Cattle Nutrition and Forage Quality

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Animal nutrition in its broadest sense is the gathering of food, a source of nutrients, and the digestion and subsequent action of those nutrients on respective body tissue.

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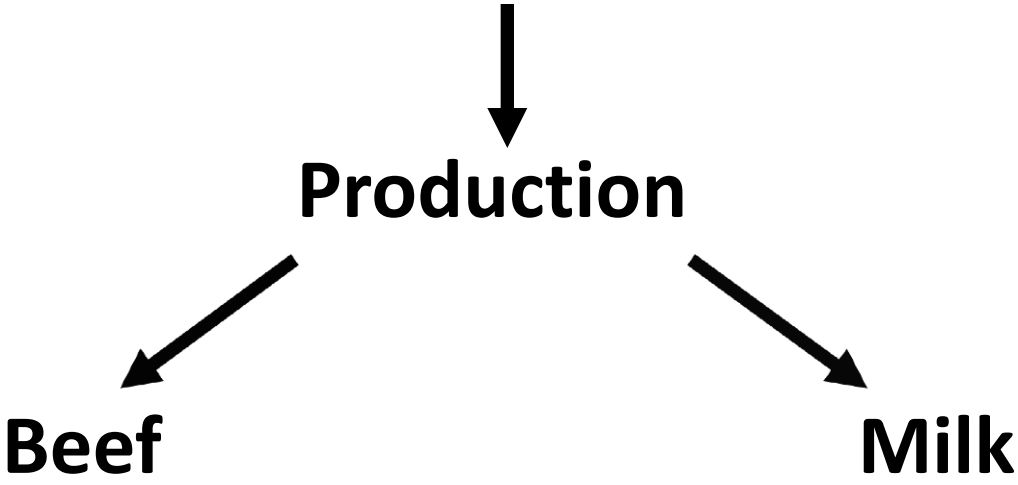
DMI X Forage Digestible Nutrient Content

=

Total Usable Nutrient Intake



Classes of Nutrients

- **Energy**
  - Carbohydrates
    - Fiber
    - NFC
  - Fats
- **Protein**
- **Minerals**
- **Vitamins**
- **Water**

Body Functions
Nutrient Partitioning

Maintenance

Growth

Lactation

Fattening

Things to Remember When Feeding Ruminants

1. They are ruminants
2. The majority of their diet will consist of forage
3. Since the diet consists largely of forage, the forage should supply the majority of the animals' nutrient requirements
4. If forage is to supply the majority of nutrients the forage (hay) needs to be of the appropriate quality to do so


Forage Quality
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Sample I.D.	**#1 Red Clover Hay**		**#2 Alfalfa Hay**	
	As Is	Dry	As Is	Dry
Moisture……%	9.591		14.607	
Dry Matter……%	90.409	100.000	85.393	100.000
Crude Protein……%	12.473	13.796	14.965	17.525
A.D. Fiber……%	33.018	36.520	35.711	41.820
N.D. Fiber……%	39.843	44.070	43.747	51.230
TDN……%	52.283	57.829	45.645	53.453
NE Lact MCAL/LB	.524	.579	.451	.529
NE Gain MCAL/LB	.275	.304	.206	.241
NE Maint MCAL/LB	.507	.561	.421	.493
Digst E MCAL/LB	1.045	1.156	.931	1.069
Nitrogen……%	1.996	2.207	2.394	2.804
Nitrate (NO#-)……%	Negative		Negative	
RFV	128		102	

Name……John Doe
Address……Ava, MO

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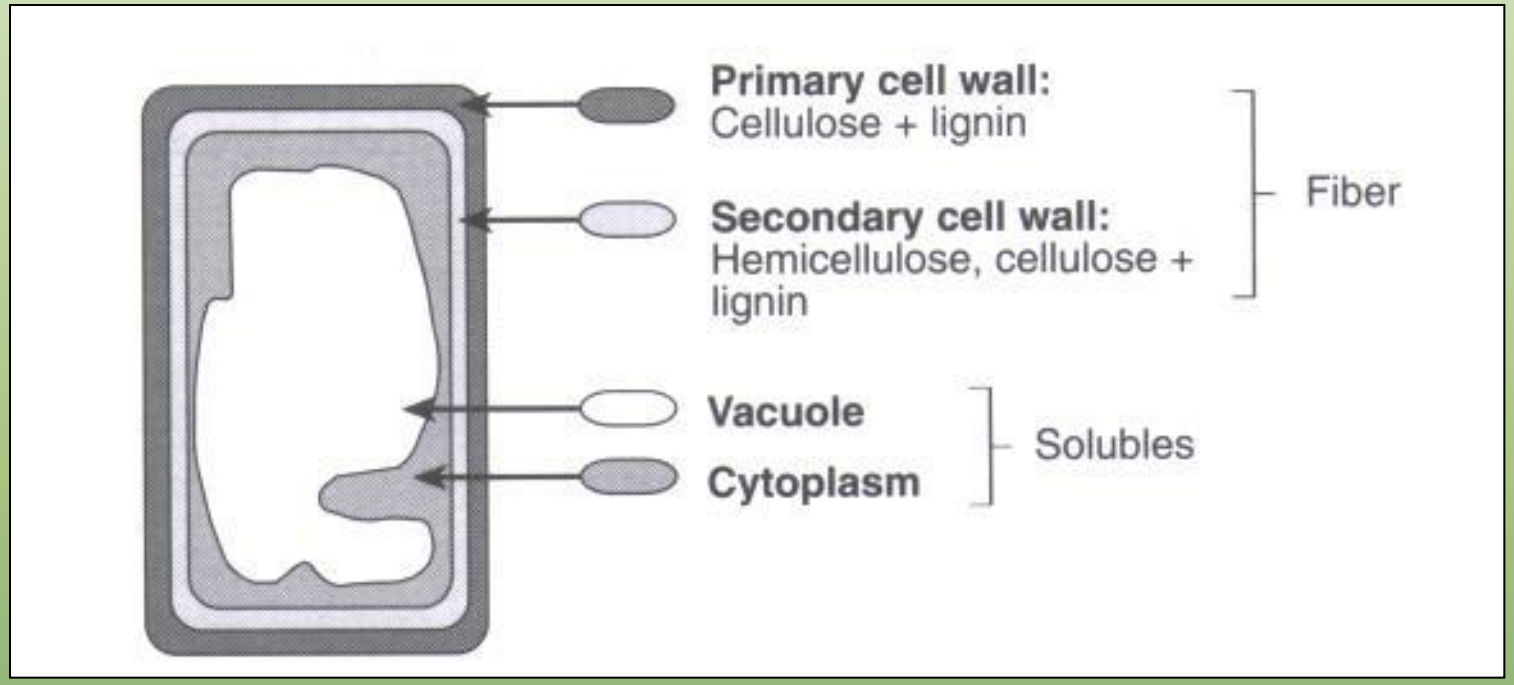

Plant cell with forage quality components of the cell wall.

Custom Laboratory Inc.

Monty Dade – customlb@keinet.net
P.O. Box 391, 204 C Street
Golden City, MO 64748-9989 - 417-537-8337

Sample Date 02/10/05
Sample I.D. Orchardgrass Hay

	As Is	Dry
Moisture…%	12.000	
Dry Matter…%	88.000	100.000
Crude Protein…%	13.200	15.000
A.D. Fiber…%	30.800	35.000
N.D. Fiber…%	48.400	55.000
TDN…%	51.040	58.000
NE Lact MCAL/LB	.510	.580
NE Gain MCAL/LB	.264	.300
NE Maint MCAL/LB	.502	.570
Digst E MCAL/LB	.968	1.100
Nitrogen…%	2.108	2.396
Nitrate (NO#-)…%	Negative	
RFV	99	

Name…John Doe
Address…Hartville MO

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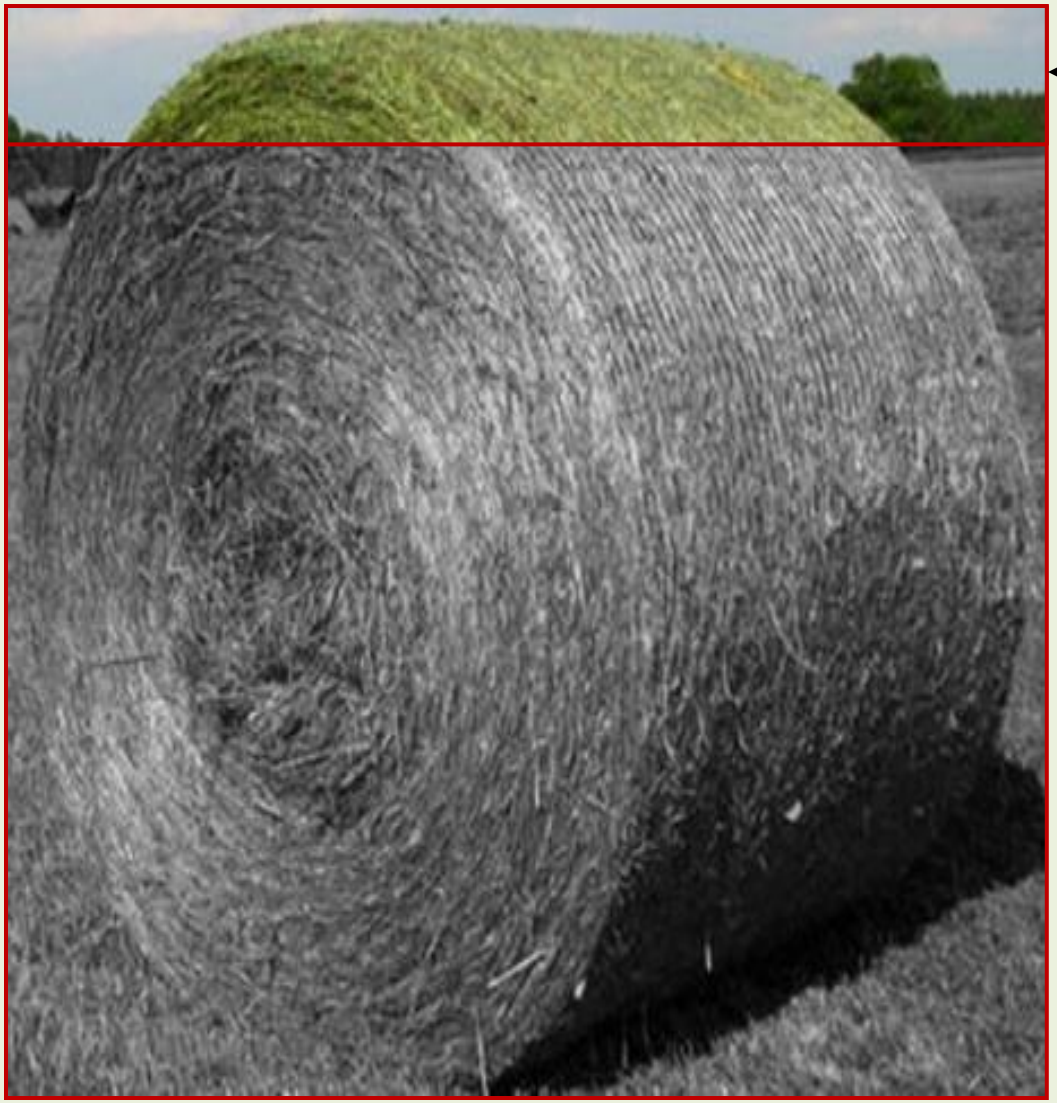
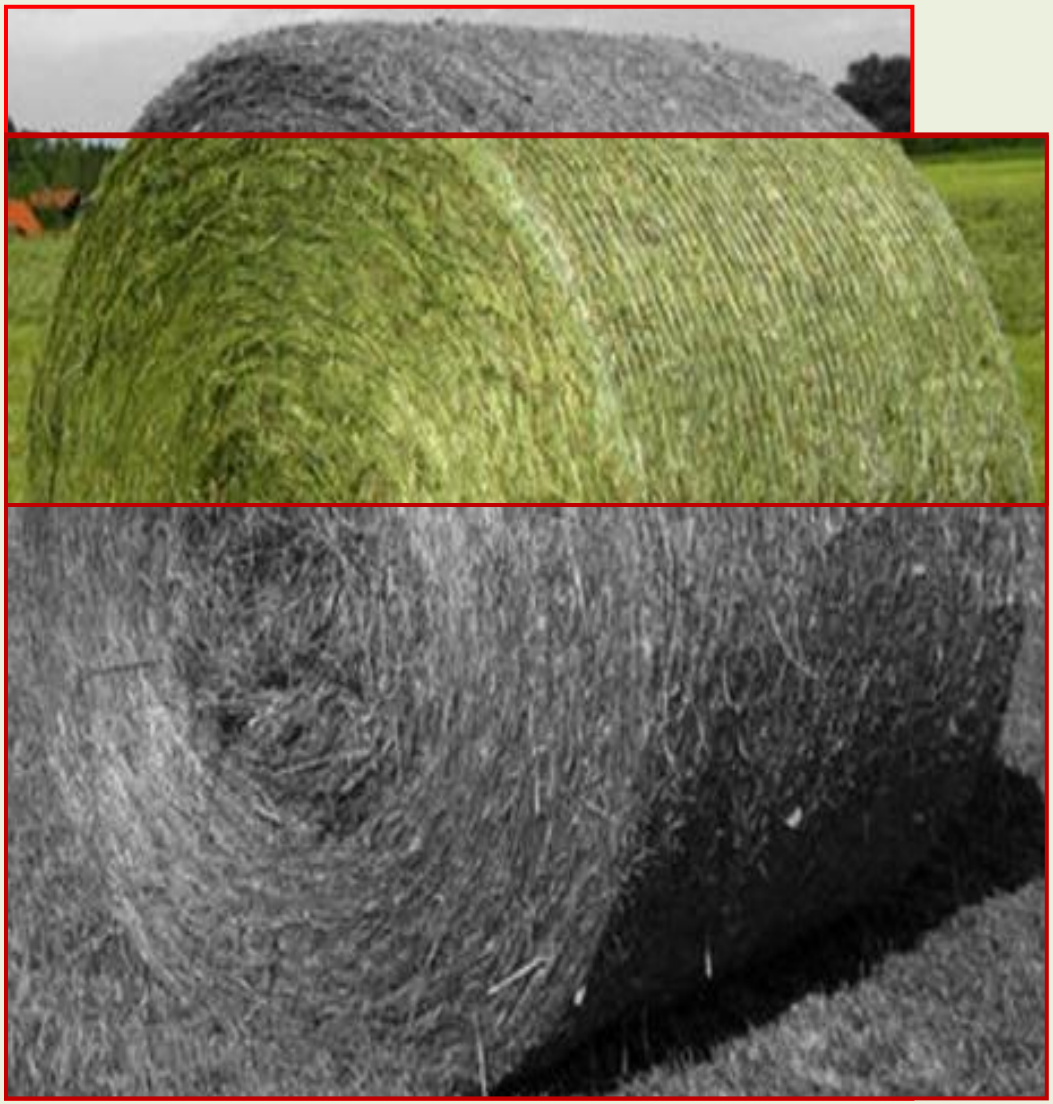
Hay – As Fed



Moisture – 12%

Moisture – 12%

Dry Matter – 88%



Moisture – 12%

Cell Contents - 38%

-**Highly Digestible**

- Sugars
- Starches
- Some Proteins
- Other Carbohydrates
- NPN
- Fats

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Moisture – 12%

Cell Contents
- 38%

NDF – 55%

"Roughage" or "Bulk"

Intake decreases as this component increases.

Hemicellulose – Digestible

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Moisture – 12%

Cell Contents
- 38%

NDF – 55%

ADF – 35%

Slowly digestible, digestibility decreases as this component increases.

Cellulose - Slowly Digestible
Lignin – Not digestible

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Moisture – 12%

Cell Contents
- 38%

NDF – 55%

ADF – 35%

Ash – 7%

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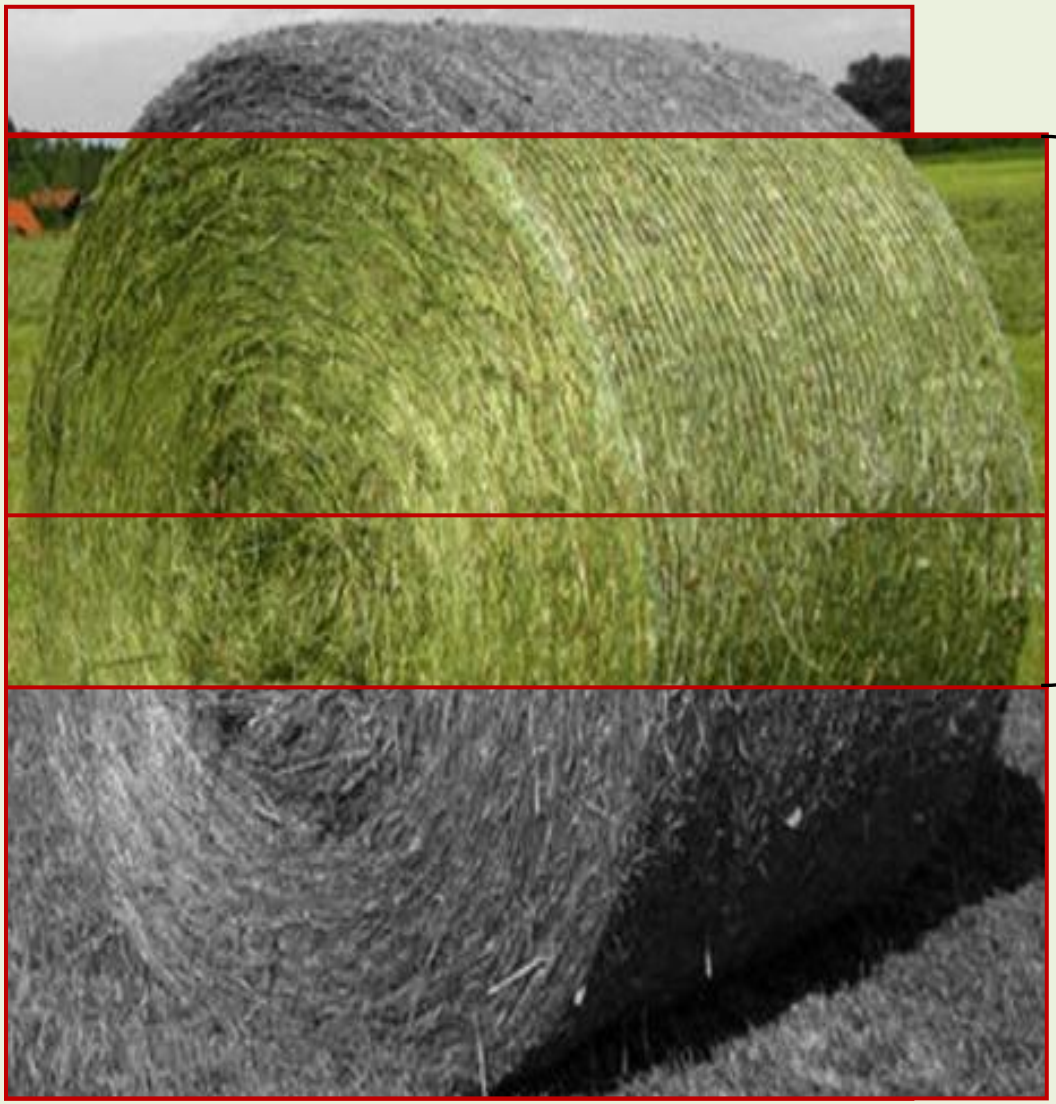
Ash

- Calcium
- Phosphorus
- Magnesium
- Potassium
- Sodium
- Sulfur
- Iron
- Copper
- Manganese
- Zinc
- Aluminum
- Molybdenum
- Selenium



Moisture – 12%

Cell Contents-38%

Digestible - 58% TDN

Digestible NDF- 20%

ADF – 35%

Ash – 7%

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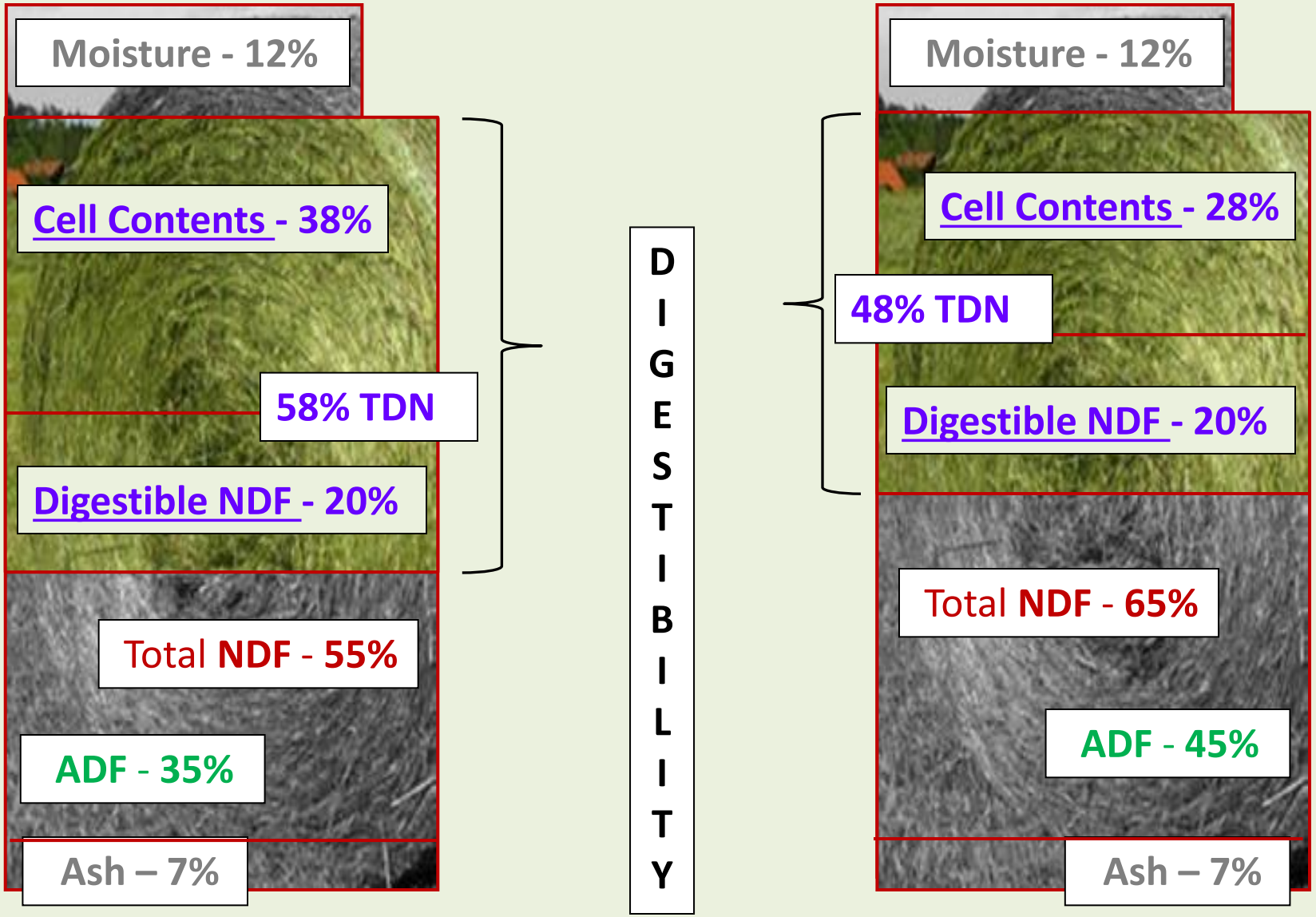

580# DDM/1000# bale

480# DDM/1000# bale

580/480=1.208 or 20% more DDM in the better hay.

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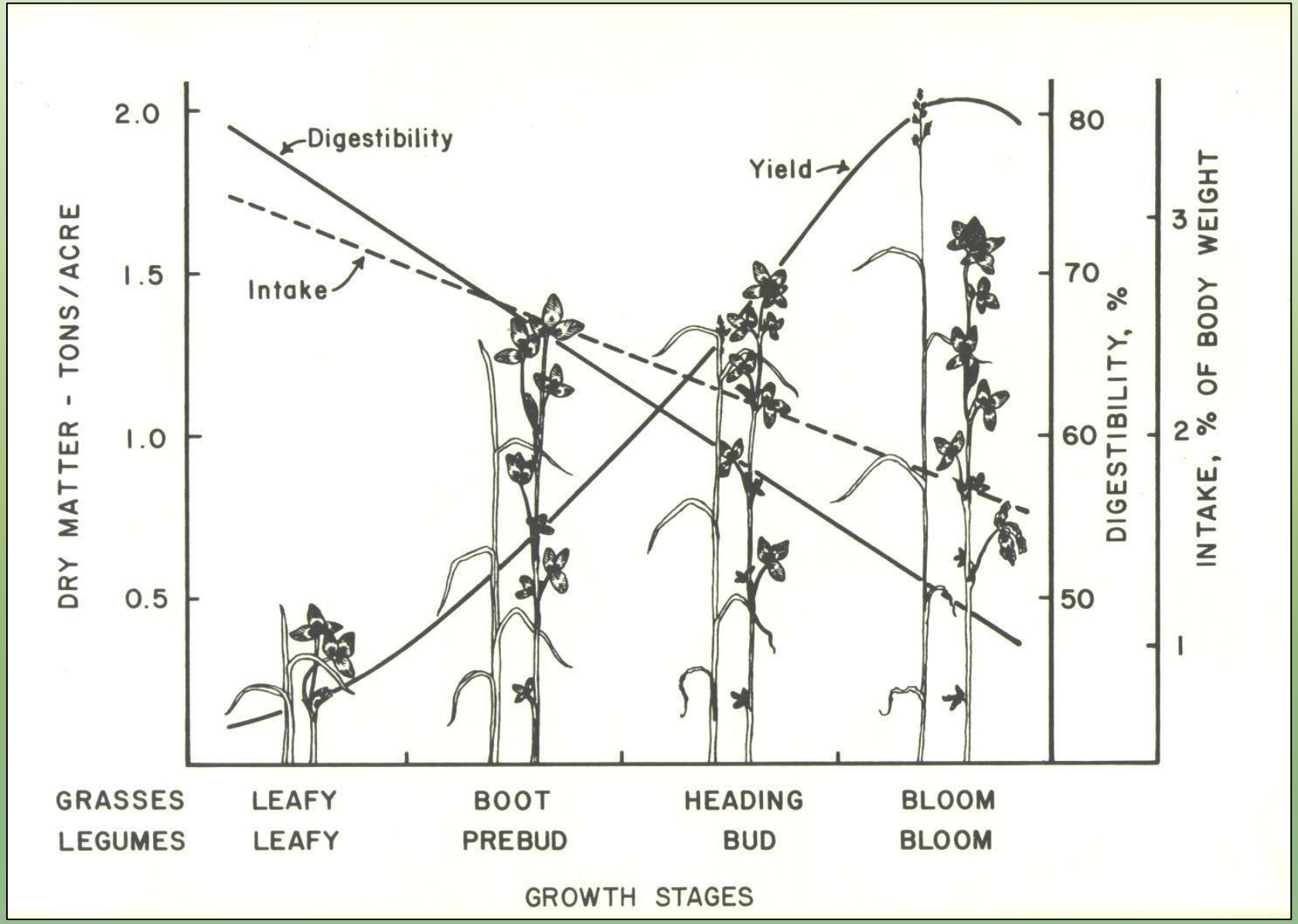
What Drives Forage Quality?

Forage	NDF %	ADF %	CP %	NE-m Mcal/lb	NE-g Mcal/lb
Alfalfa					
Vegetative	35	28	24	0.68	0.42
Midbloom	46	35	17	0.59	0.31
Full Bloom	50	37	15	0.57	0.26
Tall Fescue					
Vegetative	55	30	20	0.68	0.42
Midbloom	63	35	16	0.61	0.34
Full Bloom	70	42	9	0.57	0.28

What is the primary factor influencing fiber content?

Plant maturity



Comparative Fiber Characteristics of Grasses and Legumes

	% NDF	%ADF
Alfalfa (early bloom)	**42**	**31**
Orchardgrass (early vegetative)	**55**	**31**

Estimating Dry Matter Intake

- 2.0% - 3.0% BW
- 1.2 % - 1.3% BW in NDF

RFV – A Measure of Overall Forage Quality

$$\text{RFV} = \frac{\text{DDM X DMI}}{1.29}$$

$$\text{DMI} = \frac{120}{\text{Forage NDF (\% of DM)}}$$

$$\text{DDM} = 88.9 - 0.779\ (\text{ADF \%})$$

RFV of Full Bloom Alfalfa = 100

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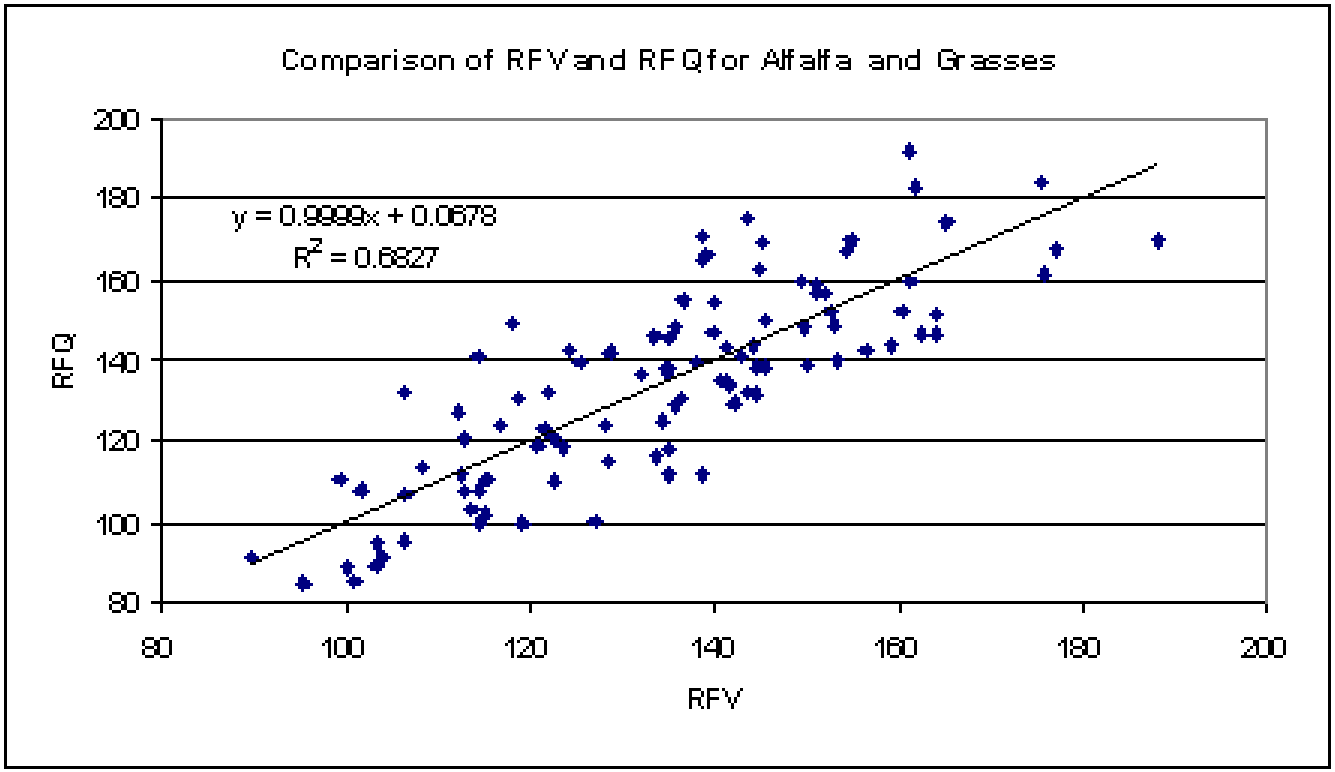
RFQ – An Improved Index

- RFV estimates digestibility based on ADF
- A better approach would be to actually measure digestibility
  - This is what is done when calculating RFQ
  - RFQ utilizes 48-hour in vitro NDF digestibility



Undersander, Wisconsin

RFQ Calculations

$$\underline{\text{RFQ}} = \frac{(\text{DMI}_{\text{legume}}, \%\ \text{of BW}) \times (\text{TDN}_{\text{legume}}, \%\ \text{of DM})}{1.23}$$

$$\text{DMI}_{\text{leg.}} = \frac{120}{\text{NDF} + (\text{NDFD} - 45) \times .374 / 1350 \times 100}$$

$$\text{TDN}_{\text{leg.}} = (\text{NFC}*.98) + (\text{CP}*.93) + (\text{FA}*.97*2.25) + (\text{NDFn}) \times (\text{NDFD}/100) - 7$$

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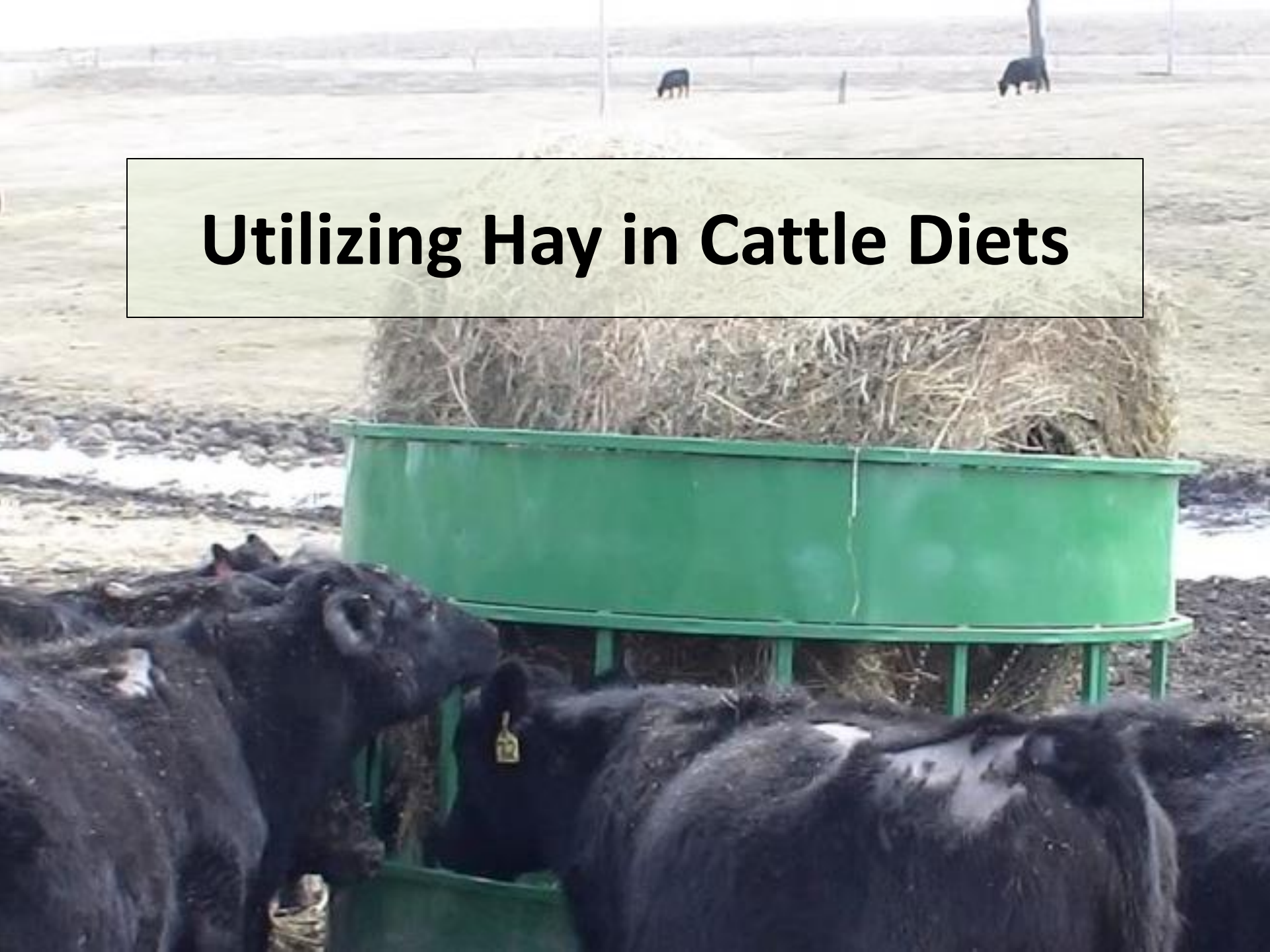

Utilizing Hay in Cattle Diets

Comparison of Animal Performance from Hay of Good or Low Quality

Good Grass Hay	
CP	13.14
ADF	37.0
NDF	58.7
TDN	58.3
NE Maint	.568
RFV	95

Low Quality Grass Hay	
CP	11.38
ADF	44.3
NDF	73.0
TDN	51.3
NE Maint	.459
RFV	70

Animal Requirements vs Forage Quality at Different Maturities

600 lb. Beef Steer, 2.0 lb. ADG

	Intake % bw	Intake lb DM	CP lb	NEm Mcal	ADG lb/day
Requirement	2.4	14.4	1.74	5.16	-
Good Grass	2.13	12.78	1.68	7.26	1.3
Common Grass	1.71	10.27	1.17	4.71	0

Animal Requirements vs Forage Quality at Different Maturities

1200 lb. Beef Cow, average milking ability (20#) first 3-4 months post-partum

	Intake % bw	Intake lb DM	CP lb	NEm Mcal
Requirement	2.3	27.8	2.8	16.2
Good Grass	2.13	25.6	3.36	14.5
Common Grass	1.71	20.5	2.33	9.42

Animal Requirements vs Forage Quality at Different Maturities

1200 lb. Beef Cow, low milking (10#) first 3-4 months post-partum

	Intake % bw	Intake lb DM	CP lb	NEm Mcal
Requirement	2.3	24.9	2.19	13.7
Good Grass	2.13	25.6	3.36	14.5
Common Grass	1.71	20.5	2.33	9.41

Animal Requirements vs Forage Quality at Different Maturities

1200 lb. Dry Cow

	Intake % bw	Intake lb DM	CP lb	NEm Mcal
Requirement	2.0	24.2	1.45	9.0
Good Grass	2.13	25.6	3.36	14.9
Common Grass	1.71	20.5	2.33	9.41

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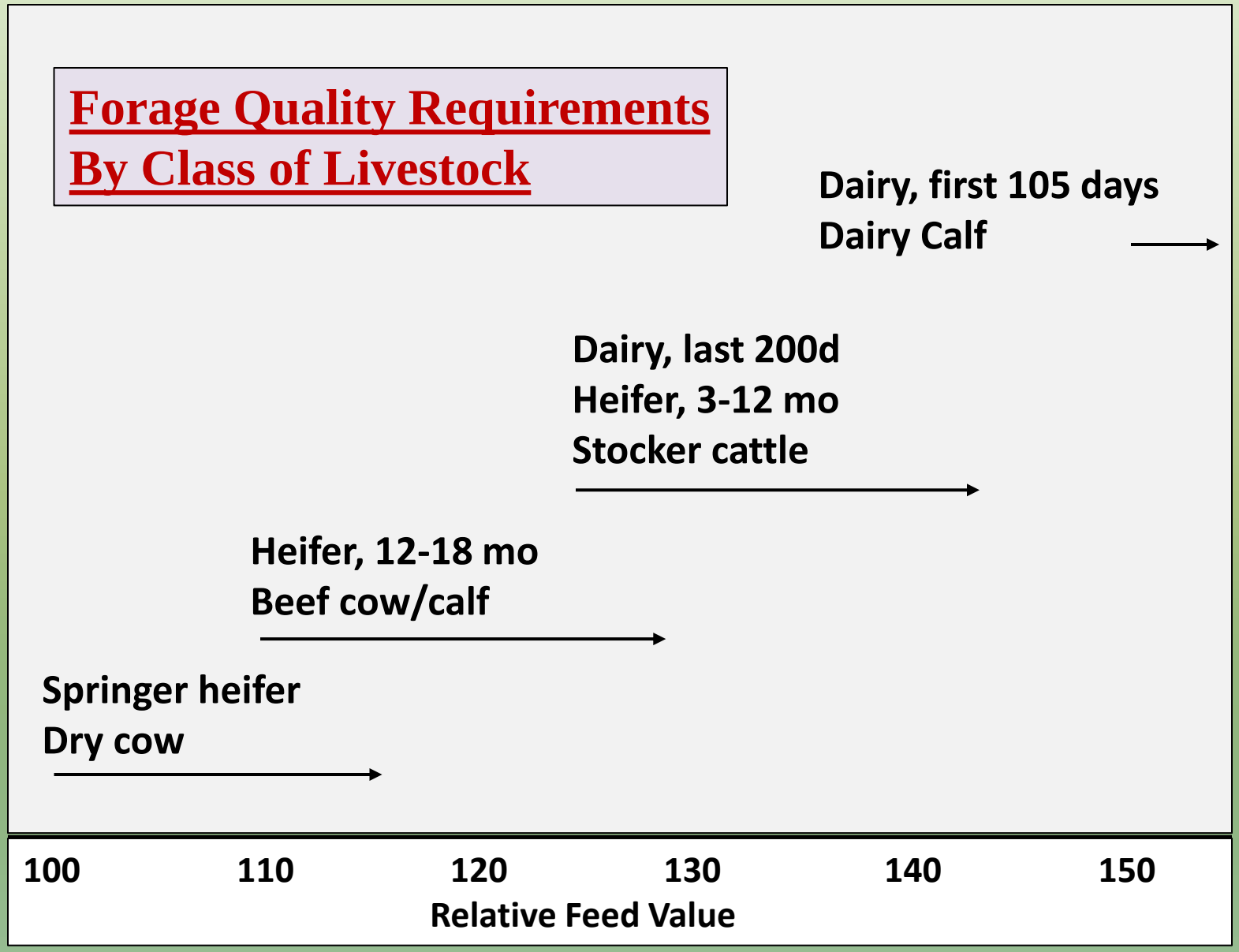
Animal Requirements vs Forage Quality at Different Maturities

1200 lb. Beef Cow, average milking ability, first 3-4 months post-partum

	Intake % bw	Intake lb DM	CP lb	NEm Mcal
Requirement	2.3	27.8	2.8	16.2
Hay #1	2.8	34.1	4.70	19.1
Hay #2	2.5	29.0	5.12	14.3

Forage Quality Requirements By Class of Livestock



Supplementation of Forages

- Supplementation will be necessary in some cases
  - Protein
  - Energy
  - Minerals
  - Vitamins

Energy – Protein Supplementation

- In most situations, energy (not protein) is the most limiting nutrient
- Energy sources
  - Grains (corn, milo, wheat, barley, etc)
    - High in starch
    - Will depress fiber fermentation in the rumen
    - 0.5% bw should be the limit for feeding grain
      - For a 500 lb calf that is 2.5 lb.

Energy – Protein Supplementation

- By-products
  (CGF, soy hulls, wheat midds, DDGS)
  - Little or no starch
  - High in energy – digestible fiber
  - Do not depress fiber digestion like starch

Table 2. Performance of steers receiving fescue hay supplemented with corn, soybean hulls or wheat middlings.

Item	Control	Corn	Soybean hulls	Wheat middlings
Hay dry matter intake (% body weight)	2.09	1.79	1.85	1.82
Supplementary dry matter intake (% body weight)	0	0.7	0.7	0.7
Average daily gain (lbs.)	0.66	1.32	1.5	1.52

Adapted from Crawford and Garner (1993, p. 185).

Some Common By-Product Feeds

Feedstuff	CP	NE Maint.
Ground Corn	9.4	.91
Corn Gluten Feed	25.6	.78
Dried Distillers Grain	30.0	.93
Hominy Feed	11.9	.85
Rice Bran	15.5	.93
Soy Hulls	13.9	.66
Wheat Midds	18.5	.76

Minerals

- **Salt**
  - Most forages are low in sodium (Na)
    - Supplementing with common white or red salt (either loose or block) is cheap, easy insurance

Minerals

- Salt
- **<u>Macro-minerals (Ca, P, K, Mg)</u>**
  - Calcium (Ca) and Phosphorus (P) will need to be supplemented in most cases
  - Potassium should be adequate in most hay
  - Magnesium (Mg) will be adequate for most cattle but supplementation may be needed for lactating cows: reqt. - .20% of diet

Minerals

- Salt
- Macro-minerals
- **Micro-minerals**
  - Copper
  - Zinc
  - Selenium

Vitamins

- **Vitamin A**
- Vitamin A is not found in hay. Hay contains the Vitamin A precursor Beta-Carotene that is converted to Vitamin A by the animal.
- Beta-Carotene is present in green plants but is not stable once forages have been harvested.

Vitamins

- **Vitamin A**
- Supplement as follows
  - Calves: 20,000 IU per day
  - Pregnant Cows: 30,000 IU per day
  - Lactating Cows: 45,000 IU per day

Vitamins

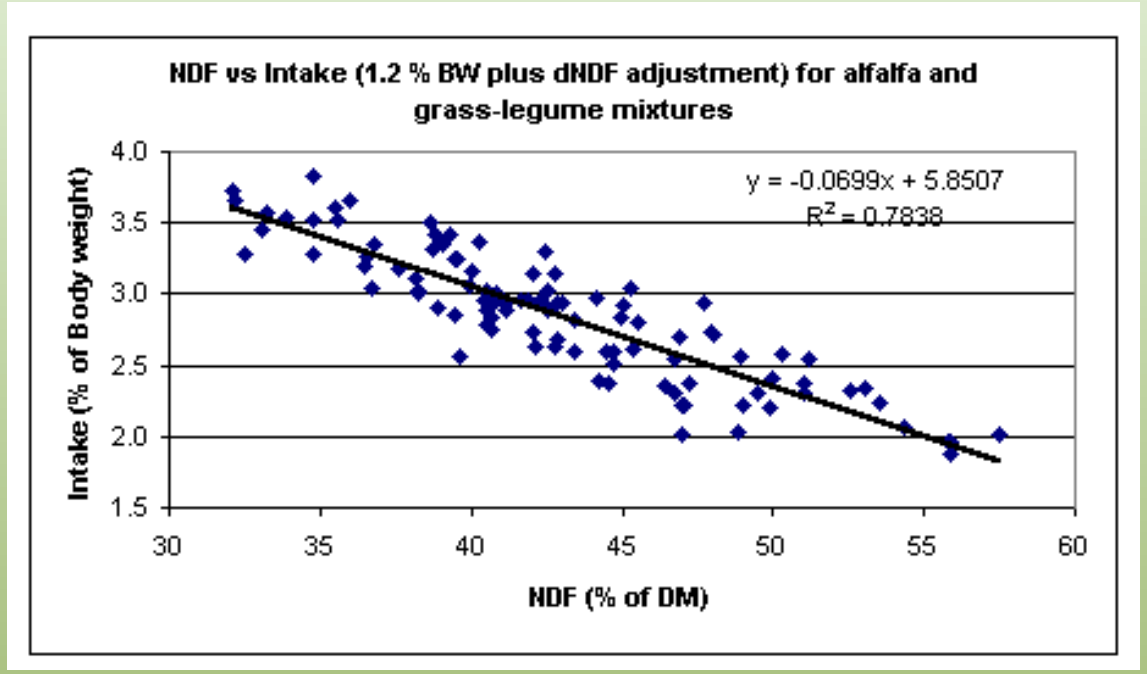
- **Vitamin D**
- Under normal conditions, cattle receive adequate vitamin D from exposure to direct sunlight or from consumption of three to four pounds of sun-cured forages daily.
  - Supplementation at 125 IU per pound of diet DM will alleviate potential shortages.

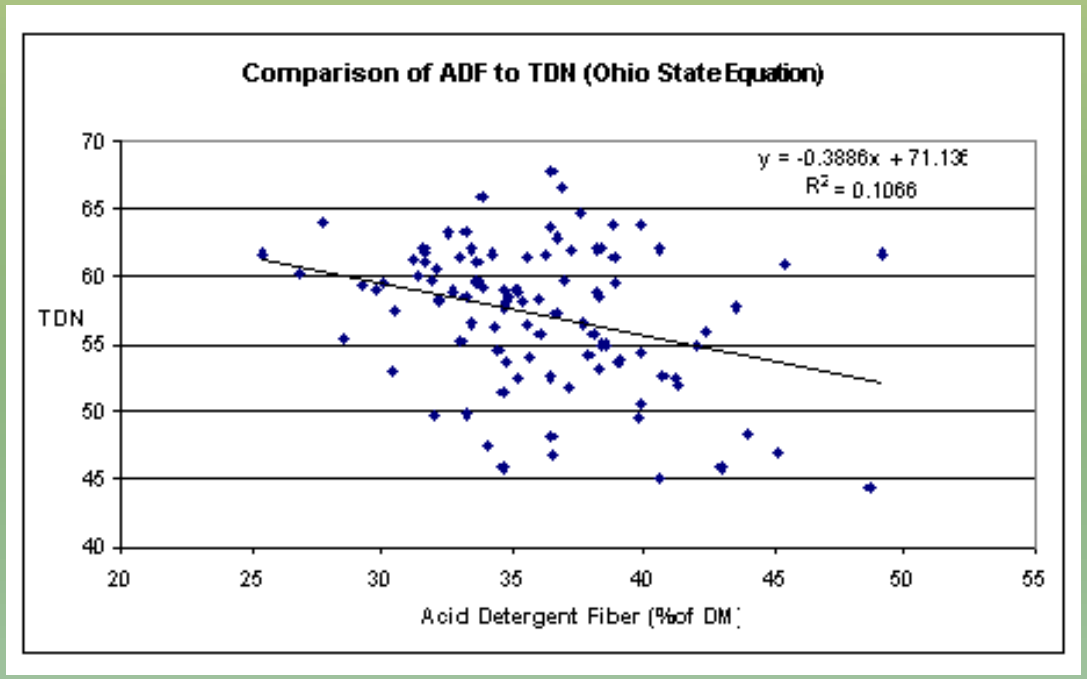
Vitamins

- **Vitamin E**
- Most rations fed to beef cattle in Missouri are adequate in vitamin E
- Can be supplemented as a precaution

Conclusion

- Forages are the cornerstone of ruminant nutrition
- Forage quality needs to match production expectations
- In cases where forage quality is not optimum supplementation will be necessary


NDF vs Intake (1.2 % BW plus dNDF adjustment) for alfalfa and grass-legume mixtures
y = -0.0699x + 5.8507
R² = 0.7838
Intake (% of Body weight)
4.0
3.5
3.0
2.5
2.0
1.5
30
35
40
45
50
55
60
NDF (% of DM)


Comparison of ADF to TDN (Ohio State Equation)
y = -0.3886x + 71.13
R² = 0.1066
TDN
70
65
60
55
50
45
40
20
25
30
35
40
45
50
55
Acid Detergent Fiber (%of DM)