SOIL&WATER

CONSERVATION VIRTUAL FIELD TRIP SERIES

U of A 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

Improving Soils and Profitability through Collaboration Virtual Field Trip

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By Diedre Young, Soybean Science Challenge Coordinator

Improving Soils and Profitability through Collaboration Virtual Field Trip

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

Arkansas NGSS Suggestions:

<u>Integrated Biology:</u>

Topic one: Cycling of Matter and Energy

BI-LS1-5: Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy.

Science and Engineering Practices: Developing and Using Models (BI-LS1-5), Constructing Explanations and Designing Solutions (BI-LS1-5)

Crosscutting Concepts: Energy and Matter (BI-LS1-5)

Disciplinary Core Ideas: LSI.C: Organization for matter and energy flow in organisms

Connections to the Arkansas English Language Arts Standards: SL11-12.5

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

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: MP2, 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: MP2, MP4

4 Improving Soils and Profitability through Collaboration Virtual Field Trip

Integrated Chemistry:

Topic One: Matter and Chemical Reactions:

Cl-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 (CL-ESS2-5)

Crosscutting Concepts: Structure and Function (CL-ESS2-5)

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

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

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

Cl1-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 (Cl1-ETS1-2)

Disciplinary Core Ideas: ETS1.C: Optimizing the Design Solution (Cl1-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.

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

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

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

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

Crosscutting Concepts: Energy and Matter (EVS-ESS2-6)

Disciplinary Core Ideas: ESS2.D: Weather and Climate

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

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 2: Energy

EVS-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.

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

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

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.

Science and Engineering Practices: Constructing explanations and designing solutions (EVS-ESS3-1)

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

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World. (EVS-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 Mathematic Standards: MP.2. HSN.Q.A.1,2,3

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-ESS3-3: Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

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

Crosscutting Concepts: Stability and Change (EVS-ESS3-3)

Connections to Engineering, Technology and Applications of Science: Influence of Science, Engineering and Technology on Society and the Natural World (EVS-ESS3-3)

Disciplinary Core Ideas: ESS3.C Human Impacts on Earth Systems

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

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.

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)

Disciplinary Core Ideas: LS4.C Adaptation. LS4.D Biodiversity and Humans

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

Connections to the Arkansas Mathematic Standards: MP.2

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.

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

Crosscutting Concepts: Cause and Effect (EVS-ESS3-1)

Disciplinary Core Ideas: ESS3.A: Natural Resources

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

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

Objective: Students will understand the importance of moisture sensing and cover crops in regards to conservation of water, and the lessening of the environmental impact the loss of nutrients and water have on the local ecosystem. Students will learn that collaboration between farmers and local districts helps everyone by improving productivity while protecting the local ecosystems.

Assessment: Students will write a reflection paper on what they learned about collaboration, and protection of our ecosystem resources from the Virtual Field Trip Video.

Key Points: Alternate crop production, soil moisture, water moisture chemistries, group collaborations.

Materials:

- You will need to register online if you plan to watch the field trip 'live' on August 19. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uaex.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 *Improving Soils and Profitability through Collaboration Virtual Field Trip*, go to www.uaex.edu/soywhatsup and click on the ' teacher curriculum' icon on the left hand side of the page. This will take you to the link for the video. Give IT a few days to edit for posting.
- 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 crop cover and soil moisture. What is crop cover? What are the advantages of crop cover? How does a crop cover in the winter help a cash crop for the summer? What can crop cover do for the soil? How can a crop cover be beneficial for local insects? Why is soil moisture important to a farmer? Are there degrees of soil moisture? Is this important, if so why? How is soil moisture measured? What are the agencies in this area that could be beneficial for both farmers and consumers?

Engage:

Tell the students that they are going to watch a video titled '*Improving Soils and Profitability through Collaboration Virtual Field Trip'*. Before they start the video, have the students break into groups to define the following words:

- Cover Crop
- Biodiversity
- Carbon cycling
- Cash crop
- Soil moisture sensors
- Water chemistries
- No-till system
- Local Conservation Agencies for your area
- Biomass

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 and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially Nitrates) and discourages weed growth. Many farmers are not aware of this tool for water and nutrient conservation so local conservation districts are now collaborating with farmers to work with them on this profitable and ecologically sustainable alternative.

Biology Teachers: This is a good time to cover/review cycling of matter, the water cycle and water chemistries. You should also cover human impact on ecological systems and how population dynamics/agriculture affect the local ecology.

Chemistry Teachers: Cover water solubility including dipole moments, water's impact on earth systems, and how today's technology is preserving water in our ecosystems.

Environmental Science Teachers: This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology.

AG Teachers: This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology, and the economics of farming profitability by switching to no till/cover crop farming.

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 more profit for the farmer, better sustainability and is environmentally friendly. Many farmers are not aware of this alternative so county agencies are teaming up with local farmers to collaborate on profitable and sustainable cover crop farming.

Show the video '*Improving Soils and Profitability through Collaboration Virtual Field Trip'.*

Elaborate:

After the video, break the students into three groups; the *Local Agency* group, the *Moisture Measuring* group, and the *Winter Cover Crop* group. Have each group brainstorm their area of study and explain to the class how important their area is to farming and conservation. 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 has also had a huge impact on our personal lives through the water we use and the food we eat. Reiterate how local government and private agencies can work with farmers in a positive way to not only increase their profitability but also help them to become sustainable responsible businessmen.

Assign a brainstorming project that allows students to design their own alternate growing methods or have students research local agencies and how they could benefit local farmers.

Have an agent from a local government agency or a local extension agent come to the classroom to explain how farmers and their people can and do collaborate.

Assign a brainstorming project that allows students to design their own alternate growing methods.

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3D-Student Science Performance

Author: Diedre Young, Soybean Science Challenge Coordinator

Grade: 9-12:

Integrated Biology

Integrated Chemistry

Environmental Science

Agricultural Science

Improving Soils and Profitability through Collaboration Virtual Field Trip

Lesson Topics:

Life and Earth Systems

Cycling of Matter

Human Impacts on Earth Systems

Water Solubility

Sustainability

Performance Expectations (Standard) from State Standards or NGSS:

<u>Integrated Biology:</u>

Topic one: Cycling of Matter and Energy

BI-LS1-5: Use a model to demonstrate how photosynthesis transforms light energy into stored chemical energy. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]

Connections to the Arkansas English Language Arts Standards: SL11-12.5. Make strategic use of digital media (e.g., textual, graphical, auditory, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (BI-LS1-5, BI-LS1-7)

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-ESS2-5: 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)

Integrated Chemistry:

Topic One: Matter and Chemical Reactions:

Cl-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. (Cl-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. (Cl-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 Mathematic Standards:

MP.4 Model with Mathematics? (CI1-ETS1-2)

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

EVS-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.]

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. (EVS-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. (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.]

Lesson Performance Expectations:

- Students will understand crop coverage for cash crops is an ecological and economical friendly alternative to tilling.
- Students will apprehend the value of water and mineral conservation crop cover has for agriculture.
- Students will understand how crop cover protects the biodiversity of insects in the area.
- Students will comprehend the science behind crop cover including cycling of matter and water solubility.
- Students will understand that collaboration between local agencies and farmers benefits both.

Objective: Students will understand the importance of moisture sensing and cover crops in regards to conservation of water, and the lessening of the environmental impact the loss of nutrients and water have on the local ecosystem. Students will learn that collaboration	**Student Science Performance** ***Phenomenon: Tilling of soil removes essential minerals, causes erosion, and decreases beneficial insects. No-till cover crops conserve minerals, decrease erosion and protect beneficial insects. Collaborating with state and local agencies helps farmers to incorporate this new agricultural technology.*** ***Gather*** 1. Students will break into groups and define the following words: • Cover Crop • Biodiversity • Cash crop • Carbon Cycling • No-till system • Water Chemistries • Biomass • Researching local conservation agencies • Soil Moisture Sensors

between farmers and local districts helps everyone by improving productivity while protecting the local ecosystems.

Assessment: Students will write a reflection paper on what they learned about collaboration, and protection of our ecosystem resources from the Virtual Field Trip video.

Key Points: Alternate crop production, soil moisture, water moisture chemistries, group collaborations.

Materials:

- You will need to register online if you plan to watch the field trip 'live' on August 19. Once you

(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. Safety advice and other insights about the gathering portion of the lesson should also be included here. 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: How does a crop cover in the winter help a cash crop for the summer?
Q: Why can a crop cover help the soil?
Q; How can a crop cover be beneficial for local insects?
Q: Why is soil moisture important to a farmer?
Q: Are there degrees of soil moisture? How is this important to a farmer?
Q: How is soil moisture measured?
Q: What local agencies in the area could be beneficial to farmers and consumers?

(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.)

Do a KWL Chart about what students know about crop cover and soil moisture. What is crop cover? What are the advantages of crop cover? How does a crop cover in the winter help a cash crop for the summer? What can crop cover do for the soil? How can a crop cover be beneficial for local insects? Why is soil moisture important to a farmer? Are there degrees of soil moisture? Is this important, if so why? How is soil moisture measured? What are the agencies in this area that could be beneficial for both farmers and consumers?

Tell the students that they are going to watch a video titled '*Improving Soils and Profitability through Collaboration Virtual Field Trip.'* Before they start the video, have the students break into groups to define the following words:

- Cover Crop
- Biodiversity

have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uaex.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 *Improving Soils and*	• Carbon cycling • Cash crop • Soil moisture sensors • Water chemistries • No-till system • Local Conservation Agencies for your area • Biomass 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 and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially Nitrates) and discourages weed growth. Many farmers are not aware of this tool for water and nutrient conservation so local conservation districts are now collaborating with farmers to work with them on this profitable and ecologically sustainable alternative. *Biology Teachers:* This is a good time to cover/review cycling of matter, the water cycle and water chemistries. You should also cover human impact on ecological systems and how population dynamics/agriculture affect the local ecology. *Chemistry Teachers:* Cover water solubility including dipole moments, water's impact on earth systems, and how today's technology is preserving water in our ecosystems. *Environmental Science Teachers:* This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology. *AG Teachers:* This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agriculture affect the local ecology, and the economics of farming profitability by switching to no-till/cover crop farming. Farmers have to be constantly aware of the resources they use to grow their crops. No-

Profitability through Collaboration Virtual Field Trip, go to www.uaex.edu/soywhatsup and click on the 'teacher curriculum' icon on the left hand side of the page. This will take you to the link for the video. Keep in mind it will take several days for IT to edit and post. • 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.	till cover crops mean less water and chemicals (herbicide and insecticide) treatments. This translates into more profit for the farmer, better sustainability and is environmentally friendly. Many farmers are not aware of this alternative, so county agencies are teaming up with local farmers to collaborate on profitable and sustainable cover crop farming. Show the video '*Improving Soils and Profitability through Collaboration Virtual Field Trip'.* ***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 *Local Agency* group, the *Moisture Measuring* group, and the *Winter Cover Crop* group. Have each group brainstorm their area of study and explain to the class how important their area is to farming and conservation. 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.

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 crop cover and soil moisture. What is crop cover? What are the advantages of crop cover? How does a crop cover in the winter help a cash crop for the summer? What can crop cover do for the soil? How can a crop cover be	

beneficial for local insects? Why is soil moisture important to a farmer? Are there degrees of soil moisture? Is this important, if so, why? How is soil moisture measured? What are the agencies in this area that could benefit both farmers and consumers? **Engage:** Tell the students that they are going to watch a video titled '*Improving Soils and Profitability through Collaboration Virtual Field Trip.'* Before they start the video, have the students break into groups to define the following words: • Cover crop • Biodiversity • Carbon cycling • Cash crop • Soil moisture sensors • Water	

chemistries • No-till system • Local Conservation Agencies for your area • Biomass 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 and protects beneficial insects that live in the area. Crop cover adds essential minerals to the soil (especially Nitrates) and discourages weed growth. Many farmers are not aware of this tool for water and nutrient conservation, so local conservation districts are now collaborating with farmers to work with them on this profitable and ecologically sustainable alternative.	

Biology Teachers: This is a good time to cover/review cycling of matter, the water cycle and water chemistries. You should also cover human impact on ecological systems and how population dynamics/agricultu re affect the local ecology. *Chemistry Teachers:* Cover water solubility including dipole moments, water's impact on earth systems, and how today's technology is preserving water in our ecosystems. *Environmental Science Teachers:* This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agricultu re affect the local	

ecology. *AG Teachers:* This is a good time to cover/review soil and soil erosion, water cycle, biodiversity of insects, human impact on ecological systems and how population dynamics/agricultu re affect the local ecology, and the economics of farming profitability by switching to no-till/ cover crop farming. **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 more profit for the farmer, better sustainability and is environmentally	

friendly. Many farmers are not aware of this alternative, so county agencies are teaming up with local farmers to collaborate on profitable and sustainable cover crop farming. Show the video '*Improving Soils and Profitability through Collaboration Virtual Field Trip.*' **Elaborate:** After the video, break the students into three groups; the *Local Agency* group, the *Moisture Measuring* group, and the *Winter Cover Crop* group. Have each group brainstorm their area of study and explain to the class how important their area is to farming and conservation. 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 has also had a huge impact on our personal lives through the water we use and the food we eat. Reiterate how local government and private agencies can work with farmers in a positive way to not only increase	

their profitability but also help them to become sustainable responsible businessmen. Assign a brainstorming project that allows students to design their own alternate growing methods or have students research local agencies and how they could benefit local farmers. Have an agent from a local government agency or a local extension agent come to the classroom to explain how farmers and their people can and do collaborate. Assign a brainstorming project that allows students to design their own alternate growing methods.	

Formative Assessment for Student Learning
Elicit Evidence of Learning: *This box is the individual communication performance from the student prompts in Appendix A*

Students will understand the process of crop coverage is an ecological and economical friendly alternative to tilling. Students will	*This section provides a range of typical student responses, often using a three-point scale.* • *Full understanding: Student will have* *participate fully in the post video* • *Partial understanding: student will* • *Limited understanding: Student will*	*performance. When the action includes extensive* • *Action for student who displays partial* • *Extensions of learning for student who* *for a cash crop. Students could also* *farmers.*

SEP, CCC, DCI Featured in Lesson	**Science Essentials** *(Student Performance Expectations From Appendix C, D, E)*
Science Practices	
Developing and Using Models (BI-LS1-5) (B16-ETS1-3) (BI-LS2-5) (EVS-ESS2-6) (EVS-LS4-6) Constructing explanations and designing solutions (BI-LS1-5) (BI-LS2-3) (BI-ESS3-1) (BI-ESS3-4) (EVS-ETS1-2) (EVS-ESS3-1) (EVS-LS2-7) (EVS-ESS3-4) (CI1-ETS1-2) Analyzing and interpreting data (BI-ESS2-2) Planning and Carrying Out Investigations (BI-ESS2-5) (EVS-ESS2-5) (CI-ETS1-2) (EVS-ESS3-3) Engaging in Argument from Evidence	• 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. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence,

(BI-ESS3-2) (EVS-ESS3-2) Asking Questions and Defining Problems (B17-ETS1-1) (EVS4-ETS1-3) Planning and Carrying Out Investigations (CI-ESS2-5)	and logical arguments regarding relevant factors. • Analyze complex real world-problems by specifying criteria and constraints for successful solutions. • Use mathematical representations of phenomena to support claims.
Crosscutting Concepts Energy and Matter (BI-LS1-5) (BI-LS2-3) (EVS-ESS2-6) Systems and system models (BI-LS2-5) Stability and Change (BI-ESS2-2) (BI-ESS3-4) (EVS-ESS3-3) (EVS-LS2-7) Structure and Function (BI-ESS2-5) (EVS-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) 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)	• 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

Disciplinary Core Ideas	
LS1.C: Organization for matter and energy flow in organisms LS2.B: Cycling of matter and energy transfer in ecosystems ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate ESS2.C: The Role of Water in Earth's Surface Processes (CL-ESS2-5) 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.C: Optimizing the Design Solution LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C Adaptation LS4.D Biodiversity and Humans	• As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. • 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 decreases beneficial insects. No-till cover crops conserve minerals, decrease erosion and protect beneficial insects. Collaborating with state and local agencies helps farmers to incorporate this new agricultural technology.

Group Performances:

1. Ask questions to plan an investigation for understanding that by using help from local agencies, teaching no-till crop cover can help farmers save minerals and soil plus benefit the local ecology.
2. Plan an investigation by defining the words necessary and having questions ready for the video.
3. Construct an explanation by forming groups and discussing how these agency/farmer collaborations and conservation efforts can affect where they live.
4. Use a model to explain how teaching no-till crop cover farming can decrease mineral loss, erosion and help both the local ecology and economy.

Class Discussion

Individual Performances:

1. Develop an argument for helping farmers learn about how no-till 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 August 19. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uaex.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 *Improving Soils and Profitability through Collaboration Virtual Field Trip*, go to www.uaex.edu/soywhatsup and click on the 'teacher curriculum' icon on the left-hand side of the page. This will take you to the link for the video. Keep in mind it will take several days for IT to edit and upload the video to the website.
- 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 cover crop farming and local agency collaborations:**

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

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

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

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

https://division.uaex.edu/docs/2016%20strategic%20plan%20update-5-5.pdf

https://www.uaex.edu/business-communities/local-foods/Arkansas%20LFRM%20Project%20Meetup%20Report%20June%202017.pdf

The University of Arkansas System Division of Agriculture offers all its Extension and Research programs and services without regard to race, color, sex, gender identity, sexual orientation, national origin, religion, age, disability, marital or veteran status, genetic information, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.