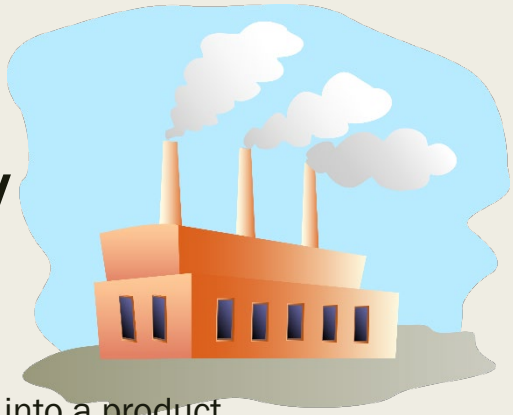
LESSON NINE:

How Plants Grow and Respond to Grazing

Plants Are Like a Factory



Factories utilize the manufacturing process to use energy to turn raw materials into a product. Like a factory, plants utilize the photosynthetic process to use solar energy to turn carbon dioxide, water, nutrients and minerals from the soil into carbohydrates and the waste product oxygen.

The above ground plant parts and roots are like a factory warehouse. The leaves, stems and flowers bring in the carbon dioxide through tiny pores on the lower side of leaves and the roots bring in water and other nutrients.

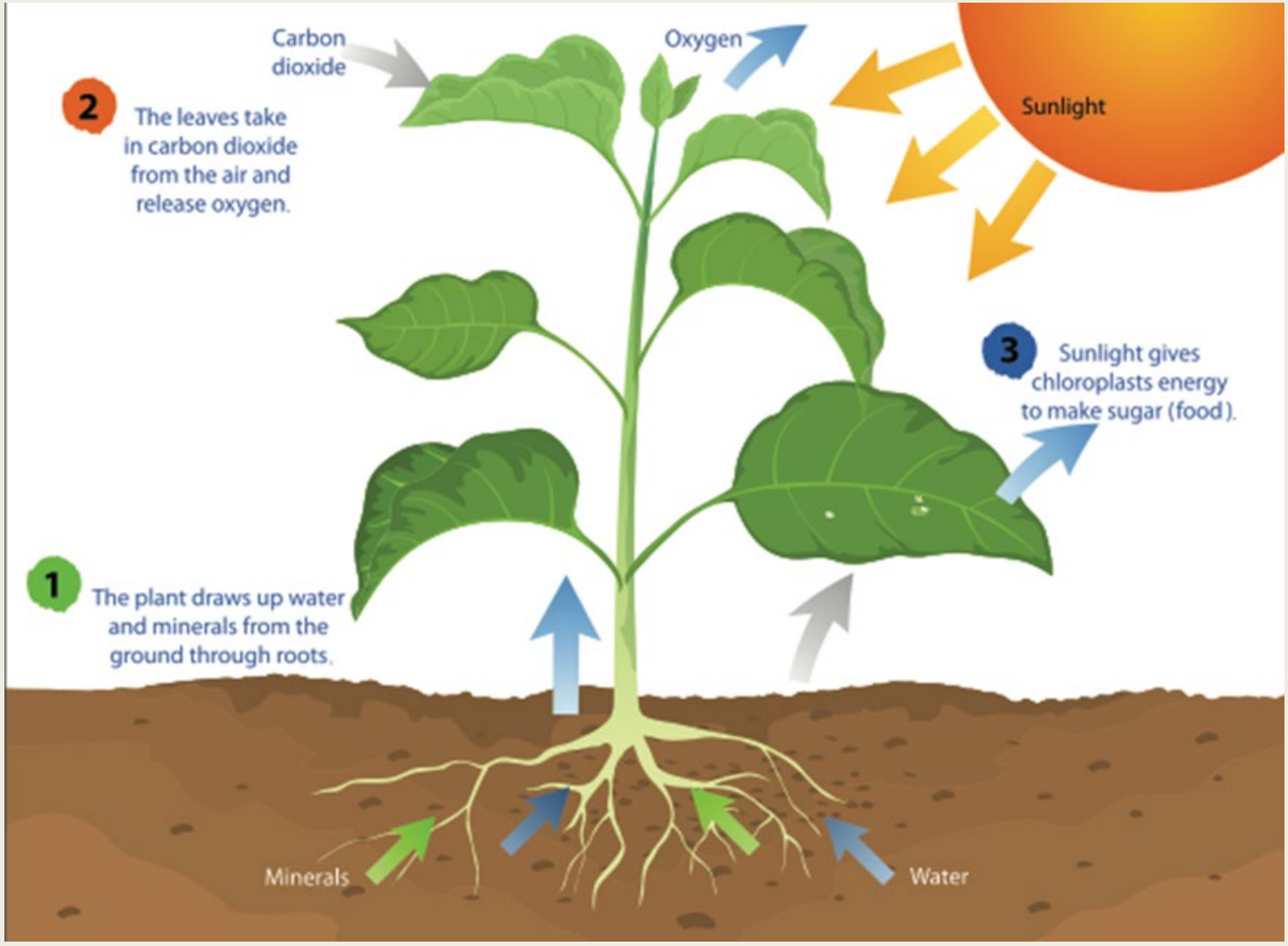
Chlorophyll is like a solar panel that provides energy to run the plant factory. Chlorophyll makes photosynthesis possible by absorbing solar energy. The more leaves on the plant, the more solar panels there are to collect the energy. More energy equals more production.

A number of chemical reactions occur to combine carbon dioxide and water into glucose. Glucose is combined with other elements to form proteins, complex carbohydrates, fats and plant oils.

The plant can use the products for upkeep of the factory, or store it for later use. The above ground stored materials may be consumed by the customers which are herbivores. The plant materials provide energy and nutrients to the herbivores.

Grazing is a natural ecological process that occurs on all rangelands.

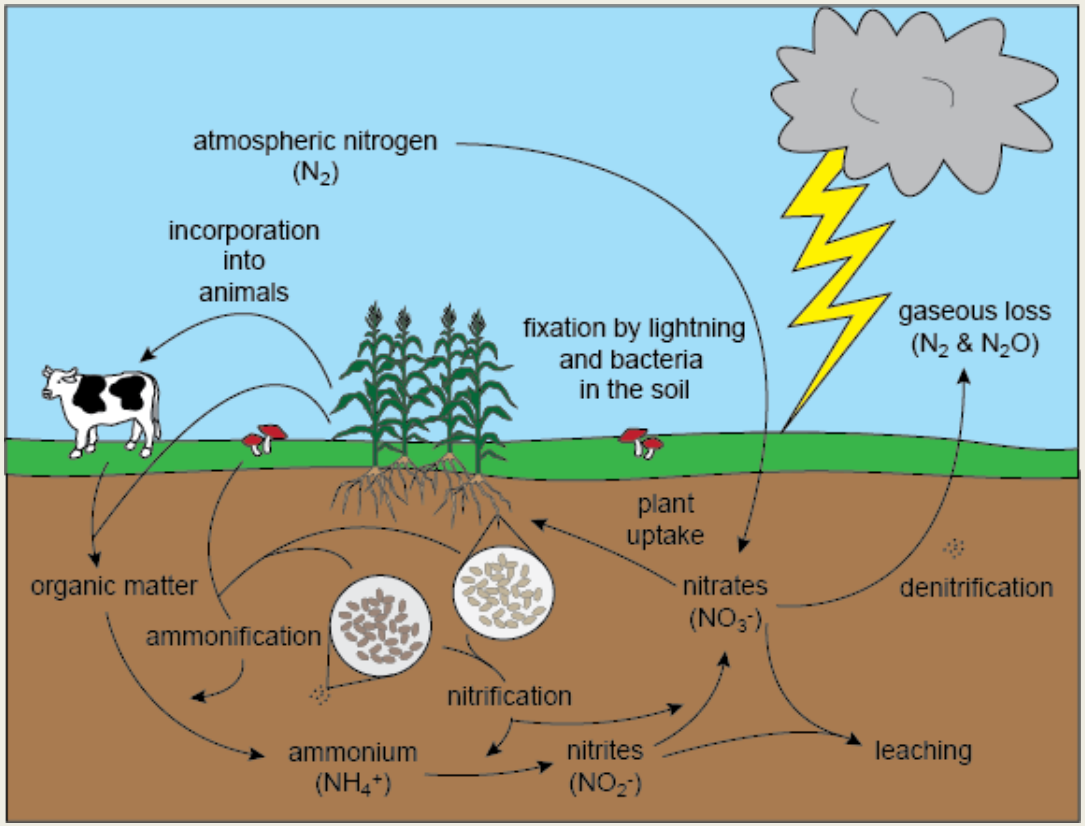
The Plant Factory - Simplified



The Plant Factory Is Complex

In real life, the plant factory is much more complicated. The photosynthetic process is impacted by the water cycle (weather and climate), the nitrogen cycle (shown below), the mineral cycle and energy flow.

The process is also impacted by how the plants were managed in the past (when grazed, how much was grazed, how long the plants were allowed to recover), and the soils on which the plants are growing (texture, organic matter, water holding capacity).



All plants have areas of tissues called growing points.

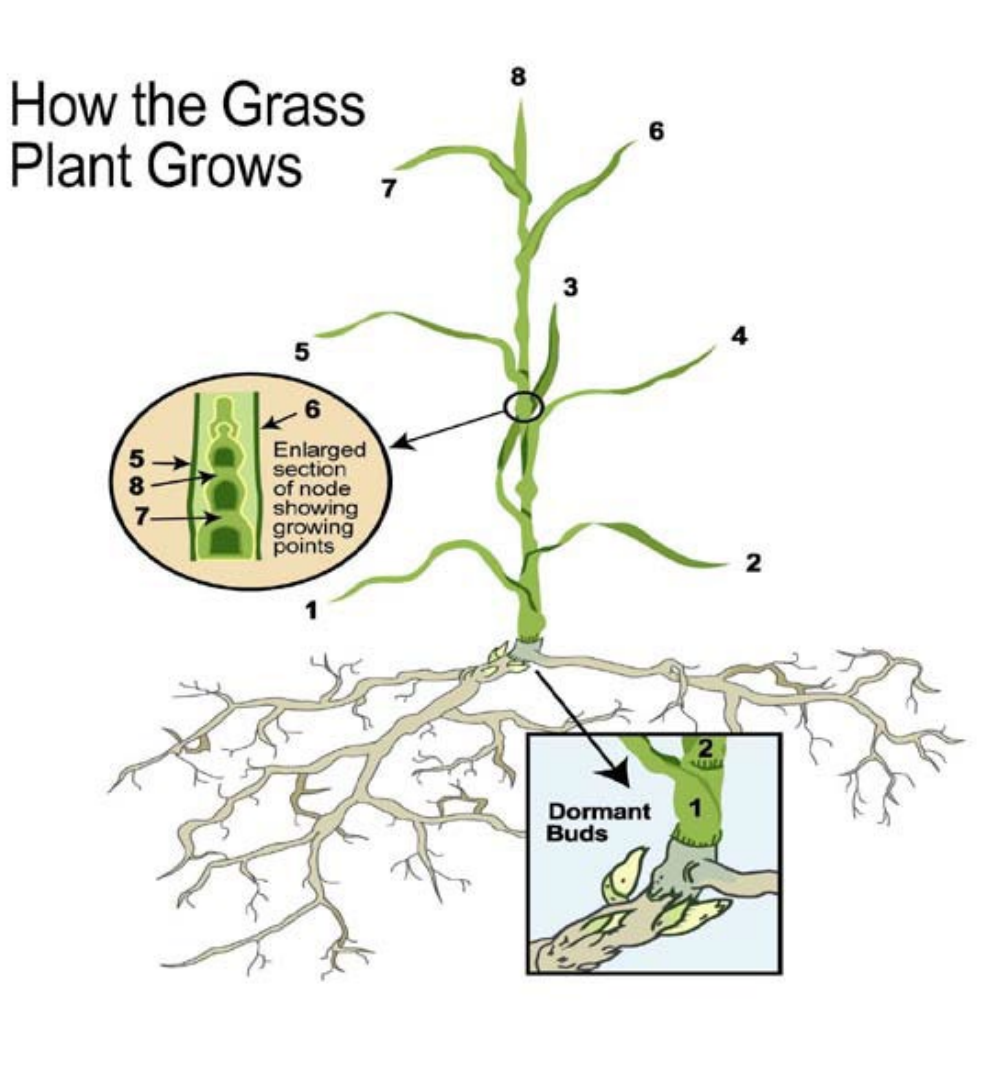
In grasses, the main growing points are located in the root crown or base of the plant.

The root crown has several to many buds or growing points each of which can produce new tillers and roots.

Tillers are connected and share water, carbohydrates and nutrients.

Each tiller has its own set of growing points that produce leaves. As the plant grows, the growing point elevates.

New leaves are pushed upward from the growing point.



Function of Grass Buds

Perennial grasses develop buds on the root crown each year. These buds contain stored energy that keeps the buds alive through the winter and allows them to produce new tillers in the spring.

The stored energy is used to grow the plant to the 2-3 leaf stage. At this point photosynthesis is at a rate that the plant can grow without relying on stored energy.

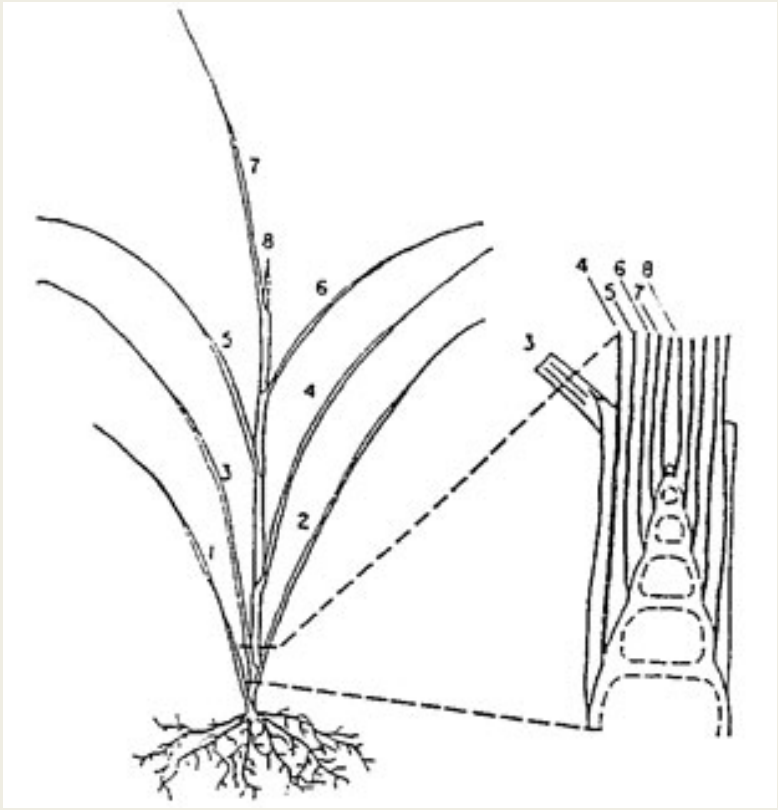
If the plant does not make buds or store enough energy in each bud to keep it alive through the winter, the tiller and eventually the plant will die.

Growing Points in Grasses

Buds contain apical meristem (a region of plant tissue made up of actively dividing cells) that produces leaves. As the plants grow, the growing points are elevated from the base of the plant. In perennial grasses:

1. There is one growing point at the base of the leaf blade. This growing point produces all of the cells that make up the leaf blade.
2. There is a growing point at the base of the leaf sheath. This point can only produce sheath cells
3. The tip of a tiller has a terminal growing point. This growing point will produce the seed head of the grass
4. The fourth growing point is the axillary bud at each node. Under good growing conditions, this will produce a new tiller.

When the growing point is removed, secondary growing points along the shoot are activated and lateral growth occurs.



What is Defoliation?

Defoliation is removal of plant material. The most common type of defoliation is from livestock grazing. Wildlife and insects, can also cause significant defoliation.

In order for plants to remain healthy and productive, adequate leaf area must remain after defoliation for the plant to be able to photosynthesize and manufacture energy to produce more plant material – leaves, stems, seeds and roots.

The plants also need to produce and store energy in the form of carbohydrates to start growth in the next season. If plants are repeatedly grazed too heavily, the plants will suffer long lasting negative effects and damage.

Photo: Grasshoppers, such as those on the sand bluestem plant can cause significant defoliation when their numbers are high.

Plant Response to Grazing and:

Plant Structure

Differences in structure allows some plants to tolerate grazing better than others.

1. Plants that delay elevation of their growing points regrow quickly after grazing and use less nutrients and water.
2. Plants that produce numerous viable buds are better able to withstand grazing
3. Plants that develop new shoots at different times during the grazing season withstand grazing better than those that develop all shoots at the same time.

Photo: Blue Grama is able to withstand heavy grazing due to its short stature and because its growing points are kept close to the ground.

Plant Response to Grazing and:

Plant Physiology:

Differences in physiology allow some plants to tolerate grazing.

1. Plants that regrow quickly replace leaf tissue and photosynthesize sooner.
2. Plants that are more competitive in obtaining water and nutrients tolerate grazing better than those that are less competitive.
3. Plants that are stimulated to absorb nutrients when grazed tolerate grazing better than those that are not stimulated or that absorb fewer nutrients when grazed.
4. Plants that can quickly move nutrients and water among shoots or from roots to shoots tolerate grazing well.

Photo: The fine leafed grass in the center of the photo is Kentucky bluegrass. It is an example of a plant that can regrow quickly (as compared to the sand bluestem near the top of the photo).

Plant Response to Grazing and:

Grazing Management:

1. Plants that are grazed lightly to moderately recover faster than heavily grazed plants.
2. Plants are less damaged by grazing when adequate time, moisture and nutrients are available.
3. Plants are more likely to be damaged when they are producing buds, producing seeds and flowers, or completing growth for the season.
4. Plants are least likely to be damaged by grazing when they are dormant (from after a killing frost until spring green-up).
5. Plants are more likely to be damaged during a drought when soil moisture is inadequate

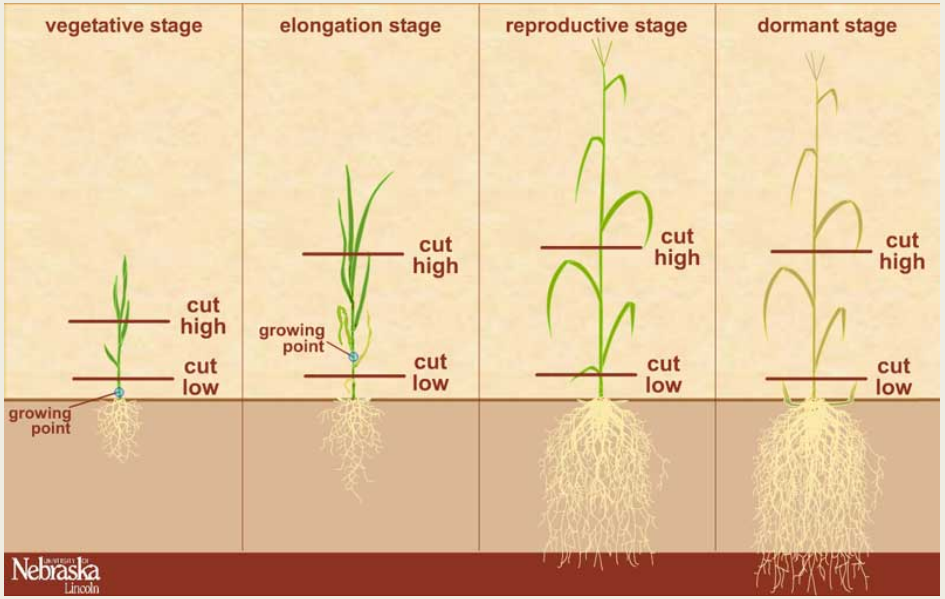
Photo: Overgrazed rangeland, primary grasses are blue grama, buffalograss, cheatgrass and three awn.

Plant Response to Location of Growing Point

One of the biggest factors of plant response to grazing is the location of the growing point compared to the level of grazing. If the grass is defoliated above the growing point, regrowth is rapid.

If the main growing point is removed, but the other growing points remain, regrowth will still occur.

If the all of the growing points are removed, the plant will stop growing and new growth must be started from a different dormant bud.

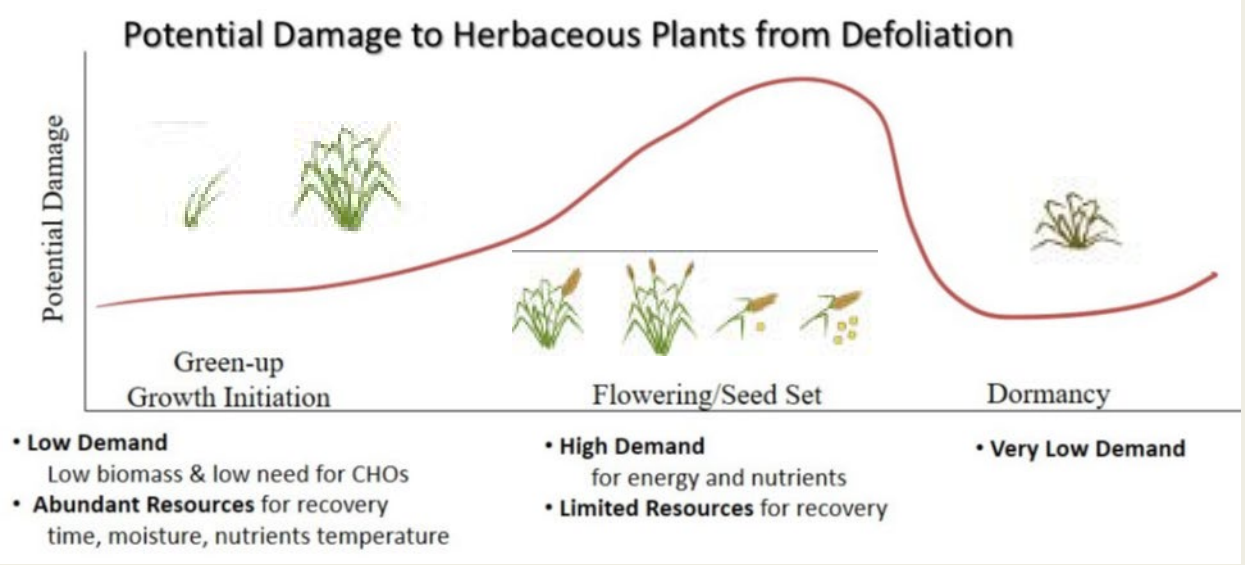


Plant Response to Time of Grazing

The time during the growing season that grazing occurs impacts plant response to grazing. When growing conditions are good – good soil moisture, warm temperatures, good light conditions – photosynthesis rates are high.

In spring and summer, with the growing points still intact, grazing will not impact the ability of the plant to continue to grow actively. There is still enough time for the plants to store energy and produce buds.

Late summer and fall defoliation can negatively impact storage of carbohydrates and negatively impact the next year's growth. Buds need enough energy to initiate spring growth. Stored carbohydrates keep the buds alive so that they can initiate growth of new tillers in the spring.



Intensity of Grazing and Plant Response

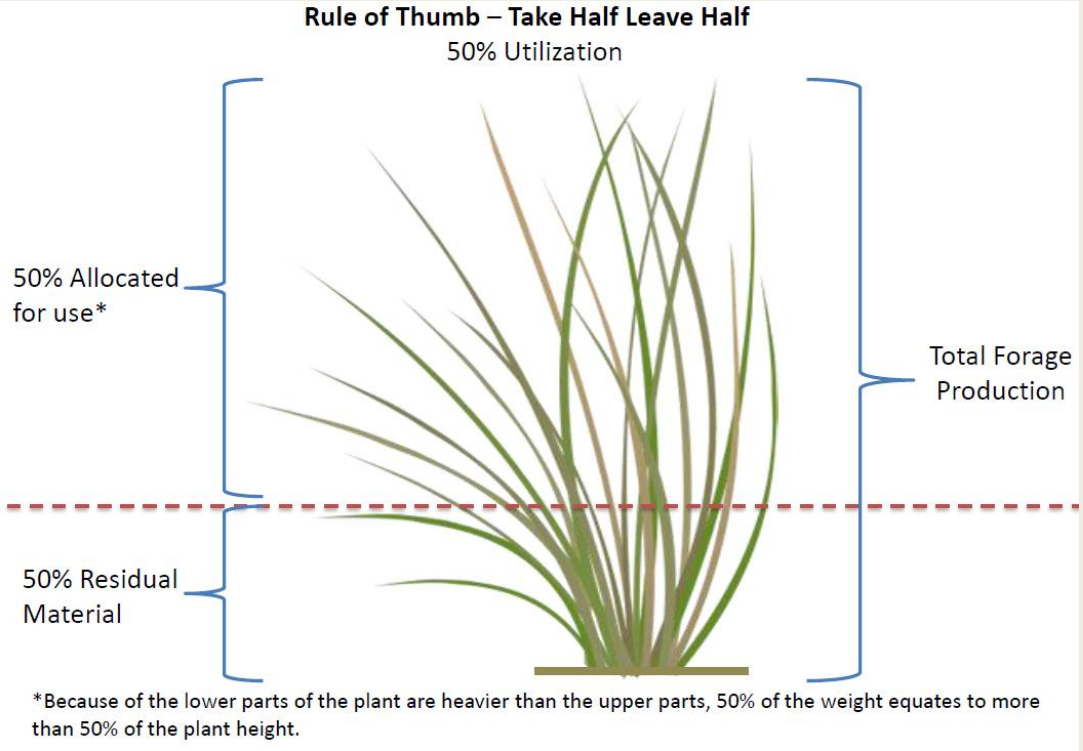
Rangelands developed with grazing animals.

Rangelands require grazing to be healthy and productive land. Grazing stimulates plants to produce more tillers than ungrazed plants. Well managed grazing favors desirable plants, reduces weed invasion, increases soil organic matter, improves wildlife habitat and reduces fuel loads that promote wildfires.

Repeated, long-term heavy grazing or overgrazing can remove desirable plants, decrease water infiltration into soil, increase soil erosion, reduce water quality, increase weed invasion and eventually move the plant community to a less desirable state.

What is Moderate Grazing?

"Take half, leave half" is a primary principle of grazing management. When 50% of the leaf area (by weight) remains after defoliation, the plants will generally maintain or improve in health and productivity.



How Does Moderate Grazing Impact the Plant?

Allows the plant to maintain adequate leaf area to photosynthesize, grow and produce buds which become future tillers.

Moderate grazing has a significant impact on root systems. Roots are vital in supplying water and minerals to the above ground portion of the plant.

At moderate grazing levels, root growth does not stop. At high grazing levels root growth stops for a period of time. When 90 percent of the leaves are removed, root growth stops completely for over two weeks.

Heavier grazing levels may be desirable in the short term to achieve management objectives, but long-term, repeated heavy grazing will damage the plant community.

Percent of leave volume removed	Percent root growth stoppage
10-40%	0%
50%	2-4%
60%	50%
70%	78%
80-90%	100%

What Happens When Roots Aren't Replaced?

In a healthy plant community, desirable grasses, forbs, and shrubs dominate the plant community. The plant canopy is dense and root systems are thick and dense. (A on drawing).

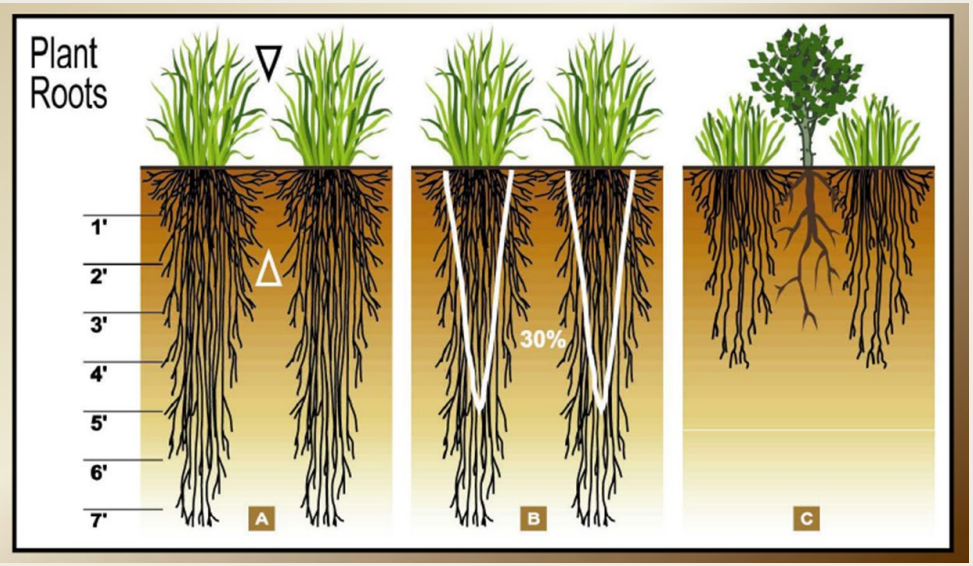
Each year approximately 30% of a plants roots die and must be replaced. When plants are heavily grazed and not allowed to recover before being grazed again, the root system weakens, just like the above ground plant canopy. (B on drawing)

Fewer roots means less water and nutrients are available to the plant which further weakens the plant.

Weakened roots result in weaken plants. This allows less desirable plants to increase and invasive plants and noxious weeds to invade the plant community. (C on drawing).

Weakened plants can lead to increased bare soil, increased erosion, reduced water infiltration and reduced functioning of ecological processes.

Fewer roots and more weeds means less productive pastures which support fewer grazing animals (both domestic and wildlife).



Root Responses to Defoliation

Root growth decreases as more than 50% of leaf area is removed.

The more frequent the defoliation, the greater the impact on root growth.

Intense, frequent defoliation has a greater negative impact on plants than either intense or frequent defoliation alone.

Severe grazing reduces the absorptive area of roots and the volume of soil available for obtaining water and soil nutrients.

Severe grazing increases the competitive advantage of weeds.

Activities & References

Activities

- Read through the references for a more complete discussion of how plants grow and respond to disturbances.

References

- https://globalrangelands.org/topics/rangeland-ecology/grass-growth
- http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1120069862&topicorder=5
- Grass: The Stockman's Crop

END OF LESSON NINE