Soil and Plant Basics

2016 EKS Grazing School

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What Plants Need to Grow…

- Sunlight
- Air
- Water
- An anchor point for plant roots – aka soil!

We can do little to affect sunlight or air.
That means focused energy on soil and water!

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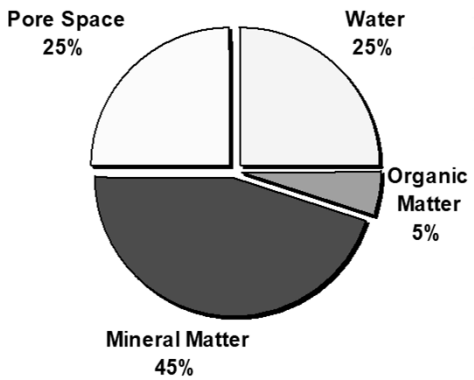
What is Soil?



Mineral

- Sand, Silt, Clay

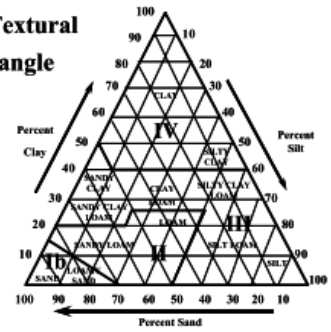
Organic Matter

-Decomposed Plants

- Decomposed Microorganisms

-Decomposed Animal Material

Soil Textural Triangle



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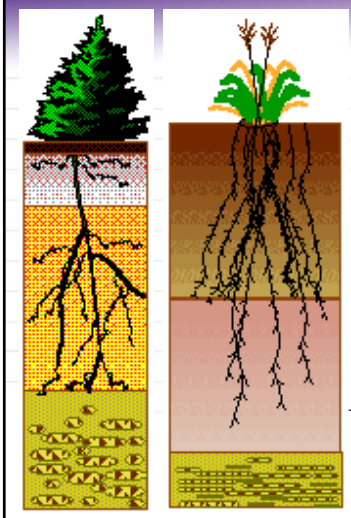
Consisting of…Soil Horizons



Surface Soil - Zone of maximum organic matter accumulation/leaching

Subsoil - Zone of maximum accumulation of clay, iron, lime and aluminum. Lighter in color than surface soil.

Parent Material - Geological material such as loess or glacial till similar to the original material from which A and B horizons developed.

Bedrock - Varies greatly in thickness and depth.

Crop	Rooting Depth	Major Feeding Zone
Alfalfa	20 ft. +	50% in top 3.5 ft.
Bromegrass	5.5 - 6.5 ft.	75% in top 3.5 ft.
Wheat	4 – 6 ft.	80% in top 3 ft.
Corn	4 - 7.5 ft.	75% in top 2 ft.
Grain Sorghum	4.5 - 6 ft.	75% in top 3.5 ft.

Weaver, Root development of field crops

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Offsetting 'deficiencies' in soils…

- Native grasses don't tend to require the fertility levels of our introduced species, more effectively extracting nutrients from the soil and more efficiently utilizing them for plant growth.
- Introduced species – including the brome and fescue that dominate our introduced pastures – typically have a nutrient requirement.

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What do grasses require?

- Thirteen essential nutrients
  - *Nitrogen, phosphorus, potassium*, calcium, magnesium, *sulfur*
  - Iron, manganese, boron, molybdenum, copper, zinc, and chlorine
- Micros are needed in lower concentrations to ensure adequate supply
- Organic matter is an important source!

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Nitrogen

- Nitrogen functions in the plant
  - Proteins
  - Chlorophyll
  - Enzymes and other compounds
  - Necessary for respiration, growth and reproduction
- Nitrogen fertilization
  - Required in largest quantities and most frequently deficient
  - Increased forage yield and quality of nonlegumes
  - Improved root growth and H_2O use efficiency

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P/K/S

- Phosphorous plays a key role in many vital plant processes:
  - root development
  - Reproduction
  - energy transfer.
- Potassium affects:
  - plant vigor
  - disease resistance
  - forage quality
  - winter survival
- Sulfur is critical to:
  - protein formation
  - N-fixation (legumes)
  - maintaining root growth

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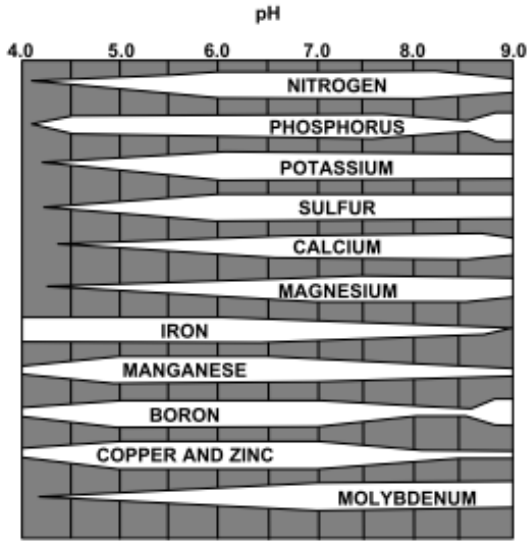
Soil pH

- Soil pH affects availability of the previously mentioned nutrients
- In general the solubility and availability of nutrients are greatest in acid soils and lowest in high pH calcareous soils

Effect of Soil pH on Nutrient Availability



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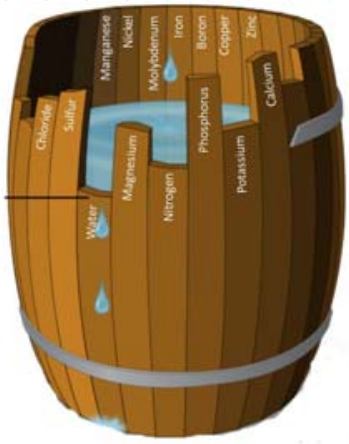
Fitting it all together…



- Leave one nutrient deficient and productivity is limited
- Note the water stave…
  - In dryland forage production, water may well be limiting to maximum production – but it doesn't make balanced fertility any less important!
- When applicable – soil test! Help the soil provide what the forage that is planted on it needs!

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Rotational Grazing & Nutrient Recycling

- Grazing animals excrete in their feces and urine between 70 and 90% of N, P, and K they consume from forage
- Rotational grazing provides better manure distribution than continuous grazing
  - Smaller paddocks and shorter distance to water found in rotational grazing systems improve manure distribution

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PLANT GROWTH AND DEVELOPMENT

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Plant Types…

- Cool vs. Warm Season
  - When plants reach certain temperatures, they begin to grow
    - C3 species are cool season plants, growing well when temperatures are in the 40's through 75 degrees F.
    - C4 species are warm season plants, growing well when temperatures are from 70 – 95 degrees F
- Grass vs. Legume
  - Grazing can affect them differently!
- Annual vs. Perennial
  - May very well change our approach to grazing management

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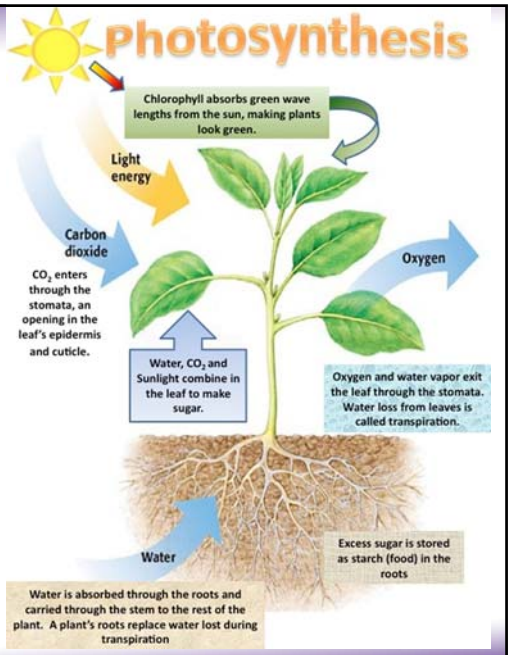
Simply put…

- Leaves grow
  - Sunlight captured and converted to carbohydrates, that's photosynthesis…
    - Energy is converted to proteins, fibers, oils, etc… as the plant develops new leaves/stems/seeds
    - Unused energy for those processes accumulates or is stored in roots and the plant crown
      - From here, we get regrowth after grazing and spring green up



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A quick explanation of grass growth & development

- A grass plant is made up of tillers that produce roots and leaves
  - Vegetative: mostly leaves
  - Reproductive: stems/seedheads/roots/leaves
- We typically break tiller growth in to three stages:
  - Vegetative
  - Elongation/Jointing
  - Reproductive

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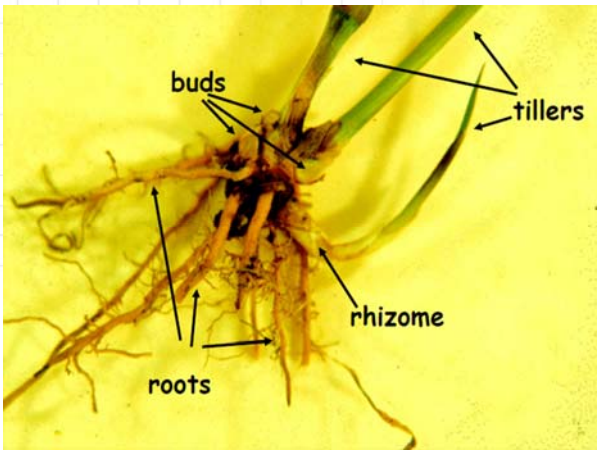
The start of vegetative growth…



- Leaves extend in length or height from the formation & growth of new cells at the base of each leaf blade near the leaf sheath.
- Other leaves push up through the center of the plant, expanding as they extend.
- Buds @ the base of the plant produce tillers or shoots.
  - Tillers are made of up a set of repeating units bunched at the bottom of the plant: Leaf, Stem node, Stem internode, Bud
- The growing point is located near the soil line during the vegetative stage

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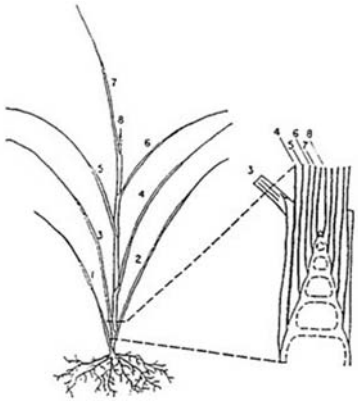
Vegetative growth notes…

- Chlorophyll development is rapid – but may not meet plant needs, requiring energy 'draws' from the plant crown until 2-3 leaves are formed***
- Leaves have a definite life span. Peak photosynthesis occurs when fully expanded, declining as they age until they can no longer support themselves and they die.



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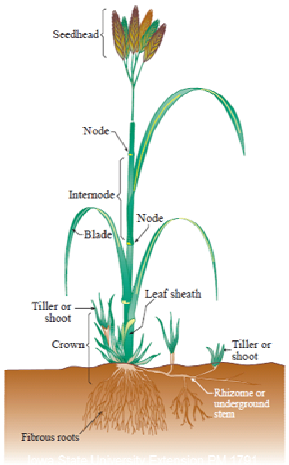
Next…the Elongation/Jointing Stage



- Growing points extend above ground and can be removed.
  - If only leaf tips are removed, growth continues.
  - If growing points along the base of the leaf near the sheath are removed, regrowth has to occur from the crown.
- Upper stem internodes lengthen while lower internodes stay the same
- Energy is being sent to:
  - New leaves
  - Roots
  - Seedhead?

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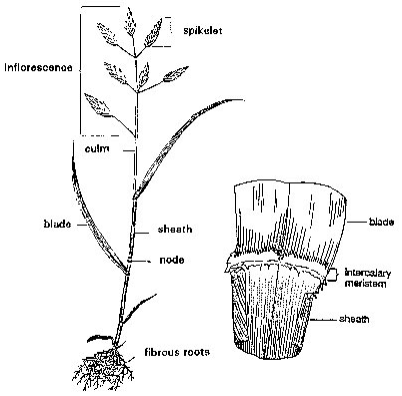
A switch to reproduction…

- As leaves senesce, plant hormones stimulate reproductive growth:
  - Stems develop
  - Fewer leaves are produced
  - A flower stalk (culm) expands
  - A seedhead (inflorescence) is produced.
- Growing point (apical meristem) moves up through the plant and can be removed initiating leafy tiller growth from dormant basal buds that will form new tillers.
- Chlorophyll production continues and feeds roots



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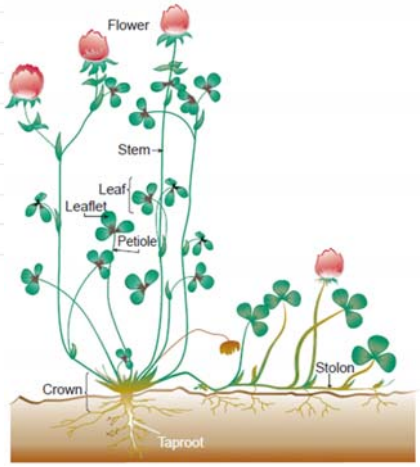
The Legume Difference



- Legume growth is a little different:
  - Alfalfa: upright growth habit with growing point near the tip
  - Red Clover/Birdsfoot Trefoil: intermediate growth habit and growing points further down the plant
  - White Clover: grows along soil surface on stolons that keep growing points close to the ground
- In general, broadleaves will have buds at the stem tip and along the stem at each leaf-stem junction.
- Most legume species also have dormant buds at the stem base, or crown, of the plant. These crown buds are the source of the first growth in the spring and can quickly produce new, leafy regrowth when growing stems are grazed or clipped.

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Answering the 'why do I need to know this…' question!

- Think of your forage as consisting of two parts:
  - ABOVE ground, leaves grow, receiving energy from roots/crowns/stems/older leaves, developing until it can support itself. Once it can support itself via photosynthesis, it sends energy to other parts of the plant: Other leaves, Stems, Seeds, Roots**
  - BELOW ground, as the roots 'kicked' off that new plant, it reduced root mass to do so and awaits replenishment
  - So long as the above ground growth continues as it needs to, roots will be replenished. If something goes 'awry' in the process, bad things can happen!
- Understanding growth and development can help you maximize growth of both!

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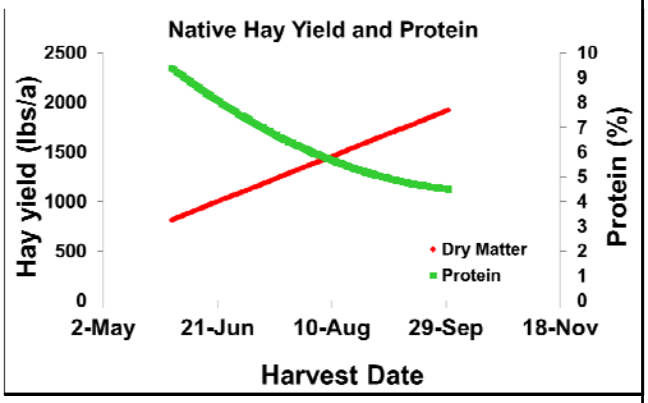
That's what we always do, isn't it?

- Not so much…
  - Since we want to provide a high quality forage diet, we like to harvest earlier in the life cycle when we have more leaves…lower fiber contents…and high levels of nutrients/energy to satisfy animal needs.
  - But if we harvest all of that leaf area, then roots can't be replenished, new leaves won't take off, and growth levels decline.



Baker et. al, 1999

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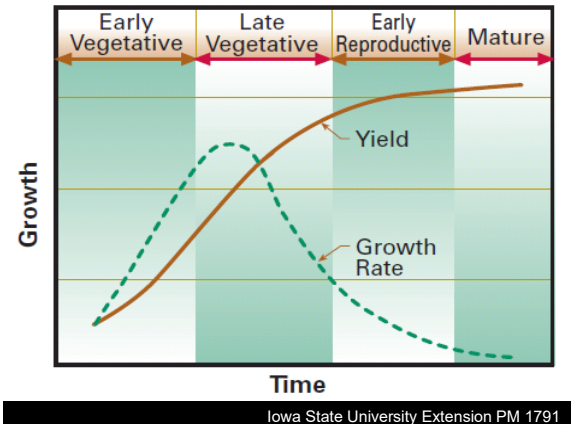
And…

- If we wait too long, digestibility/palatability declines as the leaf starts to senesce, and the animal won't meet nutrient demand – even as we are increasing yield!



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What we end up with is…

- Mature plants that are lower in quality
- Seedheads that have consumed energy
- Significant removal of new leaves that at one point were trying to replenish root reserves and stimulate new leaves.
  - If that's not happening, what's happening to the plant?

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Corresponding Root Growth

% Leaf Removed	% Root Growth Stopped	
10	0	
20	0	
30	0	
40	0	
50	2 to 4	
60	50	
70	78	
80	100	← Stops root growth 12 days
90	100	← Stops root growth 18 days

To remain healthy, 30% of grass root systems must be replaced annually

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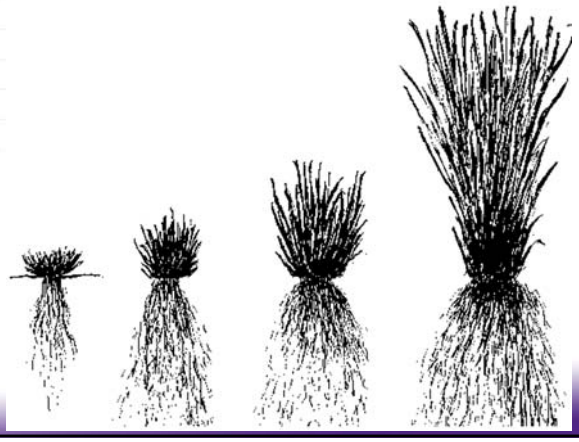
Bottom Line:

- We have to know how the plant is going to respond to our harvest management.



Root Growth = Top Growth = Root Growth = Top Growth = you get the idea

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Remember

- 5% of plant food is taken from the soil:
  - Roots gather raw materials (water, nutrients) which are converted into plant food by the leaves
- 95% of plant food is taken from the air
  - Leaves are Food Factories

Our grazing management affects both!

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Questions?

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Meristem

Where cell division takes place. In other words, where growth occurs.

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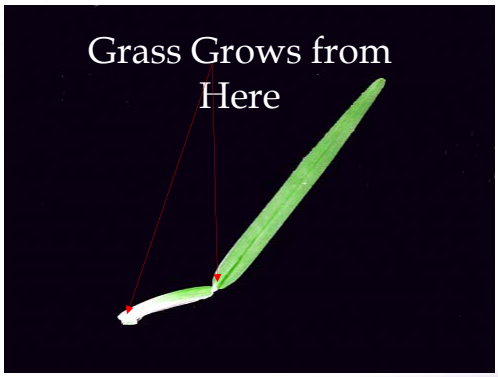
Where Does Grass Grow From?



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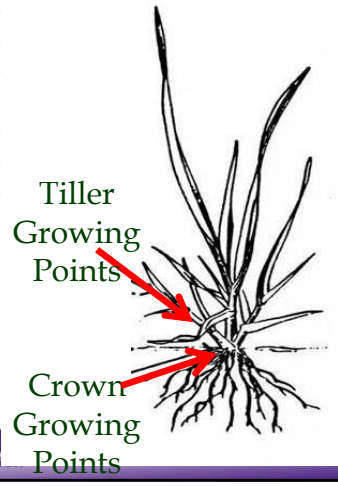
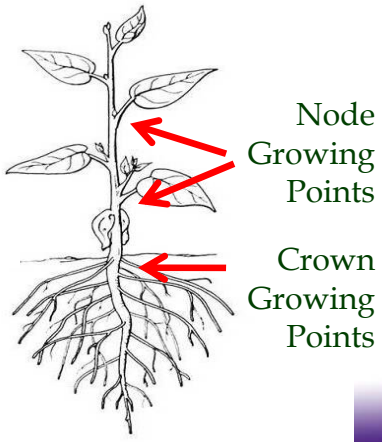
Plant Meristems

Monocots
Grasses, Sedges



Dicots
Broadleaves



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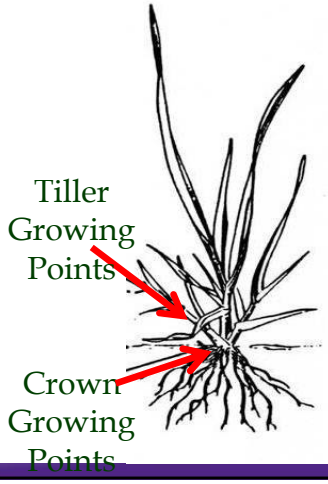
Plant Growing Points

Dicots

Node Growing Points

Crown Growing Points

Monocots
Grasses, Sedges



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