2

PLANTS

MODULE 2 | Investigating Rangeland Systems and Practices

SKILL LEVEL

Middle School: Grades 6, 7, 8

KEY TERMS

Autotroph, drought, forbs, grasses, grass-like plants, shrubs, photosynthesis

EDUCATION STANDARDS

SD Science:

- MS-LS1-6
- MS-LS2-2

NGSS:

- MS-LS1-6
- MS-LS2-2

TIME NEEDED

Activity 1: 20 min
Activity 2: 30 min (24 hr set up)
Activity 3A: 50 min
Activity 3B: 50 min
Activity 3C: 50 min
Activity 4: 10 min

MATERIAL LIST

- Chalkboard or whiteboard
- Printable items from Appendices
- Computer w/ projector
- Materials listed for each activity

FUNDING ACKNOWLEDGEMENT

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EXPECTED LEARNER OUTCOMES

OBJECTIVE 1
Students will be able to identify products and reactants of photosynthesis.

OBJECTIVE 2
Students will understand the impact of drought and grazing in a rangeland system.

OBJECTIVE 3
Students will analyze the growing process of native rangeland plants.

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OBJECTIVE 4
Students will learn that grazing causes a more concentrated root system in range grasses compared to non-grazing.

OBJECTIVE 5
Students will understand that drought and flooding have negative consequences on rangeland plants.

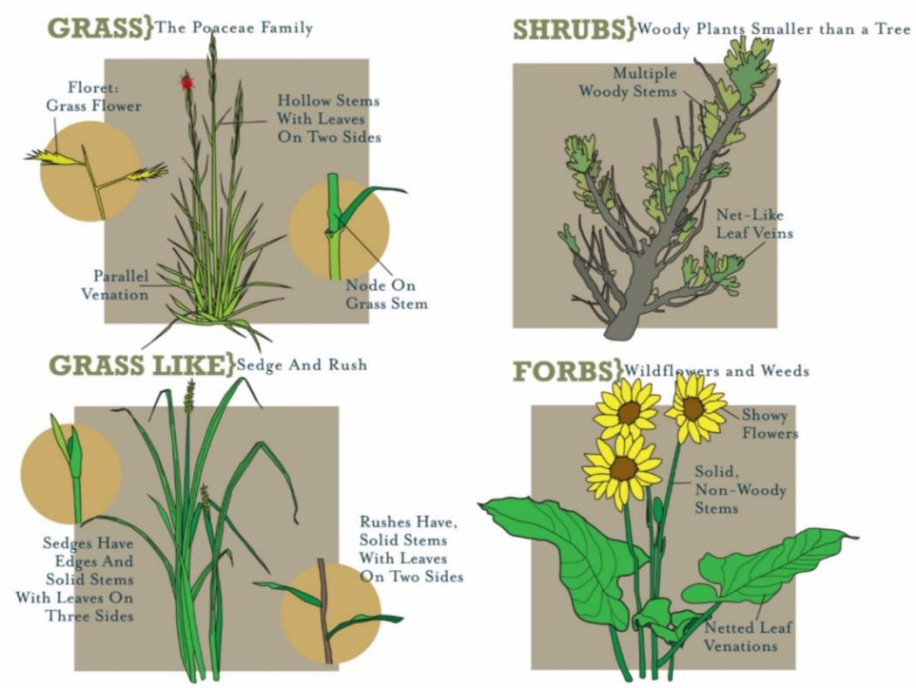

Figure 1. Different categories of rangeland plants. (Source: Idaho Rangeland Resource Commission).

BACKGROUND

Plants are a critical component in rangelands - they prevent soil erosion, provide shelter for grassland birds, food and habitat for ungulate species such as deer and antelope, habitat for pollinators such as butterflies and bees, and food for cattle.

What can plants do that humans can't do? They can use the energy from the sun to make food! All plants - regardless if they are a grass, grass-like, shrub, or forb - perform **photosynthesis** as their way of making food. If a plant gets hungry, it can't walk into a restaurant or a grocery store to get food. Plants are producers (**autotrophs**), which means that they make or producer their own food. Specifically, plants are an autotroph that collect energy from the sun and takes that energy and turns in into organic molecules that are used for growth, reproduction, and defense.

What is Photosynthesis?
Photosynthesis is the process plants use to make their own "food" from the sun's energy, carbon dioxide, and water. During photosynthesis, carbon dioxide and water combine with solar energy to create glucose, a carbohydrate ($C_6H_{12}O_6$), and oxygen.

The process can be summarized as:

in the presence of sunlight, carbon dioxide + water → glucose + oxygen.

Glucose, the main product of photosynthesis, is a sugar that acts as the "food" source for plants. The glucose is then converted into usable chemical energy, ATP, during cellular respiration. The oxygen formed during photosynthesis, which is necessary for animal life, is essentially a waste product of the photosynthesis process.

Almost all organisms obtain their energy from photosynthetic organisms. For example, if a bird eats a caterpillar, then the bird gets the energy that the caterpillar gets from the plants it eats. The bird indirectly gets energy that began with the glucose formed through photosynthesis. Therefore, the process of photosynthesis is central to sustaining life on Earth. In eukaryotic organisms, photosynthesis occurs in chloroplasts. Only cells with chloroplasts - plant cells and algal (protist) cells - can perform photosynthesis. Animal cells and fungal cells do not have chloroplasts and, therefore, cannot photosynthesize. That is why these organisms, as well as the non-photosynthetic protists, rely on other organisms to obtain their energy. These organisms are heterotrophs.

Watch the Amoeba Sister's video to learn how the light dependent and light independent cycle work together to create glucose for plants. https://www.youtube.com/watch?v=uixA8ZXx0KU (8 minute video)

Any excess energy from photosynthesis is stored in the plant tissue as starch. Starch is white and powdery - it contains glucose, which plants use for food. To form starch, a plant needs to conduct photosynthesis - so, the presence of starch in a leaf is *evidence of photosynthesis*.

There are different types of plants that can be found in rangelands. Knowing what plants are in a rangeland helps guide management decisions. Correctly identifying rangeland plants requires knowledge of and information about plant characteristics and plant types. Because there are so many different types of range plants, it helps to group them based on appearance and growth habits.

The shape of a plant's leaf is often a good place to start in trying to determine the identification. Other distinguishing characteristic include the margins (edges) and the venation (pattern of veins) on the leaves. You can group range plants and classify them according to growth form, life span, season of growth, origin, and value as forage. The main growth forms/plant types to discuss with students are: grasses, grass-like, shrubs, and forbs (Figure 1).

VOCABULARY

AUTOTROPH: An organism that can produce its own food using light, water, carbon dioxide, or other chemicals.

DROUGHT: A period with unusually persistent dry weather that continues long enough to cause serious problems, like crop damage or water supply shortages.

FORBES: Plants with stems that are not woody and they sometimes have "showy" flowers.

GRASSES: Have long narrow leaves and hollow, jointed stems. Generally, grasses do not have colored flowers and their seeds are grain-like. There are two rows of leaves on a grass's stem, and the veins on the leaves are parallel.

GRASS-LIKE PLANTS: Look like grasses but have solid stems without joints. The stems are often triangular. Like grasses, the veins in the leaves are parallel.

SHRUBS: Woody plants that are smaller than a tree, and veins on their leaves look like a spider web.

PHOTOSYNTHESIS: The process that green plants do to use sunlight to make food from carbon dioxide and water.

ACTIVITY #1: DINOSAUR EXTINCTION

ESTIMATED TIME: 20 MIN

This video and exercise start with something that most students find interesting - dinosaurs!

Materials

- Computer and projector to show the YouTube video
- Piece of paper (1 per student)

1. Watch the YouTube video to students: https://youtu.be/Y8Ij9xboreA "How Dinosaurs Went Extinct!" and have the students make observations, noting what they see. (3 minute video)
    a. Presence of plants early in the video (before 0:18)
    b. Collision of asteroid 0:43-0:47
        i. What happens after the collision? (can be demonstrated with a container of flour and bouncy ball)
            1. Creates a crater
            2. Creates a cloud of dust
    c. Broken trees
    d. No vegetation
    e. Dead animals
    f. A few live animals
2. Ask students to explain why the dinosaurs that ***did*** survive the meteor strike still ended up dying?
    a. The answer connects to the learning objective of this activity: a huge cloud dust occurred because of the meteor strike prevented plants from going through photosynthesis, impacting the food chain. Note: this might need to be pointed out to the students.
3. This will establish with students that plants are critical to life - both when dinosaurs where alive and for our own existence today.
4. Have students create an acrostic, which will serve to help students think about any knowledge they already have on photosynthesis.
    a. Students will need a piece of paper and will write the word "photosynthesis" vertically. Have them write full sentences, instead of having them use single words or short phrases, building off each letter. You might want to provide an example of a word or concept they have studied before.
    b. Example for P: Plants make their own food.

ACTIVITY #2: PHOTOSYNTHESIS – THE STARCH TEST

ESTIMATED TIME: 30 MIN (24 HR SET UP)

**Make sure that students can see what you're doing as you perform the starch test!

**Ask students to write down the steps you are taking in a "lab notebook," or on a piece of paper, so that they can actively and intelligently engage with the demonstration, both by writing out the steps involved in the experiment and by recording their scientific observations.

Materials for Demonstration

- 2 plants – Golden Pothos (a forb) is ideal and can be found at many home improvement stores
    - *For Optional Advancement - 2 Pothos with variegated leaves (white and green leaves)*
- Dark Space (closet or other place without windows)
- Bright Space (window sill or similar location with lots of light)
- 1 Bottles, Ethyl Alcohol or Rubbing Alcohol (Can find at Target/Walmart)
- 1 Beaker (250 ml size)
- 1 Sauce Pan (2 quart size)
- 1 Heat Source (stove top or a hot plate)
- 1 Tweezers
- 2 Shallow Dishes
- 1 Bottle, Iodine Solution (Can find at Target/Walmart)

Preparation

1. **Prep:** Place 1 of the 2 plants in a dark room for 24 hours; place the other plant on a sunny windowsill.
2. Wait 24 hours (note that you can place the plants 24 hours before the class period, and then start with step 3, or you can start at the very beginning with a discussion of the characteristics of the plant as you introduce the lesson (green, large shiny leaves, vine-like, it's a forb, not a grass, etc.).

Activity - Demonstration

1. Discuss with students what you did with the plants – they were placed in two different locations for 24 hours.
    a. Can students tell a difference between which plant was in the dark room and which was by the window? Why or why not?
2. Fill the beaker with ethyl alcohol.
3. Place the beaker in a saucepan full of water.
4. Heat the pan until the ethyl alcohol starts to boil and then remove from heat - this should take a few minutes, but be careful to not overheat the ethyl alcohol.
5. Take a single leaf from the "dark room" plant and a single leaf from the "sunny room" plant - make sure you don't confuse them!
6. One by one, dip each of the leaves in the hot water for 60 seconds, using tweezers.
7. Now, drop the leaves in the beaker of ethyl alcohol for 2 minutes (until they turn almost white).
8. Set each leaf in a labeled shallow dish ("dark room," "sunny room").
9. Cover each leaf with some iodine solution and watch what happens.
10. Ask students to record their scientific observations.
11. What happens:

- The hot water acts to kill the leaf
- The ethyl alcohol breaks down the chlorophyll, which removes the green color from the leaf.
- When iodine is added to the leaves, one leaf will turn blue-black in color and the other will be reddish-brown. This is because iodine acts an indicator of starch and turns blue-black when starch is present.

12. Conclusion: the leaf that was in the sunny room will turn blue-black, demonstrating that the leaf performed photosynthesis and produced starch.

Advancement:

1. Perform the same test, this time using a Pothos with variegated leaves (leaves that are both green and white). You can use a leaf from this Pothos and ask students where on the variegated leaf do you think you would find starch?

ACTIVITY #3A: RANGE PLANT DISCOVERY EXPERIMENT SETUP

ESTIMATED TIME: 50 MIN PERIOD

Materials

For each group

- 1 Jiffy Tray (Can find at Runnings, Target/Walmart, Amazon – to hold the water)
- 8 Jiffy Pellets (Can find at Runnings, Target/Walmart, Amazon – they are small peat pods)
- 1 cup for water
- ½ cup measuring cup
- 1 teaspoon grass seed
- 1 teaspoon forb seed
- 8 Popsicle sticks (4 labeled Grass, 4 labeled Forb)

For each student

- Handout #1 – Range Plant Discovery Experiment

Activity

1. Divide students into 4 or 5 groups, depending on how many students you have in your class. Aim for about 4 students per group. Give each group a notebook.
2. Ask one student to take notes for the day, reminding them that they are setting up an experiment, and are taking part in the scientific process.
3. Each group gets a tray with 8 jiffy pellets and a cup for water.
4. Have each group pour ½ cup of water onto their **tray, not onto the pellets.**
    a. Was that enough water to make the jiffy pellet swell to its full size? (2 inches tall, and soft)
    b. Ask students why the jiffy pellets did not moisten all way.
    c. Introduce the term **drought** and discuss how drought is a dry soil condition. Note: If students have already learned about the "Dirty '30s" and the Dust Bowl, they should easily connect to the term.
5. Have each group add 1 whole cup of water to the tray and continue to watch the jiffy pellets.
    a. Was that enough water?
6. Repeat the process of adding water and having students observe and document the effect on the jiffy pellets. They should continue until the jiffy pellets are full size and evenly moist.
7. Have students make a shallow hole in the jiffy pellet, but remind them to **not** rip the netting on the outside of the pellet.
8. Give each group of students about **1 teaspoon** of seeds from the GRASS seed packet and **1 teaspoon** of seeds from the FORB seed packet. Be sure to keep these separated from one another.
9. Have students observe and write down their observations about seed size, color, shape.
10. Have students divide the GRASS seeds into 4 equal parts. Plant each part in a jiffy pellet (so you will have 4 pellets with GRASS seeds).
    a. Have students label 4 individual popsicle sticks with "GRASS" and gently stick it in the pellet.
    b. Ask students to gently cover the seeds back up with soil.
11. Have students divide the FORB seeds into 4 equal parts. Plant each part in a jiffy pellet (so they will have 4 pellets with FORB seeds).
    a. Have students label 4 individual popsicle sticks with "FORB" and gently stick it in the pellet.
    b. Ask students to gently cover the seeds back up with soil.

12. Ask students to gently pour a small amount of water on the jiffy pellets and then place their tray in a cool room (not cold).
13. Each group of students should make up a schedule so that each member of the group checks on the pots once a day until they have spouted and grown to about 2-3 inches tall. This will take approximately 7-14 days.
    a. Each member should record: how much they watered, any observations of the plantings (for example, is there a difference in how fast the forbs versus grasses are emerging? Or what do the forbs look like when they emerge compared to the grasses?)
    b. Have students use Handout #1 for this.
    c. Tell the group to report to you when the grasses have reached 2 inches tall.
14. Discuss with students that you will work with the range plants again, once all the pots have sprouted and the grasses have reached 3 inches high. Again, this will take approximately 7-14 days.
15. Once the grasses and forbs have sprouted (or most of them), have students move their trays to a sunny location.
    a. Note: the pellets will dry out faster in these conditions, so remind students to check on moisture levels regularly.
16. Schedule a class period to continue with part B of the lesson in a few days.

ACTIVITY #3B: RANGE PLANT TREATMENTS AND OBSERVATIONS

ESTIMATED TIME: 50 MIN

Materials

For each group

- 8 index cards
- Plants from Activity #3A
- 1 plastic dropper
- 1 ruler

For each student

- Handout #2 – Range Plant Treatment & Observation

Activity

In this aspect of Activity #3, students become stewards of the land - like ranchers are - and they will have to make decisions about grassland management.

1. Distribute 8 index cards to each group. Ask each group to number them 1-8, writing the corresponding info on each card:
    a. Card 1 - GRASS cut to 1 inch tall and jiffy pellet kept evenly moist. When grass reaches 3 inches tall, it gets cut again to 1 inch tall.
    b. Card 2 - GRASS not cut at all and jiffy pellet kept evenly moist.
    c. Card 3 - GRASS not cut at all, jiffy pellet receives only 10 drops of water every 5 days.
    d. Card 4 - GRASS not cut at all, jiffy pellet is kept in a plastic cup that always has 2 inches of water in it.
    e. Card 5 - FORB cut to 1 inch tall and jiffy pellet kept evenly moist. When forb reaches 3 inches tall, it gets cut again to 1 inch tall.
    f. Card 6 - FORB not cut at all and jiffy pellet kept evenly moist.
    g. Card 7 - FORB not cut at all, jiffy pellet receives only 10 drops of water every 5 days.
    h. Card 8 - FORB not cut at all, jiffy pellet is kept in a plastic cup that always has 2 inches of water in it.
2. Each group should have the 8 plants they grew in Activity 4A. They will assign an index card/treatment to each plant. Cards 1-4 are assigned to the grasses and cards 5-8 are assigned to the Forbs.
3. The students should then perform the designated treatment on each of the plants.
    a. Students should conduct and record beginning observations.
    b. Ask them to include specifics, again noting differences between grasses and forbs.
    c. Have students use Handout #2 for this.
4. Continue this for 10 days or longer (as your time and schedule allow) having the students continue to record observations. The plants will continue to undergo changes.

ACTIVITY #3C: RANGE PLANT DISCUSSION AND CONCLUSIONS

ESTIMATED TIME: 50 MIN

Activity

1. Continue the experiment and the scientific process by asking students these questions:
    a. What condition has the healthiest forb and grass?
    b. What condition killed the forb and grass? Why?
    c. What condition resulted in stress for the plants? Why?
    d. How did you notice the plant was stressed?
    e. When did you notice the stress? How long did it take to appear?
    f. Compare and contrast the plants that received too much water (were flooded) and those that received too little water (experienced drought) - can you form a conclusion about the role of water on rangeland plants?
    g. Did all groups have the same results? If not, why did they differ?
2. Next, ask students to gently tear each jiffy pellet in half vertically to observe root growth.
    h. Ask the same questions as outlined in Step 1, A-G, except connect the questions to root conditions this time.
    i. Hopefully, students will have observed that cutting the grass to 1 inch tall resulted in a more vigorous root system. A similar result should have occurred for the forb cut to 1 inch tall.
        i. Ask students what animals exist in a rangeland system that graze/eat grass? (antelope, cattle, horses, deer)
        ii. The grazing forces the plants to put resources into their root system, as compared to their aboveground system, helping to establish the root system and project the soil.
    j. Ask students the following questions:
        i. Which condition is optimal for rangeland plants? Why?
        ii. Is it possible to have optimal conditions on all the rangeland in South Dakota? Why or why not?
        Possible answers from students: Yes, it is possible - we can be careful of how we use the land for grazing and how we take care of the land OR No, a large part of South Dakota is rangeland, and it is impossible to control moisture and other conditions on such a large area. (This should highlight to students why it is so important to focus on what we can control - good grazing practices and land management.)

ACTIVITY #4: CLASSROOM ASSESSMENT

ESTIMATED TIME: 15 MIN

3-2-1 Format for Activities #1 and 2

1. Have each student get out a piece of paper.
2. Ask students to write down:
   a. 3 ideas that were presented
   b. 2 examples of how they can use their knowledge of soils
   c. 1 unresolved area/"muddiest" point that they didn't quite understand
3. Have students get into pairs and share their 3-2-1 with a partner.
4. Ask students to turn in their paper; read through them to gauge how well students understand Activities #1 and 2, paying particular attention to the 1 unresolved area/"muddiest" point to go over with the class again to clarify their learning.

ESTIMATED TIME: 10 MIN

Reflection Paper for Activity #3

1. Have each student get out a piece of paper to write on.
2. Ask students to: describe the impact of drought and grazing in a rangeland system. What effect does grazing have on the root structure of a plant compared to a plant that hasn't been grazed?

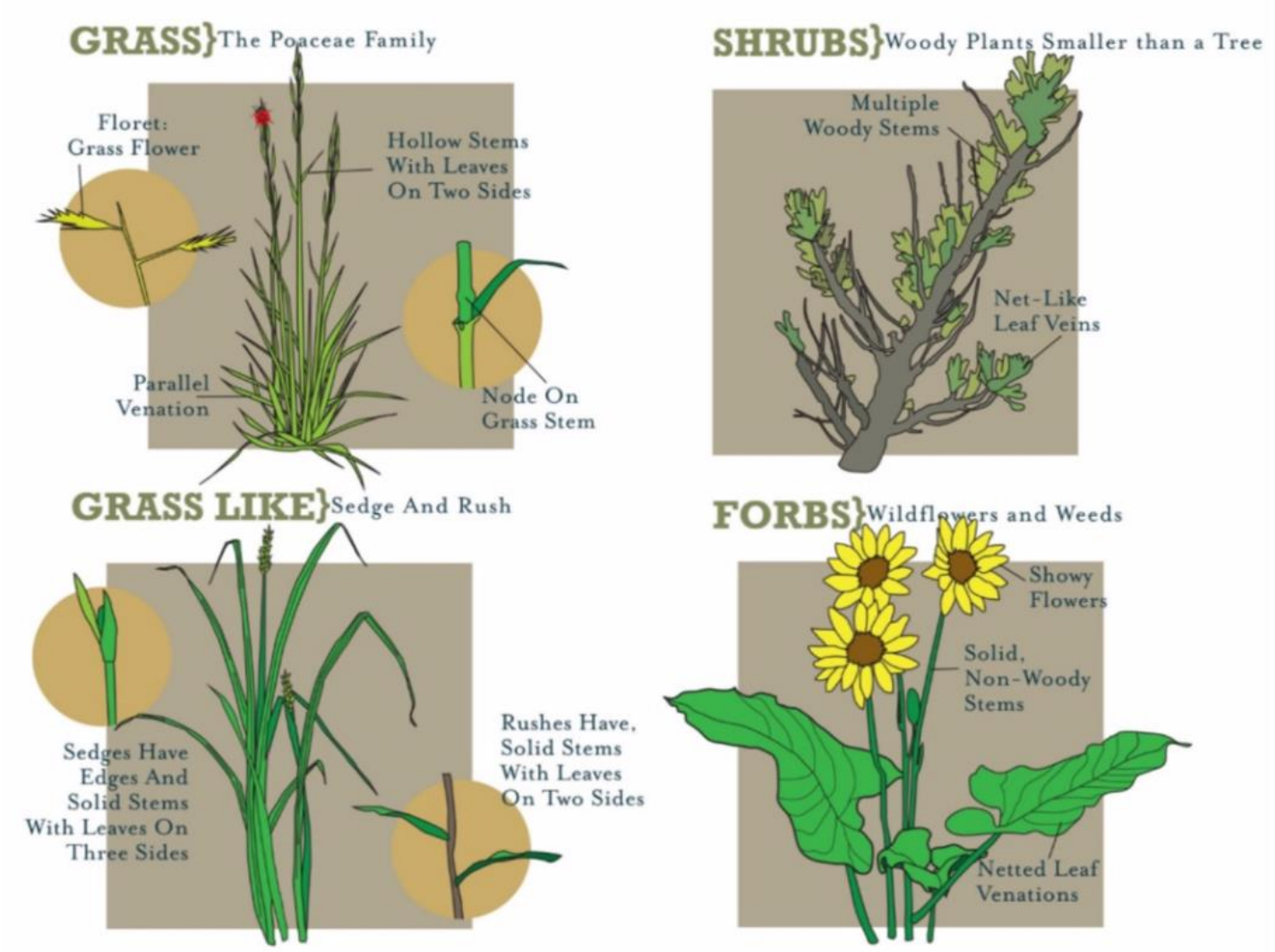

Figure 2. Different categories of rangeland plants. (Source: Idaho Rangeland Resource Commission).

RANGE PLANT DISCOVERY EXPERIMENT

Student name: _____

Date	How much water was added?	Observations

RANGE PLANT TREATMENT & OBSERVATIONS

Student name: _____

Treatment	Observations
Card 1 - GRASS cut to 1 inch tall and jiffy pellet kept evenly moist. When grass reaches 3 inches tall, it gets cut again to 1 inch tall.	
Card 2 - GRASS not cut at all and jiffy pellet kept evenly moist.	
Card 3 - GRASS not cut at all, jiffy pellet receives only 10 drops of water every 5 days.	
Card 4 - GRASS not cut at all, jiffy pellet is kept in a plastic cup that always has 2 inches of water in it.	
Card 5 - FORB cut to 1 inch tall and jiffy pellet kept evenly moist. When forb reaches 3 inches tall, it gets cut again to 1 inch tall.	
Card 6 - FORB not cut at all and jiffy pellet kept evenly moist.	
Card 7 - FORB not cut at all, jiffy pellet receives only 10 drops of water every 5 days.	
Card 8 - FORB not cut at all, jiffy pellet is kept in a plastic cup that always has 2 inches of water in it.	

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