



***Introduction to Agricultural Sustainability Virtual Field Trips:  
Improving Soils and Profitability through Collaboration***



**3D-Student Science Performance**

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**Grade: 9-12:**

Integrated Biology, Integrated Chemistry, Environmental Science,  
And Agricultural Science

**Lesson Topics:**

Life and Earth Systems  
Matter and Chemical Reactions  
Human Impacts on Earth Systems  
Sustainability

## Performance Expectations (Standard) from State Standards or NGSS:

### Integrated Biology:

#### Topic 6: Life and Earth's Systems

**BI6-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:**

**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**

**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.

### **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

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

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

**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-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 farm 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.

## Formative Assessment for Student Learning

### Elicit Evidence of Learning:

#### Evidence of Student Proficiency

*Students will understand the process of crop coverage is an ecological and economical friendly alternative to tilling. Students will apprehend the value of water and mineral conservation crop cover has for agriculture and how crop cover protects the biodiversity of insects in the area. Students will comprehend the science behind soil moisture and nutrients, and how local agencies can help farmers learn more about this profitable and ecological friendly alternative to tilling.*

#### 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 for a cash crop. Students could also interview local agencies as to the collaboration they have done with local farmers.*

### 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 (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)

## Science Essentials:

- 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, 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)

## Science Essentials:

- 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

## Science Essentials:

- 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.

## 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:***

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

## **Appendix B – Materials, Preparation and Time Duration.**

### **Materials:**

- Go to [www.uaex.uada.edu/soywhatsup](http://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 cover crop farming and local agency collaborations:**

<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/FSA1095_final.pdf)

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

