Forages 101

Carolyn L. Wong
State Grazing Land Management Specialist
NRCS Pacific Island Area

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Objectives

- Awareness of forage plant anatomy
- Understand how a forage plant functions and grows
- Awareness of forage quality factors
- Understand what affects plant vigor

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Some basics about grass

- Bunch grass vs sod-forming grass
- Grasses can start from seed or vegetative sprigs (most sod-forming grasses)
- There are "cool season" (temperate) and "warm season" grasses (tropical)
- Phases of grass growth:
  - Seedling
  - Vegetative (Seedling -> Tillering)
  - Elongation or Transition
  - Reproductive

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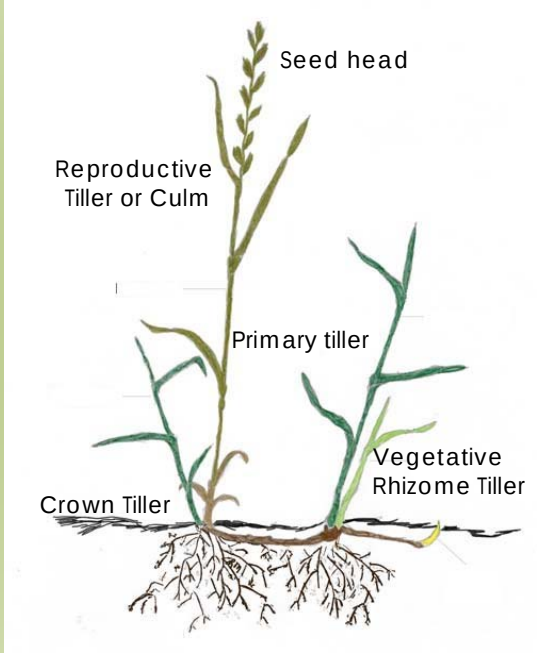
Grass Anatomy

- A grass plant is made up of tillers
- Vegetative tillers have leaves and roots
- The reproductive tiller or culm produces a stem, seed head, leaves and roots
- Tillers start from
  - Basal buds located in the crown area OR
  - Rhizomes and stolons
- Tillers are more nutritious when they are vegetative.

Source: L.L. Manske North Dakota State University



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Grass Anatomy – structures used for identification

Awn: A bristle characteristic of the spikelets of some grasses.

Node: Joint where the leaf attaches to the stem.

Internode: Area of the stem between two nodes

Rhizome: A stem that grows horizontally underground and may root at the nodes.

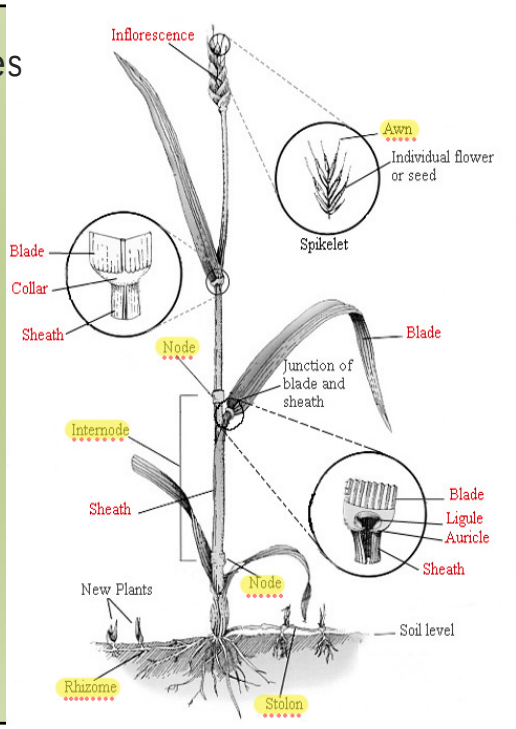
Stolon: A stem that grows horizontally above the ground that may root at the nodes

Sheath: base portion of the grass leaf that wraps around the stem

Collar: Junction between the blade and sheath.

Ligule: A thin membrane or fringe of hairs at the collar.

Auricle: An earlike lobe at the base of leaf blades adjacent to the collar.



Source: Penn State University

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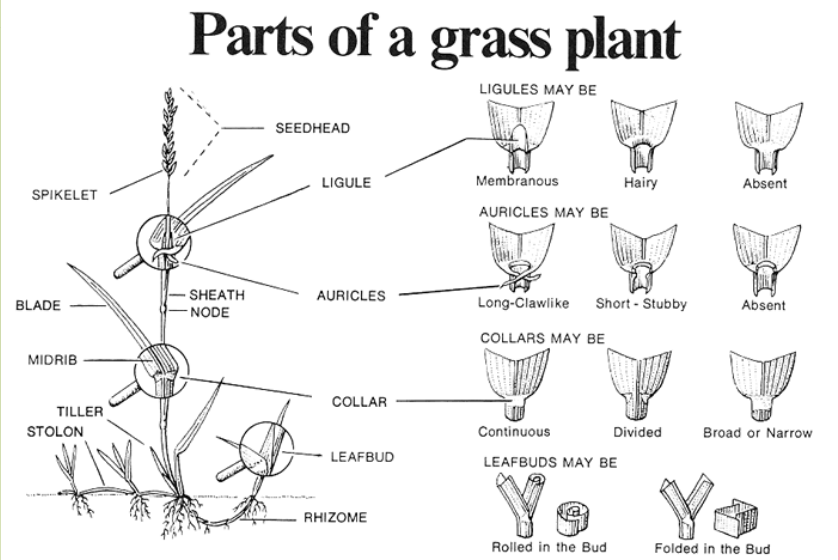
More Grass Anatomy



Source: University of Georgia

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Grass Anatomy and Physiology

- Growth, as well as re-growth, depends upon cell division and cell expansion
- These areas where cell division and expansion originate are called <u>meristems</u>
- The goal of grazing management is to maintain the apical meristems in an active growth phase
- Three types of meristems
  - Apical meristems or leaf buds
  - Intercalary meristems
  - Reproductive meristems or floral buds

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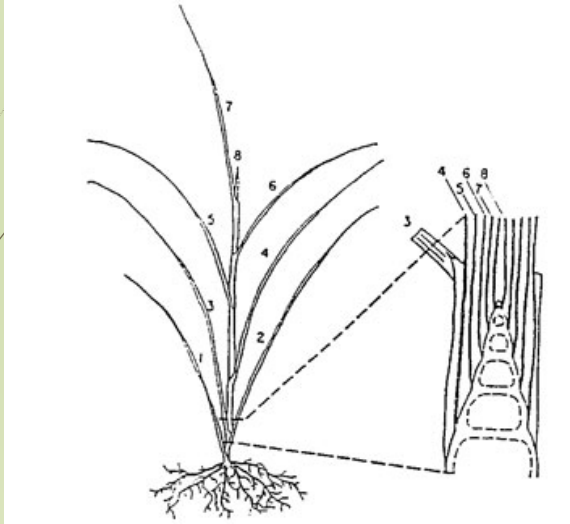
Apical meristem



Source: Colorado State University, Extension

- Responsible for leaf formation
- Known as the "growing point" or "leaf bud"
- Growth is similar to a telescope, with new leaves coming up from inside old leaf sheaths

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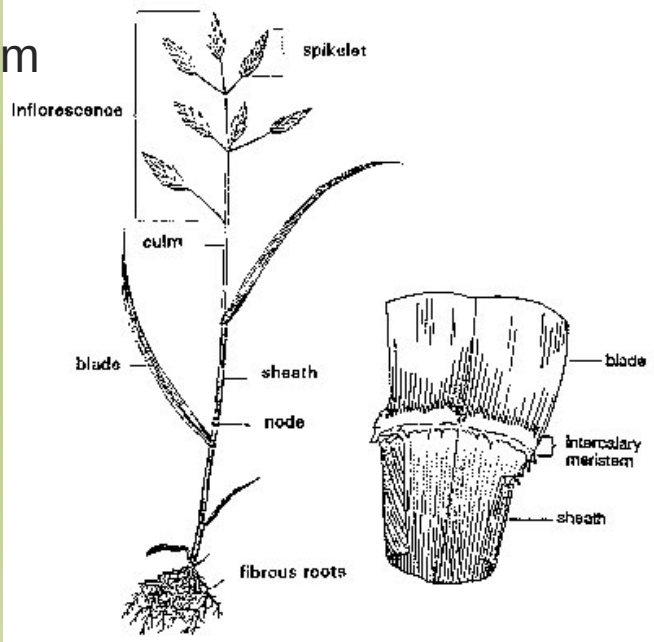
Intercalary meristem

- At the base of leaf blades, adjacent to the sheath
- Cells formed here support leaf expansion and growth.



Source: Colorado State University, Extension

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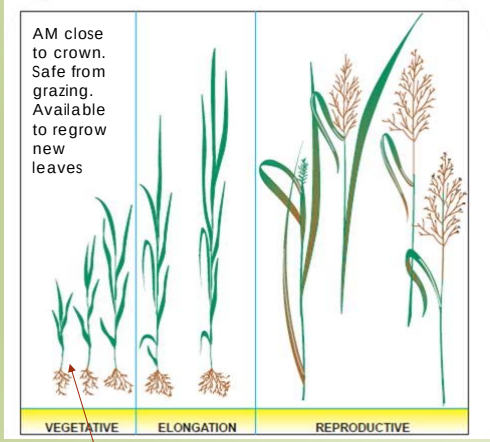
Growth phases

- Vegetative phase
  - Mostly leaf
  - No evidence of sheath elongation or culm development
  - Apical meristem is close to the ground
  - Grass is more digestible and nutritious at this stage.



Apical meristem

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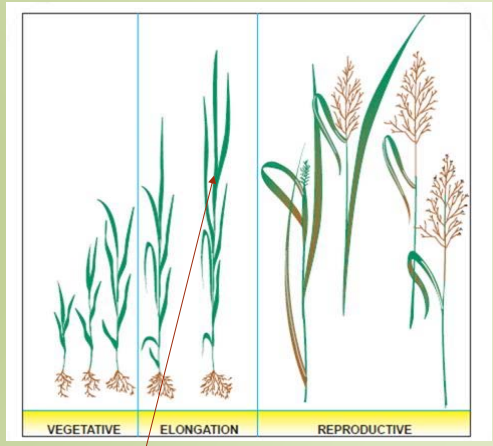
Growth phases

- Elongation or transition phase
  - Triggered when mature vegetative grass plant experiences day-length, temperature or other environmental variables
  - floral induction begins
  - Apical meristem (AM) is converted from a vegetative bud to a floral bud.
  - Leaf sheath and internode elongates elevating the floral bud (aka apical meristem)

AM elevated. Vulnerable to grazing. Now a floral bud.



Apical meristem

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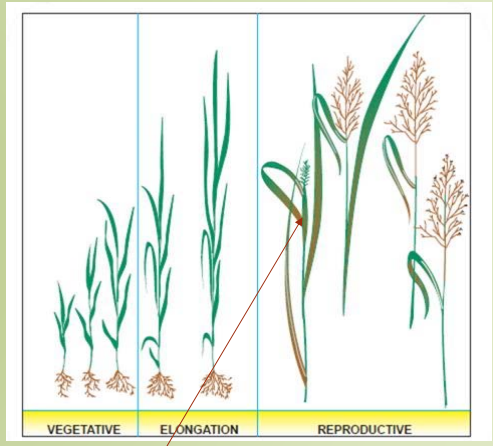
Growth phases

- Reproductive phase
  - Inflorescence forms
  - Just before it emerges it is covered by the leaf sheath – this is called the "boot stage"
  - Inflorescence emerges and seeds mature, dry and drop.
  - Grass life cycle is complete
  - Grass begins to senesce.



Apical meristem

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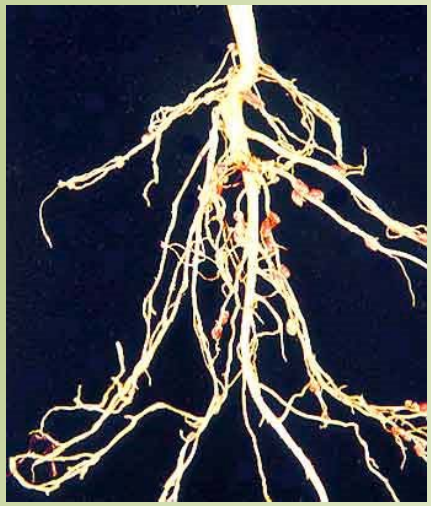
Legumes

- Specific class of “forb”
- Are often very digestible and high in crude protein
- Form symbiotic relationship with N-fixing bacteria in their roots for N-fixation
- Fixed N can be used by legume for growth or is released in soil as roots die off.
- Established by seed and/or sprigs



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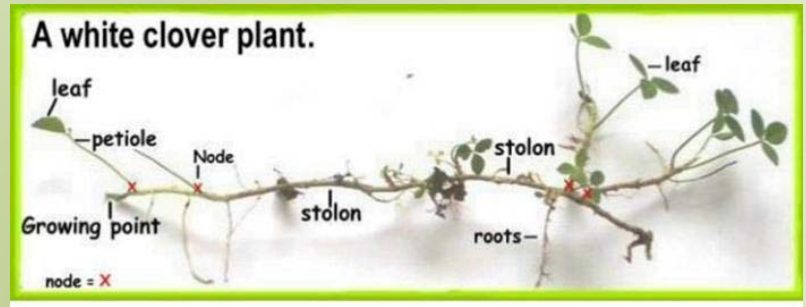
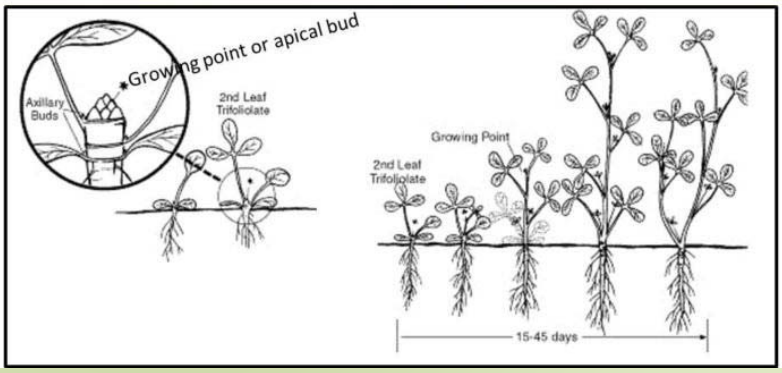
Legumes

- Have apical meristems or leaf buds like grass
- Auxiliary buds produce stems, rhizomes and stolons
- AM are often up higher on legumes than on grass plants





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N-fixation by legumes

- Most fixed N is found in leaves and stems, available as protein to grazers
- Much of N consumed by livestock is recycled via urine and manure
- Actual N fixation rates vary based on species of legume, degree of nodulation, pasture composition, soil conditions, water availability and other environmental factors.

White clover

Kaimi clover

Vetch

Leucaena

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Things to know about legumes...

- Not all legumes are good forage!
- In certain situations, may cause bloat
- Some have secondary compounds that make them toxic
- Often have some level of condensed tannins
  - Tannins, in right amounts, can be beneficial
    - By-pass protein effect
    - Anthelmintic (anti-parasitic) effects

Creeping indigo -> indospicine

Crotalaria -> alkaloids

Coffee senna -> anthraquinones and alkaloids

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Forage Quality

- A grass is not a grass is not a grass. OR
- *"Not all forages are created equal!"*
- Defining "Forage Quality" is complicated!
  - ✓ Protein
  - ✓ Fiber
  - ✓ Minerals
  - ✓ Fats
  - ✓ Sugars
  - ✓ Starches
  - ✓ Antinutritional compounds
  - ✓ Physical and olfactory factors (thorns, smells)
  - ✓ Animal class' ability to extract nutrients

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Forage Quality

- Factors that affect quality
  - Dry matter content or Percent Moisture
  - Digestibility (NDF and ADF)
  - Energy
  - Protein
  - Secondary Compounds (alkaloids, tannins, terpenes, saponins, etc)

*Intake: how much the animals can take in or consume.
*Performance: the effect of the forage source on livestock health and condition

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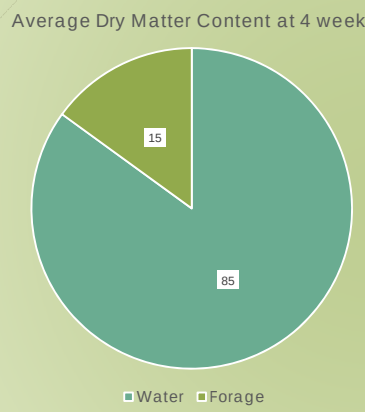
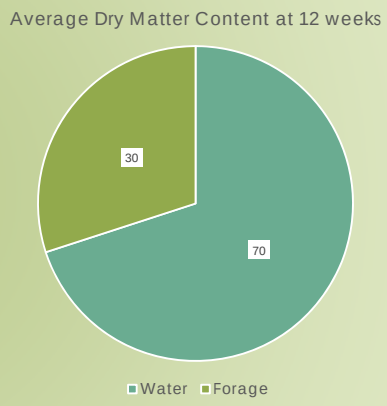
Forage Quality – Dry matter





Typical dry matter values of tropical forages

Sources: UH-CTAHR publications and Smith's Intensive Grazing Management.

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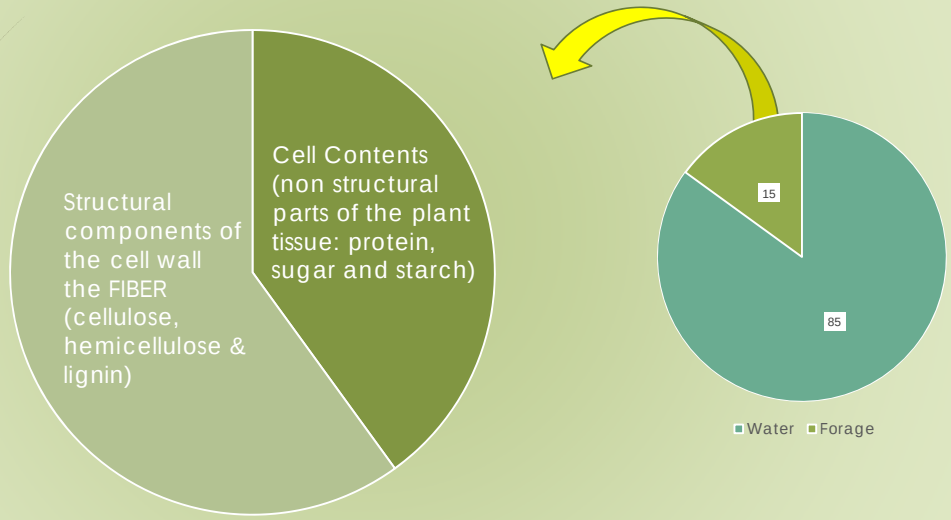
Forage Quality – Dry matter



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Forage Quality – Fiber

Cell Wall: (40-70% of DM)

Cell Solubles:
(30-60% of DM)
Sugars, Starches
(ENERGY)
Fats, **Protein**
(95-100% digestible)

Neutral Detergent Fiber NDF
- Hemicellullose (20-80% digestible)

+

Acid Detergent Fiber
- Cellulose (50-90% digestible)
- Lignin (0-20% digestible)

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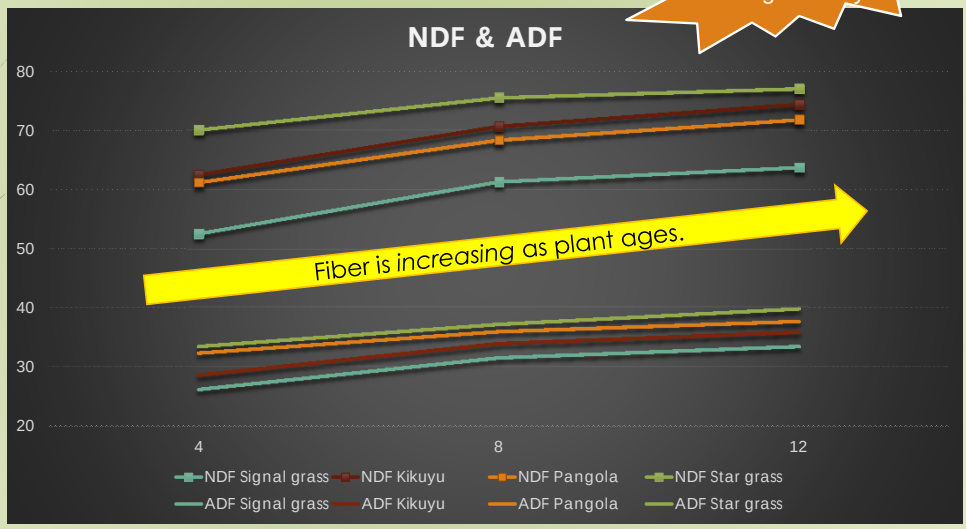
Forage Quality - Fiber

Higher Fiber = Lower Digestibility



Sources: UH-CTAHR publications

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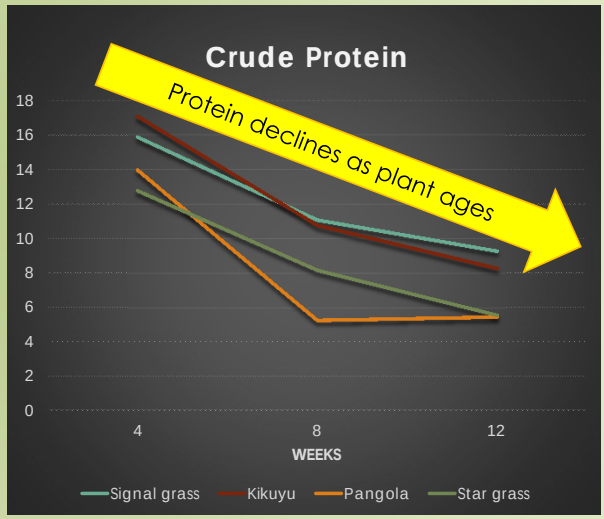
Forage Quality - Crude Protein

- % Crude Protein is an estimate derived from a measurement of Nitrogen
- Proteins are comprised of amino acids
- Depending on the actual form of protein, it can take different paths
  - Bypass protein – passes through rumen undigested
  - Degradable Intake Protein – is degraded in the rumen, some used by microoganisms, some pass through
- About 70% of ruminant protein source actual comes from microbes.



Source: UH-CTAHR publications

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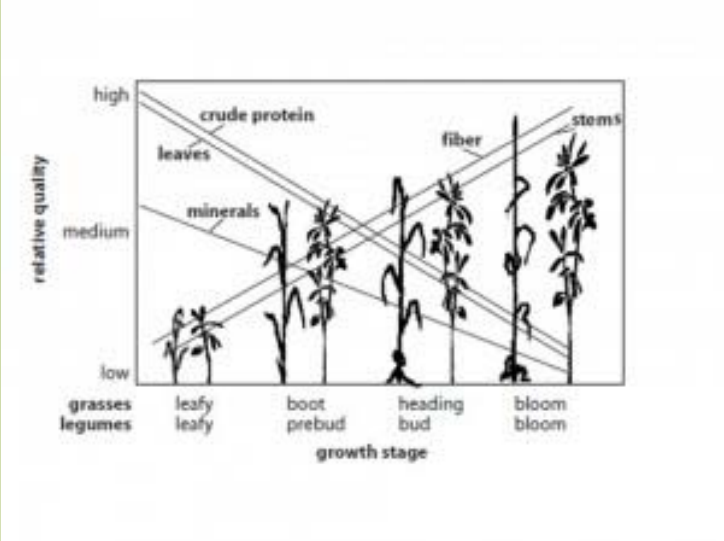
Forage Quality over Time



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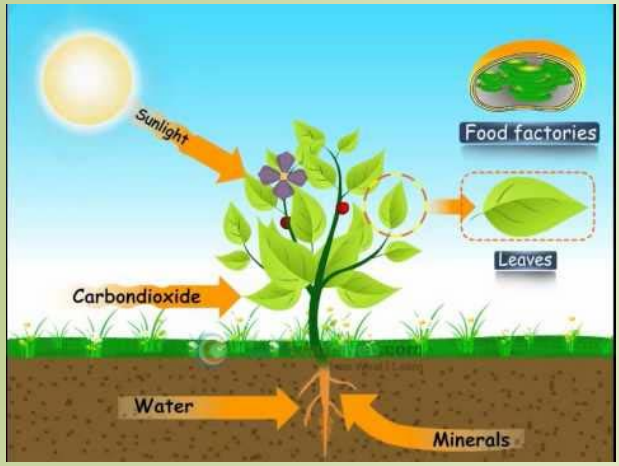
Energy production, use and storage

- Energy from the sun is combined with CO2 in the air and transformed into carbohydrates in the plant
- Photosynthesis takes place primarily in the leaves*
- Energy produced is either used immediately to support more growth or if there is excess, it is stored in the plant.
- Stored carbohydrates levels can vary even within a single day
- Stored carbs can be used to support regrowth when photosynthesis is low such as after grazing event



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Factors that affect plant vigor

- Environmental factors:
  - Moisture – too little or too much
  - Soil composition and fertility
  - Temperature
- Stress
  - Insect pressure (leaf hoppers, aphids)
  - **Grazing pressure** (domestic or wildlife)
  - Disease
- Physiological factors
  - Healthy root system
  - Availability of stored energy
  - Ability to photosynthesize
  - Presence of growing points
  - Stage of plant growth

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Forage plant reproduction

- Our tropical forages mostly behave as perennials
- Some will reproduce and spread via seed (guinea, buffel, kaimi clover, white clover, leucaena)
- Many spread vegetatively (kikuyu, pangola, signal, star grass, desmodium)
- Many do both
- Understanding how the forage reproduces is important as it affects plant density and persistence.

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Plant vigor and density affects Forage **Quantity**

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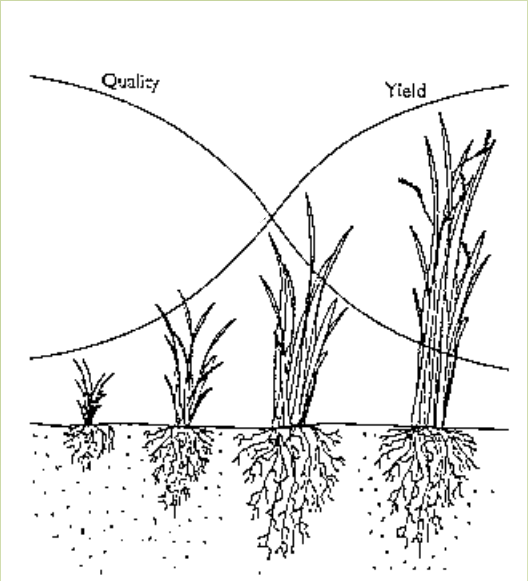
Quality and Quantity depend on plant age



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"Disturbances" and plant response

- A "disturbance" is anything that disturbs a plant's physical condition
  - Fire
  - Flooding
  - Frost
  - Herbicide
  - Mowing
  - Pruning
  - Insect attack
  - **Grazing**

The type of, degree and frequency of a disturbance can affect a plant community

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Response to disturbance

- A plant's ability to regrow after a disturbance depends on several things including
  - Type and Degree of disturbance
  - Ability to photosynthesize
  - Availability of resources (moisture, energy)
  - Presence of growing points
  - TIME

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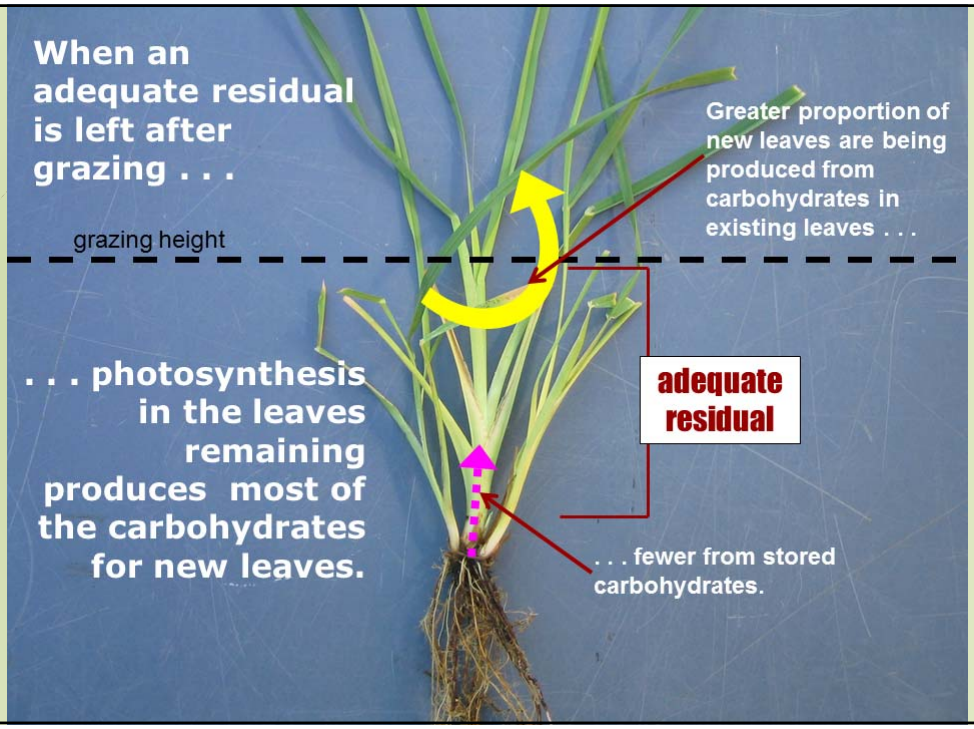

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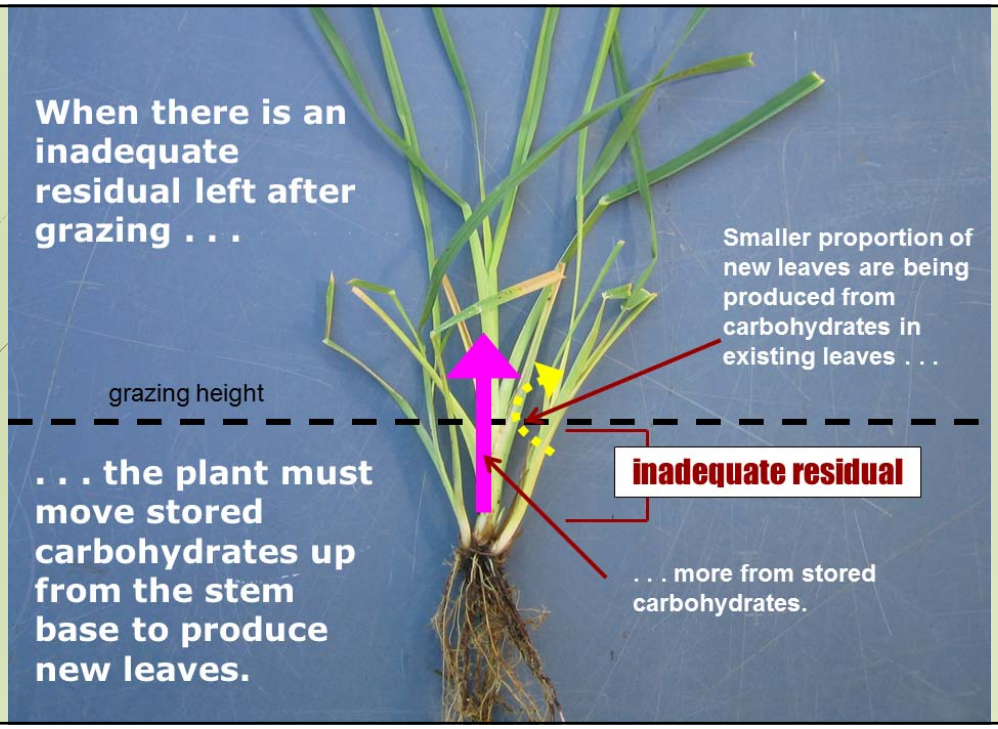

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Summary

- As conservationists we need to understand
  - Forages, how they grow and their value
  - How that is measured
  - Ecological dynamics at work in a grazing land setting
  - "grazing" is basically a managed (or unmanaged) disturbance
- This understanding will help us to
  - Properly identify resource concerns
  - Assist a producer in identifying and evaluating alternatives
  - Managing their grazing system towards achieving their management objectives.