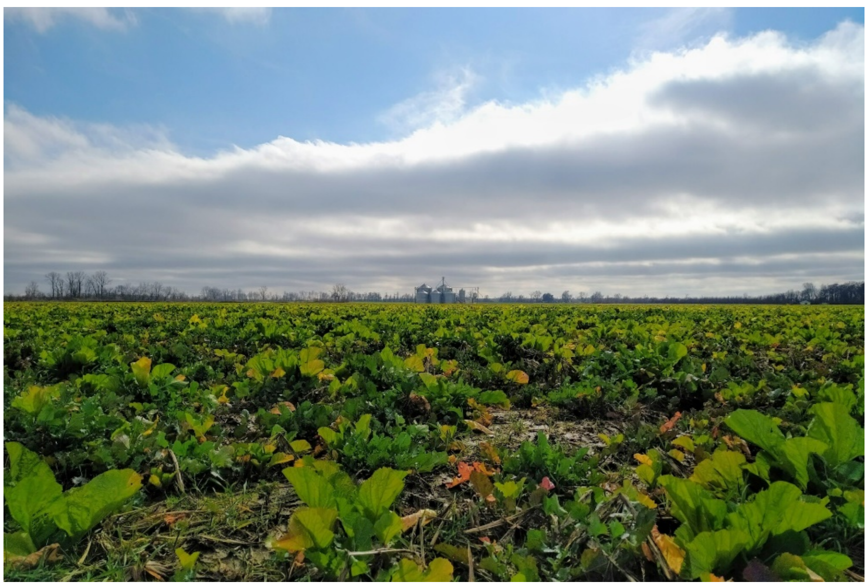
SOIL & WATER

CONSERVATION VIRTUAL FIELD TRIP SERIES

DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System | USDA United States Department of Agriculture Natural Resources Conservation Service

7E and GRC-3D Lesson Guides for the Soil and Water Conservation Soil Health Virtual Field Trip



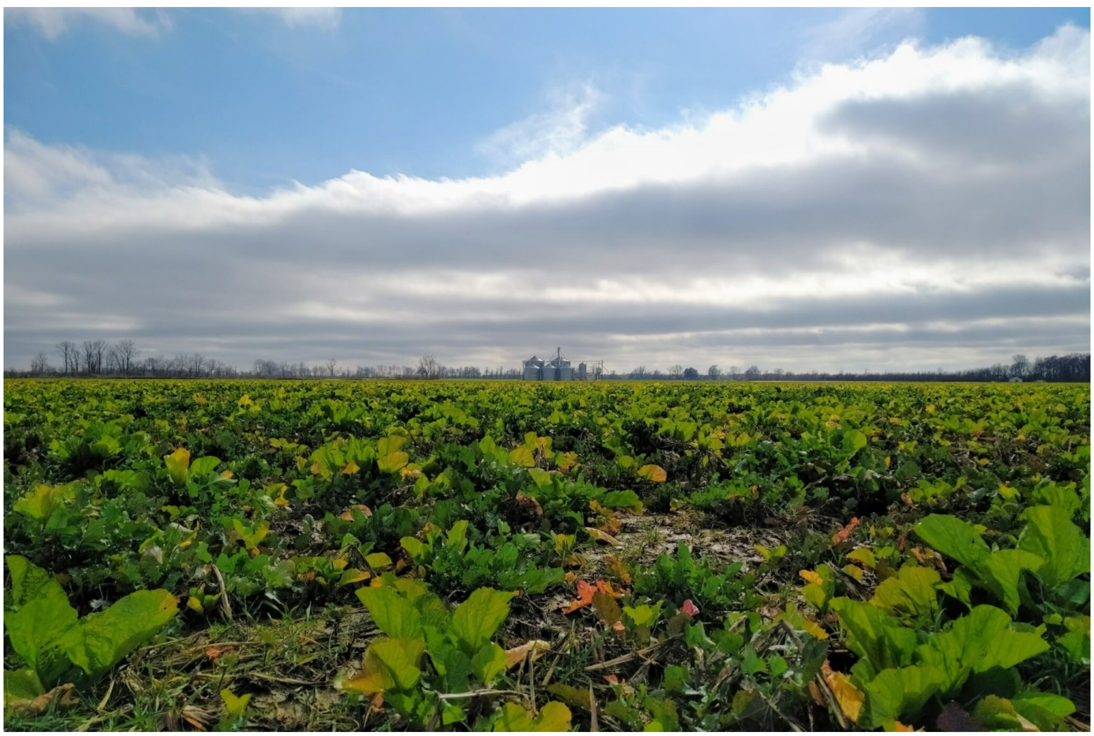
Soybean science challenge | Arkansas Soybean Promotion Board | Our Soy Checkoff Progress Powered by U.S. Farmers

www.uaex.uada.edu/soywhatsup

By Diedre Young, Soybean Science Challenge Coordinator

Arkansas Soil and Water Conservation Soil Health Virtual Field Trip

Grades 9-12 Integrated Biology, Integrated Chemistry, Environmental Science, Earth Science and Agricultural Science



Arkansas NGSS Suggestions:

Integrated Biology:

BI-LS2-3: Construct and revise an explanation based on evidence for cycling of matter and flow of energy in aerobic and anaerobic conditions.

Science and Engineering Practices: Constructing explanations and designing solutions (BI-LS2-3).

Crosscutting Concepts: Energy and matter (BI-LS2-3).

Disciplinary Core Ideas: LS2.B: Cycling of matter and energy transfer in ecosystems.

Connections to the Arkansas Disciplinary Literacy Standards: RST11-12.1, WHST.9-12.2, WHST.9-12.5.

BI-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, hydrosphere, atmosphere and geosphere.

Science and Engineering Practices: Developing and using models (BI-LS2-5).

Crosscutting Concepts: Systems and system models (BI-LS2-5).

Disciplinary Core Ideas: LS2.B: Cycling of matter and energy transfer in ecosystems. PS3.D: Energy in chemical processes.

Topic 6: Life and Earth's Systems

BI-ESS2-2: Analyze geoscience data to make the claim that one change to the Earth's surface can create feedbacks that cause changes to other Earth's systems.

Science and Engineering Practices: Analyzing and interpreting data (BI-ESS2-2).

Crosscutting Concepts: Stability and Change (BI-ESS2-2).

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World (BI-ESS2-2).

Disciplinary Core Ideas: ESS2.A: Earth Materials and Systems. ESS2.D: Weather and Climate.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.1-12.12.

Connections to the Arkansas Mathematical Standards: MP.2, HSN.Q.A.1, HSN.Q.A.3.

BI-ESS2-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.

Science and Engineering Practices: Planning and Carrying Out Investigations (BI-ESS2-5).

Crosscutting Concepts: Structure and Function (BI-ESS2-5).

Disciplinary Core Ideas: ESS2.C: The Role of Water in Earth's Surface Processes.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.7.

Connections to the Arkansas Mathematical Standards: HSN.Q.A.3.

B16-ETS1-3: 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.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (B16-ETS1-3).

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World. (BI16-ETS1-3).

Disciplinary Core Ideas: ETS1.B: Developing Possible Solutions.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.7, 11-12.8, 11-12.9.

Connections to the Arkansas Mathematical Standards: MP.2, MP.4.

Topic 7: Human Impacts on Earth Systems

BI-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (BI-ESS3-1).

Crosscutting Concepts: Cause and Effect (BI-ESS3-1).

Disciplinary Core Ideas: ESS3.A: Natural Resources, ESS3.B: Natural Hazards.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.1, WHST.9-12.2.

Connections to the Arkansas Mathematical Standards: MP.2, HSN.Q.A.1.

3 Arkansas Soil and Water Conservation: Soil Health

BI-ESS3-2: Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost benefit ratios.

Science and Engineering Practices: Engaging in Argument from Evidence (BI-ESS3-2).

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World (BI-ESS3-2). Science Addresses Questions About the Natural and Material World (BI-ESS3-2).

Disciplinary Core Ideas: ESS3.A: Natural Resources, ETS1.B: Developing Possible Solutions.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.1, RST.11-12.8.

Connections to the Arkansas Mathematical Standards: MP.2.

BI-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (BI-ESS3-4).

Crosscutting Concepts: Stability and Change (BI-ESS3-4).

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World (BI-ESS3-4).

Disciplinary Core Ideas: ESS3.C: Human Impacts on Earth Systems, ETS1.B: Developing Possible Solution.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.1, RST.11-12.8.

Connections to the Arkansas Mathematical Standards: MP.2, HSN.Q.A.1.

B17-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Science and Engineering Practices: Asking Questions and Defining Problems (B17-ETS1-1).

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World (B17-ETS1-1).

Disciplinary Core Ideas: ETS1.A: Defining and Delimiting Engineering Problems.

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.7-9.

Connections to the Arkansas Mathematical Standards: MP.2, MP.4.

Integrated Chemistry:

Topic One: Matter and Chemical Reactions:

CI-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices: Planning and Carrying Out Investigations (CI-ESS2-5).

Crosscutting Concepts: Structure and Function (CI-ESS2-5).

Disciplinary Core Ideas: ESS2.C: The roles of water in Earth's Surface Processes (CI-ESS2-5).

Connections to the Arkansas Disciplinary Literacy Standards: WHST.9-12.7.

Connections to the Arkansas Mathematic Standards: HSN.Q.A.3.

CI1-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (CI1-ETS1-2).

Disciplinary Core Ideas: ETS1.C: Optimizing the Design Solution (CI1-ETS1-2).

Connections to the Arkansas Mathematic Standards: MP.4.

Environmental Science:

Topic One: Systems

EVS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices: Planning and Carrying Out Investigations (EVS-ESS2-5).

Crosscutting Concepts: Structure and Function (EVS-ESS2-5).

Disciplinary Core Ideas: ESS2.C The roles of water in Earth's Surface Processes (EVS-ESS2-5).

Connections to the Arkansas Disciplinary Literacy Standards: WHST.9-12.7.

Connections to the Arkansas Mathematic Standards: HSN.Q.A.3.

EVS1-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Science and Engineering Practices: Asking Questions and Defining Problems. (EVS1-ETS1-1).

Crosscutting Concepts: Influence of Engineering, Technology and Science on Society and the Natural World. (EVS1-ETS1-1).

Disciplinary Core Ideas: ETS1.A: Defining and Delimiting Engineering Problems. (EVS1-ETS1-1).

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.7, RST.11-12.8, RST.11-12.9.

Connections to the Arkansas Mathematic Standards: MP.2, MP.4.

Topic 4: Sustainability

EVS-ESS3-2: Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

Science and Engineering Practices: Engage an Argument from Evidence (EVS-ESS3-2).

Crosscutting Concepts: Influence of Science, Engineering and Technology on Society and the Natural World. Science Addresses Questions about the Natural and Material World. (EVS-ESS3-2).

Disciplinary Core Ideas: ESS3.A: Natural Resources. ETS1.B: Developing Possible Solutions (EVS-ESS3-2).

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.8.

Connections to the Arkansas Mathematic Standards: MP.2.

EVS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (EVS-LS2-7).

Crosscutting Concepts: Stability and Change (EVS-LS2-7).

Disciplinary Core Ideas: LS2.C: Ecosystem Dynamics, Functioning, and Resilience, ESS3.A: Natural Resources, ESS3.C: Human Impacts on Earth Systems, ETS1.B: Developing Possible Solutions. (EVS-LS2-7).

Connections to the Arkansas Disciplinary Literacy Standards: RST.9-10.8, RST.11-12.1, RST.11-12.8, WHST.9-12.7.

Connections to the Arkansas Mathematic Standards: MP.2, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3.

EVS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science and Engineering Practices: Using Mathematics and Computational Thinking (EVS-LS4-6).

Crosscutting Concepts: Cause and Effect (EVS-LS4-6).

Influence of Engineering, Technology and Science on Society and the Natural World. (EVS1-ETS1-1).

Disciplinary Core Ideas: LS4.C: Adaptation, LS4.D: Biodiversity and Humans, ETS1.B: Developing Possible Solutions (EVS-LS4-6).

Connections to the Arkansas Disciplinary Literacy Standards: WHST.9-12.5, WHST.9-12.7.

EVS4-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practices: Using Mathematics and Computational Thinking (EVS-ESS3-3).

Crosscutting Concepts: Cause and Effect (EVS-LS4-6), Stability and Change (EVS-ESS3-3), Systems and System Models (EVS-ESS3-6).

Disciplinary Core Ideas: ETS1.B: Developing Possible Solutions (EVS-LS4-6).

Connections to the Arkansas Mathematic Standards: MP.2.

Earth Science:

Topic 2: Earth Systems

ES-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices: Carrying Out Investigations (ES-ESS2-5).

Crosscutting Concepts: Structure and Function (ES-ESS2-5).

Disciplinary Core Ideas: The Roles of Water in Earth's Surface Processes (ES-ESS2-5).

Connections to the Arkansas Literacy Standards: RST.9-12.7.

Connections to the Arkansas Mathematics Standards: HSN.Q.A.3.

ES-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Science and Engineering Practices: Developing and Using Models (ES-ESS2-6).

Crosscutting Concepts: Energy and Matter (ES-ESS2-6).

Disciplinary Core Ideas: ESS2.D: Weather and Climate.

Connections to the Arkansas Literacy Standards: RST.11-12.1, 8.

Connections to the Arkansas Mathematics Standards: MP.2, MP.4, HSN.Q.A.1-3.

ES2-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Science and Engineering Practices: Asking Questions and Defining Problems (ES2-ETS1-1).

Crosscutting Concepts: Influence of Engineering, Technology and Science on Society and the Natural World (ES2-ETS1-1).

Disciplinary Core Ideas: ETS1.A: Defining and Delimiting Engineering Problems.

Connections to the Arkansas Literacy Standards: RST.11-12.7-9.

Connections to the Arkansas Mathematics Standards: MP.2, MP.4.

ES2-ETS1-3: **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.**

Science and Engineering Practices: Constructing Explanations and Designing Solutions (ES2-ETS1-3).

Crosscutting Concepts: Influence of Engineering, Technology and Science on Society and the Natural World (ES2-ETS1-3).

Disciplinary Core Ideas: ETS1.B: Developing Possible Solutions (ES2-ETS1-3).

Connections to the Arkansas Literacy Standards: WHST.9-12.7-9.

Connections to the Arkansas Mathematics Standards: MP.2, MP.4.

Topic 3: Human Sustainability

ES-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (ES-ESS3-1).

Crosscutting Concepts: Cause and Effect (ES-ESS3-1). Influence of Engineering, Technology and Science on Society and the Natural World. (ES-ESS3-1).

Disciplinary Core Ideas: ESS3.A: Natural Resources, ESS3.B: Natural Hazards.

Connections to the Arkansas Literacy Standards: RST.11-12.1.

Connections to the Arkansas Mathematics Standards: MP.2, HSN.Q.A.1-3.

ES-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Science and Engineering Practices: Engaging in Argument from Evidence (ES-ESS3-2).

Crosscutting Concepts: Influence of Engineering, Science Addresses Questions about the Natural World (ES-ESS3-2).

Disciplinary Core Ideas: ESS3.A: Natural Resources, ETS1.B: Developing Possible Solutions.

Connections to the Arkansas Literacy Standards: RST.11-12.1, 8.

Connections to the Arkansas Mathematics Standards: MP.2.

ES-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (ES-ESS3-4).

Crosscutting Concepts: Stability and Change (ES-ESS3-4), Science Addresses Questions about the Natural World (ES-ESS3-4).

Disciplinary Core Ideas: ESS3.C: Human Impacts on Natural Systems, ETS1.B: Developing Possible Solutions.

Connections to the Arkansas Literacy Standards: RST.11-12.1, 8.

Connections to the Arkansas Mathematics Standards: MP.2, HSN.Q.A.1-3.

ES3-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Science and Engineering Practices: Asking Questions and Defining Problems (ES3-ETS1-1).

Crosscutting Concepts: Influence of Engineering, Technology and Science on Society and the Natural World. (ES3-ETS1-1).

Disciplinary Core Ideas: ETS1.A: Defining and Delimiting Engineering Problems.

Connections to the Arkansas Literacy Standards: RST.11-12.7-9.

Connections to the Arkansas Mathematics Standards: MP.2, MP.4.

ES3-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Science and Engineering Practices: Constructing Explanations and Designing Solutions (ES3-ETS1-2).

Disciplinary Core Ideas: ETS1.C: Optimizing the Design Solution.

Connections to the Arkansas Mathematics Standards: MP.2, MP.4.

Objective: Students will understand that soil health encompasses the physical (how well the soil holds together and infiltrates water), chemical (pH, nutrient concentrations, etc.), and biological (living plant roots, soil microbes and other organisms like earthworms) properties of soils. When all of these properties are improved, it can have positive impacts on agricultural production and profitability.

Assessment: Students will write a reflection paper on what they learned about soil health and its impact on agriculture production and profitability.

Key Points: Physical soil health (water and soil retention), chemical soil health (pH and nutrient concentrations), biological soil health (humus, living organisms and microbes/fungus), biodiversity, biological controls, conservation of water and minerals.

Materials:

- You will need to register online if you plan to watch the field trip 'live' on November 5. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you. If you register during the live feed, you will be automatically directed to the site. You will receive an automated email with the link to the live feed and a reminder email with a link one hour before the VFT begins.
- If you plan to watch the recorded *Arkansas Soil and Water Conservation Soil Health Virtual Field Trip*, go to www.uaex.uada.edu/soywhatsup and click on the '*virtual field trips and lessons'* icon on the left-hand side of the page. This will take you to the link for the video.
- Paper writing utensils for students (if in class).

Preparation:

If this is being done in class, it is highly recommended that you, the teacher, do research on the key words given below.

Time Duration: two class periods.

The video is about 60 minutes long (45 minutes plus any questions). Assume about 15 minutes for students to look up vocabulary and prepare questions for the video session, 15 minutes to teach essential concepts and about 15 minutes for group discussion and reflection after the video.

Elicit:

Do a KWL Chart about what students know about soil health. What is soil health? What three areas encompass soil health? How does someone determine soil is healthy? Why would soil health be important to a farmer? Why would soil health be important to you as a consumer?

Engage:

Tell the students that they are going to watch a video titled '*Arkansas Soil and Water Conservation Soil Health Virtual Field Trip.'* Before they start the video, have the students break into groups to define the following words:

- Cover Crops
- Biodiversity
- Humus
- Soil; Include the major types of soil (sandy, loam, clay) definitions
- No-till system
- pH of soil
- Types of nutrients found in soil
- Types of organisms found in soil (nematodes, earthworms, fungus, etc.)
- Biomass
- Water infiltration in soil
- Integrated weed management

Once all the words are defined, have each group come up with two questions they have about the above word groups that may be answered in the video. ***Their jobs are to turn in the questions and the answers by the end of the virtual field trip.****

*The live video stream will give your students an opportunity to ask questions throughout the field trip. If they are not finding their questions adequately answered during the broadcast, you can send in their questions to be answered at the end of the video.

Explain:

BEFORE THE VIDEO, be sure the students understand that no-till cover crops are an ecological alternative to tilling and standard chemical usage. Crop cover also increases water retention in the soil and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially nitrates) keeping it healthy, and it discourages weed growth. Crop cover, no-till and soil health measurements not only help the farmer, but they ensure the environment is protected also.

Biology Teachers: This is a good time to cover/review cycling of matter, the water cycle, soil composition and soil biology. Also consider covering biodiversity of insects (Hemiptera, Odonata, etc.) that might interact with crops.

Chemistry Teachers: Consider covering soil chemistries and reactions, water properties and the water cycle plus herbicide/insecticide chemical reactions.

Earth Science Teachers: Soil health is paramount to a thriving ecology. Cover soil components, the carbon and water cycle and soil chemistries.

Environmental Science Teachers: This is a good time to cover/review soil (and its components), soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology. Also cover how technology and new crop techniques can improve ecological conservation.

AG Science Teachers: This is a good time to review no-till vs tilling, soil health including mineral load, basic plant physiology and conservation farming practices.

Explore:

Farmers have to be constantly aware of the resources they use to grow their crops. No-till cover crops mean less water and chemicals (herbicide and insecticide) treatments. This translates into less cost for the farmer, better sustainability and is environmentally friendly.

Show the video *'Arkansas Soil and Water Conservation Soil Health Virtual Field Trip.'*

Elaborate:

After the video, break the students into three groups; *The Impact of Soil Health* group, the *No-Till* group, and the *Cover Crop* group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come up with at least six ways total and then report them to the rest of the class.

Evaluate:

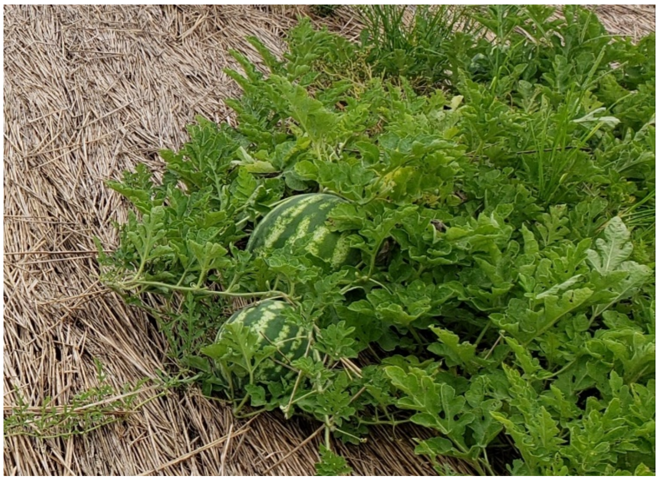
Students will turn in a two-paragraph reflection paper on what they learned and how these conservation efforts can affect where they live. They also need to give the answers to their two questions from the video.

Extend:

End the lesson with how the conservation practices of farmers to decrease their dependence on water and chemicals also has a huge impact on our personal lives through the water we use and the food we eat.

Assign a brainstorming project that allows students to design their own alternate growing methods, or ways to improve soil health while growing crops.

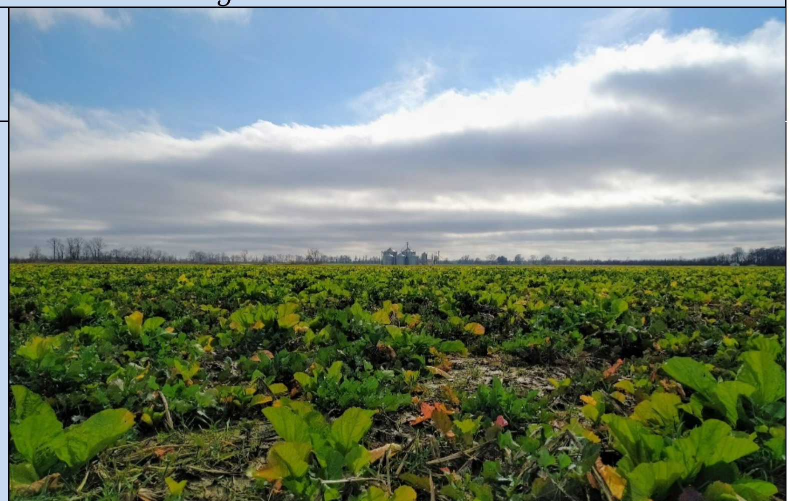
Have an extension agent or local farmer come to your classroom and talk about no-till cover crops in your local community.



3D-Student Science Performance

Author: Diedre Young, Soybean Science Challenge Coordinator

Grade: 9-12th grade Integrated Biology, Integrated Chemistry, Environmental Science, Earth Science and Agricultural Science



Lesson Topics:

Cycling of Matter

Life and Earth Systems

Natural Resources

Human Impact on Earth Systems

Sustainability

Effect of Water on Life and Earth Systems

Water Conservation and Ecology

Soil and Water Conservation Soil Health Virtual Field Trip

Performance Expectations (Standard) from State Standards or NGSS:

Integrated Biology:

Topic one: Cycling of Matter and Energy

BI-LS2-3: Construct and revise an explanation based on evidence for cycling of matter and flow of energy in aerobic and anaerobic conditions. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (BI-LS2-3).

WHST.9 -12: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes (BI-LS2-3).

WHST.9 -12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience (BI-LS2-3).

BI-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, hydrosphere, atmosphere and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

Topic 6: Life and Earth's Systems

BI-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples could include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (BI-ESS2-2).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively (BI-ESS2-2).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (BI-ESS2-2).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (BI-ESS2-2).

BI-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on the properties of water and the water cycle.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (BI-ESS2-5).

Connections to the Arkansas Mathematical Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (BI-ESS2-5).

B16-ETS1-3: 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. [AR Clarification Statement: Solutions could include those designed by students or identified from scientific studies.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (BI16-ETS1-3).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (BI16-ETS1-3).

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (BI16-ETS1-3).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively(BI16-ETS1-3).

MP.4: Model with mathematics (BI16-ETS1-3).

Topic 7: Human Impacts on Earth Systems

BI-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the way climate change has impacted human populations and how natural resources and natural hazards impact human societies. Examples of climate change results which affect populations or drive mass migrations could include changes to sea level, regional patterns of temperature and precipitation, and types of crops and livestock available. Examples of the dependence of human populations on technology to acquire natural resources and to avoid natural hazards could include damming rivers, natural gas fracking, thunderstorm sirens, and severe weather text alerts.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (BI-ESS3-1).

WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes (BI-ESS3-1).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively (BI-ESS3-1).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (BI-ESS3-1).

BI-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost benefit ratios.*[AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the designs of possible solutions. Emphasis is on the conservation, recycling, and reuse of resources (minerals and metals), and on minimizing impacts. Examples could include developing best practices for agricultural soil use, mining (coal, tar sands, and oil shales), and pumping (petroleum and natural gas).]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (BI-ESS3-2).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (BI-ESS3-2).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively (BI-ESS3-2).

BI-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [AR Clarification Statement: This PE is partially addressed in this course. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, and changes in land surface (urban development, agriculture or livestock, and surface mining). Examples for limiting future impacts could range from local efforts (reducing, reusing, and recycling resources) to large-scale bioengineering design solutions (altering global temperatures by making large changes to the atmosphere or ocean).]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (BI-ESS3-4).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (BI-ESS3-4).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively (BI-ESS3-4).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (BI-ESS3-4).

B17-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples could include recycling, increased atmospheric carbon dioxide, ocean acidification, impacts on marine populations, increased wildfire occurrence, deforestation, and overfishing.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (B17-ETS1-1).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (B17-ETS1-1).

RST.11.12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (B17-ETS1-1).

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively (B17-ETS1-1).

MP.4: Model with mathematics (B17-ETS1-1).

Environmental Science:

Topic One: Systems

EVS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [AR Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations could include stream transportation and deposition, erosion rates vary related to soil composition and moisture content, or freeze/thaw cycle. Examples of chemical investigations could include chemical weathering and recrystallization by testing the solubility of different materials, and collecting/analyzing water quality data through public data sets (USGS). Arkansas specific investigations could include karst terrain (Blanchard Caverns) and Mississippi River and its tributaries (river channel shape and river water pollution).]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (EVS-ESS2-5).

Connections to the Arkansas Mathematic Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (EVS-ESS2-5).

EVS-ESS2-6: Develop a quantitative model to describe the cycling of carbon through the hydrosphere, atmosphere, geosphere and biosphere. [AR Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, rock cycle, and biosphere. Arkansas topics could include agriculture (burning of hydrocarbons, use of natural resources), and energy-related industries including transportation.]

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS-ESS2-6).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (EVS-ESS2-6).

HN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (EVS-ESS2-6).

EVS1-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Qualitative and quantitative constraints can be used to analyze a major global challenge. Examples could include water quality with relation to biosphere, atmosphere, cryosphere, and geosphere.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (EVS1-ETS1-1).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (EVS1-ETS1-1).

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (EVS1-ETS1-1).

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS1-ETS1-1).

MP.4: Model with mathematics (EVS1-ETS1-1).

Topic 2: Energy

EVS2-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller more manageable problems that could be solved through engineering. [AR Clarification Statement: Examples of solutions could include, designing and refining solutions using solar cells and energy recovery from waste practices. Examples of constraints could include use of renewable energy forms and efficiency modeling.]

Connections to the Arkansas Mathematic Standards:

MP.4: Model with mathematics (EVS2-ETS1-2).

Topic 4: Sustainability

EVS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [AR Clarification Statement: Emphasis is on sustainability of natural resources, extracting natural resources, and how human societies are economically impacted by these phenomena.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (EVS-ESS3-1).

WHST.9 -12.2: Write informative/explanatory texts, including the narrations of historical events, scientific procedures/experiments, or technical processes (EVS-ESS3-1).

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively.

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (EVS-ESS3-1).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (EVS-ESS3-1).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (EVS-ESS3-1).

EVS-ESS3-2: Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.* [AR Clarification Statement: Emphasis is on conservation, sustainability (e.g., recycling and reuse of resources), and minimizing impacts (e.g., Low Impact Design).]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (EVS-ESS3-2).

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS-ESS3-2).

EVS-ESS3-3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. [AR Clarification Statement: Emphasis is on Arkansas-specific management and conservation of, costs of implementation and regulation of, and land use of (agriculture, mining, recreation, and urbanization) natural resources.]

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS-ESS3-3).

MP.4: Model with mathematics (EVS-ESS3-3).

EVS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [AR Clarification Statement: Emphasis in this course is on Arkansas-specific solutions. Examples of human activities can include land use (agriculture, forestry, recreation, industry); sustainable and non-sustainable practices (crop rotations, eradication of invasive species); and solution resources may include Low Impact Design (LID) or bioremediation (Faulkner County, AR; Gulf of Mexico hypoxia zone.)]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.9 -10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem (EVS-LS2-7).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (EVS-LS2-7).

WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (EVS-LS2-7).

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS-LS2-7).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (EVS-LS2-7).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (EVS-LS2-7).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (EVS-LS2-7).

EVS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [AR Clarification Statement: Emphasis is on designing solutions for a proposed problem (e.g., micro-bead pollution, invasive species, effects of sedimentation on the Arkansas Fatmucket, White-nose Syndrome affecting bat populations, and environmental pollution from hormones and antibiotics).]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9 -12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience (EVS-LS4-6).

WHST:9 -12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (EVS-LS4-6).

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively (EVS-LS4-6).

EVS4-ETS1-3: 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. [AR Clarification Statement: Modeling complex real-world problems using computer software could include simulating future population growth in terms of limited resources or evaluating water flow through different Earth and geo-engineered materials.]

Connections to the Arkansas Mathematic Standards:

MP.2 Reason abstractly and quantitatively (EVS4-ETS1-3).

Integrated Chemistry:

Topic One: Matter and Chemical Reactions

CI-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids.]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (ES-ESS2-5).

Connections to the Arkansas Mathematics Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (ES-ESS2-5).

CI1-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of real-world problems could include wastewater treatment, production of biofuels, and the impact of heavy metals or phosphate pollutants on the environment.]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and medial in order to address a question or solve a problem.

Connections to the Arkansas Mathematic Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measuring when reporting.

MP.4: Model with mathematics.

Earth Science:

Topic 2: Earth Systems

ES-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [AR Clarification Statement: Emphasis is on conducting investigations involving weathering. Examples of investigations (mechanical) could include analyzing local stream transportation and deposition data, collecting erosion data on various soil types, and evaluating water systems distributions and quality (Google Earth Time lapse feature or USGS National Real-time Stream Gaging and National Water Information System.) Examples of investigations (chemical) could include collecting/analyzing water quality data or accessing water quality data through public data sets (e.g., USGS). Arkansas examples could include surface water (e.g., streams, rivers, lakes), karst terrain (dissolution caverns such as Blanchard Caverns) and the Mississippi river and its tributaries.].

Connections to the Arkansas Literacy Standards:

WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation (ES-ESS2-5).

Connections to the Arkansas Mathematics Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (ES-ESS2-5).

ES-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [AR Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through natural (peat bogs) and human engineered reservoirs (composting).]

Connections to the Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES-ESS2-6).

MP.4: Model with mathematics (ES-ESS2-6).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (ES-ESS2-6).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (ES-ESS2-6).

ES2-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples of major global challenges for Earth's Systems could include the interrelationships between humans and urban/rural land use, mining practices, and deforestation.]

Connections to the Arkansas Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (ES2-ETS1-1).

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (ES2-ETS1-1).

Connections to the Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES2-ETS1-1).

MP.4: Model with mathematics (ES2-ETS1-1).

ES2-ETS1-3 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. [AR Clarification Statement: Solutions to complex real-world issues where realistic criteria and constraints are accounted for could include evaluating energy resources available on other planets, various building configurations/constraints, drip agriculture systems and solar powered fans.]

Connections to the Arkansas Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (ES2-ETS1-3).

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (ES2-ETS1-3).

Connections to the Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES2-ETS1-3).

MP.4: Model with mathematics (ES2-ETS1-3).

Topic 3: Human Sustainability

ES-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [AR Clarification Statement: Examples of Arkansas-specific natural resources could include diamonds, novaculite, natural gas, and bauxite-aluminum deposits. Examples of Arkansas-specific natural hazards could include sinkholes in karst terrain, pollution of groundwater aquifers, flashfloods, ice storms, and earthquakes.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

Connections to Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES-ESS3-1).

MP.4: Model with mathematics (ESS-ESS3-1).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (ESS-ESS3-1).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (ESS-ESS3-1).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (ESS-ESS3-1).

ES-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [AR Clarification Statement: Arkansas-specific examples of solutions could include the natural gas industry, hydroelectric, wind farms, urban recycling programs, coal, and nuclear power (Arkansas Nuclear One).]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (ES-ESS3-2).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (ES-

ESS3-2).

Connections to Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES-ESS3-2).

ES-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [AR Clarification Statement: Examples of data on the impacts of human activities could include pollutants released (silt and sediments), changes to biomass (clearcutting), and areal changes in land surface use (urban development, agriculture and livestock, earth materials mining). Examples for limiting future impacts could range from local efforts (recycling) to large-scale geoengineering design solutions (lock and dam system, state and national parks).]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account (ES-ESS3-4).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (ES-ESS3-4).

Connections to Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES-ESS3-4).

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays (ESS-ESS3-4).

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling (ESS-ESS3-4).

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities (ESS-ESS3-4).

ES3-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples of major global challenges applied to human sustainability could include ground water depletion in Arkansas and its unique rock formations. Examples of solutions broken down into more manageable problems through engineering could include designing methods to solve complex problems by sustaining life on other planets, designing earthquake resistant homes with emphasis on Arkansas rock formations, designing better irrigation systems for plants, and designing flood mitigation prevention techniques.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem (ES3-ETS1-1).

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information (ES3-ETS1-1).

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible (ES3-ETS1-1).

Connections to Arkansas Mathematics Standards:

MP.2: Reason abstractly and quantitatively (ES3-ETS1-1).

MP.4: Model with mathematics (ES3-ETS1-1).

ES3-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Solutions to complex issues could include evaluating energy resources available on other planets, evaluating various building configurations, evaluating and implementing drip agriculture systems and solar powered fans.]

Connections to Arkansas Mathematics Standards:

MP.4: Model with mathematics (ES3-ETS1-2).

Lesson Performance Expectations:

- Students will understand crop coverage and no-till is an ecological and economical friendly alternative to tilling.
- Students will understand that crop coverage and no-till contribute to soil health.
- Students will apprehend the value of water and mineral conservation no-till and crop cover have for agriculture.
- Students will understand how crop cover protects the biodiversity of insects in the area.
- Students will comprehend the science behind types of crop cover.
- Students will realize how important soil chemistries and soil types are to keeping an area healthy.

Objective: Students will understand	**Student Science Performance** ***Phenomenon: Tilling of soil removes essential minerals, causes erosion, and increases water loss. No-till and cover crops conserve minerals, decrease erosion***

that soil health encompasses the physical (how well the soil holds together and infiltrates water), chemical (pH, nutrient concentrations, etc.), and biological (living plant roots, soil microbes and other organisms like earthworms) properties of soils. When all of these properties are improved, it can have positive impacts on agricultural production and profitability. **Assessment:** Students will write a reflection paper on what they learned about soil health and its impact on agriculture production and profitability. **Key Points:** Physical soil health (water and soil retention), chemical soil health (pH and	***and improve water retention in the soil.*** ***Gather*** 1. Have the students break into groups to define the following words: • Cover Crops • Biodiversity • Humus • Soil; Include the major types of soil (sandy, loam, clay) definitions • No-till system • pH of soil • Types of nutrients found in soil • Types of organisms found in soil (nematodes, earthworms, fungus, etc.) • Biomass • Water infiltration in soil • Integrated weed management *(Teaching Suggestions: This section should contain a brief overview of information teachers will need to facilitate the lesson. This may include links to video clips, links to readings, crosscutting concepts, and core ideas to emphasize. Also include safety advice and other insights about the gathering portion of the lesson. When materials for the investigation are needed, we recommend that you include them in the appendix.)* ***Reason*** *(In this section students are generally: evaluating information, analyzing data, using mathematical/computational thinking, constructing explanations, developing arguments, and/or using models to reason, predict, and develop evidence.)* 2. Students in groups will come up with two questions they have about the above word groups that may be answered in the video. ***Class Discussion:*** *Questions to initiate Discussion:* *Q: What is crop cover?* *Q: What are the advantages of crop cover?* *Q: What is no-till?* *Q: What are the advantages of no-till?* *Q: Why can a crop cover and no-till keep soil healthy?* *Q: How can no-till and crop cover be beneficial for local insects and waterways?* *(Teaching Suggestions: In this section provide insights into the focus of the class discussion. The questions are typically how, why, or what causes. This is a good place to prompt with crosscutting concepts.)*

nutrient concentrations), biological soil health (humus, living organisms and microbes/fungus), biodiversity, biological controls, conservation of water and minerals. **Materials:** • You will need to register online if you plan to watch the field trip 'live' on November 5. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you. If you register during the	Do a KWL Chart about what students know about soil health. What is soil health? What three areas encompass soil health? How does someone determine soil is healthy? Why would soil health be important to a farmer? Why would soil health be important to you as a consumer? Tell the students that they are going to watch a video titled '*Arkansas Soil and Water Conservation Virtual Field Trip.'* Before they start the video, have the students break into groups to define the words located on page 16. Once all the words are defined, have each group come up with two questions they have about the above word groups that may be answered in the video. ***Their jobs are to turn in the questions and the answers by the end of the virtual field trip.**** *The live video stream will give your students an opportunity to ask questions throughout the field trip. If they are not finding their questions adequately answered during the broadcast, you can send in their questions to be answered at the end of the video. ***BEFORE THE VIDEO,*** be sure the students understand that no-till cover crops are an ecological alternative to tilling and standard chemical usage. Crop cover also increases water retention in the soil and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially nitrates) keeping it healthy, and it discourages weed growth. Crop cover, no-till and soil health measurements not only help the farmer, but they ensure the environment is protected also. *Biology Teachers:* This is a good time to cover/review cycling of matter, the water cycle, soil composition and soil biology. Also consider covering biodiversity of insects (Hemiptera, Odonata, etc.) that might interact with crops. *Chemistry Teachers:* Consider covering soil chemistries and reactions, water properties and the water cycle plus herbicide/insecticide chemical reactions. *Earth Science Teachers*: Soil health is paramount to a thriving ecology. Cover soil components, the carbon and water cycle and soil chemistries. *Environmental Science Teachers:* This is a good time to cover/review soil (and its components), soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology. Also cover how technology and new crop techniques can improve ecological conservation. *AG Science Teachers:* This is a good time to review no-till vs tilling, soil health including

<table>
<tr>
<td>live feed, you will be automatically directed to the site. You will receive an automated email with the link to the live feed and a reminder email with a link one hour before the VFT begins.
• If you plan to watch the recorded Arkansas Soil and Water Conservation Soil Health Virtual Field Trip, go to www.uaex.uada.edu/soywhatsup and click on the 'virtual field trips and lessons' icon on the left-hand side of the page. This will take you to the link for the video.</td>
<td>mineral load, basic plant physiology and conservation farming practices.

Communicate (In this section students will be communicating information, communicating arguments (written and oral for how their evidence supports or refutes an explanation, and using models to communicate their reasoning and make their thinking visible.)

After the video, break the students into three groups; The Impact of Soil Health group, the No-Till group, and the Cover Crop group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come up with at least six ways total and then report them to the rest of the class.

Students will turn in a two-paragraph reflection paper on what they learned and how these conservation efforts can affect where they live. They also need to give the answers to their two questions from the video.</td>
</tr>
</table>

• Paper writing utensils for students (if in class). **Preparation:** If this is being done in class, it is highly recommended that you, the teacher, do research on the key words given below. **Time Duration: two class periods.** The video is about 60 minutes long (45 minutes plus any questions). Assume about 15 minutes for students to look up vocabulary and prepare questions for the video session, 15 minutes to teach essential concepts and about 15 minutes for group discussion and reflection after the video. **Elicit:** Do a KWL Chart about what students know about soil health.	

What is soil health? What three areas encompass soil health? How does someone determine soil is healthy? Why would soil health be important to a farmer? Why would soil health be important to you as a consumer? **Engage:** Tell the students that they are going to watch a video titled '*Arkansas Soil and Water Conservation Soil Health Virtual Field Trip.*' Before they start the video, have the students break into groups to define the following words: • Cover Crops • Biodiversity • Humus • Soil; Include the major types of soil (sandy, loam, clay) definitions • No-till system • pH of soil	

• Types of nutrients found in soil • Types of organisms found in soil (nematodes, earthworms, fungus, etc.) • Biomass • Water infiltration in soil • Integrated weed management Once all the words are defined, have each group come up with two questions they have about the above word groups that may be answered in the video. ***Their jobs are to turn in the questions and the answers by the end of the virtual field trip.**** *The live video stream will give your students an opportunity to ask questions throughout the field trip. If they are not finding their questions	

adequately answered during the broadcast, you can send in their questions to be answered at the end of the video. **Explain:** ***BEFORE THE VIDEO,*** be sure the students understand that no-till cover crops are an ecological alternative to tilling and standard chemical usage. Crop cover also increases water retention in the soil and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially nitrates) keeping it healthy, and it discourages weed growth. Crop cover, no-till and soil health measurements not only help the farmer, but they ensure the environment is protected also.	

Biology Teachers: This is a good time to cover/review cycling of matter, the water cycle, soil composition and soil biology. Also consider covering biodiversity of insects (Hemiptera, Odonata, etc.) that might interact with crops. *Chemistry Teachers:* Consider covering soil chemistries and reactions, water properties and the water cycle plus herbicide/insecticide chemical reactions. *Earth Science Teachers*: Soil health is paramount to a thriving ecology. Cover soil components, the carbon and water cycle and soil chemistries. *Environmental Science Teachers:* This is a good time to cover/review soil (and its components), soil erosion, water	

cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology. Also cover how technology and new crop techniques can improve ecological conservation. *AG Science Teachers:* This is a good time to review no-till vs tilling, soil health including mineral load, basic plant physiology and conservation farming practices. **Explore:** Farmers have to be constantly aware of the resources they use to grow their crops. No-till cover crops mean less water and chemicals (herbicide and insecticide) treatments. This translates into less cost for the farmer, better sustainability and is	

environmentally friendly. Show the video *'Arkansas Soil and Water Conservation Soil Health Virtual Field Trip.'* **Elaborate:** After the video, break the students into three groups; *The Impact of Soil Health* group, the *No-Till* group, and the *Cover Crop* group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come up with at least six ways total and then report them to the rest of the class. **Evaluate:** Students will turn in a two-paragraph reflection paper on what they learned and how these conservation efforts can affect where they live. They also need to give the answers to their	

two questions from the video. **Extend:** End the lesson with how the conservation practices of farmers to decrease their dependence on water and chemicals also has a huge impact on our personal lives through the water we use and the food we eat. Assign a brainstorming project that allows students to design their own alternate growing methods, or ways to improve soil health while growing crops. Have an extension agent or local farmer come to your classroom and talk about no-till cover crops in your local community.	

Formative Assessment for Student Learning		
Elicit Evidence of Learning: *This box is the individual communication performance from the student prompts in appendix A*		
Evidence of Student Proficiency *Students will understand the process of crop coverage and no-till is an ecological and economical friendly alternative farming method. Students will comprehend the value of water and mineral conservation no-till and crop cover has for the soil and how soil health is essential for crops and the local ecosystem.*	**Range of Typical Student Responses** *This section provides a range of typical student responses, often using a three-point scale.* *Descriptors of grade-level appropriate student responses:* • *Full understanding: Student will have all the vocabulary defined, two questions for the video and will participate fully in the post video discussion. Reflection paper will show full connection between what they experienced and understand.* • *Partial understanding: student will have 75% of the vocabulary defined and one question for the video. Reflection paper will only show partial connection between what they experienced and understand.* • *Limited understanding: Student will have 50% or less of vocabulary defined, no questions for the video and show no understanding of what was learned in the reflection paper.*	**Acting on Evidence of Learning** *This is a brief description of the instructional actions to take based on the students' performance. When the action includes extensive descriptors and/or materials you may wish use* ***Appendix C.*** *Description of instruction action and response to support student learning.* • *Action for student who displays partial or limited understanding: student will be partnered with a student who has full understanding and material will be reviewed with mentoring from the teaching student.* • *Extensions of learning for student who displays full understanding: Assign a brainstorming project that allows students to design their own cover crop alternative.*

SEP, CCC, DCI Featured in Lesson	**Science Essentials** *(Student Performance Expectations From Appendix C, D, E)*
Science Practices Developing and Using Models (B1-ETS1-3) (BI-LS2-5) (EVS-ESS2-6) (ES-ESS2-6) (CI-ETS1-2) Constructing explanations and designing solutions (BI-LS2-3) (BI-ESS3-4) (EVS-ETS1-2) (EVS-ESS3-1) (EVS-LS2-7) (EVS-ESS3-4) Analyzing and interpreting data (ES-ESS2-5) Planning and Carrying Out Investigations (BI-ESS2-5) (EVS-ESS2-5)	• Use a model to predict the relationships between systems or between components of a system. • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. • Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution. • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data and refine the design accordingly.

Asking questions and defining problems (ESS-ETS1-1) Engage an Argument from Evidence (CI-ESS2-5)	• Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors. • Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.
Crosscutting Concepts Energy and Matter (BI-LS2-3) (EVS-ESS2-6) (ES-ESS2-6) Systems and system models (BI-LS2-5) (CI-ETS1-2) Stability and Change (BI-ESS3-4) (EVS-ESS3-3) (EVS-LS2-7) Structure and Function (BI-ESS2-5) (EVS-ESS2-5) (ES-ESS2-5) Influence of Science, Engineering and Technology on Society and the Natural World (BI16-ETS1-3) (BI-ESS3-2) (BI-ESS3-4) (B17-ETS1-1) (EVS-ESS3-1) (EVS-ESS3-2) (EVS-ESS3-3) (ES-ETS1-1, ES-ETS1-2) Cause and Effect (BI-ESS3-1) (EVS-ESS3-1) (EVS-LS4-6) (EVS-ESS3-1) Science Addresses Questions About the Natural and Material World (BI-ESS3-2) Interdependence of Science and Technology (CI-ETS1-2)	• The total amount of energy and matter in closed systems is preserved. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Science knowledge indicates what can happen in natural systems-not what should happen. The latter involves ethics, values and human decisions about the use of knowledge • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.
Disciplinary Core Ideas LS1.C: Organization for matter and energy flow in organisms	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

LS2.B: Cycling of matter and energy transfer in ecosystems PS3.D: Energy in chemical processes ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate ESS2.C: The Role of Water in Earth's Surface Processes ETS1.B: Developing Possible Solutions ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ETS1.A: Defining and Delimiting Engineering Problems ETS1.B/C: Optimizing the Design Solution LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C Adaptation LS4.D Biodiversity and Humans	• Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. • The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. • Resource availability has guided the development of human society. • Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

Appendices: This section contains the lesson performance that students will see during the lesson and any other resources students will use to engage in the science performances. The appendices may also contain examples of student work.

Appendix A - Student Prompts

Student Prompts for the Lesson

Phenomenon: Tilling of soil removes essential minerals, causes erosion, and increases water loss. No-till and cover crops conserve minerals, decrease erosion and improve water retention in the soil.

Group Performances:

Ask questions to plan an investigation for understanding that no-till and crop cover can save minerals and soil plus benefit the local ecology.

Plan an investigation by defining the words necessary and having questions ready for the video.

Construct an explanation by forming groups and discussing how these conservation efforts can affect where they live.

Use a model to explain how no-till and crop cover farming can decrease mineral loss, erosion and help the local ecology by improving soil health.

Class Discussion

Individual Performances:

1. Develop an argument for how no-till and cover crop farming can and does help the economy and ecology in our local area.

The student prompt can be used to engage students in science performances and typically have 3-5 group performances and one individual performance. The individual performance typically lies *within the communicate reasoning part of the sequence and often serves as a formal formative assessment. Often teachers add opportunities for class discussion into the instructional sequence to discuss things like "Good Questions to Find Resources" or "Class Debate" or "Discussion of Science Language Student Should Use."*

***Appendix B* - Materials, preparation and time duration.**

Materials:

- You will need to register online if you plan to watch the field trip 'live' on November 5. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you. If you register during the live feed, you will be automatically directed to the site. You will receive an automated email with the link to the live feed and a reminder email with a link one hour before the VFT begins.
- If you plan to watch the recorded *Arkansas Soil and Water Conservation Soil Health Virtual Field Trip*, go to www.uaex.uada.edu/soywhatsup and click on the '*virtual field trips and lessons'* icon on the left-hand side of the page. This will take you to the link for the video.
- Paper writing utensils for students (if in class).

Preparation:

If this is being done in class, it is highly recommended that you, the teacher, do research on the key words given on page 12.

Time Duration: two class periods.

The video is about 60 minutes long (45 minutes plus any questions). Assume about 15 minutes for students to look up vocabulary and prepare questions for the video session, 15 minutes to teach essential concepts and about 15 minutes for group discussion and reflection after the video.

Appendix C - **Below are good resources for understanding no-till and cover crop farming better.**

https://www.uaex.uada.edu/publications/pdf/FSA-2186.pdf

https://www.uaex.uada.edu/publications/pdf/FSA1095_final.pdf

https://www.uaex.uada.edu/publications/pdf/FSA-2156.pdf

https://www.uaex.uada.edu/media-resources/news/july2019/07-12-2019-Ark-Regenerative-Ag.aspx