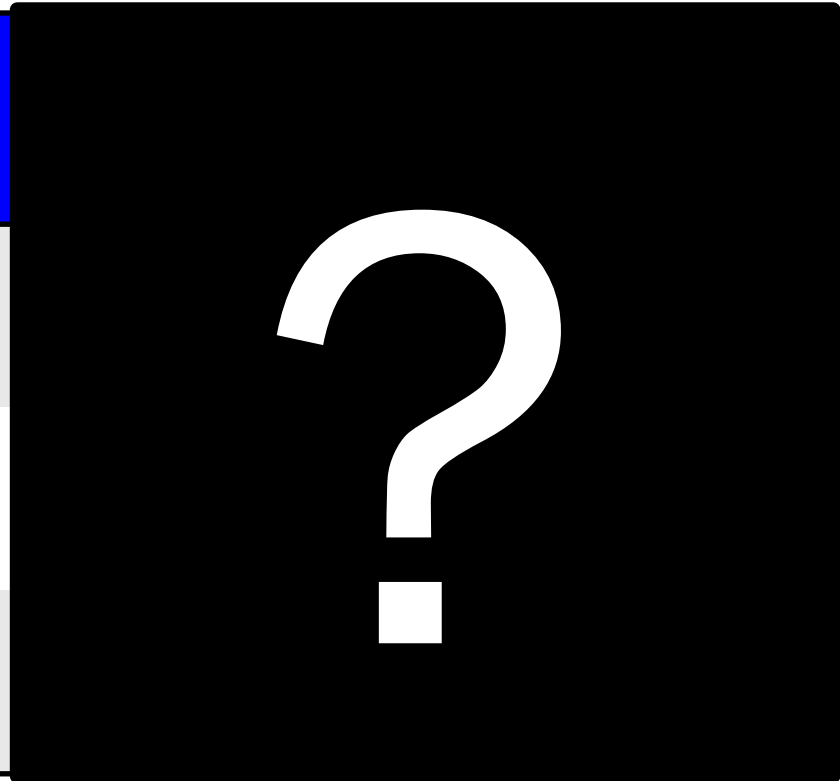
- Results in high intake
  - *Consumed in large amounts*
  - *High DMI*
- Is digestible
  - *Large amounts of nutrients*
  - *High TDN*
- Contains proper balance of needed nutrients

$$\text{Relative Forage Quality (RFQ)} = \text{TDN} * \text{DMI} / 1.23$$



# Matching Animal Requirements and Forage Quality

Stage of Production	TDN % Required	CP % Required
Dry Pregnant	48	7
Peak Lactation	60	12
Late Lactation	55	9



# Unless you Test...



# It's Just a Guess!



Photo credit: Bobby Smith, Morgan CEC

**The least used and least understood element of a good forage management plan.**



# FORAGE SAMPLING DO'S AND DON'T'S

Obtaining a Representative Sample

# Grab sampling





# Grab Sampling



# Tools For Taking a Forage Sample

Use the proper tools!



# Hay Probes

Push in

Drill Style

Pre-Made

Custom  
Built

Single  
Core

Multi  
Core

Canister

In Bag

# Push in



Penn State Probe- Single



Colorado Hay Probe -Multi

# Push in



Star Quality Samplers

Photo credit: [starqualitysamplers.com](http://starqualitysamplers.com)

# Drill Type



Penn State Probe



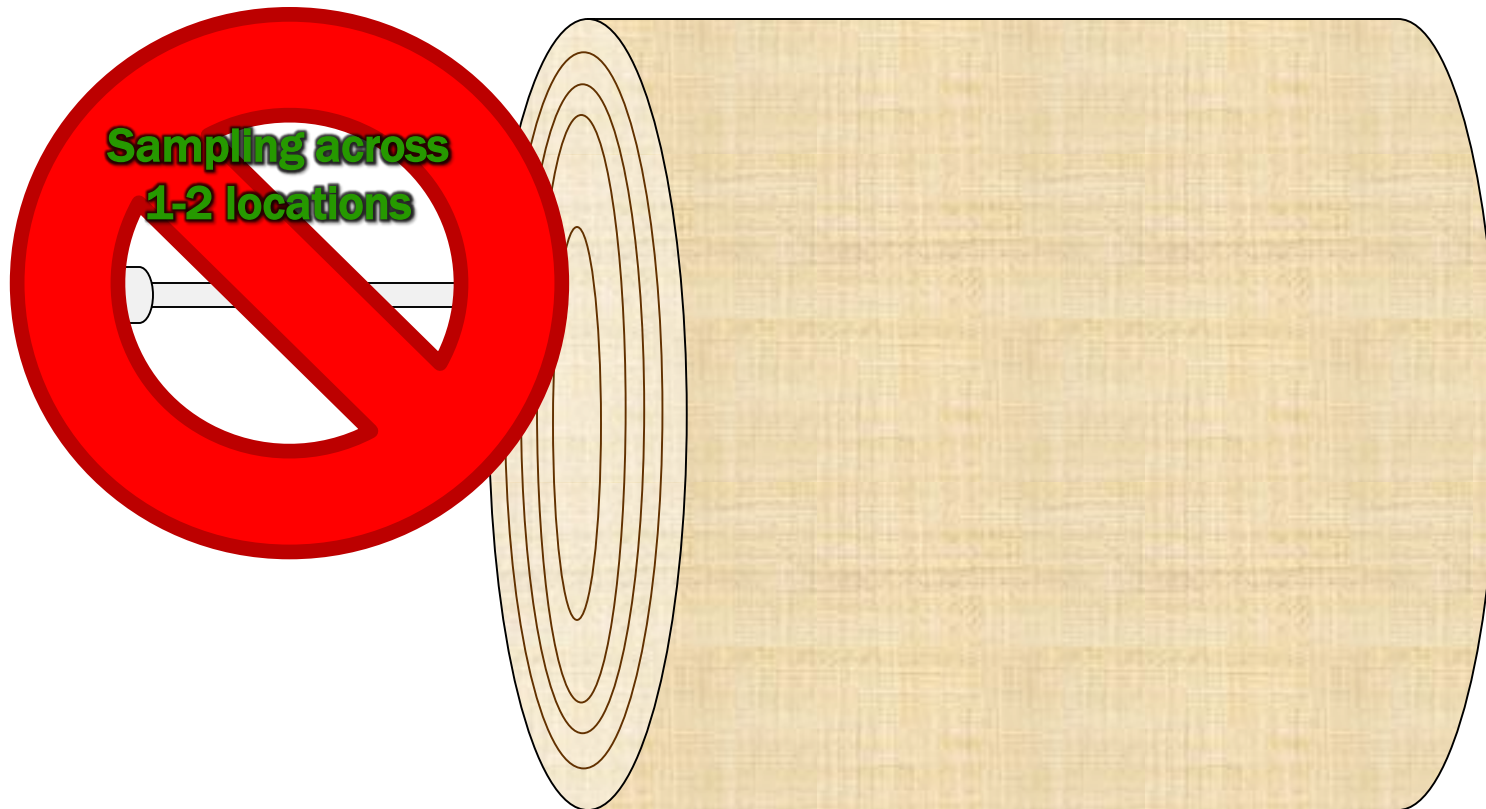
Star Quality Samplers

# Drill Type



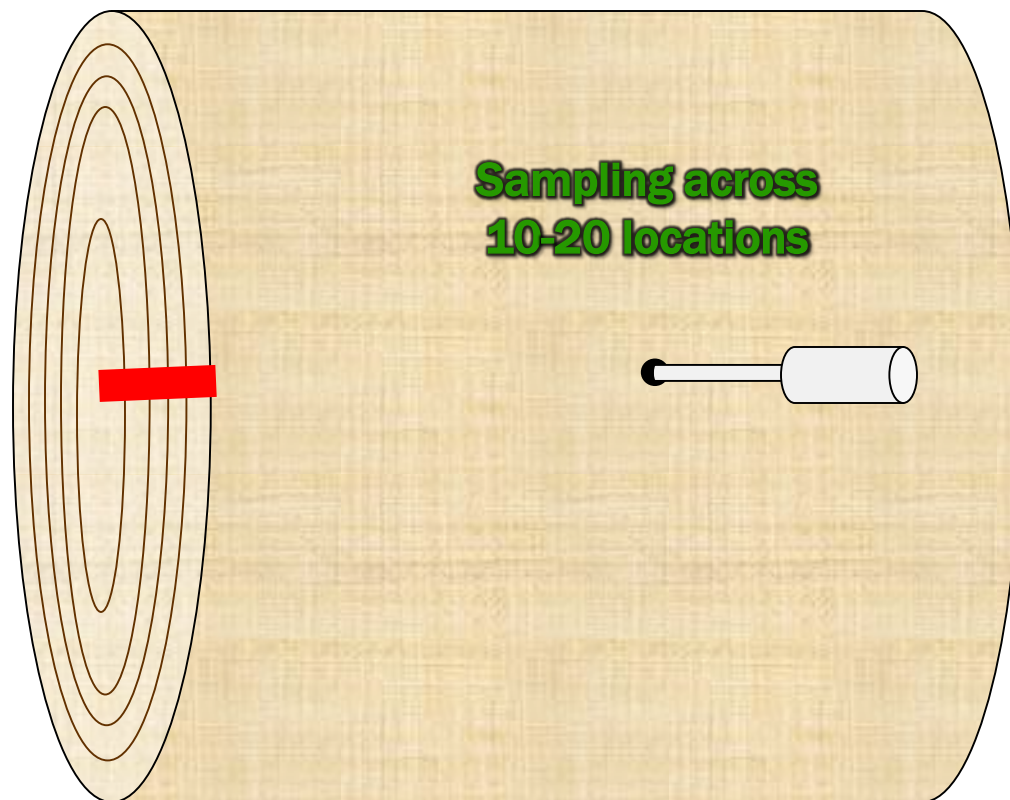
Custom built

# Which way do we cut?





# Which way do we cut?



# Cut Across Windrows



# How To Take a Forage Sample

- Sample from each field AND cutting (“Lot” of hay).
- Use bale corer to get a representative sample from 20 bales per lot.
- Insert the sampler fully and cross-ways to the stems.



# How To Take a Forage Sample

- Fill a clean quart-size plastic bag with about ½ lb of forage.
- Label each bag with details.
- Send to an accredited lab (National Forage Testing Association), such as the UGA Feed and Environmental Water Lab.
- For details, see the FAQ page on [www.georgiaforages.com](http://www.georgiaforages.com)



## Do:

- Use the proper tools
- Cut across the windrow
- Sample each “lot” separately
- Randomly select which bales to sample

## Don't:

- Grab Sample
- Cut into a windrow
- Combine all samples into one analysis
- Select only the best “looking” bales

# Other Tips and Tricks

- Get a Good Drill with a GOOD battery
- Buy extra tips/adapters

OR have a way to sharpen/fix them





Ladies –  
You can do it...  
just put your hips into it!



# Reading a Forage Quality Analysis




# Nutritive Value

- The potential for supplying nutrients
  - *i.e Nutrient concentration, digestibility, and end-products*
- Nutrient concentration can be determined through lab analysis
  - *Wet Chemistry (Van Soest)*
  - *Near Infrared Reflectance Spectroscopy (NIRS)*
  - *Crude Protein, Acid Detergent Fiber, Neutral Detergent Fiber, and In-vitro Dry Matter Digestibility*

## Highlights of a Forage Quality Analysis Report

There is a lot of useful information on a forage analysis report. However, it can be daunting. Highlighted below are the five key aspects of a forage analysis report. In nearly all situations, focus should be placed on the values in the "Dry-Matter" basis column. Because moisture can vary across a wide range, using the DM basis will allow for more of an "apples-to-apples" comparison. Furthermore, the DM percentages and concentrations are the values used by most nutritionists when developing rations and determining the economic value of a forage lot.



THE UNIVERSITY OF GEORGIA  
**COOPERATIVE EXTENSION**  
College of Agricultural and Environmental Sciences & Faculty and Extension Services

Feed and Environmental Water Laboratory  
2300 College Station Road  
Athens, Georgia 30602-4356  
Web site: <http://feed.ces.uga.edu>

### Feed and Forage Analysis Report

(CSC-CEA Square)

**Client Information**

Georgia Farms  
123 Bulldog Way  
Prettytown, GA 37777  
Sample: 01  
Agent: IM, Good

Crop: ALFALFA  
Use: Hay  
Species: DAIRY  
Class/Weight: LACTATING COWS

**Location**

053  
1. Jul 4, 2012  
Jul 4, 2012

**County Information**

Seneca County  
900 Dawgway Road  
Prettytown, GA 37777  
Phone: 706-ASK-UGA1  
e-mail: uge0999@uga.edu

Relative Forage Quality (RFQ): 208.6  
Dry Matter Intake (DMI): 3.71% Live Body Weight  
Ration Formulation: No

Near Infrared Reflectance (NIR) Analysis			
	As-Sampled	Dry-Matter	
Crude Protein	21.5 %	24.0 %	Total Digestible Nutrients
Crude Fiber (Estimated)	18.7 %	20.9 %	61.9 %
Neutral Detergent Fiber	30.8 %	34.4 %	0.640 MC/Rb
Acid Detergent Fiber	23.71 %	26.47 %	0.697 MC/Rb
Lignin	4.44 %	4.95 %	0.452 MC/Rb
Non-fibrous Carbohydrates	30.78 %	34.36 %	1.131 KC/Rb
Digestible Neutral Detergent Fiber	16.39 %	18.30 %	1283 KC/Rb
Neutral Detergent Fiber Digestibility	47.62 %	53.15 %	10.4 %
Digestible Dry Matter (Estimated)	60.95 %	78.09 %	89.6 %
			100 %

**Other Analyses**

	As-Sampled	Dry-Matter
Nitrogen	840 ppm	938 ppm

**Learning for Life**

The University of Georgia and Pelt Valley State University, the U.S. Department of Agriculture and counties of the area cooperating.  
Cooperative Extension offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, gender or disability.  
An equal opportunity institution across organizations concerned to a diverse world today.

**1) RFQ can help compare across forage types and to ranges necessary for the specific livestock class.**

**2) TDN and other energy values can be compared to the needs of the livestock class and similarly priced forages of the same species.**

**3) CP values can be compared to the needs of the livestock class and similarly priced forages of the same species.**

**4) Fiber and lignin levels can be compared to the needs of the livestock class and similarly priced forages of the same species.**

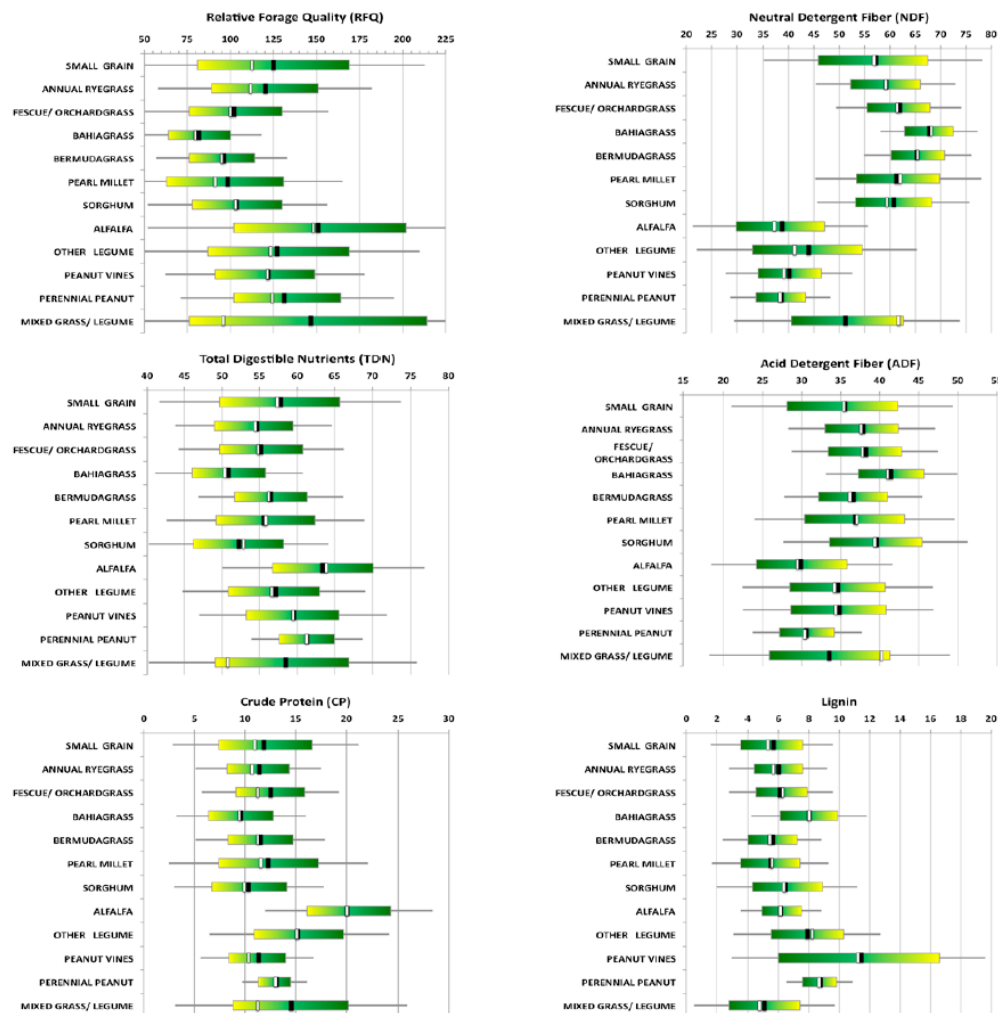
**5) Ensure that nitrates are in a range that is acceptable to the livestock class being fed and compare to similarly priced forages of the same species.**

**Table 2.** Summary of the primary uses of the forage quality metrics specified on reports from the University of Georgia's Feed and Environmental Water Laboratory.

Metric	Abbrev.	Units	Analytical Method	Important Uses			Involved in Estimating DM Intake
				Ration Balancing	Nutritional Diagnostics	Energy Estimates	
<b><u>Standard Procedures</u></b>							
Relative Forage Quality <sup>1</sup>	RFQ	unitless	NIR				
Crude Protein	CP	%	NIR, WC	x	x		x
Crude Fiber <sup>2</sup>	CF	%	NIR				
Neutral Detergent Fiber	NDF	%	NIR, WC	x	x		x
Acid Detergent Fiber	ADF	%	NIR, WC	x			x
Lignin		%	NIR, WC				
Total Digestible Nutrients	TDN	%	NIR	x	x	x	x
Net Energy of Lactation	NE <sub>l</sub>	Mcal/lb	NIR	x	x	x	
Net Energy of Maintenance	NE <sub>m</sub>	Mcal/lb	NIR	x	x	x	
Net Energy of Gain	NE <sub>g</sub>	Mcal/lb	NIR	x	x	x	
Metabolizable Energy	ME	kcal/lb	NIR	x	x	x	
Moisture		%	Oven				
Dry Matter <sup>3</sup>	DM	%	Oven	x			
<b><u>Mineral Analyses</u></b>							
Phosphorus	P	%	ICP	x	x		
Potassium	K	%	ICP	x	x		
Calcium	Ca	%	ICP	x	x		
Magnesium	Mg	%	ICP	x	x		
Manganese	Mn	PPM	ICP	x	x		
Iron	Fe	PPM	ICP	x	x		
Aluminum	Al	PPM	ICP	x	x		
Copper	Cu	PPM	ICP	x	x		
Zinc	Zn	PPM	ICP	x	x		
Sodium	Na	PPM	ICP	x	x		
<b><u>Other Analyses</u></b>							
Total Fat		%	WC	x	x		
Nitrates <sup>4</sup>	NO <sub>3</sub> -N	PPM	WC	x	x		
Ash		%	Oven				
Sulfur	S	%	ICP		x		
Arsenic	Ar	PPM	ICP		x		
Selenium	Se	PPM	ICP	x	x		
Bound Protein		%	NIR		x		
pH		unitless	WC		x		
Salt		%	WC		x		
Total Aflatoxin <sup>4</sup>		ppb	WC		x		

## Forage Quality of Major Southern Forages: Summary Statistics

Figure 11 provides a graphical summary of the statistics on over 16,000 forage samples that were submitted to the University of Georgia's Feed and Environmental Water Lab between July 2003 – February 2011. To better understand how a particular forage lot compares to others, compare the data on the report to the summary statistics provided here.



**Figure 11.** The average (black vertical lines), median (white vertical lines), typical expected<sup>1</sup> range (color bars), and the extent<sup>2</sup> of what is commonly low or high for a species (extent of horizontal gray lines) for RFQ, TDN, CP, NDF, ADF, and lignin in samples of various forage species submitted to the UGA Feed and Environmental Water Laboratory during July 2003 – February 2011.

<sup>1</sup> One standard deviation about the mean.

<sup>2</sup> Two standard deviations about the mean.

# Fiber Factors



## Acid Detergent Fiber (ADF)

- Lignin, Cellulose, and Ash (silica)
- Not hemicellulose
- Is a good indicator of digestibility of a forage

**Higher ADF =  
Lower Digestibility**

## Neutral Detergent Fiber (NDF)

- Includes all cell wall material
- ADF + Hemicellulose
- Is a good indicator of the intake potential of a forage

**Higher NDF =  
Lower Intake Potential**

# RFQ Simplifies Comparisons

- Relative Forage Quality
  - *Predicts energy based on fiber quality and intake*
- Combined into a single value
  - *RFQ of 100 is ~ = to full-bloom alfalfa*
  - *RFQ allows comparisons to be made across forage species*

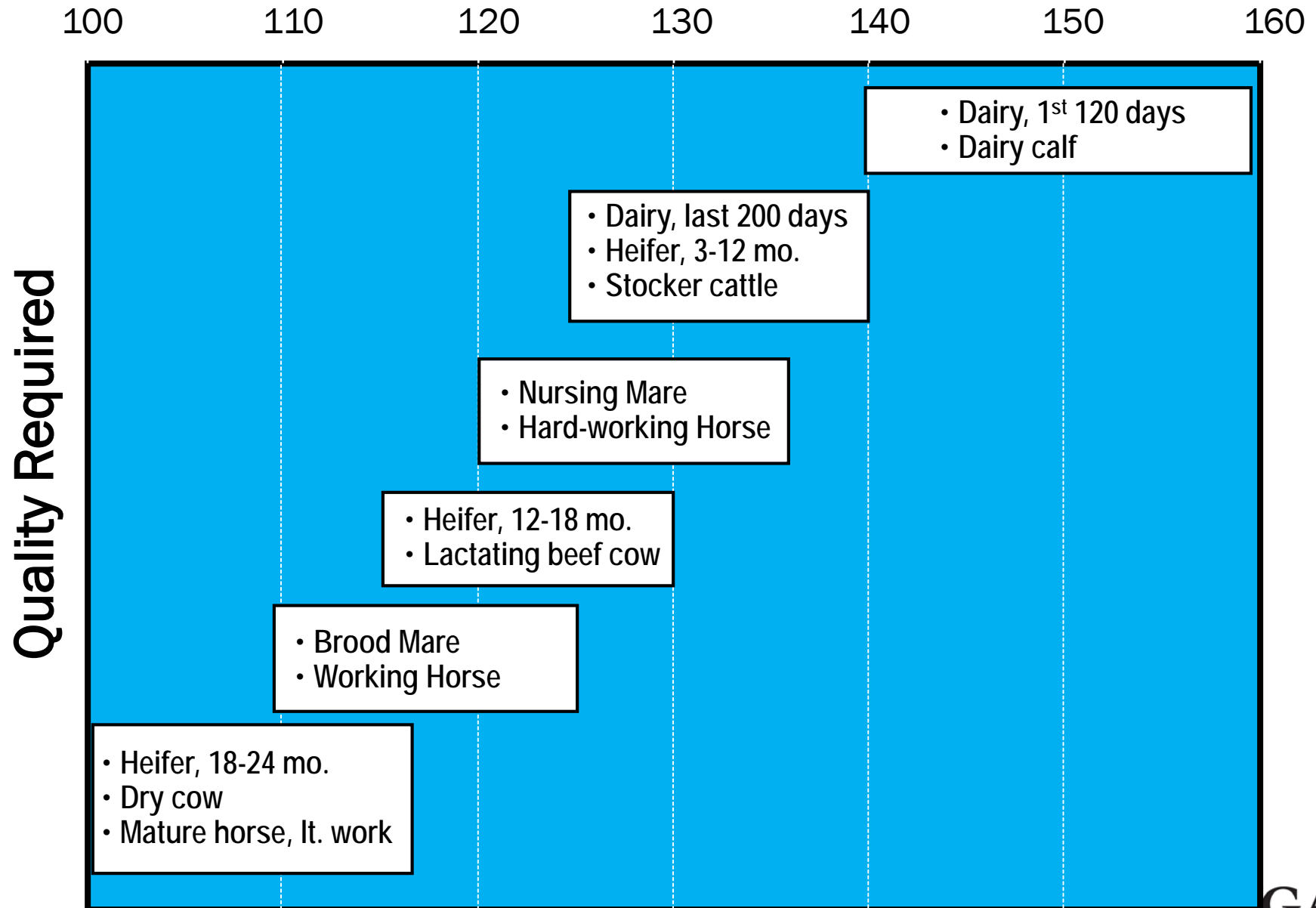


# RFQ Simplifies Comparisons

- Relative Forage Quality
  - *Predicts energy based on fiber quality and intake*
- Combined into a single value
  - *RFQ of 100 is ~ = to full-bloom alfalfa*
  - *RFQ allows comparisons to be made across forage species*
  - *Allows hay to be easily assigned to appropriate physiological stages*



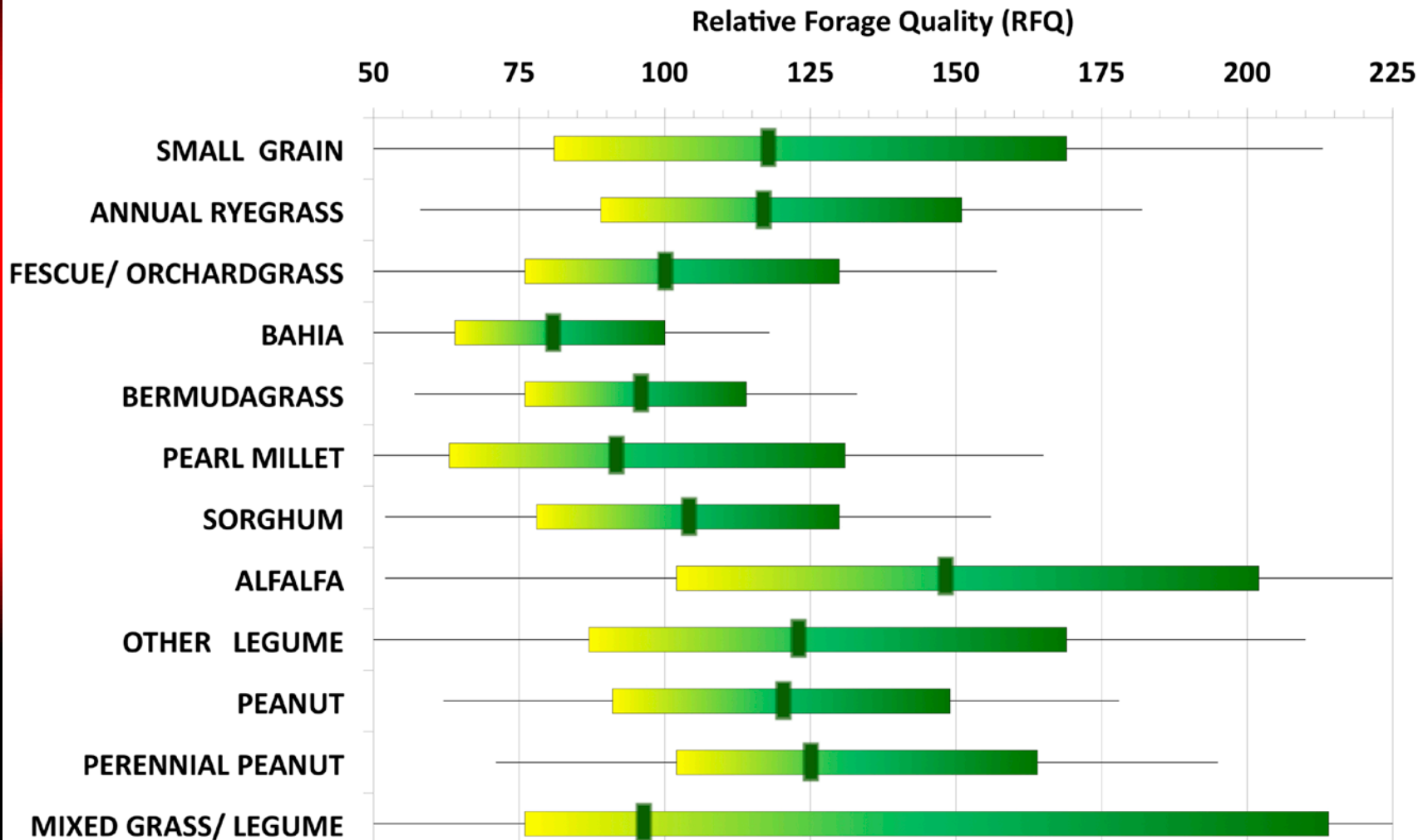
# Relative Forage Quality (RFQ)



Adapted from Undersander et al., 2011



# Typical Range in Quality of Common Forages



Typical expected range (color bars), median (dark green vertical lines) and the extent of what is typically considered exceptionally low or high for a species (extent of horizontal black lines represents two std. dev. away from the mean). Based on statistic from samples submitted to the UGA FEW Lab between July 2003 – February 2011.

# Unless you Test...



# It's Just a Guess!

# Questions?



[www.georgiaforages.com](http://www.georgiaforages.com)

[www.ugabeef.com](http://www.ugabeef.com)

1-800-ASK-UGA1

