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

Course:	Biology 9-12	**Unit:**	Vertical Gardening - Agriculture Careers
Lesson Title:	Introduction to Vertical Farming		
Estimated Time:	4 class periods of 40 minutes		

Objectives:

1) Define vertical farming and describe its purpose
2) Compare and contrast various vertical garden designs

Equipment Needed:

Individual device to research different gardening designs

Projector/computer to show the video "Vertical Farming: Growing in New Directions"

Supplies Needed:

Paper/notebooks for t-charts and exit slips
Paper copies of the article Vertical Farming- No Longer a Futuristic Concept (1 per student)
Paper copies of the Frayer Model graphic organizer (1 per student)
Paper copies of Vertical Garden Design Listening Chart Version 1 or Version 2 (1 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)

For more suggestions, please visit:
https://www.washington.edu/doit/equal-access-science-and-students-sensory-impairments

Instructor Directions & Estimated Time	Procedures
Day 1 40 minute period	Building activity
Day 2 40 minute period	Comparing designs

Day 3 40 minute period	Create an agriculture career mind map
Day 4 40 minute period	Answer career questions and assemble garden

No.	9-12 Next Generation Science Standards		
HS-ETS1-3	Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.		
	Disciplinary Core Ideas	Science and Engineering Practices	Cross-Cutting Concepts
	ETS1.B: Developing Possible Solutions	Constructing Explanations and Designing Solutions	Structure and Function

No.	9-12 National Agriculture Literacy Outcomes
T1. 9-12 F	f. Evaluate the various definitions of “sustainable agriculture,” considering population growth, carbon footprint, environmental systems, land and water resources, and economics
T2. 9-12 D	d. Evaluate evidence for differing points of view on topics related to agricultural production, processing, and marketing (e.g., grazing, genetic variation, and crop production; use of fertilizers and pesticides; open space; farmland preservation; animal welfare practices, world hunger)
T4. 9-12 C, E,&F	c. Discuss population growth and the benefits and concerns related to science and technologies applied in agriculture to increase yields and maintain sustainability e. Identify current and emerging scientific discoveries and technologies and their possible use in agriculture (e.g., biotechnology, bio-chemical, mechanical, etc.) f. Predict the types of careers and skills agricultural scientists will need in the future to support agricultural production and meet the needs of a growing population

Supporting Resources
Instructions for building 3 growing systems (Tower Gardens curriculum)
Aeroponics research/engineering design process (National Ag in the classroom lesson)
Hydroponics research/Test tube hydroponics (National Ag in the classroom lesson)
Aquaponics research (National Ag in the classroom lesson)

Vocabulary	
Vertical farming	An indoor/outdoor modular planter with multiple levels of vertically spaced planters
Hydroponics	the growing of plants in nutrient solutions with or without an inert medium (such as soil) to provide mechanical support
Aeroponics	the growing of plants by suspending their roots in the air and spraying them with nutrient solutions
Aquaponics	a system of growing plants in the water that has been used to cultivate aquatic organisms

Careers Mentioned	
Biosystems Engineer	Develop techniques and processes for living systems, including microbes, plants, and animals.
Sales Representative - Equipment and Ag Systems	A representative specializing in optimizing sales in agricultural equipment, ag systems, or precision agriculture technology.
Crop Consultant	Also known as a crop advisor, it provides advice to farmers about what types of crops to plant in a particular area.
Food Processing Plant Manager	The operations manager will direct and coordinate activities concerned with the safe production of company products to ensure the timely completion of quality products by performing duties personally or through subordinate supervisors.
Precision Ag Specialist	Provide support and technical assistance to growers who are using precision technologies on their farms.
Irrigation Consultant	Work with municipal, corporate, and residential clients to design and manage irrigation projects for new construction and enhancements to existing landscapes.
Grain Operation Manager	Oversees daily operation at a grain elevator or other grain storage facilities.

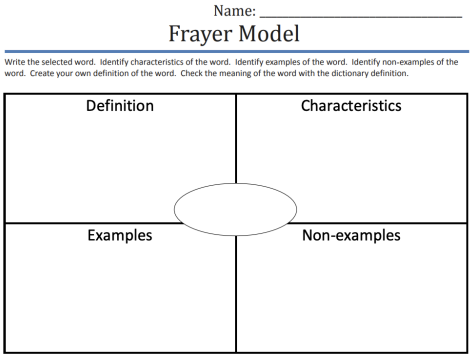
Research and Development Engineer	Performs research and development duties for their company.
Water Resource Engineer	Designs and oversees the building of new dams, reservoirs, canals, and pipelines. They also design water supply systems for cities and towns.

Day 1

Essential Question: How can we address the need for greater food production for a rising global population?

1) Before students watch the 2-minute video, "Vertical Farming: Growing in New Directions" California Academy of Sciences, ask the students to create a T-chart on a piece of paper. Their goal is to record/draw 2-3 observations from the video and 2-3 questions they have. (5 minutes with video)

I notice	I wonder


Name: _____

Frayer Model

Write the selected word. Identify characteristics of the word. Identify examples of the word. Identify non-examples of the word. Create your own definition of the word. Check the meaning of the word with the dictionary definition.

Definition | Characteristics

Examples | Non-examples

2) After the video, have students share their responses with partners and then as a whole class. Prompt them to identify what problems their generation is facing. (5 minutes)

3) Pass out a Frayer Model graphic organizer to each student. In the center, students write "Vertical farming". Preview the article "Vertical Farming- No Longer a futuristic concept" with them and model annotations/active reading strategies as they look for a) a definition of vertical farming b) a visual representation of a vertical farm c) examples of vertical farming practices and d) non-examples of vertical farming (ie traditional agricultural practices.) Allow students time to work in small groups before sharing as a class. (15 minutes)

4) Divide the class into 2 teams: Team 1 must list 2-5 advantages of vertical farms; Team 2 must list 2-5 disadvantages of vertical farms. Students can refer to the "Vertical Farming- no longer a futuristic concept" article for support. Give students 3-5 minutes to list information, then share out with the class. Record their answers on a T-chart to refer to during future lessons. If time allows, ask students to sketch a symbol that represents each advantage/disadvantage listed to provide visual support. (10 minutes)

5) Inform students that they will be designing/building vertical gardens to address local issues of food security. Give them 2-3 minutes to sketch and label a possible design on a piece of paper as an **exit ticket.** They can list materials they will need as well as questions they have. If time allows, they can share their thoughts with the class. (5 minutes)

Day 2

Essential Question: What are the essential components of a vertical garden?

1) Bellringer: Have students define a vertical farm and describe its characteristics in small groups. Ask them to explain why this method would be useful for addressing food security in their community. Students can refer to their Frayer Models/exit slips from the previous class period if they need assistance recalling this information. (5 minutes)

2) Jigsaw activity: Students will research 3 types of vertical gardening designs. For each design, they must identify the method of nutrition delivery to plants, draw or copy/paste an image of this garden type, list materials and space required, and identify 2 or more advantages and 2 or more disadvantages of this vertical gardening design. After researching for 15 minutes, they will present their findings to 2 classmates who have researched other gardening designs and complete the Vertical Garden Design Listening Chart Version 1 or Version 2 (30 minutes)

Research Websites:

Green Wall
https://www.uwrf.edu/URSCA/greenwall/WhatIsAGreenwall.cfm

Green Facade
https://extension.umd.edu/sites/extension.umd.edu/files/publications/FS-978%20Green%20Facades-%20Ecological%20Designed%20Vertical%20Vegetation.pdf

Free-Standing Tiered Vertical Garden
https://www.lawnstarter.com/blog/landscaping/vertical-gardening-ideas/

Hydroponics
https://extension.umn.edu/how/small-scale-hydroponics

Aquaponics
https://www.ucdavis.edu/food/aquaculture-aquaponics

Soil-Based Vertical Gardening
https://www.spider-farmer.com/blog/hydroponics-vs-soil-culture-which-should-you-choose-for-your-plants/

Aeroponics
https://modernfarmer.com/2018/07/how-does-aeroponics-work/

Hydro-, Aqua-, and Aeroponics
https://terrascope2024.mit.edu/?page_id=313

3) Exit slip: Which vertical design will be most practical and why?

Name Date Class **Vertical Garden Listening Chart**

Title: Vertical Garden Design Research Discussions					
Column 1: Name of vertical garden design	Column 2: Method of nutrition delivery	Column 3: Picture or image of vertical garden design	Column 4: materials and space required	Column 5: 2 or more advantages of this design	Column 6: 2 or more disadvantages of this design
Green Wall Video Article					
Green Facade Video Article					

Day 3

Essential Question: What careers and job skills are related to vertical gardens?

1) Bellringer: Create a mind map with all of the jobs you currently know that are related to agriculture. Share with your table partners/class when finished. (5 minutes)

2) Careers Lesson using the Career Information Reading Activity Texts (30 minutes)

Procedure:

1. Assign students to pairs for reading. Students will read aloud to each other and highlight important details in the text.
2. After reading the text, the partners will then work together to answer the following questions:
   a. Name the most important WHO or WHAT
   b. Tell the most important thing about the WHO or WHAT
   c. Say the main idea in 10 words or less
3. Have student pairs write their 10-word summaries in the provided blanks on each career page.
4. If another student pair has the same career, have the groups compare their answers.

5. Have each career group share with the rest of the class their 10-word summaries. The teacher may need to check with groups before sharing out to make sure their summaries are accurate.

3) After covering these different careers, have students add them to their bellringer mind maps that can be used as exit tickets (5 min)

Day 4

1) Bellringer: Have students answer the Career Questions as a reminder of the careers discussed the day before. (5 minutes)

2) Students identify which type of garden system they will build and work in teams to assemble it. As they work, remind them to think of the skills they need to complete this task successfully. (30 minutes)
*Teams may need additional time to assemble.

3) After assembly, students create a list of the skills they have utilized and consider which agricultural careers are related to these skills. For additional information, they can refer to the Career Information appendix as well as their reading from Day 1. (5 minutes)

BACKGROUND

Vertical Farming

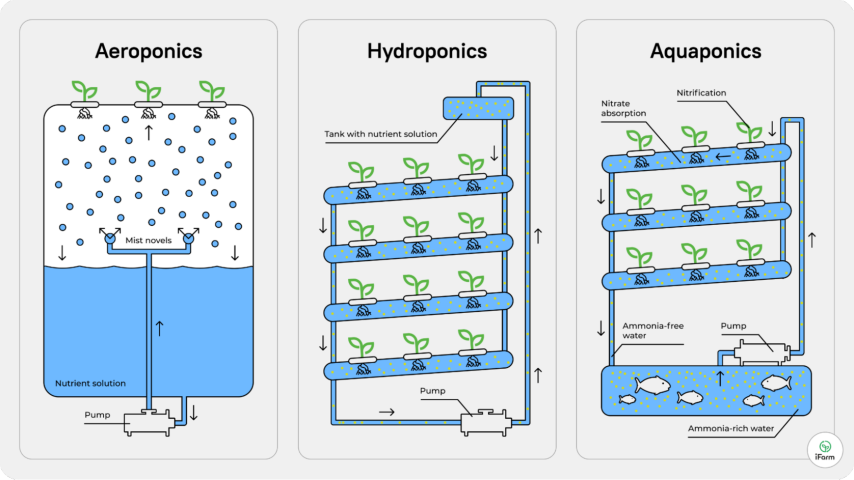
The modern concept of vertical farming started in the 1990s when farmers needed more means to grow more food in a smaller space. These multilayered structures allow crops to be grown indoors, stacked vertically. The design makes the use of space efficient and can make it more accessible to urban communities. These farms use significantly less water than traditional farming, and the water that is used can be recycled, further conserving resources. By growing food closer to metropolitan areas, the carbon footprint will be cut down because of the decreased transportation leading to more fresh produce with reduced spoilage. This method allows for crops to grow in every region without geographical restrictions. Scientists can repurpose shipping containers to use as research labs and farming units. While there are advantages to vertical farming, some of the disadvantages include high energy costs for lighting and climate control but also the demand for the skilled workforce needed to manage and use these systems effectively. Another major challenge is finding and using an alternative light source. Because of the stacked systems, plants cannot use the Sun as an energy source, increasing overall costs.

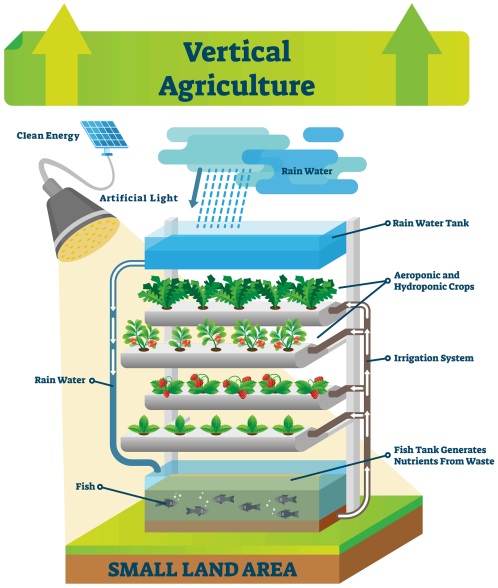
Many hydroponic, aquaponic, and aeroponic systems utilize the vertical farming system. These systems provide us a way to produce food without relying on soil and large amounts of water than traditional farming. Hydroponics is a way of growing plants without the use of soil but using nutrient-rich water. By controlling the nutrients, water, and light it enables faster growth and higher yields. Aeroponics is a method of growing plants without soil, where the roots are suspended in air and misted with a nutrient-rich solution. This allows for efficient nutrient absorption and faster plant growth. In contrast, aquaponics combines fish production with hydroponics. The fish waste is used as nutrients for the plants and the plants help filter and clean the water, which helps create a sustainable ecosystem. Some of the most successful crops in this environment have seemed to be leafy greens and lettuce because of the fact that they can be sold as a whole, while other crops like corn only sell the fruits leaving just the vegetative parts of the plant. Other plants like small fruits and vegetables have the potential to be successful in the vertical farming environment. Cereal and row crops may still be better suited for traditional farming. By modernizing these growing methods, we are given the potential to revolutionize global food security. Food security is the ability to have access to enough nutritious and safe food, as well as affordability and sustainability to live a healthy life.

Many careers relate to this lesson. A biosystems engineer plays a critical role in designing and optimizing vertical farming systems, focusing on sustainable and efficient energy, water, and nutrition delivery. Sales Representatives are essential for connecting vertical farming companies with customers and distributors, ensuring that innovative products and services reach the market effectively. Crop Consultants guide farmers and system operators in selecting the best crops for vertical farming environments and improving yields. Food Processing Plant Managers oversee operations that transform harvested crops into packaged goods, ensuring food safety and efficiency in processing. Precision Ag Specialists use advanced technology, such as sensors and data analytics, to monitor and enhance crop performance in vertical farming systems. Irrigation Consultants design and manage water delivery systems tailored to hydroponic, aeroponic, and aquaponic setups, maximizing water conservation. Grain Operation

Managers are critical in handling and storing harvested grains, although they are more commonly associated with traditional farming, their expertise is becoming increasingly relevant as vertical farming begins to expand into staple crops. Research and Development Engineers focus on innovating farming techniques, such as developing energy-efficient lighting or exploring new plant varieties suited for controlled environments. Finally, Water Resource Engineers contribute by ensuring sustainable water use and recycling systems within vertical farming operations, addressing one of the method's key advantages. Together, these careers exemplify the interdisciplinary collaboration required to support and advance vertical farming, paving the way for a more secure and sustainable global food system.

- Additional information at these links:
  - How far can vertical farming go?
  - The Rise of Vertical Farming: Revolutionizing Agriculture - Thanksgiving Point.
  - The Hydroponic / Aeroponic / Aquaponic – Vertical Farming Debate.
  - Vertical Farming: Why Growing Up Can Make a Difference - Bowery
  - Leafy Green Farms
  - "Vertical Farming- no longer a futuristic concept"
  - "Vertical Farming: Growing in New Directions"
  - Frayer Model Graphic Organizer
- Reference this document with the careers related to this lesson
  - https://docs.google.com/document/d/19-lF50Kc-z_Cnl4AHnsKu7WCHf4rhft_Vh4-7MgQe84/edit





***National Ag in the classroom lessons already provide background information on these topics:**

Aeroponics Lesson

Brief Definition: A method of growing plants without soil, where the roots are suspended in air and misted with a nutrient-rich solution. This allows for efficient nutrient absorption and faster plant growth.

Aquaponics

Brief Definition: A system that combines raising fish or aquaculture and hydroponics. The fish waste provides nutrients for the plants, while the plants help filter and clean the water, creating a sustainable ecosystem.

Hydroponics

Brief Definition: A method of growing plants without soil using nutrient-rich water. Controlling the nutrients, water, and light enables faster growth and higher yields.

Suggestions for instruction

As you work through the lessons, connect them to real-world problems that are relevant to your students. For example, refer to how urban areas have limited space for traditional farming, so the use of vertical farming could be a solution for providing food in those areas. Students in rural areas may have a hard time seeing how vertical farming could be a viable solution for food production when they live in an area that appears to have plenty of land available for farming. Another perspective to pursue for rural communities would be the lack of fresh produce when certain foods are not in season. Indoor vertical farming facilities could help meet our nutritional needs in rural areas where access to fresh produce may be scarce at times and help reduce our dependence on imported foods.

When students are building their vertical towers, having recyclable materials on hand is beneficial. Encourage students to come up with designs that use recyclable materials. An additional building day may be necessary if students need to bring in their own materials. If you plan on students conducting experiments using their vertical garden, make sure they design it in a way that allows for different treatments to easily be administered, such as having two different pots per level. A vertical garden should have a minimum of 2 levels, but you can set your design requirements to be higher if desired.

Basic Tower Garden Maintenance

Basic Maintenance for the Tower Garden can be found at the following website:
https://us.towergarden.com/pages/growing-guidance

Notes on Classroom Maintenance of the Tower Garden

Start-up

Plant seeds in rock wool squares placed in a plastic tray deep enough to hold water at least halfway up the side of the rock wool cubes. Use only water to water the seedlings when they are in the tray. Place the tray in a sunny window. Leave the seedlings uncovered or else

they will develop mildew or other fungal diseases. From planting, expect it will take approximately 2 to 3 weeks before the rock wool squares can be transplanted to the grow tower. Plant more rock wool squares than you need in case some seeds do not come up. Plant 3 to 5 seeds per rock wool cube. For plant species that get larger, thin to one or two plants per rock wool cube by cutting other seedlings from their base. If the Tower Garden is going to be inside a classroom, you will need to purchase the LED lights attachment. Classroom lighting will not be enough on its own. If your classrooms tend to be colder, especially during the winter months, plant small cool-season plants such as lettuce, cilantro, and parsley.

Classroom Use

Use masking tape to label each space on the tower with which plant species is in each tower spot if you are growing several different types of plants. This will help you track which plants work best in your space. You could also label the spots with student names and have students track plant growth such as height and number of leaves each week. As the plants get bigger, the tower's nutrient solution levels will need to be checked more frequently. When you check water levels, check the water pump to ensure it is not becoming clogged with roots. The roots of the plants will grow down into the tower and dangle from each level. Have students wash their hands with soap and water prior to harvesting your crops. When growing plants such as lettuce and spinach, you will not want to harvest leaves once the plant starts growing a tall stalk and producing flowers (also called "bolting"). The leaves will likely be bitter due to flower production. You can either let the plants continue to flower to teach students about the life cycle of plants, or you can remove the plants to start over.

Pests and Diseases

Pest issues are more likely if the Tower Garden is operated outside or near a window that is open frequently. Contact your local extension office to help identify any pests or diseases and how you can control them.

Cleanup

Disassembling and cleaning the tower when the plants are done producing is recommended. Leftover plant materials could be used to teach students about composting if resources are available to start a composting project. Rock wool cubes can be broken apart to improve aeration of compost, but they will not decompose as they are made of rock. If parts of the tower have lots of lime scale, they can be soaked in a large tub of diluted vinegar solution to remove it. Scrub the parts with soap and water to clean. If any plants contracted diseases or pests, the parts of the tower can be soaked in a solution of one part household bleach with nine parts water for at least 10 minutes to sanitize the tower.

Who is Kansas Agriculture?

Kansas agriculture continues to be a vital force in the state's economy, bringing in dollars and providing many jobs. As the top industry in Kansas, agriculture accounts for over 40% of the total economy, and according to the most recent statistics, there are 58,569 farms in the state producing and raising top crops and livestock. Approximately 88% of the state's land is under agricultural production, and family-owned farms and ranches are the backbone of Kansas agriculture; 84.6% are family-owned.

Kansas is ranked (2024):
#1 for Sorghum for Grain which makes up 53.2% of the US total
#1 for Cropland which makes up 7.4% of the US total
#1 for Winter Wheat which makes up 16.1% of the US total
#3 for Red Meat Production which makes up 10.7% of the US total
#6 for Beef Cows which makes up 4.5% of the US total
There are 100,655 total producers in Kansas with 34,579 being female.

To view Kansas' complete ranking in U.S. Agriculture:

https://www.agriculture.ks.gov/home/showpublisheddocument/9780/638633671812100000

Careers:

Biosystems Engineer:

Description: Biological Systems Engineers develop the techniques and processes for living systems, including microbes, plants, and animals. They provide input to produce and process food, fiber, energy, chemical feedstock, and pharmaceuticals. Emphasis is placed on protecting and conserving our natural resources, including efficient use of soil and water, environmental protection of air and water quality, and bio-based remediation of contaminated soils.

Education:
Bioengineers and biomedical engineers typically need a bachelor's degree in bioengineering, biomedical engineering, or a related engineering field. Some positions require a graduate degree.

Salary:
A Biosystems Engineer in the Kansas City area makes, on average, $99,254 per year, or $894 (1%) more than the national average annual salary of $98,360. Kansas ranks number 40 out of 50 states nationwide for Biosystems Engineer salaries.

Links: https://www.youtube.com/watch?v=b48zefL94rw

https://www.careers.egr.msu.edu/biosystemengineering

https://www.ziprecruiter.com/Salaries/Biosystems-Engineer-Salary

Sales Representative - Equipment and Ag Systems:

Description: Sales representatives specializing in agricultural equipment, ag systems, or precision agriculture technology optimize retail sales of their products to an assigned territory. They often travel to locations within an assigned territory to negotiate orders for seeds for crops, pesticides, fertilizer, garden equipment, and food for animals, as well as livestock. The duties of an agricultural sales representative include finding potential clients, educating customers on the installation, operation, and maintenance of machines, recommending products, managing inventory, and preparing contracts and reports. An ag sales rep may attend tradeshows and conferences regularly to stay current on industry trends.

Education:
The qualifications you need to become an agricultural sales representative typically include a bachelor's degree in agribusiness, agriculture, economics, animal or crop science, or a related field.

Salary: According to ZipRecruiter, an Agricultural Sales Representative in the Kansas City area makes, on average, $61,114 per year, or $473 (1%) more than the national average annual salary of $60,641. Kansas ranks 29th out of 50 states nationwide regarding agricultural sales representative salaries.

Links: https://www.agcareers.com/career-profiles/sales-representative-equipment-and-ag-systems.cfm

https://www.ziprecruiter.com/Jobs/Agricultural-Sales-Representative/--in-Kansas

Crop Consultant:

Description: A crop consultant, also known as a crop advisor, advises farmers about what types of crops to plant in a particular area. As a crop consultant, your job is to consult closely with your clients about soil, seeds, budgets, and other environmental conditions, such as rainfall and humidity. You also maintain close relationships with suppliers, such as seed banks and fertilizer companies. A crop consultant is also very knowledgeable about crop diseases, pests, and other issues that may plague a farmer's crops.

Education: To begin your career as a crop consultant, earn an agricultural-based degree, studying agronomy, soil management, or a closely related field in environmental science. Prior experience working in agriculture, such as internships at a farm or an agriculture business, can give you a leg up when looking for jobs. Earning your Certified Crop Advisor license is also a plus. Useful skills include strong analytical problem-solving, verbal and written communication, and excellent customer service.

Salary: A Crop Consultant in Kansas makes, on average, $53,783 per year, or $381 (1%) more than the national average annual salary of $53,402. Kansas ranks number 26 out of 50 states nationwide for Crop Consultant salaries.

Links: https://www.agcareers.com/career-profiles/crop-advisor.cfm

https://www.ziprecruiter.com/Salaries/Crop-Consultant-Salary--in-Kansas

Food Processing Plant Manager:

Description: The Operations Manager will direct, and coordinate activities concerned with the safe production of company products to ensure timely completion with quality products by performing the following duties personally or through subordinate supervisors. As an operations manager, your job is to manage materials, packaging, and raw materials such that all materials are available to meet scheduling requirements on a timely basis by working closely with the purchasing and inventory manager, ensuring plant safety through compliance with safety standards, achieve compliance for product quality, food safety, and food defense as issued by the QC (Quality Control) Department while maintaining overall plant efficiency, and manage cost and manufacturing components.

Education: Majority of Food Processing Plant Managers have a bachelor's degree. Even though most food processing plant managers have a college degree, it's possible to become one with only a high school degree or GED. Most food processing plant managers, 20% to be exact, major in animal science. Some other common majors for a food processing plant manager include engineering and veterinary medicine majors.

Salary: A Food Processing Plant Manager in your area makes on average $114,285 per year, or $1 (0.005%) less than the national average annual salary of $115,538. Kansas ranks number 28 out of 50 states nationwide for Food Processing Plant Manager salaries.

Links: https://www.ziprecruiter.com/Salaries/Food-Processing-Plant-Manager-Salary

https://www.smartstaff.ca/job-listing/plant-manager-food-industry/

Precision Ag Specialist:

Description: Precision agriculture specialists provide support and technical assistance to growers who are using precision technologies on their farms. They implement actual work of grid and contour differential global positioning systems for soil sampling as well as developing informational and recommendation maps. Implement actual work of differential global positioning systems, implement variable rate application of lime and nutrients, implement practical application of record keeping and nutrient management plans, provide training for other retail employees in precision agriculture, interpret satellite remote sensing to identify and map field variability, prepare fertility, fungicide, and seeding maps and recommendations, and understand and participate in the business plan and strategies.

Education: A bachelor's degree in agricultural engineering, agronomy, or agricultural business. Having your certified crop adviser certification may also be required. Prior sales experience can be a bonus, as sales skills can help you build and maintain customer relationships. These positions also prefer candidates with several years of hands-on experience with agricultural equipment, and at least one to two years of experience specifically with precision agriculture technologies.

Salary: A Precision Agriculture Specialist in Kansas makes on average $68,460 per year or $1 (0.022%) more than the national average annual salary of $65,433. Kansas ranks number 42 out of 50 states nationwide for Precision Agriculture Specialist salaries.

Links: https://www.ziprecruiter.com/Salaries/Precision-Agriculture-Specialist-Salary

https://www.agandfoodcareersinpa.com/precisionagspecialist.html#:~:text=Precision%20Agriculture%20Specialists%20provide%20support,developing%20informational%20and%20recommendation%20maps.

Irrigation Consultant:

Description: Irrigation consulting companies work with municipal, corporate, and residential clients to design and manage irrigation projects for new construction and enhancements to existing landscapes. Consultants review the building site, water availability, and other constraints for each project, then design an irrigation system that meets the client's requirements and budget. Consultants develop detailed drawings that specify which types and brands of products should be used and how they should be installed. Depending on the client and project size, they may also oversee the bidding process, recommend contractors, and monitor installation to ensure that plans are being interpreted and implemented correctly.

Education: A bachelor's degree in agricultural engineering, agronomy, or agricultural business. However, there is no specific post-secondary education program in irrigation. Typically, irrigation consultants have completed a training program as a landscape architect or landscaping technician. As there are no educational requirements, some consultants have gained their knowledge through work experience in a range of positions in irrigation. Technical drawing skills are an absolute requirement in this position. There is a range of short courses in technical drawing or the use of AutoCAD® programs available at the community college level.

Salary: The average salary of Irrigation Consulting jobs will vary according to location, department, and job description. The estimated total pay for an Irrigation Technician is $77,007 per year in the United States area, with an average salary of $59,996 per year.

Links:

https://www.irrigation.org/IA/Workforce_Development/Career_Opportunities/Irrigation_Consulting_Company/IA/Workforce_Development/Career_Opportunities/Irrigation_Consulting_Company.aspx#:~:text=Consultants%20review%20the%20building%20site,how%20they%20should%20be%20installed.

https://www.agcareers.com/career-profiles/irrigation-specialist.cfm

https://www.glassdoor.com/Salaries/irrigation-consultant-salary-SRCH_KO0,21.htm

Grain Operation Manager:

Description: A grain operations manager oversees daily operations at a grain elevator or other grain storage facility. As a grain operations manager, you manage workers, direct them in the loading and unloading of grains from trucks or rail cars, monitor grain mixing, and ensure the quality of the grain and storage. Your responsibilities include performing maintenance on the equipment at the facility, including the pneumatic conveyors or bucket elevators that lift grain into silos or bins, and handling all customer orders and shipments.

Education: The qualifications to work as a grain operations manager typically include a high school diploma or equivalent and several years of experience at a grain elevator or similar facility. Some large facilities prefer candidates who have advanced training or education in agriculture or agricultural business.

Salary: As of Aug 7, 2023, the average annual pay for a Grain Elevator Superintendent in Kansas is $62,822 a year.

Links:

https://www.agcareers.com/career-profiles/grain-elevator-manager.cfm

https://www.ziprecruiter.com/Salaries/Grain-Elevator-Superintendent-Salary--in-Kansas

Research and Development Engineer:

Description: An R&D engineer performs research and development duties for their company. They use research theories, principles and models to perform a variety of experiments and activities. Not only do R&D engineers create new products, but they also redesign existing company products. Overall, they aim to improve their company's current technologies and develop innovations to elevate the organization's position in their industry and

market. An R&D engineer's duties depend on the industry they work in, the products they develop, and the existing products sold by the company they work for. Despite this, they have some common duties, which often include designing a variety of products, drawing product sketches, determining product dimensions and creating mockups of proposed products, developing ideas for products and leading the product development through to fruition, leading project teams and managing all team members to ensure project completion, and creating detailed plans with various teams including the engineering and marketing teams to manage product development and production.

Education: While not all employers require you to have a bachelor's degree as an R&D engineer, it's often a preferred qualification. Consider earning a Bachelor's Degree in Engineering or a related field like biotechnology. If you don't decide to pursue a degree, make sure you have an industry-related or R&D-specific work history to showcase your expertise in this field. Consider applying for an industry-related internship that can help you gain skills relevant to this job position. Though you don't necessarily need an internship to pursue this career, completing one can help you impress hiring managers and set you apart from other applicants.

Salary: As of Aug 7, 2023, the average annual pay for a Research And Development Engineer in the United States is $92,666 a year. A Research And Development Engineer makes on average $96,092 per year, or $2 (0.018%) more than the national average annual salary of $92,666. Kansas ranks number 42 out of 50 states nationwide for Research And Development Engineer salaries.

Links:

https://hr.psu.edu/research-and-development-engineer

https://www.ziprecruiter.com/Salaries/Research-And-Development-Engineer-Salary

Water Resource Engineer:

Description: A water resources engineer designs and oversees the building of new dams, reservoirs, canals, and pipelines. They also design water supply systems for cities and towns. An engineer often creates a layout of the proposed system and uses computer simulations to test it for efficiency. A wastewater engineer usually oversees the design and construction of sewage treatment plants, making sure that they produce clean effluent. They also make sure that the plant operates within environmental regulations. They determine whether the area supports the water infrastructure, identifying any soil and geological conditions that may affect the performance of a dam or levee. They conduct laboratory tests on soil samples from an area to test for contaminants such as bacteria and heavy metals before the building begins. A water resources engineer tries to prevent floods using methods such as dams and levees, develops plans for controlling groundwater flow, and studies how changes to aquatic habitats impact wildlife and marine life, such as fish and seaweed. A water resources engineer develops complex computer models

based on environmental studies and weather data. They also use these predictive models to determine policies related to conservation so that damaging activities do not occur. A water resource engineer researches new methods for supplying drinking water to growing populations in urban areas and engages in research studies that help prevent the spread of disease by improving sanitation.

Education: To pursue a career in water resource engineering, most candidates earn a bachelor's degree and a master's degree in civil engineering. Additionally, they must apply to receive a certificate from the American Academy of Water Resources Engineers.

Salary: A Water Resource Engineer in your area makes on average $87,359 per year, or $1 (0.006%) more than the national average annual salary of $86,283. Kansas ranks number 30 out of 50 states nationwide for Water Resource Engineer salaries.

Links:

https://www.environmentalscience.org/career/water-resource-engineer

https://www.ziprecruiter.com/Salaries/Water-Resource-Engineer-Salary

Take a look at the Career Glossary to find other related careers!

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Frayer Model

About the Strategy

A FRAYER MODEL is a graphic organizer that helps students determine or clarify the meaning of vocabulary words encountered while listening, reading, and viewing texts. It is used before reading to activate background knowledge, during reading to monitor vocabulary, or after reading to assess vocabulary. This strategy supports students' acquisition of new words and using resource materials by providing students with a structure to examine words for their definitions, characteristics, examples, and non-examples. Word learning requires multiple exposures to the word within meaningful contexts.

Implementation of the Strategy

- Select a word from a self-contained passage of text.
- Establish the purpose of the strategy.
- Provide students with a Frayer Model and use a think-aloud as you model the process of using the Frayer Model to analyze the word and determine its meaning.
    - Write the selected word.
    - Write the characteristics of the selected word. Scaffold as needed.
    - Write examples of the selected word. Scaffold as needed.
    - Write non-examples of the selected word. Scaffold as needed.
    - Write a definition for the selected word in your own words. Scaffold as needed.
    - Check the meaning of the word with the dictionary definition.
- Have students use the Frayer Model to determine the meaning of words. Scaffold as needed.

Measuring Progress

- Teacher observation
- Conferencing
- Student journaling
- Frayer Model as a formative assessment

Research

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Wisconsin State Standards Strand

Language

- Vocabulary Acquisition and Use

Grade Level

6-12

Purpose

Use with students to support vocabulary development: introduce new vocabulary words and explicitly teach how to use resource materials

When to Use

Before Reading
During Reading
After Reading

Grouping

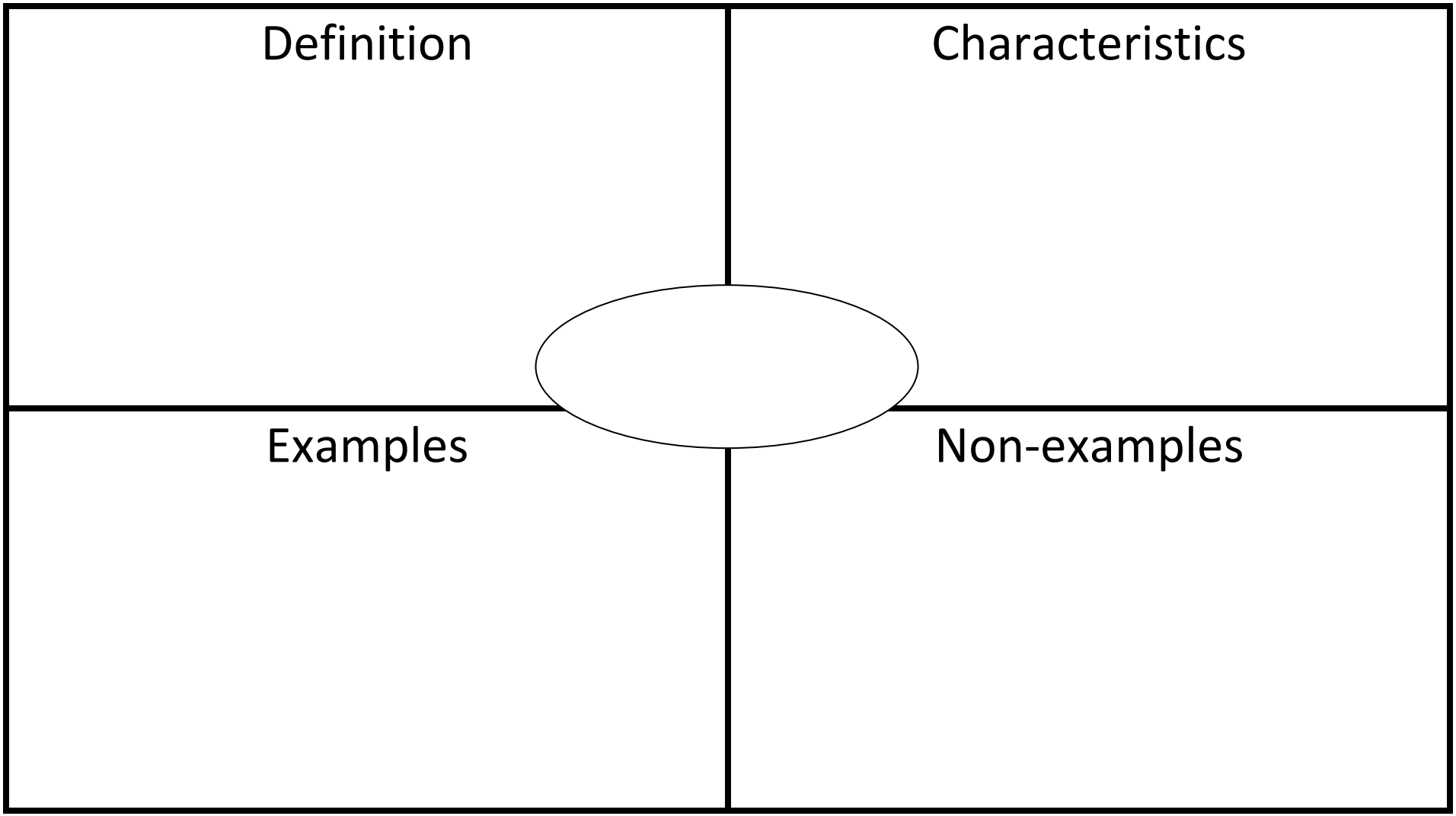
Whole class
Small group
Partners
Individual

WISCONSIN DEPARTMENT OF PUBLIC INSTRUCTION

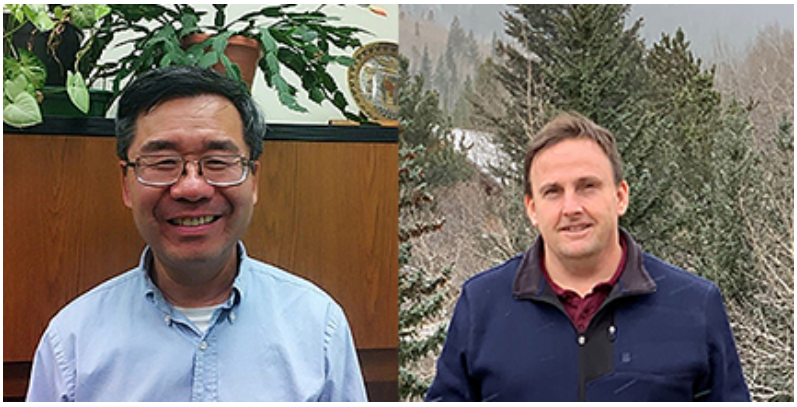
Name: _____

Frayer Model

Write the selected word. Identify characteristics of the word. Identify examples of the word. Identify non-examples of the word. Create your own definition of the word. Check the meaning of the word with the dictionary definition.



Vertical Farming – No Longer A Futuristic Concept



Dr. Kai-Shu Ling is a research plant pathologist with the Vegetable Research Laboratory in Charleston, SC.

Dr. James Altland is a research horticulturalist with the Application Technology Research Unit in Wooster, OH.

Welcome *Drs. Ling and Altland* to ***Under the Microscope***.

UM – *How does vertical farming differ from conventional agriculture?*

JA: Traditional farming involves planting crops in soil on open fields with natural sunlight and irrigation. However, vertical farming takes place inside, grows crops in stacked layers, and uses artificial growing systems such as hydroponics, aquaponics, or other methods of soilless agriculture.

UM – *What are the advantages of vertical farming?*

KL: Vertical farming offers many benefits that traditional farming cannot. For example, while the crops produced by traditional farming are limited by geographic region and seasonal changes, vertical farming allows growers to grow regional or seasonal crops indoors year-round. They can grow crops anywhere a greenhouse or controlled environment can be established. As a result, consumers (especially those in urban areas typically far from traditional farmlands) can also have easier access to fresher produce.

We're currently repurposing ship containers to become vertical farming research units. Although vertical farming's high costs can often be discouraging, shipping containers and abandoned warehouses are readily available and relatively inexpensive. Converting them into vertical farming environments not only breathes life back into discarded infrastructure but also puts fresh produce in parking lots and urban centers.

JA: Vertical farming also uses much less land. For some crops, 10 to 20 times the yield can be obtained per acre in vertical farming compared to open-field crops. Other advantages are that vertical farms are in enclosed structures, so not subject to extreme or inclement weather. Vertical farms are being built in deserts, high-population urban areas, and other places that traditional open-field farming is not practical.

UM – *What are the limitations to this type of farming? What is ARS doing to overcome these challenges?*

JA: The major disadvantage is that you give up access to the Sun, which is most abundant (and free) source of energy on Earth. Growing plants vertically in stacked systems often requires artificial light sources, which can become costly. Vertical farming also requires humidity control through expensive and energy-intensive heating, ventilation, and air conditioning (HVAC) systems.

KL: Another limitation is the general lack of knowledge and experience in maximizing crop productivity under a controlled environment. To address this, ARS established a Grand Challenge synergy project on controlled environment agriculture (CEA) in 2018. This project is a national coordinated research effort to generate knowledge for both greenhouse and vertical farming practices by improving plant genetics and breeding, LED lighting and environment control, hydroponic/aquaponic nutrient solutions, plant pest and disease management, and food quality and safety practices.

These tomatoes are being grown hydroponically (in a nutrient-rich solution rather than in soil) in a greenhouse. Small fruiting crops like tomatoes have great potential for vertical farming production. (Photo by Kai-Shu Ling, D4685-1)

UM – *How will consumers benefit from vertical farming techniques?*

JA: Vertical farming crops can often be grown without pesticides and are much less likely to be contaminated by pathogens harmful to humans such as *E. coli*.

KL: Consumers will benefit from locally grown, fresh, safe produce with better taste, quality, at year-round availability.

UM – *What crops are best grown through vertical farming? Which crops are better suited for traditional farming?*

JA: Currently, lettuce and other leafy greens are the most popular crops for vertical farming. While research is underway to grow all types of crops in vertical farms, the most successful ones today would be those that can be grown hydroponically, have relatively short compact growth forms, and can be harvested in their entirety. For example, lettuce can be harvested in its whole form, as opposed to corn where only the cob is harvested for sale and the rest must be disposed of some other way.

KL: We're currently investigating the vertical farming potential of small fruits (e.g., strawberries) and fruiting vegetables (e.g., tomato, pepper). Some other ARS research programs are also working on some larger fruit tree crops (e.g., apple, citrus, and peach).

Cereal and row crops (e.g., corn, rice, wheat and soybeans) are still better suited for traditional farming.

Interior view of a vertical farm in Minneapolis, MN. (Photo by James Altland, D4686-1)

UM – *Are the fruits and produce grown from vertical farming different – nutritionally, aesthetically, flavor-wise – from those grown by traditional methods?*

KL: Currently, most cultivars used for vertical farming are the same as those used in open field production. Therefore, nutrition, taste and quality of fruits and produce grown under vertical farming are typically the same or similar to those produced in traditional field productions.

JA: Adding on to that, ARS is looking to research nutritive quality and sensorial qualities (taste, feel, flavor) of select crops grown in vertical farms vs. traditional open field.

UM – *How much of the farming market will vertical farming comprise, say 10 years down the road?*

KL: Vertical farming is an emerging technology. Although it is still a small market right now, it has tremendous growth potential as environment control, automation, and crop production technologies are improved and energy costs are reduced. It is hard to predict how this industry will grow in the future, but I believe that it's possible that vertical farming can take over approximately 50% of leafy green markets in the U.S. and some small portions (~5%) of small fruit (strawberry) and tomato markets in 10 years.

Cucumbers grown in a controlled environment. ARS researchers are currently developing sustainable growing media for this type of production system. (Photo by James Altland, D4687-1)

UM – *I understand that vertical farming has launched into space. What are you hoping to accomplish with this effort?*

JA: NASA is keenly interested in CEA agriculture for its use on long-term manned space missions.

KL: Agreed. NASA is a pioneer in research on crop production under controlled environment. NASA continues to improve the technologies for growing vegetables and fruits in space for future Moon and Mars explorations. USDA has a long history of collaboration with NASA on controlled environment agriculture research.

UM – *Vertical farming seems to be a very futuristic concept, but gears are already in motion for practical implementation. What are some of ARS's current vertical farming projects and what are you and your team hoping to accomplish?*

JA: We are involved in hydroponics, nutrition and fertilization, water quality, pest management (diseases and insects), lighting, carbon dioxide consumption, and energy modeling. Our unit is also building a new and modern vertical farm facility on the campus of the University of Toledo to study this method of crop production more intensely.

KL: Much of the research involving vertical farming overlaps with the work that has already been done with greenhouses. Scientists abroad have also been developing new vertical farming techniques that are specially tailored to their country's needs, something that we hope to also apply in the U.S. through the ARS grand challenge synergy project. – by **Georgia Jiang**, ARS Office of Communications.

https://agclassroom.org/matrix/lesson/720/

Aeroponic Engineering and Vertical Farming (Grades 9-12)

Grade Level

9 - 12

Purpose

Students will use the *Engineering Design Process* to develop and construct an aeroponic garden to grow a food crop. Students will develop and apply an understanding of plant anatomy and physiology related to plant growth and ultimately discuss the possibilities and limitations of using vertical farming to produce our food. Grades 9-12

Estimated Time

2-3 class periods for preparation and construction followed by 3-4 weeks of observation

Materials Needed

Engage:

- Farm of the Future video

Activity 1: What do Plants Need?

- Aeroponic Farming PowerPoint slides

Activity 2: Vertical Garden Engineering Design Challenge

- *Aeroponic Farming* PowerPoint slides
- Aeroponic Garden Design Challenge handout, 1 per student -OR- Design notebooks (composition books), 1 per student
- Per group of 3-4 students:
    - 5 gallon bucket, with lid
    - 5-7 seedling plants (ideally plants that are edible or produce edible fruit)
    - 150-300 gph submersible water pump
    - 360° shrub sprinkler heads (½", threaded)
    - 6" x ½" threaded sprinkler risers
    - 5-7 net pots and foam collars (2" or 3")
    - Hydroponic nutrient solution
        - This can be purchased (we tested General Hydroponics FloraGro) or you can mix your own)
    - Grow lights or greenhouse
- Assorted tools
    - Drill hole saw (2" or 3" to match net pot size)
    - Drill
    - Electrical timer that can be programmed in 30 minute increments
    - Extension cords and/or power strip to plug in the pump in each bucket

Optional Activity: Programming Activity

- 6 ft extension cord
- Wall adapter power supply*
- Arduino and breadboard holder*
- Small breadboard*
- Screwdriver*
- Craft knife
- Wire stripper/cutter/crimping tool
- A to MiniB USB cable*
- Solid State Relay*
- Electrical tape or shrink tube
- Sparkfun RedBoard Microcontroller* (or any Arduino Uno device is equivalent)
- Hook-up wire* (black and red, 22 AWG)

- 6 Copper wire ends*
- Jumper wires
- PC or laptop (Windows, Mac OS, Linux)
- Aeroponic Garden Programming Activity instructions and PowerPoint slides

*These items are included in the Arduino Controlled Relay kit, which is available for purchase from agclassroomstore.com.

Vocabulary

aeroponics: a technique for growing plants without soil or sunlight in which the roots of the plant are suspended in the air and misted periodically with nutrient-rich water and light is provided by specialized grow lights

aquaponics: a system of aquaculture in which the waste produced by farmed fish or other aquatic animals supplies nutrients for plants grown hydroponically, which in turn purify the water

carbon dioxide: a gas consisting of one carbon atom bonded to two oxygen atoms; the byproduct of cellular respiration in animal cells and combustion of organic materials; essential to the process of photosynthesis in plant cells

hydroponics: the method of cultivating plants using a mineral nutrient solution in a water solvent without the use of soil

photosynthesis: the process by which plants convert carbon dioxide, water, and light energy into sugars and oxygen in order to store energy; the opposite of cell respiration

stomata: small openings in the leaves and stems of plants which can open and close to exchange oxygen and water vapor for carbon dioxide

transpiration: the process by which plants release water vapor back into the atmosphere through their stomata

water cycle: the series of conditions through which water naturally passes from water vapor in the air to being deposited (as by rain or snow) on earth's surface and finally back into the air through evaporation and transpiration

Name Date Class **Vertical Garden Listening Chart**

Title: Vertical Garden Design Research Discussions					
Column 1: Name of vertical garden design	Column 2: Method of nutrition delivery	Column 3: Picture or image of vertical garden design	Column 4: materials and space required	Column 5: 2 or more advantages of this design	Column 6: 2 or more disadvantages of this design
Green Wall Video Article					
Green Facade Video Article					

Freestanding Tiered Vertical Garden Video Article					

Reflect: Which vertical garden design do you think is most practical for this classroom? Why?

Name

Vertical Garden Listening Chart

Title: Vertical Garden Design Research Discussions					
Column 1: Name of vertical garden design	Column 2: Method of nutrition delivery	Column 3: Picture or image of vertical garden design	Column 4: materials and space required	Column 5: 2 or more advantages of this design	Column 6: 2 or more disadvantages of this design
Hydroponic Vertical Farm Video Article					
Aquaponic Vertical Farm Video Article					

Soil-based Vertical Farm Video Article					
Aeroponic Vertical Farm Video Article					

Reflect: Which vertical garden design do you think is most practical for this classroom? Why?

Career 1: Biosystems Engineer

Description: Biological Systems Engineers develop the techniques and processes for living systems, including microbes, plants, and animals. They provide input to produce and process food, fiber, energy, chemical feedstock, and pharmaceuticals. Emphasis is placed on protecting and conserving our natural resources, including efficient use of soil and water, environmental protection of air and water quality, and bio-based remediation of contaminated soils.

Education:
Bioengineers and biomedical engineers typically need a bachelor's degree in bioengineering, biomedical engineering, or a related engineering field. Some positions require a graduate degree.

Salary:
A Biosystems Engineer in the Kansas City area makes, on average, $99,254 per year, or $894 (1%) more than the national average annual salary of $98,360. Kansas ranks number 40 out of 50 states nationwide for Biosystems Engineer salaries.

Links: https://www.youtube.com/watch?v=b48zefL94rw

https://www.careers.egr.msu.edu/biosystemengineering

https://www.ziprecruiter.com/Salaries/Biosystems-Engineer-Salary

10 word summary:

Career 2: Sales Representative - Equipment and Ag Systems

Description: Sales representatives specializing in agricultural equipment, ag systems, or precision agriculture technology optimize retail sales of their products to an assigned territory. They often travel to locations within an assigned territory to negotiate orders for seeds for crops, pesticides, fertilizer, garden equipment, and food for animals, as well as livestock. The duties of an agricultural sales representative include finding potential clients, educating customers on the installation, operation, and maintenance of machines, recommending products, managing inventory, and preparing contracts and reports. An ag sales rep may attend tradeshows and conferences regularly to stay current on industry trends.

Education:
The qualifications you need to become an agricultural sales representative typically include a bachelor's degree in agribusiness, agriculture, economics, animal or crop science, or a related field.

Salary: According to ZipRecruiter, an Agricultural Sales Representative in the Kansas City area makes, on average, $61,114 per year, or $473 (1%) more than the national average annual salary of $60,641. Kansas ranks 29th out of 50 states nationwide regarding agricultural sales representative salaries.

Links: https://www.agcareers.com/career-profiles/sales-representative-equipment-and-ag-systems.cfm

https://www.ziprecruiter.com/Jobs/Agricultural-Sales-Representative/--in-Kansas

10 word summary:

Career 3: Crop Consultant

Description: A crop consultant, also known as a crop advisor, advises farmers about what types of crops to plant in a particular area. As a crop consultant, your job is to consult closely with your clients about soil, seeds, budgets, and other environmental conditions, such as rainfall and humidity. You also maintain close relationships with suppliers, such as seed banks and fertilizer companies. A crop consultant is also very knowledgeable about crop diseases, pests, and other issues that may plague a farmer's crops.

Education: To begin your career as a crop consultant, earn an agricultural-based degree, studying agronomy, soil management, or a closely related field in environmental science. Prior experience working in agriculture, such as internships at a farm or an agriculture business, can give you a leg up when looking for jobs. Earning your Certified Crop Advisor license is also a plus. Useful skills include strong analytical problem-solving, verbal and written communication, and excellent customer service.

Salary: A Crop Consultant in Kansas makes, on average, $53,783 per year, or $381 (1%) more than the national average annual salary of $53,402. Kansas ranks number 26 out of 50 states nationwide for Crop Consultant salaries.

Links: https://www.agcareers.com/career-profiles/crop-advisor.cfm

https://www.ziprecruiter.com/Salaries/Crop-Consultant-Salary--in-Kansas

10 word summary:

Career 4: Food Processing Plant Manager

Description: The Operations Manager will direct, and coordinate activities concerned with the safe production of company products to ensure timely completion with quality products by performing the following duties personally or through subordinate supervisors. As an operations manager, your job is to manage materials, packaging, and raw materials such that all materials are available to meet scheduling requirements on a timely basis by working closely with the purchasing and inventory manager, ensuring plant safety through compliance with safety standards, achieve compliance for product quality, food safety, and food defense as issued by the QC (Quality Control) Department while maintaining overall plant efficiency, and manage cost and manufacturing components.

Education: Majority of Food Processing Plant Managers have a bachelor's degree. Even though most food processing plant managers have a college degree, it's possible to become one with only a high school degree or GED. Most food processing plant managers, 20% to be exact, major in animal science. Some other common majors for a food processing plant manager include engineering and veterinary medicine majors.

Salary: A Food Processing Plant Manager in your area makes on average $114,285 per year, or $1 (0.005%) less than the national average annual salary of $115,538. Kansas ranks number 28 out of 50 states nationwide for Food Processing Plant Manager salaries.

Links: https://www.ziprecruiter.com/Salaries/Food-Processing-Plant-Manager-Salary

https://www.smartstaff.ca/job-listing/plant-manager-food-industry/

10 word summary:

Career 5: Precision Ag Specialist

Description: Precision agriculture specialists provide support and technical assistance to growers who are using precision technologies on their farms. They implement actual work of grid and contour differential global positioning systems for soil sampling as well as developing informational and recommendation maps. Implement actual work of differential global positioning systems, implement variable rate application of lime and nutrients, implement practical application of record keeping and nutrient management plans, provide training for other retail employees in precision agriculture, interpret satellite remote sensing to identify and map field variability, prepare fertility, fungicide, and seeding maps and recommendations, and understand and participate in the business plan and strategies.

Education: A bachelor's degree in agricultural engineering, agronomy, or agricultural business. Having your certified crop adviser certification may also be required. Prior sales experience can be a bonus, as sales skills can help you build and maintain customer relationships. These positions also prefer candidates with several years of hands-on experience with agricultural equipment, and at least one to two years of experience specifically with precision agriculture technologies.

Salary: A Precision Agriculture Specialist in Kansas makes on average $68,460 per year or $1 (0.022%) more than the national average annual salary of $65,433. Kansas ranks number 42 out of 50 states nationwide for Precision Agriculture Specialist salaries.

Links: https://www.ziprecruiter.com/Salaries/Precision-Agriculture-Specialist-Salary

https://www.agandfoodcareersinpa.com/precisionagspecialist.html#:~:text=Precision%20Agriculture%20Specialists%20provide%20support,developing%20informational%20and%20recommendation%20maps.

10 word summary:

Career 6: Irrigation Consultant

Description: Irrigation consulting companies work with municipal, corporate, and residential clients to design and manage irrigation projects for new construction and enhancements to existing landscapes. Consultants review the building site, water availability, and other constraints for each project, then design an irrigation system that meets the client's requirements and budget. Consultants develop detailed drawings that specify which types and brands of products should be used and how they should be installed. Depending on the client and project size, they may also oversee the bidding process, recommend contractors, and monitor installation to ensure that plans are being interpreted and implemented correctly.

Education: A bachelor's degree in agricultural engineering, agronomy, or agricultural business. However, there is no specific post-secondary education program in irrigation. Typically, irrigation consultants have completed a training program as a landscape architect or landscaping technician. As there are no educational requirements, some consultants have gained their knowledge through work experience in a range of positions in irrigation. Technical drawing skills are an absolute requirement in this position. There is a range of short courses in technical drawing or the use of AutoCAD® programs available at the community college level.

Salary: The average salary of Irrigation Consulting jobs will vary according to location, department, and job description. The estimated total pay for an Irrigation Technician is $77,007 per year in the United States area, with an average salary of $59,996 per year.

Links:

https://www.irrigation.org/IA/Workforce_Development/Career_Opportunities/Irrigation_Consulting_Company/IA/Workforce_Development/Career_Opportunities/Irrigation_Consulting_Company.aspx#:~:text=Consultants%20review%20the%20building%20site,how%20they%20should%20be%20installed.

https://www.agcareers.com/career-profiles/irrigation-specialist.cfm

https://www.glassdoor.com/Salaries/irrigation-consultant-salary-SRCH_KO0,21.htm

10 word summary:

Career 7: Grain Operation Manager

Description: A grain operations manager oversees daily operations at a grain elevator or other grain storage facility. As a grain operations manager, you manage workers, direct them in the loading and unloading of grains from trucks or rail cars, monitor grain mixing, and ensure the quality of the grain and storage. Your responsibilities include performing maintenance on the equipment at the facility, including the pneumatic conveyors or bucket elevators that lift grain into silos or bins, and handling all customer orders and shipments.

Education: The qualifications to work as a grain operations manager typically include a high school diploma or equivalent and several years of experience at a grain elevator or similar facility. Some large facilities prefer candidates who have advanced training or education in agriculture or agricultural business.

Salary: As of Aug 7, 2023, the average annual pay for a Grain Elevator Superintendent in Kansas is $62,822 a year.

Links:

https://www.agcareers.com/career-profiles/grain-elevator-manager.cfm

https://www.ziprecruiter.com/Salaries/Grain-Elevator-Superintendent-Salary--in-Kansas

10 word summary:

Career 8: Research and Development Engineer

Description: An R&D engineer performs research and development duties for their company. They use research theories, principles and models to perform a variety of experiments and activities. Not only do R&D engineers create new products, but they also redesign existing company products. Overall, they aim to improve their company's current technologies and develop innovations to elevate the organization's position in their industry and market. An R&D engineer's duties depend on the industry they work in, the products they develop, and the existing products sold by the company they work for. Despite this, they have some common duties, which often include designing a variety of products, drawing product sketches, determining product dimensions and creating mockups of proposed products, developing ideas for products and leading the product development through to fruition, leading project teams and managing all team members to ensure project completion, and creating detailed plans with various teams including the engineering and marketing teams to manage product development and production.

Education: While not all employers require you to have a bachelor's degree as an R&D engineer, it's often a preferred qualification. Consider earning a Bachelor's Degree in Engineering or a related field like biotechnology. If you don't decide to pursue a degree, make sure you have an industry-related or R&D-specific work history to showcase your expertise in this field. Consider applying for an industry-related internship that can help you gain skills relevant to this job position. Though you don't necessarily need an internship to pursue this career, completing one can help you impress hiring managers and set you apart from other applicants.

Salary: As of Aug 7, 2023, the average annual pay for a Research And Development Engineer in the United States is $92,666 a year. A Research And Development Engineer makes on average $96,092 per year, or $2 (0.018%) more than the national average annual salary of $92,666. Kansas ranks number 42 out of 50 states nationwide for Research And Development Engineer salaries.

Links:

https://hr.psu.edu/research-and-development-engineer

https://www.ziprecruiter.com/Salaries/Research-And-Development-Engineer-Salary

10 word summary:

Career 9: Water Resource Engineer

Description: A water resources engineer designs and oversees the building of new dams, reservoirs, canals, and pipelines. They also design water supply systems for cities and towns. An engineer often creates a layout of the proposed system and uses computer simulations to test it for efficiency. A wastewater engineer usually oversees the design and construction of sewage treatment plants, making sure that they produce clean effluent. They also make sure that the plant operates within environmental regulations. They determine whether the area supports the water infrastructure, identifying any soil and geological conditions that may affect the performance of a dam or levee. They conduct laboratory tests on soil samples from an area to test for contaminants such as bacteria and heavy metals before the building begins. A water resources engineer tries to prevent floods using methods such as dams and levees, develops plans for controlling groundwater flow, and studies how changes to aquatic habitats impact wildlife and marine life, such as fish and seaweed. A water resources engineer develops complex computer models based on environmental studies and weather data. They also use these predictive models to determine policies related to conservation so that damaging activities do not occur. A water resource engineer researches new methods for supplying drinking water to growing populations in urban areas and engages in research studies that help prevent the spread of disease by improving sanitation.

Education: To pursue a career in water resource engineering, most candidates earn a bachelor's degree and a master's degree in civil engineering. Additionally, they must apply to receive a certificate from the American Academy of Water Resources Engineers.

Salary: A Water Resource Engineer in your area makes on average $87,359 per year, or $1 (0.006%) more than the national average annual salary of $86,283. Kansas ranks number 30 out of 50 states nationwide for Water Resource Engineer salaries.

Links:

https://www.environmentalscience.org/career/water-resource-engineer

https://www.ziprecruiter.com/Salaries/Water-Resource-Engineer-Salary

10 word summary:

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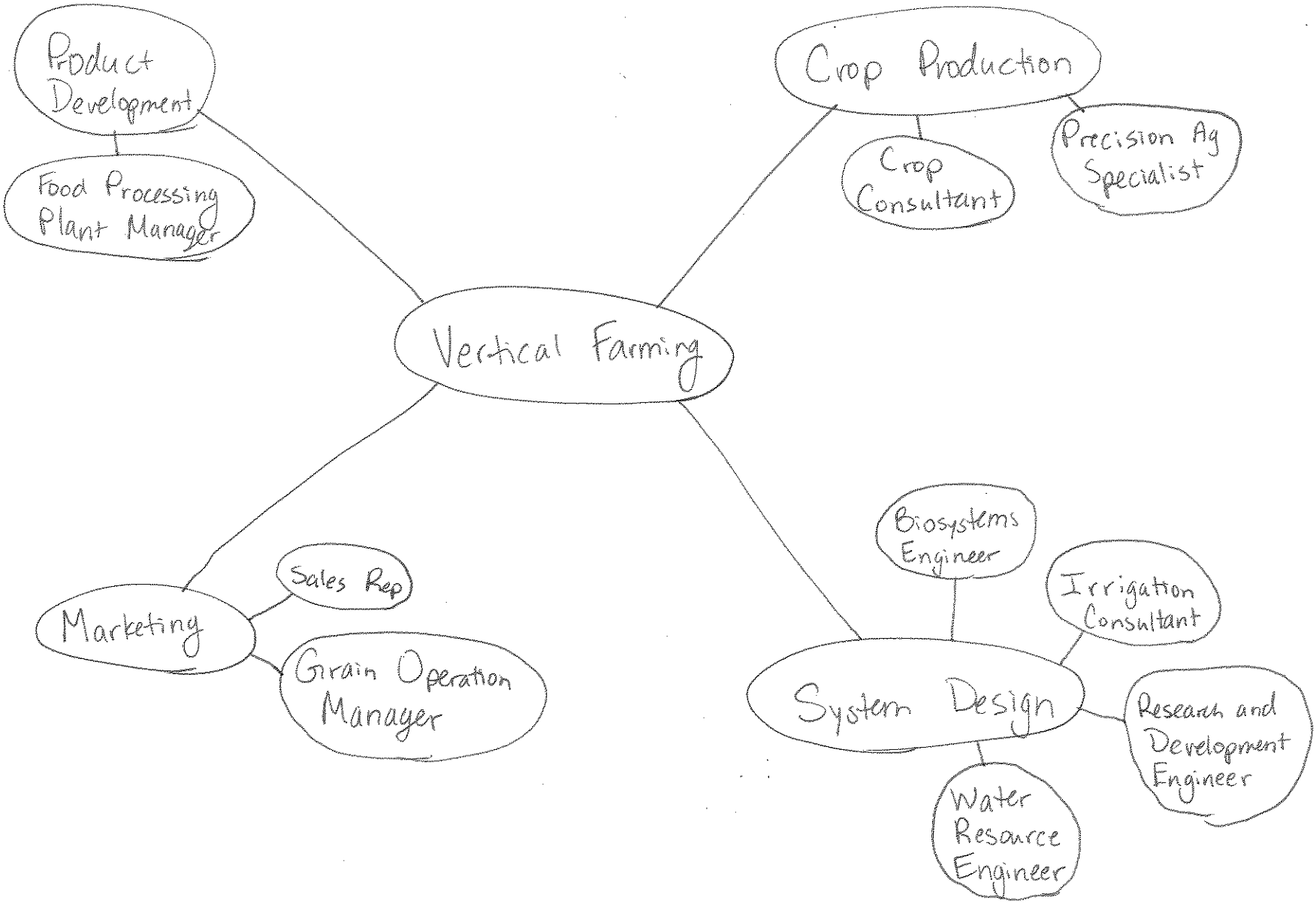
Which of the careers presented did you not know about?

Which careers surprised you? Why?

Would you have any interest in any of the careers? Why or why not?


Vertical Farming
Product Development
Food Processing Plant Manager
Crop Production
Crop Consultant
Precision Ag Specialist
Marketing
Sales Rep
Grain Operation Manager
System Design
Biosystems Engineer
Irrigation Consultant
Research and Development Engineer
Water Resource Engineer