Sustainable Livestock

GRADE LEVEL	4th-12th Grade with California Content Standards for 4th-6th and 9th-12th
SUBJECTS	Life Sciences, Sustainability, Food, Mathematics
DURATION	Preparation: 10 minutes Activity: 60 minutes
SETTING	Classroom

Objectives

Students learn about the food, water, and space needs of common livestock animals. Using math and problem solving skills they will learn how many animals can live on their imaginary 100 acre ranch. Students will discover how land use and food consumption can be sustainable.

Materials

- Copies of the activity worksheets and charts
- Colored pencils (3 colors per student)

Preparation (10 minutes)

1. Read through the teacher background information provided.
2. Print copies of "How much food, water, and space" chart.
3. Print copies of the "Livestock Grazing" worksheets (3 pages).

Vocabulary

- **arid rangeland:** ecosystems that experience very little rainfall, have very shallow soil, and are typically covered with only grasses and shrubs that can use water and nutrients very efficiently. Droughts are common in these areas.
- **climate change:** a regional change in temperature and long term weather patterns
- **desertification:** process by which once fertile land becomes barren and unproductive.
- **livestock:** animals, such as cows and goats, raised by humans for food.
- **sustainable:** meeting current human needs without endangering our descendants. There is a broad, scientific consensus that our current environmental demands are unsustainable, causing climate change, degradation of natural habitats, loss of species, and shortages of essential resources.
- **temperate rangeland:** ecosystems with very deep and nutrient-rich soils and sufficient moisture to support many types of plants.
- **rotational grazing:** periodically moving livestock to fresh rangelands to allow pastures to re-grow.

Teacher Background

Humans have raised livestock on grassy land throughout the world for a very long time. When managed effectively, this land can be **sustainable** and productive year after year. The conditions of the ecosystem where the pasture is located determine how much grass can grow there each year. For instance, in northern California, there are **temperate rangelands** which have very deep and nutrient-rich soils with sufficient moisture to support many types of plants. In these pastures, studies show that each acre can produce 2,000 to 12,000 pounds of dry matter (grasses) each year. In contrast, ecosystems that experience very little rainfall and have much shallower soils are typically covered with only grasses and shrubs that can use water and nutrients very efficiently. These areas are called **arid rangelands** and are found in various parts of North America, such as Southern California, as well as areas of Africa such as parts of Kenya and Somalia. In these places, an acre of land may yield only 200 to 1,500 pounds of grass per year (ATTRA, 2008).

Additionally, arid rangelands are also found in areas where tropical rainforests are cut down, such as in Colombia. Millions of acres of rainforest are slashed and burned, which means that the land is set on fire in order to clear it. The cleared land is then turned into grass pastures for cows. These cows get butchered and are often sent to the United States to be put into fast-food hamburgers, frozen meat products, and canned pet food. For every quarterpound fast-food hamburger that comes from the rainforest, 55 square feet of rainforest is destroyed. That is the size of a small kitchen! And that's just for one hamburger!

Furthermore, as climate is beginning to change in California and beyond, ranchers may need to start dealing with temperate rangelands changing to arid rangelands. This change will have huge implications on food productivity around the world.

When livestock ranchers decide what types of animals and in what quantities they want to stock their land, there are many factors to consider: the benefits of each animal, how much food and water specific animals need, how much space each animal requires, how long an animal lives, etc. In order to be successful in the long term, all of these considerations must be balanced with keeping the land healthy and productive. Overgrazing and the constant pounding of the soil by the hooves of livestock animals may speed up the effects of erosion by wind or water and prevent plants from growing. The process by which once fertile land becomes barren and unproductive is called **desertification** (USGS, 1997). By carefully developing a plan for rotating livestock and dividing up their land, ranchers can avoid these outcomes and help keep the land usable.

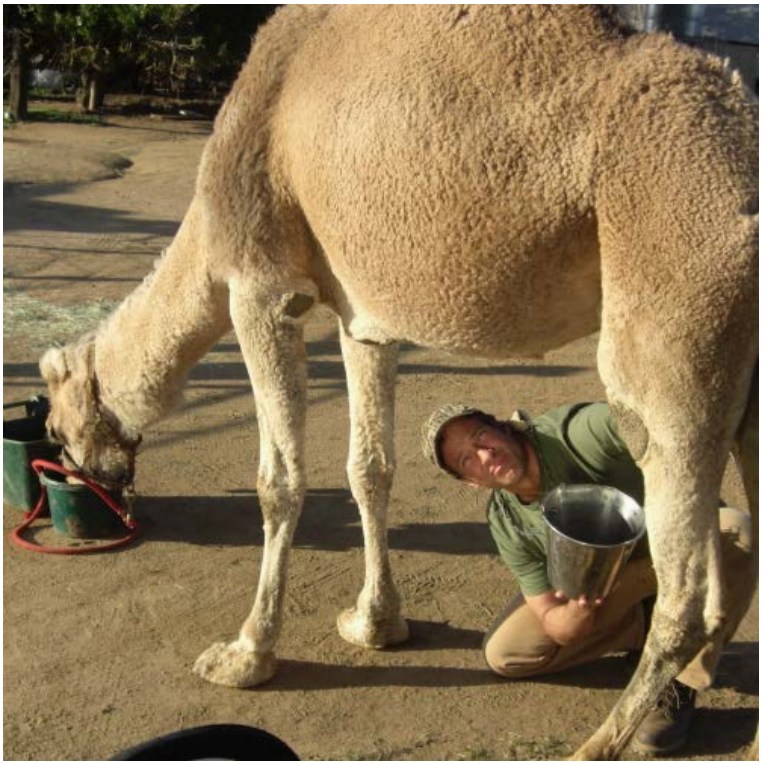
Additionally the supply and demand of meat and dairy also influence the amount of land designated for livestock usage. Recent research also shows that the average American eats over 200 pounds of meat each year, which is much higher than the recommended daily intakes. Because of the increase in food production, reports from the UN show that over 30% of the earth's ice-free land is used for the production of livestock. When people follow recommended nutritional guidelines the demand on meat and dairy products decreases and therefore the impact on natural habitats are lessened.

CASE STUDY: Camels- the Alternative Livestock

In Kenya goats, sheep and camels are common livestock since they are hearty and able to survive droughts. Camels, while still rare, are being bred very successfully as livestock due to their drought tolerance, lean meat and lean milk. The Food and Agricultural Organization of the United Nations estimates that the industry will grow to $10 billion worldwide within the next 10 yeas. Camels may especially become more prevalent as climate change causes deserts to grow.

Aside from being a hearty creature, camel milk is also high in vitamins C & B, iron and insulin. It is non-allergenic and has 10 times the antibacterial and antiviral properties as cow's milk. Because camel milk is much more similar to human milk people find it easier to digest. It has been used to treating Crohn's Disease, diabetes and some forms of cancer.

The dromedary camel (*camelus dromedarius*) has been domesticated by humans for the past 3000-4000 years. They are most successful in warm and arid conditions. They are recognizable by their long-curved necks and single hump, which is made of fat and fibrous tissue. This fat reserve allows them to survive periods without eating. Aside from this, they also have some other adaptations ideal for life in deserts. For instance, they possess a double row of eyelashes to protect their eyes from sand. Furthermore, they can conserve water by shifting their body temperature by about 8 degrees Celsius during a day. This allows them to avoid sweating. They also can survive losing up to 30% of their body's water (most other mammals would die after losing 15%), and can drink up to 10 liters of water a minute (Naumann, 1999).



Activity

Introduction

1. Ask students what they know about animals that humans use for food. Which animals are used and what do these animals need to survive and grow? Discuss how all of these animals are grazers and traditionally eat only plant material (primarily grass).

2. Discuss how domesticated livestock have been raised in different places all over the world for thousands of years. Because plant growth rates depend on natural conditions such as climate, different ecosystems vary in how much plant material they can produce. Consequently, very productive ecosystems can support more animals than less productive ones and livestock types vary based on the biome in which it is located.

Procedure

1. Tell the students that their long lost Great Aunt has unfortunately passed away but has left them each with 100 acres of prime grazing land in northern California and they need to come up with a Ranch Management Plan for the newly acquired area.

2. Distribute "How much food, water, and space" charts to each student. Briefly discuss the information listed, answer any questions and explain to students that they will be using the data provided on the chart to answer questions and solve some problems.

3. Pass out the "Livestock Grazing in Northern California" worksheets and show them how to create symbols for their chosen animals and mark them on their sheet. Give them time to draw out their plan.

4. Discuss as a class why students made the choices that they did. How many used all or most of their land? Which animals did they choose and why? Ask students what they think might happen to land that is used over and over by livestock without a break.

5. Introduce overgrazing, desertification and sustainability as it relates to a livestock ranch. Have students develop a new sustainable ranching plan for Northern California.

6. Based on their new knowledge and success with sustainable ranching in northern California they have been called upon to consult with ranchers in Kenya, Africa and in the Amazon Rainforests of Colombia. Introduce the difference between the two biomes: temperate pasture (like those found in Northern California) and arid rangeland (like those found in Kenya, Africa and Southern California). Discuss how temperate pastures have deep, nutrient-rich soils, and plentiful moisture. In contrast, arid rangelands get very little rain and tend to have much shallower soil that supports only limited water-efficient plants and shrubs.

7. In small groups have the students develop a plan for arid rangelands with recommendations on which animals to use.

Wrap Up Discussion

1. Discuss how the ranching plans were adapted for the two different environments.
2. How do different biomes affect food production in different areas?
3. The average American eats 200 pounds of meat per year. How many Americans could your sustainable California land feed? Usually only half of an animal's weight is edible (bones, fur and fat generally are not).
4. For nutritional reasons it is recommended that people eat 100 pounds of meat per year. How do you think eating less meat might affect land use?
5. California's climate is changing and many ranches are dealing with less available water. What recommendations would you make to Californians?

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Fourth Grade Correlated California Content Standards

Mathematics
Number Sense (3.0): Students solve problems involving addition, subtraction, multiplication, and division of whole numbers and understand the relationships among the operations.

Mathematical Reasoning (1.0): Students make decisions about how to approach problems. (2.0): Students use strategies, skills, and concepts in finding solutions. (3.0): Students move beyond a particular problem by generalizing to other situations.

Life Sciences
2. All organisms need energy and matter to live and grow. As a basis for understanding this concept: (a.) *Students know* plants are the primary source of matter and energy entering most food chains. (b.) *Students know* producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem. 3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept: b. Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Fifth Grade Correlated California Content Standards

Mathematics
Number Sense (2.0): Students perform calculations and solve problems involving addition, subtraction, and simple multiplication and division of fractions and decimals: (2.1) Add, subtract, multiply, and divide with decimals; add with negative integers; subtract positive integers from negative integers; and verify the reasonableness of the results. (2.2) Demonstrate proficiency with division, including division with positive decimals and long division with multidigit divisors.

Mathematical Reasoning (1.0): Students make decisions about how to approach problems: (1.1) Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns. (1.2) Determine when and how to break a problem into simpler parts

Sixth Grade Correlated California Content Standards

Ecology (Life Sciences)
5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment. As a basis for understanding this concept: (a.) *Students know* energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs. (b.) *Students know* matter is transferred over time from one organism to others in the food web and between organisms and the physical environment. (e.) *Students know* the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Ninth- Twelfth Grade Correlated California Content Standards

Ecology (Life Sciences)
6.e) Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept: *students know* a vital part of an ecosystem is the stability of its producers and decomposers.

Correlated NGSS Standards

Scientific & Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concept
•Developing and using models •Analyzing and interpreting data •Using mathematics and computational thinking	(5-LS2-1) Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment. (MS-LS2A) Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. (MS-LS2C) Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (HS-LS2A) Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem.	» Cause and effect » Systems and system models » Stability and change

How much food, water, and space do grazing animals need to survive?

Livestock Animal	Average Animal Weight	Drinking Water* per day (per year)	Food (Vegetation)* per day (per year)	Northern California required grazing area	Arid Rangelands required grazing area
Dairy Cow 	540 kg (1200 pounds)	65 L (23725 L)	15.8 kg (5767 kg)	1.75 acres	15 acres
Beef Cattle 	680 kg (1500 pounds)	59 L (21535 L)	11.3 kg (4125 kg)	1.25 acres	11 acres
Horse 	450 kg (1000 pounds)	60 L (21900 L)	10 kg (3650 kg)	1 acre	10 acres
Pig 	90kg (200 pounds)	17 L (6205 L)	4.2 kg (1533 kg)	0.5 acres	4 acres
Camel 	500-600 kg (1300 pounds)	Highly variable (can go weeks without drinking if plants are moist)	3.5 kg (1278 kg)	0.5 acres	3 acres
Goat 	22kg (50 pounds)	5 L (1825 L)	2.5 kg (913 kg)	0.25 acres	2 acres
Sheep 	80kg (175 pounds)	11 L (4015 L)	1.7 kg (620 kg)	0.25 acres	2 acres

* This is the amount an individual animal needs in order to survive.

Livestock Grazing in Northern California

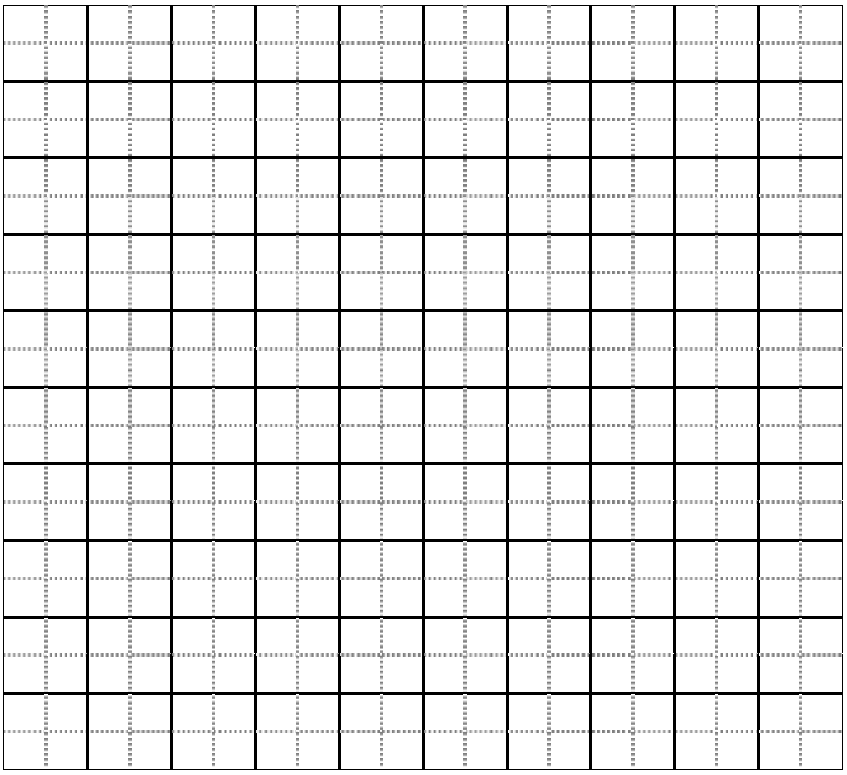
Name: _____ Date: _____

Congratulations! Through a stroke of great fortune, you have been given 100 acres of prime grazing land in Northern California (Note: One acre is the area of land covered by 90 yards of a football field). Now you have the important task of figuring out which livestock to raise.

1. Choose your own combination of at least 3 different animals, and calculate how many of each you can have on your land. Each square on the grid represents one acre of land in Northern California.

    a. Choose a symbol for each type of animal you've picked and write it in the legend to the right of the grid. By referring to the Food, Water and Space chart, include how many acres each one requires. (For example, a dairy cow requires 1.8 acres in Northern California, so you would mark 1.8 squares for each dairy cow on your land.)

    b. Then, write the symbols in the grid squares used for each animal. Draw an outline around each individual animal's area so you can count them more easily.



Grid Legend

Symbol	Animal	Acres	Total #

= 1 acre

Report your business plan. How many of each animal did you choose? Why did you choose them? What will they provide to you?

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2. My Sustainable Northern California Ranch Plan

Welcome to year two of ranching. Has all or almost all of the grass been eaten? Can you come up with a better plan for using your land more thoughtfully, so that it will be sustainable and can produce grass year after year? (Hint: Try "rotational grazing.")

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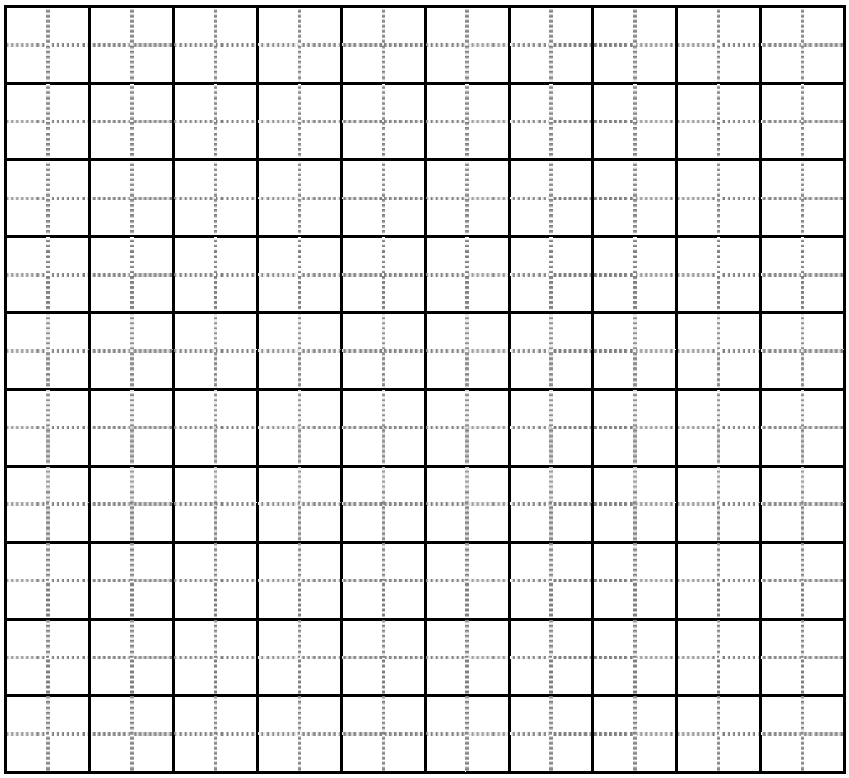

Grid Legend

Symbol	Animal	Acres	Total #

= 1 acre

How is this plan different than what you did in your first ranching plan? Why is it important to think ahead?

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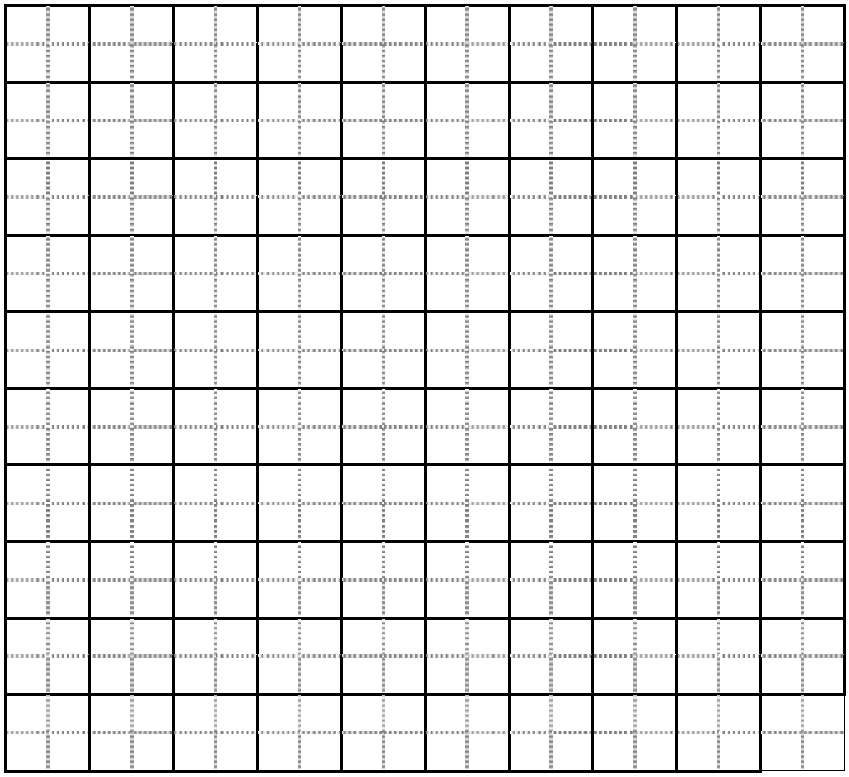
3. My Sustainable Arid Rangeland Ranch Plan

Because you have created a sustainable plan in the temperate rangelands, ranchers in Kenya and in the Amazon want to hire you to come up with a sustainable plan for their ranches.

Refer to the Food, Water and Space chart to design an appropriate and successful plan for that area. Hint: Many ranchers in Kenya, an arid rangeland, are switching to camel milk and meat for their products. Can you guess why?



Grid Legend

Symbol	Animal	Acres	Total #

= 1 acre

How did your California plan differ from the plan you came up with in this arid land? Why was it different?

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