

Curriculum development was supported by the USDA National Institute of Food and Agriculture.	 Kansas Foundation for AGRICULTURE IN THE CLASSROOM	Curriculum Development Team Chelsea McCall Emily Duello Katie Hutchison Chelsey Crabtree
--	---	--

Course:	Biology 9-12	Unit:	Vertical Gardening - Agriculture Careers
Lesson Title:	Is a Bigger Garden Always Better? How to design the right-sized garden system?		
Estimated Time:	4 class periods of 40 minutes		

Objectives:

- 1) List the advantages and disadvantages of different farm sizes and be able to define **Economies of scale.**
- 2) Calculate and compare the output of a vertical garden versus the output of a traditional garden bed.
- 3) Develop a scaled model of a garden bed that will meet consumer demand in the school setting.
- 4) Define food insecurity and share resources within the community.

Equipment Needed:

Electronic device to access the [Cultivating Hope Project](#)
Individual student devices to complete the Cultivating Hope project

Supplies Needed:

National Ag in the Classroom's "[The Big Deal about Big Ag](#)"
Aeroponic Tower Yield [Example Calculation](#)
[Traditional Gardening Calculator](#)
Sticky notes or small pieces of paper and tape (3 pieces per student)

Accessibility Options

Students can access information visually through online videos with subtitles and auto-translations.
Utilize Speech-to-Text and text-to-speech [add-ons](#) for reading/listening/writing support (Updated 7/17/23)
Multisensory resources: model supplies

For more suggestions, please visit:

<https://files.eric.ed.gov/fulltext/EJ1340991.pdf>

References and Other Resources:

Information About Aeroponic Crop Production: <https://agrotonomy.com/crop-yield-of-a-tower-farm/>

Instructor Directions & Estimated Time	Procedures
Day 1 40 minute period	National Ag in the classroom ag economics lesson
Day 2 40 minute period	National ag in the classroom ag economics lesson
Day 3 40 minute period	Harvest vertical garden plants
Day 4 40 minute period	Cultivating Hope Project

No.	9-12 Next Generation Science Standards		
HS-LS 2-1	Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales.		
	Disciplinary Core Ideas	Science and Engineering Practices	Cross-Cutting Concepts
	LS2.A: Interdependent Relationships in Ecosystems	Developing and Using Models Obtain, Evaluate, and Communicate Information Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	Scale, Proportion, and Quantity

No.	9-12 National Agriculture Literacy Outcomes
------------	--

T1.9-12 B	b. Describe resource and conservation management practices used in agricultural systems (e.g., riparian management, rotational grazing, no-till farming, crop and variety selection, wildlife management, timber harvesting techniques) g. Identify how various foods can contribute to a healthy diet
T3.9-12 G	

Supporting Resources	
Pros and Cons of Big Ag (National Ag in the classroom lesson) https://agclassroom.org/matrix/lesson/758/	
Feeding America https://www.feedingamerica.org/hunger-in-america/food-insecurity	

Vocabulary	
Biomass (noun)	the amount of living matter (as in a unit area of volume of habitat)
Yield (noun)	the amount of harvested plant per unit area for that given time
Food insecurity (noun)	the lack of access to enough food to live a healthy life
Economies of scale (noun)	decrease in average costs as production increases

Careers Mentioned	
Economist	Study the production and distribution of resources, goods, and services by collecting and analyzing data, researching trends, and evaluating economic issues.

Day 1 and 2

Day 1-2 Essential Question: Why does the size of the farm matter?

Introduce National Ag in the Classroom's "The Big Deal about Big Ag" (Estimated time 60-90 minutes)

<https://agclassroom.org/matrix/lesson/758/>

Students will explore the advantages and disadvantages of different farm sizes and be able to describe economies of scale (the short video has auto-translated subtitles)

Day 3

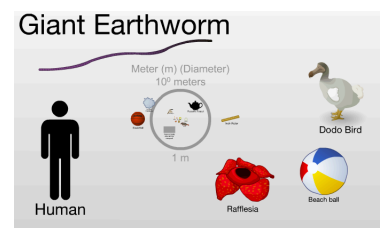
Day 3 Essential Question: How can we design a garden that will feed our school?

Bellringer: What are grams, kilograms, centimeters, and meters? Give an example (you can draw a picture) of each. (3 minutes)

For example: ***An apple weighs 200 grams.***

Discuss examples as a class. Demonstrate measurements with an electronic balance and a meter stick.

Scale of the universe (interactive site) <https://scaleofuniverse.com/en> - Have students work in pairs to choose 5 objects- 2 at the microscale, 1 at the macroscale, and 2 that are approximately 1-2 meters tall. Have them write their examples on sticky notes and put them in order on the wall (from smallest to biggest)



If students need help with unit conversions, here are some short videos they can watch:

Converting grams and kilograms: <https://www.youtube.com/watch?v=zXUICZRXDwQ>

Converting meters and centimeters: https://www.youtube.com/watch?v=kOJFSH_Bn9U.

Have students estimate the biomass of an aeroponic vertical garden based on 4-6 harvests a year.

- Example Vertical Aeroponic Tower Calculation [Document](#)
- Here's an example of a garden yield calculator for a traditional garden bed: <https://www.omnicalculator.com/biology/vegetable-yield>

Discuss with food service/cafeteria to determine the school's demand for a certain crop, i.e. lettuce or other fresh vegetables. Potentially, the class could interview a food service staff member to determine the school's needs for fresh vegetables.

Students will utilize class data and the school's demand to design a garden space using vertical and traditional gardening practices. Students will draw out their ideas on paper or create a presentation that includes calculations on school food needs and the space required to meet those needs using

traditional and vertical gardening methods. They will then present their designs to the class and discuss them.

Exit Ticket: Which garden design ideas might be most realistic for our school or community? Why?

Day 4

Day 4 Essential Question: How can we cultivate hope in our community?

Students will research levels of food insecurity in their county, identify resources for families, and create a poster to raise awareness. They will present their design to a target audience of the teacher's choice.

Cultivating Hope Project instructions with rubric

<https://docs.google.com/document/d/1Akr19bHx6AQLJRBDtuQg9snwn8LT0vSKJaovLHo2JCo/edit?usp=sharing>

<https://docs.google.com/drawings/d/126rEvkxdRneEZ2sb19V2tGwk4lsfoiHDST1naExJmiw/edit?usp=sharing>

Students will produce a presentation or poster.

Sample presentation template:

<https://docs.google.com/presentation/d/1TKMuSqx8Q60yvHWeP8x7uDtKw8JjoXjcFCm52l4nOYE/edit?usp=sharing>

Sample poster template:

<https://docs.google.com/drawings/d/126rEvkxdRneEZ2sb19V2tGwk4lsfoiHDST1naExJmiw/edit?usp=sharing>

Main topics teachers should know:

Farm sizes play a crucial role in agricultural efficiency, with each size offering distinct advantages and disadvantages. Large-scale farms benefit from economies of scale, allowing them to produce higher yields at a lower cost per unit by leveraging advanced machinery and bulk purchasing. However, they often face challenges such as high initial investment costs, reduced biodiversity, and environmental concerns like soil degradation. Smaller farms, while less resource-intensive, focus on diversified crops and local markets, which can mitigate food insecurity by increasing access to fresh produce. Yet, they may struggle with lower biomass production and limited financial resources. Understanding these dynamics helps address the community's food needs efficiently.

Comparing different farming techniques reveals innovative solutions, such as tower gardens, offer unique advantages. A tower garden can produce a higher yield per square foot than traditional garden beds due to vertical growth and optimized resource use. However, traditional garden beds often support greater biodiversity and are more accessible for community-scale food production. Calculating and comparing these outputs is essential for designing sustainable models to meet consumer demand, such as in a school setting. By developing a scaled model of a garden bed, students can learn to balance productivity with sustainability.

Food insecurity, a pressing global issue, is the lack of consistent access to nutritious food for an active and healthy life. Addressing it requires both community-level solutions, like local food banks and educational initiatives, and innovative agricultural practices. Resources such as community gardens, local food co-ops, and school-based nutrition programs can play a vital role in ensuring equitable access to fresh food, reducing food insecurity, and promoting overall community health.

Economists play a crucial role in analyzing the financial and social impacts of farm sizes, agricultural techniques, and food insecurity. They study how economies of scale benefit large farms while assessing the financial sustainability of smaller, diversified farms. By examining market trends, production costs, and consumer demand, economists help farmers make data-driven decisions to maximize efficiency and profitability.

<https://www.investopedia.com/terms/e/economiesofscale.asp>

<https://www.feedingamerica.org/hunger-in-america/food-insecurity>

<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/agricultural-techniques>

- Suggestions for instruction:

When harvesting, have students wash their hands well with soap and water and place their crop into clean food storage bags before weighing their crop. Record biomass each week for each crop, or harvest the whole plant and replant the vertical garden. Keep a class record of biomass harvested for each crop that students can use to estimate crop productivity on Day 3 of this lesson. Make sure to have plants started a couple weeks ahead of time if replanting so the vertical garden can be replanted as

soon as it is cleaned. Drain out old nutrient solution and clean the entire tower with soap and water.

Careers:

Food Processing plant manager: (See chapter 1)

Economist

Description: Economists study the production and distribution of resources, goods, and services by collecting and analyzing data, researching trends, and evaluating economic issues. Economists apply both qualitative and quantitative economic analysis to topics within a variety of fields, such as education, health, development, and the environment. Some economists study the cost of products, healthcare, or energy, while others examine employment levels, business cycles, exchange rates, taxes, inflation, or interest rates. Economists often study historical trends and use them to make forecasts. They research and analyze data using a variety of software programs. They sometimes present their research to various audiences. Many economists work in federal, state, and local government. Federal government economists collect and analyze data about the U.S. economy, including employment, prices, productivity, and wages, among other types of data. They also project spending needs and inform policymakers on the economic impact of laws and regulations. Economists working for corporations help managers and decision-makers understand how the economy will affect their business. Specifically, economists may analyze issues such as consumer demand and sales to help a company maximize its profits. Economists also work for international organizations, research firms, and think tanks, where they study and analyze a variety of economic issues. Their analyses and forecasts are frequently published in newspapers and journals.

Education: A master's degree or Ph.D. is required for most economist jobs. Positions in business, research, or international organizations often require a combination of graduate education and work experience. In addition, courses that introduce students to statistical analysis software are helpful. Students can pursue an advanced degree in economics with a bachelor's degree in several fields, but a strong background in mathematics is essential. A Ph.D. in economics may require several years of study after earning a bachelor's degree, including completion of detailed research in a specialty field. Candidates with a bachelor's degree may qualify for some entry-level economist positions, including jobs with the federal government. An advanced degree is sometimes required for advancement to higher-level positions.

Salary: The average Economist salary in the United States is \$93,827 as of, but the salary range typically falls between \$79,029 and \$107,428.

Links:

<https://www.bls.gov/ooh/life-physical-and-social-science/economists.htm#:~:text=Economists%20typically%20do%20the%20following,such%20as%20of%20financial%20markets>

<https://www.salary.com/research/salary/listing/economist-salary>



Take a look at the [Career Glossary](#) to find other related careers!

How do Kansas Ag exports affect the Global economy?

Kansas is uniquely positioned to meet the needs of growing populations around the world because of its central location, superior infrastructure, and diverse agricultural sector which produces high-quality commodities. Kansas farmers, ranchers, and agribusinesses are feeding the world. Kansas exported over \$5.3 billion in agricultural products in 2021. The leading exports include meat and edible offal, cereals, oil seed, residues and wastes, and beverages, vinegar.

In 2021, Kansas exported agriculture commodities to 187 foreign markets around the world. The top ten export markets for Kansas were: Mexico, Japan, China, South Korea, Taiwan, Canada, Hong Kong, Malaysia, Vietnam, and Brazil. The top five trade partners make up about 90 percent of Kansas's agricultural trade.

As one of the top wheat-producing states in the U.S., Kansas helps stabilize global food supplies by exporting surplus grain to wheat-dependent nations. This reduces food shortages and price volatility, ensuring a more reliable food system worldwide. Additionally, trade partnerships and agreements supported by the Kansas Farm Bureau (KFB) help expand market access for Kansas farmers, strengthening both local and international economies. By promoting competitive pricing and efficient trade routes, Kansas agriculture plays a vital role in sustaining global food security.

Organizations like the Kansas Farmers Union (KFU) advocate for fair trade policies and sustainable farming practices, ensuring that Kansas farmers can compete in the global market while maintaining environmental responsibility. These exports contribute to economic growth by generating revenue that supports rural communities and creating jobs in farming, food processing, and transportation. As a result, Kansas's agricultural exports not only sustain the state's economy but also influence international markets by keeping food supplies steady and affordable.

Biology Final Project: Cultivating Hope



Goals:

- 1) Investigate food security, agriculture, and community resources
- 2) Communicate information about resources to an audience that learns best by listening and analyzing visuals
- 3) Critique a presentation's appearance and information
- 4) Use evidence to identify a problem and describe possible solutions

Please include sources for information that you find online. Include each website that you use.

Title Page: Cultivating Hope

Background information:

a) What is food insecurity?

Source: [Feeding America](#)

b) What are 3 causes of food insecurity?

Source: [Feeding America](#)

c) What are 3 effects of food insecurity?

Source: [Feeding America](#)

d) Who is affected by food insecurity in Douglas County, Kansas? (What percent of the population?)

2 possible sources:

[Feeding America](#)

[Douglas county food resources](#)

Goal: To reduce food insecurity for _____(people) in _____(location).

Plan Options:

Option 1: Use class plant data to design a high-yield school garden

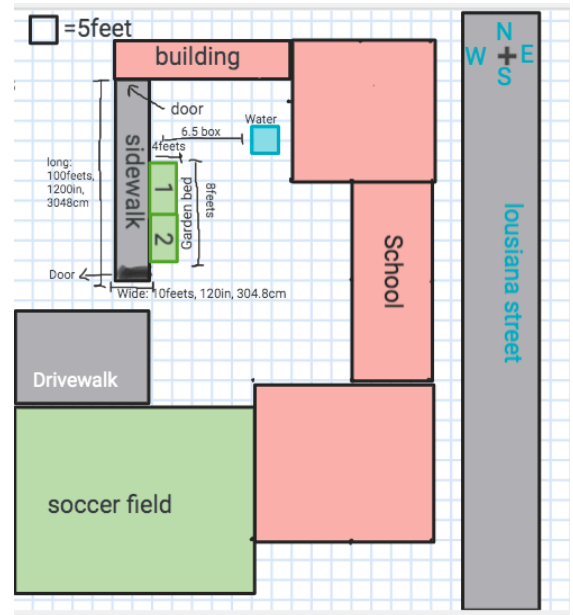
Option 2: Create educational materials (model or video) for people who want to raise their own chickens

Option 1: Garden design (Include pictures of our garden space) Background Information

- How big is it? (Length and Width in cm and inches)
- What are the advantages and disadvantages of this location? (1 or more of each)
- Who will take care of the garden? When?
- How will a school garden impact food insecurity?

Garden Design

- What type of plants will be best?
- Why did you choose these plants? (Choose 3+ plants from our class plant data)



Plant type	Needs (Light, space, etc. Be specific)	Advantages for growing this type of plant (2+)	Disadvantages for growing this type of plant (2+)

- Include a **scaled diagram** of a garden bed or a vertical garden. (Use the scale 1 box= 10 centimeters, 3 boxes= 1 meter) Use color, labels and a key. You can do this on Jamboard or on graph paper.

Insert diagram picture here

- If you could genetically engineer (cause a DNA mutation) in one of your plants, what would you change and why?

e) What physical structures would this mutation effect?

f) How will this mutation change the cell?

Part 3: Raise awareness

How can you help more people learn about ways they can limit food insecurity?

Create a bilingual poster with pictures, color and sources for more information. You can do this in google docs, google slides, or a program of your choice. Your work must be original.

Your project will be graded based on:

- 1) Accuracy of information
- 2) Quantity of information and sources
- 3) Clarity (Is it easy to read and understand? Did you speak clearly and slowly?)
- 4) Quality of work (It is obvious that you spent a lot of time and thought to create an organized, informational project?)

Your project will be screencasted and shared with your classmates on **Monday, May 22nd.**

Project Rubric- Critique Yourself and reflect on your work

Biology Final Project: Cultivating Hope 2023

	0 points	3 points- Somewhat demonstrated	4 points - Usually demonstrated	5 points- Consistently demonstrated
Diagram/model is drawn to scale with accurate dimensions	Did not complete			
Units are used correctly and consistently	Did not attempt			
Color and pictures are used appropriately to convey information	Did not attempt			
Information is accurate and complete; formal writing rules followed x2	Did not attempt			
Presentation is either presented live or screencasted	Did not attempt		-----	
Listening chart: identified keywords	Did not attempt			

appropriate for language skills				
Listening chart: Provided specific critique supported with evidence/reason	Did not attempt			
Total	Comments			

Reflection

- a) Something I did well is...
- b) Something I can improve is...

Title

The problem:

Related picture and 10+ word description

Personal reaction or connections to quotes/claims/text.

If I was a stakeholder in this situation I would feel_____
Because_____.

Someone who not feel the same as I do is _____. They most likely feel this way because_____.

I could help others develop empathy by_____.

Claim:

This problem was caused by

_____.

The person/people responsible for this problem

is/are_____

because _____.

This problem could have been avoided if_____.

The people affected are

_____,_____

_____ and _____.

This problem can be solved if

_____.

Related picture and 10+ word description

Related picture and 10+ word description

Quote from article with speaker's name and title (include source)

Gardner, A. (n.d.). *The Big Deal about Big Ag*. National Agriculture in the Classroom.
<https://agclassroom.org/matrix/lesson/758/>

Hunger and Food Insecurity. Feeding America. (n.d.).
<https://www.feedingamerica.org/hunger-in-america/food-insecurity>

Raman, M. (2024, May 17). *Vegetable Yield Calculator*. Omni Calculator.
<https://www.omnicalculator.com/biology/vegetable-yield>