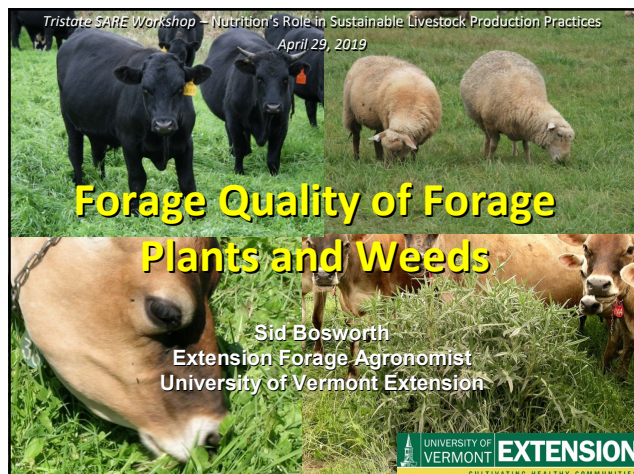


Forage and Pasture Quality



Definition of "Forage Quality"

1. Forage quality reflects an animal's response such as growth, maintenance, reproduction, work, lactation, animal product (milk, meat, wool, etc.) yield and quality when fed a particular forage

Definition of "Forage Quality"

2. Sum total of the plant constituents that influence an animal's utilization of the feed

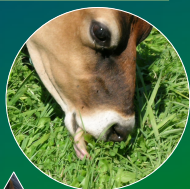
Definition of "Forage Quality"

3. Forage quality (ie., the animal response when fed a forage) is influenced by the form it is fed, the palatability of the forage, and by the quality of other feeds in the diet (associative feed affects).

Forage and Pasture Quality

Components of "Forage Quality"

- Palatability
- Forage intake
- Digestibility
- Nutritive value
- Non-nutrient factors
 - Anti-quality factors
 - Beneficial factors



Components of "Forage Quality"

- **Palatability** – Will the animal eat it?
- **Intake** (dry matter basis) – How much of the forage will the animal consume?
- **Digestibility** – What proportion of the forage will be digested and utilized by the animal?
- **Nutritional Value** – Of the digested material, what amounts of nutrients (protein, energy, vitamins, minerals, etc.) are provided?
- **Anti-quality factors** – Are there chemicals in the forage that can deter intake, digestibility, poor utilization or cause animal disorders?

Components of "Forage Quality"

- Palatability - relates to forage selection (animal behavior) when there is a choice of one plant or plant part over another.

Examples:

- Thorny/bitter weeds
- Horsenettle in hay
- Acid preservative treated hay
- Alkaloids in reed canarygrass
- Tannins in birdsfoot trefoil



- Palatability – affected by both plant factors and animal experience



Smooth bedstraw



Smooth bedstraw contains anthraquinone compounds causing irritation or sensitization in mammals

Forage and Pasture Quality

Teaching Livestock to Eat Weeds



Components of "Forage Quality"

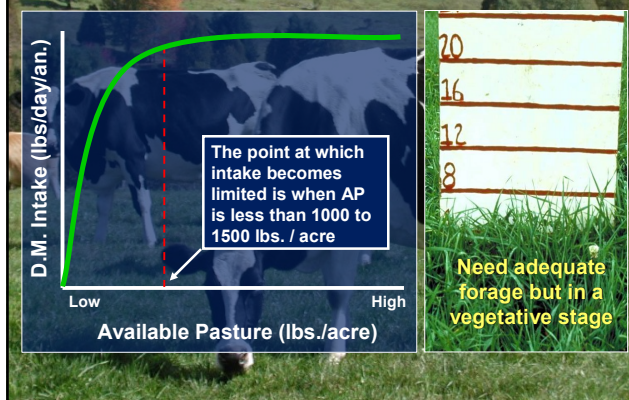
- Forage Intake – amount of forage dry matter consumed per day
 - Measured in lbs. d.m./day or % body weight

Example: 1200 lb. cow eating 2.5% of her body weight

$$1200 \text{ lbs} \times 0.025 = 30 \text{ lbs. forage dry matter per day}$$

Forage intake is greatly affected by the fiber content and fiber digestibility of the forage

Available Pasture and Intake



Components of "Forage Quality"

- Forage Digestibility

Biological/Bioassay Methods

- *In vivo* - whole animal studies
- *In situ* - Using dacron bags placed in the rumen via a fistula to measure dry matter disappearance
- *In vitro* - "test tube" method using rumen fluid and buffers to measure in vitro dry matter digestibility



Fistulated Cow



In vitro method

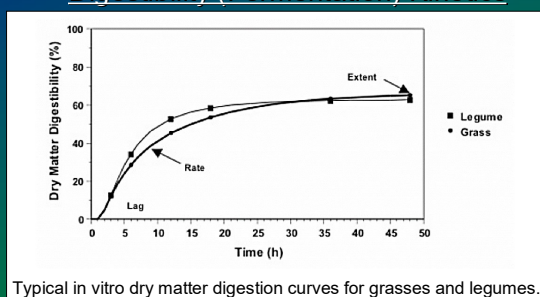


Auto analyzer

Forage and Pasture Quality

Measuring/Testing for Forage Digestibility

Digestibility (Fermentation) Kinetics



<http://amaferm.com/2014/09/18/digestion-takes-time/>

Components of “Forage Quality”

• Nutritive Value

– Forages can meet much of the protein, energy, minerals, and vitamin needs



Components of “Forage Quality”

• Non-nutritive factors

Examples:

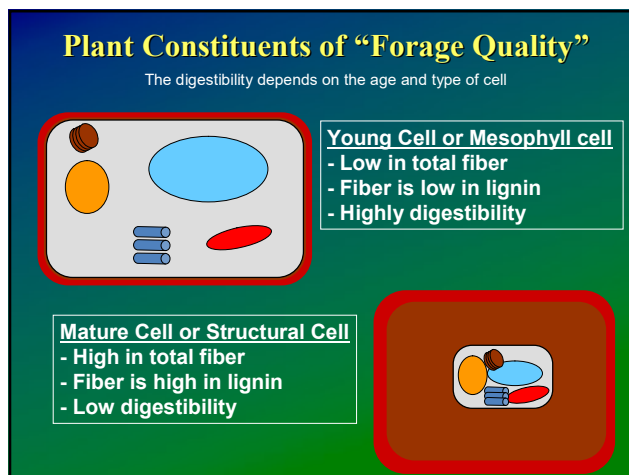
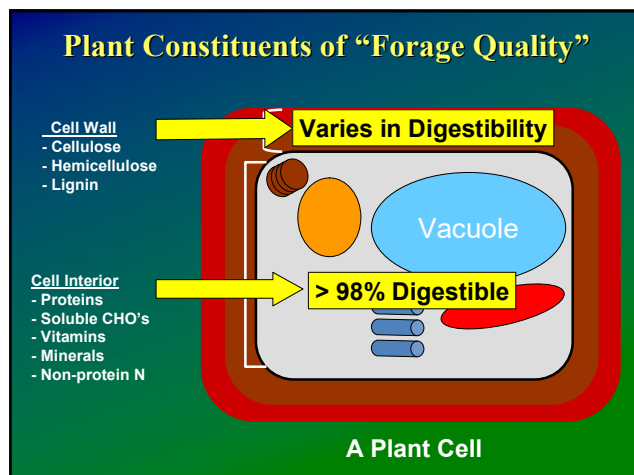
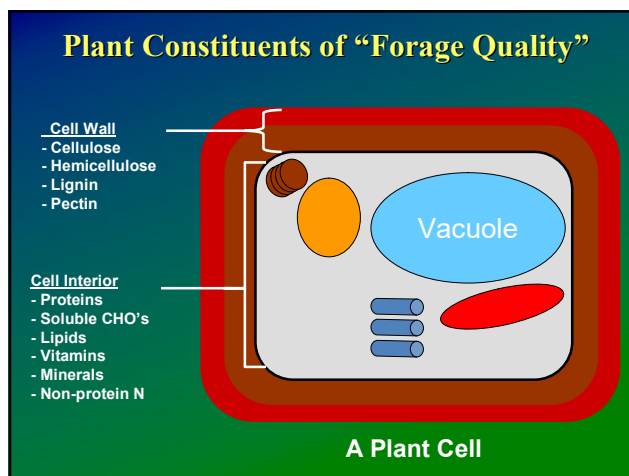
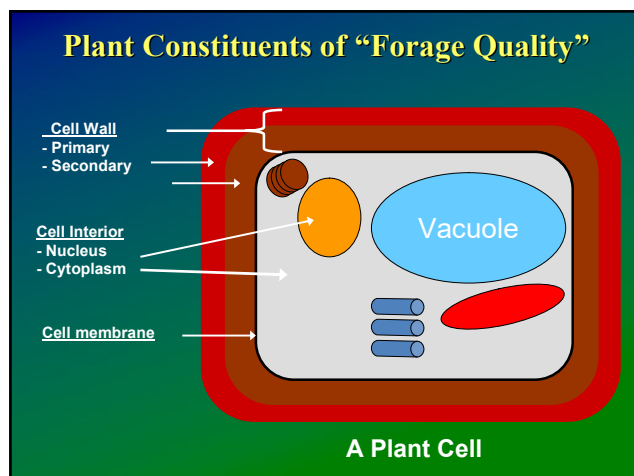
- Tall fescue endophyte
- Phytoestrogens in clovers
- Saponins in alfalfa
- Alkaloids in reed canarygrass
- Tannins in birdsfoot trefoil



Plant Constituents of “Forage Quality”



Forage and Pasture Quality



Forage and Pasture Quality

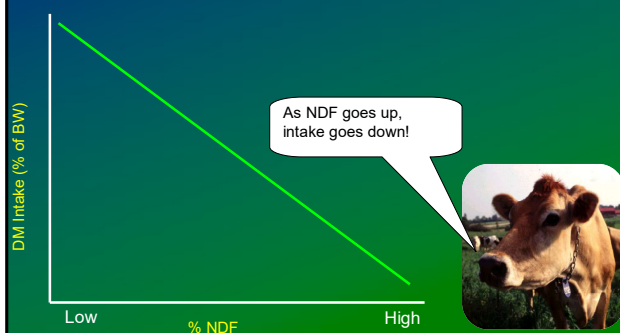
Measuring/Testing for Nutritive Value

Chemical Methods

- **Crude Protein (CP)**
 - Measures total nitrogen (true and non-protein N)
 - Multiply total N by 6.25 to predict "crude" protein
- **Neutral Detergent Fiber (NDF)**
 - measures total cell wall (cellulose, hemicellulose, lignin)
 - Used to predict potential dry matter intake
- **Acid Detergent Fiber (ADF)**
 - Measures cellulose, lignin and some cell wall protein and ash fractions
 - Used to predict digestibility and energy content
- **Energy units vary according to use**
 - NE_M , NE_G , NE_L , TDN (total digestible nutrients), Digestible Energy
 - Usually "estimated" by indirect measures of digestibility or fiber content

Neutral Detergent Fiber

NDF is basically the cell wall content of the forage



NDF Digestibility

Cell Wall

- Cellulose
- Hemicellulose
- Lignin

Varies in Digestibility

Cell Interior

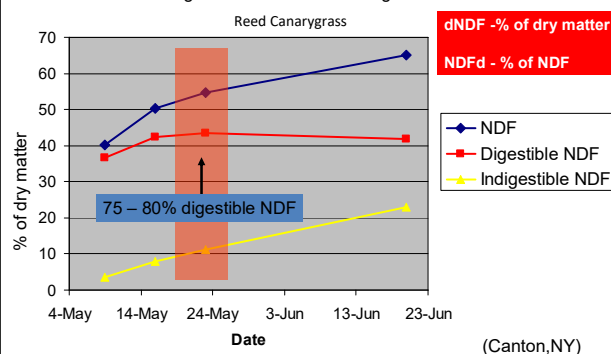
- Proteins
- Soluble CHO's
- Vitamins
- Minerals
- Non-protein N

> 98% Digestible

A Plant Cell

NDF Digestibility

Changes in Grass NDF and Digestible NDF



Forage and Pasture Quality

Using NDF for targeting when to harvest your haycrop?

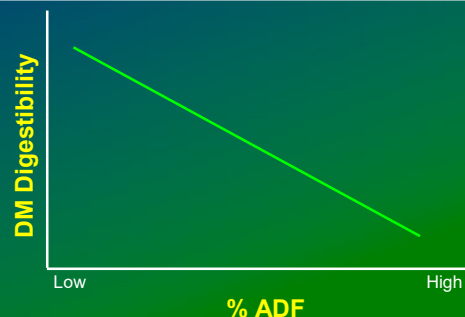
- Legume 40%
- Grass 50%
- Mixture varies
 - MML 42 - 44%
 - MMG 46- 48%



3

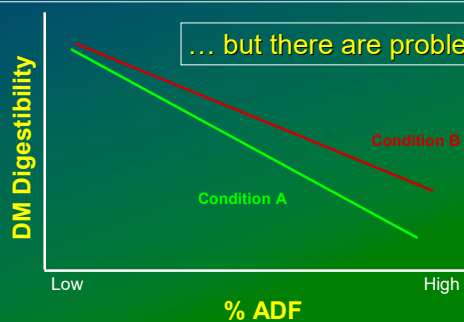
Acid Detergent Fiber

ADF has been the primary measurement to predict digestibility and energy of forages



Acid Detergent Fiber

ADF has been the primary measurement to predict digestibility and energy of forages



Forage Quality Index



Forage and Pasture Quality

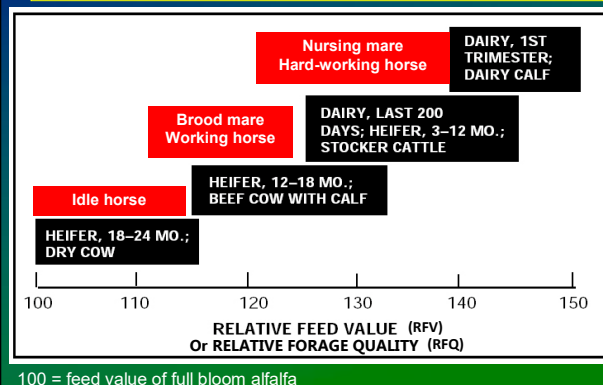
Forage Quality Index

The goal of a forage index is to have a single number that represents the quality of a given forage

- **Relative Feed Value (RFV)** - Developed in the early 1980's (best for pure legumes)
- **Relative Forage Quality (RFQ)** - Developed in the early 2000's (best for legume/grass mixtures)

A unitless number in which 100 equals the feed value of full bloom alfalfa

Forage Quality Index



Factors the Affect Forage Quality

- Plant maturity at time of harvest
- Forage crop species/ variety
- Climate, season and weather conditions
- Soil fertility
- Weeds, Diseases and Insects
- Harvest and storage factors
- Forage form and particle size
- Associated feeds

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Forage Quality and Plant Maturity



Forage and Pasture Quality

Plant Maturity and Forage Quality

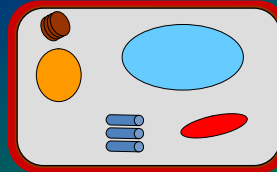
As plants mature:

- Increase in cell wall content particularly in stems



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Plant Maturity and Forage Quality

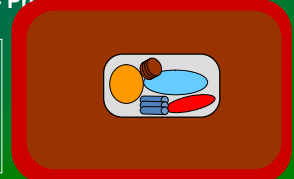


Young Cell or Mesophyll Cell

- Low in total fiber
- Fiber is low in lignin
- Highly digestibility
- Predominant in leaves

Mature Cell or Structural Cell

- High in total fiber
- Fiber is high in lignin
- Low digestibility
- Predominant in stems



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Plant Maturity and Forage Quality

As plants mature:

- Increase in cell wall content particularly in stems
- Decrease in cell wall digestibility



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Leaf to Stem Ratio

As plants mature:

- Increase in cell wall content particularly in stems
- Decrease in cell wall digestibility
- Decrease in leaf-to-stem ratio



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Forage and Pasture Quality


Leaf-To-Stem Ratio

Alfalfa Quality

Leaf
23% CP
27% NDF
18% ADF

Stem
10% CP
66% NDF
51% ADF

Whole plant quality will depend on leaf-to-stem ratio



Factors that Affect Forage Quality



- Maturity at time of harvest
- Forage crop species/ variety
- Climate, season and weather conditions
- Soil fertility
- Weeds, Diseases and Insects
- Harvest and storage factors

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Species and Forage Quality

Forage Crop Species

- Legumes versus Grasses

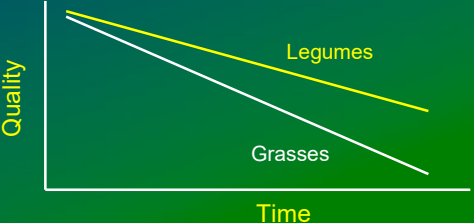


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Species and Forage Quality

Legumes Verses Grasses

- Generally, legumes maintain their quality longer as plants mature



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Forage and Pasture Quality

Variety and Forage Quality

Variety

- Generally, variety has less impact on quality than most other factors, except...
 - If a variety improves palatability or decreases anti-quality factor
 - Varieties may differ in heading date which can affect ease of making good hay

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Species/Variety and Forage Quality

Forage Crop Species/Varieties Anti-quality factors

- Fescue endophyte
- Reed canarygrass alkaloids
- Red clover slobbers
- Nitrates
- Clover estrogens
- Etc.

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What about quality and palatability issues with tall fescue?

- Endophyte levels?

Most all newer tall fescue varieties sold for haylage or pasture is either endophyte-free or has a “novel” endophyte

Endophyte Infected Tall Fescue

Fungal hyphae grow between plant cells, with the highest concentrations in the stem and seedheads.

Pollen contains no endophyte.



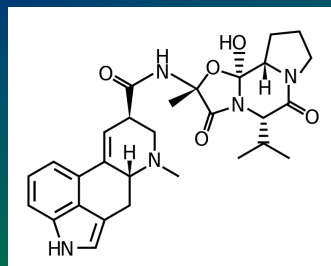
Endophyte mycelium in seed.



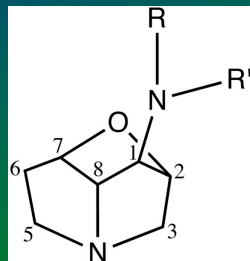
Endophyte in leaf stem tissue.

Forage and Pasture Quality

Tall Fescue Alkaloids



Ergovaline

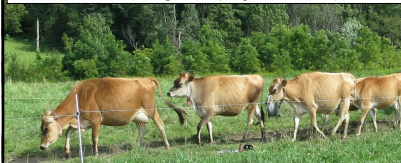


Loline

One of the Ergot Alkaloids

Northeast study conducted by USDA-ARS

Abundance in the Northeast: Tall fescue was found on 89% of the farms sampled and 84% of the pastures. Its average cover was 17.3% where present (range 0.1 - 89.9%).



Pasture Plants of the Northeastern United States 2014
Sarah Goslee, USDA-ARS Pasture Systems and Watershed Management
Research Unit, Bldg. 3702 Curtin Rd., University Park, PA 16802

Testing for endophyte

- ELISA test
- Randomly collect 60 to 100 fresh tillers
- Cut out and save the lower portion (crown and lower three inches of the tiller)
- Keep cool and fresh



Stem cross sections are placed in ELISA cells for detection

What about quality and palatability issues with tall fescue?

- Endophyte levels
- Leaf coarseness

Leaf coarseness is not likely an issue with haylage put up at high quality but it can be an issue for pasture mixtures especially with dairy cows.

Forage and Pasture Quality

Tall Fescue Leaves Can Be Very Coarse



Soft-Leaved Tall Fescue



BARENBRUG

Soft-leaved tall fescue

Traditional Rough leaf tall fescue

The Fescues

Tall Fescue



Hairs

Meadow Fescue



Smooth

Meadow Fescue

Characteristics

- More palatable than tall fescue
- Higher NDF digestibility
- More winter hardy
- Lower yielding than tall fescue

Forage and Pasture Quality

Factors the Affect Forage Quality

- Maturity at time of harvest
- Forage crop species/ variety
- Climate, season and weather conditions
- Soil fertility
- Weeds, Diseases and Insects
- Harvest and storage factors

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Weather and Forage Quality

- Warm, sunny conditions promote photosynthesis which improves growth and energy
- Cool, cloudy weather decreases energy
- Hot temperatures increase lignin content
- Dry weather often increases sugar content and legume content
- Generally, excessive rainy seasons are the worse on forage quality

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Factors the Affect Forage Quality

- Maturity at time of harvest
- Forage crop species/ variety
- Climate, season and weather conditions
- Soil fertility
- Weeds, Diseases and Insects
- Harvest and storage factors

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Forage and Pasture Quality

Pests and Forage Quality

Weeds

- Weeds can have similar forage quality to forage plants
- Their quality response to maturity is similar
- Weeds tend to mature quicker than most crops



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Weeds Can Be Nutritious

Table 1. Crude protein and in vitro dry-matter digestibility (IVDMD) of selected broadleaf and grassy weeds and three forage species.^a

Weed	% Crude protein	% IVDMD
Broadleaves		
Henbit (<i>Lamium amplexicaule</i>)	20.1–16.2	78–75
Virginia pepperweed (<i>Lepidium virginicum</i>)	31.9–17.1	86–63
Curly dock (<i>Rumex crispus</i>)	29.9–16.1	73–51
Redroot pigweed (<i>Amaranthus retroflexus</i>)	23.9–10.6	73–64
Jimsonweed (<i>Datura stramonium</i>)	25.1–16.5	72–59
Grasses		
Cheat (<i>Bromus secalinus</i>)	23.4–13.8	81–61
Little barley (<i>Hordeum pusillum</i>)	23.6–13.8	82–62
Fall panicum (<i>Panicum dichotomiflorum</i>)	19.0–7.2	72–54
Yellow foxtail (<i>Setaria lutescens</i>)	17.5–14.3	73–57
Large crabgrass (<i>Digitaria sanguinalis</i>)	14.3–6.4	79–63
Forages		
Ladino clover 'Regal'	27.2–23.2	81–83
Tall fescue 'Kentucky 31'	22.1–12.5	78–67
Rye 'Wrens Abruzzi'	27.9–13.4	79–70

^aRange of values corresponds to samples evaluated from the vegetative stage to fruiting stage (broadleaves or forbs) or heading (grasses). Palatability for these weed species was not determined. (Adapted from Bosworth et al. 1980, 1985)

But many weeds are unpalatable or toxic



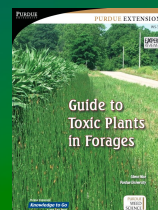
Info on Poisonous Plants

- Numerous books, fact sheets, and websites on toxic plants
 - Trust university or science-based publications
- *Consult with veterinary scientist if you have concerns*



<http://research.vet.upenn.edu/poisonousplants/Home/tabid/5034/Default.aspx>

www.extension.purdue.edu/extmedia/WS/WS_37_ToxicPlants08.pdf



Forage and Pasture Quality



Sampling Procedure

Modified from Dairy One:

- Randomly select 12-20 sites where the animals will soon be grazing and clip a handful of forage at grazing height.
- All subsamples should be combined and thoroughly mixed in a clean plastic bucket to form a composite (further cutting the forage into 2 - 3 inch (5 - 8 cm) pieces aids in blending).
- Take a one pound (0.5 kg) sample, pack tightly in a plastic bag and freeze for 12 hours prior to submitting for analysis.
- Freezing will help prevent marked chemical changes due to respiration or fermentation.



Testing For Forage Quality

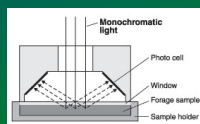
Methods of Analysis

- Wet chemistry
 - Crude Protein (N)
 - ADF, NDF
 - Starch
 - Minerals
- In vitro methods (DDM, Dig. NDF)
- Near Infrared Reflectance Spectroscopy (NIRS)

Testing For Forage Quality

Methods of Analysis

- Near Infrared Reflectance Spectroscopy (NIRS)
 - Used to predict wet chemistry and in vitro constituents



Forage and Pasture Quality

