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Kansas Foundation for AGRICULTURE IN THE CLASSROOM

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Course:	Biology 9-12	**Unit:**	Vertical Gardening - Agriculture Careers
Lesson Title:	Go with the flow: Nutrient cycling in garden ecosystems.		
Estimated Time:	4 class periods of 40 minutes		

Objectives:

1) Describe agricultural practices and analyze the value of sustainability in agriculture
2) Create a model of a garden system and justify why it is the best choice

Equipment Needed:

Projector or individual device to watch https://www.pbs.org/video/dust-bowl-dust-bowl-black-blizzards/
1 Knife (activity 1 from https://agclassroom.org/matrix/lesson/238/)
1 paper plate or cutting board (activity 1 from https://agclassroom.org/matrix/lesson/238/)

Supplies Needed:

Paper for students to do essential question
Paper Copies of vocabulary pre-test (English) (1 per student) Spanish copy
1 apple (activity 1 from National Ag in the Classroom)
Paper copies of Plant Soil Interactions Handout (Activity 4 from National Ag in the Classroom)

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: apple model

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

Instructor Directions & Estimated Time	Procedures

Day 1 40 minute period	Students create initial models of nutrient cycling in their garden ecosystem.
Day 2 40 minute period	Students create their own assessments
Day 3 40 minute period	Plant-soil interactions through dust bowl activity
Day 4 40 minute period	Journey 2050 water game

No.	9-12 Next Generation Science Standards		
HS-LS 1-3	Structure and Function: Plan and investigate to provide evidence that feedback mechanisms maintain homeostasis.		
	Disciplinary Core Ideas	Science and Engineering Practices	Cross-Cutting Concepts
	LS1.A: Structure and Function	Planning and Carrying out Investigation Developing and Using Models	Stability and Change

No.	9-12 National Agriculture Literacy Outcomes
T1. 9-12 b T5. 9-12 e	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) e. Discuss how agricultural practices have increased agricultural productivity and have impacted (pro and con) the development of the global economy, population, and sustainability

Supporting Resources
Developing and Using Models Graphic Organizer (English and Spanish)

Vocabulary	
Hydrology	a science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere
Homeostasis	A relatively stable state of equilibrium or a tendency toward such a state between the different but interdependent elements or groups of elements of an organism, population, or group
Fertilizer	Any material of natural or synthetic origin that is applied to soils or plant tissues to supply one or more nutrients essential to plant growth
Nonpoint source	nutrient pollution that results from runoff and enters the surface, groundwater, and oceans from widespread and distant activities
Point source pollution	nutrient pollution that comes from a specific source that can be identified, such as a factory or a wastewater treatment plant

Careers Mentioned	
Agronomist	Scientists who study the production of food, fiber, and other commodities

Day 1

Day 1 Essential Question: How do nutrients flow in our garden system?
1) Using their experiment design from lesson 4 as a reference, have students draw and label an initial model of their garden system with labels and arrows depicting the flow of nutrients (Focus on Nitrogen, Phosphorus, and Potassium). 5 minutes

Extension: This model could contain 2 parts: Part 1- Draw a model of your garden ecosystem with proper nutrient flow. Part 2- Draw a model of your garden ecosystem with improper nutrient flow. Where might the problems occur? What will the plant look like if this happens? (5-10 minutes)
A sample model diagram can be found at the wonderofscience.com

2) Use National Ag in the classroom lesson: Fertilizers and the environment (Activity 1). https://agclassroom.org/matrix/lesson/238/ (Apple model- illustrates how much land is available for farming). Subsequent activities in this lesson cover different types of fertilizers and how they impact the environment. (See Activity 3) Discuss eutrophication (Possible preview of precision ag)

3) Vocabulary pre-test: Give students approximately 10-15 minutes to complete this vocabulary pre-test. Parts 2 and 3 include a reflection and directions for an independent study plan.

Day 2

Day 2 Essential Question: How do I learn best? How can I share my knowledge with others?

Students will work on their independent study activities (found on page 3 of the vocabulary pre-test). Depending on the student's choice, possible materials may include notecards, paper, magazines, newspapers, markers, colored pencils, playdough, or a computer.

Once students have completed their independent study activities, they can check their knowledge by retaking the vocabulary pre-test or by creating their own assessment (Matching, multiple choice, fill in the blank, etc).

Vocabulary list: (Click here for the slide deck)

Algal bloom: a rapid increase in the population of algae in a given area of water, which often causes the water to look green

Fertilizer: any material of natural or synthetic origin that is applied to soils or plant tissues to supply one or more nutrients essential to plant growth

Nonpoint source pollution: Nutrient pollution that results from runoff and enters surface, groundwater, and the oceans from widespread and distant activities

Nutrient: a substance that provides nourishment essential for growth and the maintenance of life

Point source pollution: Nutrient pollution that comes from a specific source that can be identified, such as a factory or a wastewater treatment plant

Eutrophication: a process that occurs when a body of water receives an excessive nutrient load,

which may lead to algal blooms, oxygen depletion, and animal deaths. Adapted from: https://www.usgs.gov/centers/wetland-and-aquatic-research-center/science/science-topics/eutrophication

Hypoxia: low or depleted oxygen; in a body of water, this can lead to dead zones in aquatic environments.

Adapted from: https://oceanservice.noaa.gov/hazards/hypoxia/

Day 3

Day 3: Essential questions: What happens when crops can't absorb nutrients? How can farming practices impact the ecosystem?

1) Show students this 3-minute video clip from PBS titled "Black Blizzards" https://www.pbs.org/video/dust-bowl-dust-bowl-black-blizzards/. Ask students to record 2-3 things they notice and 2-3 things they wonder about during the video.

2) Use National AG in the classroom lesson: Plant-soil interactions (Activity 4) https://agclassroom.org/matrix/lesson/236/

Day 4

Day 4: Essential question: How can we sustainably feed the world's growing population?

Use National Ag in the Classroom's Journey 2050 Lesson 3: Water (Grades 9-12) https://agclassroom.org/matrix/lesson/584/ (45 minutes)

(This includes the Sustainability Farm Game.)

Main topics teachers should know:

Nutrients are essential for plant growth and are absorbed through the roots from the soil or growing medium. By ensuring that the nutrient glows, the plant will receive the necessary elements. The flow of nutrients depends on hydrology. Hydrology is the study of water movement, distribution, and quality within an ecosystem. In a hydroponic system, water is the main source of delivering nutrients to the roots. So that the plant receives sufficient moisture and nutrients without causing waterlogging or nutrient runoff it requires efficient water management. Water helps dissolve nutrients, making them accessible to plants. Fertilizer is a substance added to soil or water to supply nutrients for plant growth. Fertilizers can be organic or synthetic. Organic fertilizers can be things like compost or manure, while synthetic fertilizers are nitrogen-phosphorus-potassium-potassium blends. Using fertilizers can ensure that plants get the nutrients needed if it's used properly. If fertilizers are overused, it can lead to runoff and even environmental problems. Homeostasis refers to the ability of plants to maintain a stable internal environment. If plants can effectively absorb nutrients, they can regulate their internal processes, making them even more healthy.

When crops can't absorb nutrients, they experience nutrient deficiencies. Nutrients may be present in the soil, but if the pH level is too high or too low, then the plant will struggle to absorb them. Improper water management can lead to waterlogged roots or drought conditions, both of which reduce nutrient uptake. Poor drainage can wash away essential nutrients, while insufficient water prevents nutrient transport within the plant. When nutrient lockout happens, too many nutrients create an imbalance that prevents the plants from absorbing other vital nutrients.

It is also important to recognize the environmental effects that farming can bring. Point source pollution refers to the contaminants that come from a single identifiable source. For example, a drainage pipe from a certain area on a ranch or farm. Another type of pollution is Nonpoint source pollution comes from multiple indirect sources. This could be fertilizer, pesticide, or herbicide runoff from fields into nearby water sources. Nonpoint source pollution is often a major cause of water pollution in agricultural areas. Eutrophication is the process by which bodies of water become enriched with nutrients that lead to a high amount of algae growth. Although this is not direct pollution, the excess of nutrients often comes from fertilizer runoff from fields. As the algae die, the decomposition depletes the oxygen in the water, which leads to aquatic life. Hypoxia is when there is low oxygen in the water which is caused by the dead algae from eutrophication. Most marine life cannot survive in what are called “dead zones”.

Agronomists are essential for optimizing crop production and ensuring sustainable farming practices. They analyze nutrient needs, recommend precise fertilizer applications, and manage pH levels and water use to prevent nutrient deficiencies, lockout, and runoff. By addressing issues like eutrophication and pollution, agronomists promote environmentally friendly practices while improving yields. Their expertise balances agricultural productivity with environmental stewardship, making them vital in modern and sustainable farming systems.

- What is Hydrology? | U.S. Geological Survey
- Homeostasis in Plants | Regulation, Importance & Examples - Lesson | Study.com.

- Agriculture Nutrient Management and Fertilizer | US EPA
- Point Source and Nonpoint Sources of Pollution
- Eutrophication and Hypoxia | World Resources Institute

Suggestions for instruction:

To help students understand eutrophication, you may want to show a video that demonstrates how eutrophication occurs. Students can then model the process of eutrophication using modeling clay or by drawing on paper.

On day 4, you may want to give students more background on the importance of using water sustainably and what it means to use water sustainably when it comes to agriculture. This will give students a better understanding of how crop choice affects water usage and conservation.

Leading Ag Industries in Kansas

As the top industry in Kansas, agriculture accounts for over 40% of the total economy, and according to the most recent statistics, there are 58,300 farms in the state, producing and raising top crops and livestock. The Sunflower State's top commodities include cattle and calves, wheat, corn, sorghum, and soybeans. The state's nickname comes from another important crop, as Kansas ranks fourth in the nation in sunflower production. Kansas ranks No. 1 in the U.S. for the production of winter wheat and sorghum for grain. In 2021, the state produced about 59% of the nation's sorghum for grain and about 22% of the nation's wheat.

Kansas is a culinary masterpiece providing a plethora of sustainable quality ingredients it takes to feed the world. Home to a one-of-its-kind milling science program and a network of higher education resources, companies have access to a bountiful workforce trained to add zest to their operation. No matter the ingredient a company needs for their secret sauce it can be found in the Kansas food value chain, chances are one of our 15,000 agricultural companies can provide it. Our food companies range from small, family-owned companies to large, multi-national corporations and headquarters; all of which have found the economic benefit as they feed the world from Kansas' world-renowned logistics and distribution infrastructure.

Kansas sits in the animal health corridor, which is the single largest concentration of animal health interests in the world. The corridor accounts for 56 percent of the total worldwide animal health, diagnostics, and pet food sales. Exports are another major part of the industry, with a value of $3.8 billion in 2017.

With an ever-increasing percentage of the state's energy coming from renewable sources, Kansas offers an immediate advantage to companies committed to meeting corporate sustainability goals. In 2019, wind energy surpassed coal for the first time as the largest energy source for generating electricity in Kansas. Wind energy provided 41% of electricity generation in Kansas, the second-largest share for any state. Kansas offers a diverse portfolio of financial incentives to businesses and producers engaged in conventional and renewable energy production. State tax credits are available for projects that convert waste heat or biomass to energy, or otherwise offset local power usage via renewable sources. Numerous development incentives, including incentive payments, income tax credits, sales tax exemptions, financial assistance for training, and property tax exemptions are available to producers, retail dealers, and individuals who utilize alternative energy sources.

From the University of Kansas' nationally recognized drug discovery and development enterprise to the state's historical agricultural leadership at Kansas State University, to the selection of Kansas as the home of the USDA's National Bio and Agro-Defense Facility, the bioscience sector in Kansas is strong and provides value and opportunities for bioscience companies who do business in the state. Working with partners such as BioKansas, the state of Kansas offers comprehensive support for world-class research, commercialization, business start-ups, and business expansions. Kansas provides an infrastructure that fosters creative thinking and innovation to advance new technologies that help improve the health and well-being of people, animals, and other living things.

Careers:

Agronomist

Description: Agronomists are scientists who study the production of food, fiber, and other commodities. They may focus on one or more specific areas, such as soil science, plant genetics, pest management, crop rotation, irrigation systems, etc. Agronomists work with farmers to help them grow crops in a way that is sustainable and profitable. They may also provide advice on how to improve farming practices and techniques. Agronomists have a wide range of responsibilities, which can include conducting chemical analyses of soil samples to determine nutrient levels or pH levels, developing chemical applications to control pests in crops, creating proposals for new products based on their findings, conducting research on topics such as crop rotation patterns, pesticide use, and new farming techniques, conducting surveys of land to determine its suitability for agricultural use, designing irrigation systems for farms based on soil composition and climate conditions, conducting experiments on crop growth rates to determine optimal planting times, providing information to farmers about current agricultural practices and trends, and monitoring insect populations and developing strategies to mitigate their damage to crops.

Education: Most agronomists need a bachelor's degree in agriculture, agriculture science, or a related field. Some universities offer bachelor's degrees in agriculture with a concentration in agronomy. Many agronomists choose to pursue a master's degree in agriculture or agriculture science. These programs typically take two years to complete and include coursework in agriculture, agriculture science, and business.

Training & Experience: Most agronomists will receive on-the-job training in their first year of employment. This training will help the agronomist learn the specific practices and procedures of the company. It will also help the agronomist learn the specific software and computer programs the company uses.

Certifications & Licenses: Agronomists must earn a license to work in their field. To earn a license, they must pass all sections of the CPA exam and have a minimum of five years of experience. The exam includes questions on applied engineering, biology, chemistry, physics, and mathematics.

Salary: The average Agronomist salary in Kansas is $49,057, but the range typically falls between $40,377 and $61,093. Salary ranges can vary widely depending on the city and many other important factors, including education, certifications, additional skills, and the number of years you have spent in your profession.

Links:
https://www.agcareers.com/career-profiles/agronomist.cfm
https://unity.edu/careers/agronomist/#:~:text=An%20agronomist%2C%20or%20crop%20scientist,since%20the%20invention%20of%20farming.

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

Agronomist. AgCareers. (2024). https://www.agcareers.com/career-profiles/agronomist.cfm

Eutrophication. U.S. Geological Survey. (n.d.). https://www.usgs.gov/centers/wetland-and-aquatic-research-center/science/science-topics/eutrophication

How to Become an Agronomist?. Unity Environmental University. (2024, July 31). https://unity.edu/careers/agronomist/#:~:text=An%20agronomist%2C%20or%20crop%20scientist,since%20the%20invention%20of%20farming

Nutrients for Life Foundation. (n.d.-a). *Fertilizers and the Environment*. National Agriculture in the Classroom. https://agclassroom.org/matrix/lesson/238/

Nutrients for Life Foundation. (n.d.-b). *Plant-Soil Interactions (grades 9-12)*. National Agriculture in the Classroom. https://agclassroom.org/matrix/lesson/236/

US Department of Commerce. (2019, March 14). *Low or Depleted Oxygen in a Water Body Often Leads to 'Dead Zones'*. NOAA's National Ocean Service. https://oceanservice.noaa.gov/hazards/hypoxia/

Name Date

Tower Garden Lesson 5 Vocabulary Pre-test

Part 1: Complete the vocabulary chart below based on what you already know.

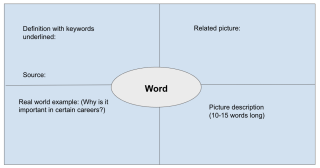
Vocabulary word	**Rate your Familiarity** **+**=I know it and can explain it ✓= I've seen or heard this word before ?= I do not know this word yet	**Best description in your own words** (You can guess!)	**Related picture with labels**
Example: **Agriculture**	+	It is what people do to get food	
1) fertilizer			
2) nutrient			
3) point source pollution			

4) non-point source pollution			
5) algal bloom			
6) eutrophication			
7) hypoxia			

Part 2: Reflection- Which words were easy to draw and explain? Which were more difficult? List the words below to help you focus your efforts as you build your professional vocabulary.

+=I know it and can explain it	✓ = I've seen or heard this word before	?= I do not know this word yet

Part 3: Independent study plan- How do you learn best? You will choose one of the learning activities below to help you memorize the definition of each vocabulary word from the pre-test.

If you like to create things on a computer:	If you like to make things with your hands:	If you like speaking:	Other ideas? Write them below and share them with your teacher
Create an online review game using: Quizlet Kahoot Blooket	Create a vocabulary box. Draw a picture or create a 3D model that represents your vocabulary word. 	Create a visual dictionary and record a screencast or video as you describe each word. You could also present this live in class. Click here for an example	

Turn in your finished learning activity to your teacher and let them know when you are ready to take your vocabulary test.

Nombre Fecha

Prueba previa de vocabulario de la lección 5 de Tower Garden

Parte 1: Complete la tabla de vocabulario según lo que ya sabe.

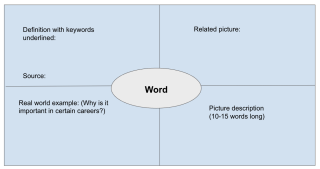
Palabra de vocabulario	**Califica tu familiaridad** **+**=Lo sé y puedo explicarlo ✓= He visto u oído esta palabra antes ?= Aún no conozco esta palabra	**La mejor descripción en tu propias palabras** (¡Puedes adivinar!)	**Imagen relacionada con etiquetas.**
Ejemplo: **Agricultura**	**+**	Es lo que hace la gente para conseguir comida.	
1) fertilizante **fertilizer**			
2) nutriente **nutrient**			
3) contaminación de fuente puntual **point-source pollution**			

4) contaminación de fuentes difusas **non point-source pollution**			
5) floración de algas **Algal bloom**			
6) eutrofización **eutrophication**			
7)hipoxia **hypoxia**			

Parte 2: Reflexión- ¿Qué palabras fueron fáciles de dibujar y explicar? ¿Cuáles fueron más difíciles? Enumere las palabras a continuación para ayudarle a concentrar sus esfuerzos mientras desarrolla su vocabulario profesional.

+=Lo sé y puedo explicarlo	✓ = He visto u oído esta palabra antes	?= Todavía no conozco esta palabra

Parte 3: Plan de estudio independiente- ¿Como aprendes mejor? Elegirás una de las actividades de aprendizaje a continuación para ayudarte a memorizar la definición de cada palabra del vocabulario de la prueba previa.

Si te gusta crear cosas en una computadora:	Si te gusta hacer cosas con tus manos:	Si te gusta hablar:	¿Otras ideas? Escríbelos a continuación y compártelos con tu profesor.
Crea un juego de revisión en línea usando: cuestionario Kahoot Blooket	Crear un cuadro de vocabulario. Haz un dibujo o crea un modelo 3D que represente la palabra de tu vocabulario. 	Cree un diccionario visual y grabe un screencast o un video mientras describe cada palabra. También puedes presentar esto en vivo en clase. Hacer clic aquí para un ejemplo	

Entrega tu actividad de aprendizaje terminada a tu maestro y avísale cuando estés listo para realizar tu prueba de vocabulario.

Name Date

Tower Garden Lesson 5 Vocabulary Post-test

Vocabulary word	**Write a description in your own words. You can also include a labeled drawing.** Escribe una descripción con tus propias palabras. También puedes incluir un dibujo con una etiqueta.
1) fertilizer el fertilizante	
2) nutrient el nutriente	
3) point source pollution la contaminación de fuente puntual	
4) non-point source pollution la contaminación de fuentes difusas	
5) algal bloom la floración de algas	
6) eutrophication la eutrofización	
7) hypoxia la hipoxia	

Definition with keywords underlined:

Related picture:

Source:

Word

Real world example: (Why is it important in certain careers?)

Picture description (10-15 words long)

Definition with keywords underlined:

Related picture:

Source:

Word

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Picture description (10-15 words long)

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