



Soil AND 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

3D-Student Science Performance

Author: Diedre Young, Soybean Science Challenge Curriculum Specialist

Grade: 9-12:

Integrated Biology

Integrated Chemistry

Environmental Science

Agricultural Science

Lesson Topics:

Life and Earth Systems

Matter and Chemical Reactions

Human Impacts on Earth Systems

Sustainability

Lesson Title



**The Science
behind Discovery Farm-Based
Water and Soil Conservation Practices Field
Trips**

Performance Expectations (Standard) from State Standards or NGSS:

Integrated Biology:

Topic 6: Life and Earth Systems:

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) 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 design 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 1: 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 1: 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 impact of human activities on the environment and biodiversity. * [AR Clarification Statement: Emphasis 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 the importance of soil and water sampling to produce healthy crops with the least amount of water and added nutrients.
- Students will learn that these test results have a major impact not only on plant growth but on the environment as well, as farmers use this information to decrease greenhouse gases and improve the ecological stance of the farming area, all while producing a viable crop.
- Students will learn that testing during current conservation methods can make a difference not only ecologically but also economically to farmers.

Objective: Students will understand the importance of soil and water sampling to produce healthy crops with the least amount of water and added nutrients. Students will learn that these

Student Science Performance

Phenomenon: Agricultural Sustainability and testing technology are the keys to a healthy ecosystem, plus productivity and profitability for farmers.

Gather: (In this section students will generally be asking questions, obtaining information, planning and carrying out an investigation, using mathematical and computational thinking, or using models to gather and organize data and/or information.)

Students will break into groups and define the following words:

Biochar
Greenhouse gases N₂O, (Nitrous Oxide) water vapor, CO₂, CH₄ (Methane)
Cover crops

test results have a major impact not only on plant growth but on the environment as well, as farmers use this information to decrease greenhouse gases and improve the ecological stance of the farming area, all while producing a viable crop. Students will learn that testing during current conservation methods can make a difference not only ecologically but also economically to farmers.

Assessment:

Students will write a half-page research paper on an agricultural science measurement of

Gas Chromatography
 Buffer strips
 No Tillage
 Polypipe irrigation
 Soil health
 Crop rotation
 LI-COR Analyzer
 Gasmeter Analyzer

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.)

1. Students will watch the video on the Virtual Field Trip.
2. Students will compare different agricultural testing methods.

Class Discussion:

Questions to initiate Discussion:

Q: What is conservation?

Q: How does one measure or test for conservation?

Q: What are the advantages of practicing conservation at all economic levels?

Q: What are some testing practices that farmers are doing and how can these practices help farmers ecologically and economically?

Q: Where do you think farmers could get help with these testing procedures?

Do a KWL Chart about agricultural sampling methods. What needs to be sampled in a field and why? How does one measure those samples? What are the advantages of measuring samples in real time versus taking the samples back to a lab? How can these practices help farmers ecologically and economically? Where do you think farmers could get help with these practices?

BEFORE THE VIDEO, be sure the students understand that real-time testing in agriculture not only benefits the environment, but also farmers. Farmers need to learn that testing during agricultural conservation of water and nutrients can translate into more profit

their choice, explaining why they feel this measurement is the most important.

Key Points:

Laboratory practices in agriculture, use of analyzers in lab and in the field, relationship of analyzer values to ecology. Testing of various key elements while implementing conservation practices.

Materials:

To watch the recorded *The Science Behind Water and Soil Conservation Virtual Field Trips*, go to www.uaex.uada.edu/soywhatsup and click on the 'Virtual Field Trips and Lessons'

for them.

Biology Teachers: This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology and economics.

Chemistry Teachers: Cover how today's technology preserves water and nutrients in our ecosystems, and on-site real-time testing translates to a better ecosystem.

Environmental Science Teachers: This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology and economics.

AG Teachers: This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology, and the economics of farming profitability by using and testing for continuous agricultural improvement.

Farmers must be constantly aware of the resources they use to grow their crops. Practicing conservation in the field means less water and chemical (herbicide and insecticide) treatments. This translates into more profit for the farmer and is environmentally friendly. To be successful at growing healthy crops all while protecting our environment from greenhouse gases, and decreasing water and nutrient loss on those crops, farmers need to do nutrient and moisture testing on a regular basis to determine what is needed in real time. This helps to decrease water and nutrient usage and helps farmers to also decrease greenhouse gas emissions.

Many farmers are learning that by continuously improving agricultural conservation, they can not only improve their overall economic gain but also the environment.

Show the video *'The Science Behind Discovery Farm-Based Water and Soil Conservation Practices Field Trips'*.

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.)

icon to the left of the webpage.
Paper and writing utensils for students in the classroom.

Preparation: If this lesson is to be done in class, it is very important that the teacher understands the vocabulary words below.

Time Duration:
One to one and a half class periods.

The video is about 60 minutes long (45 minutes plus 15 minutes question/answer). Assume about 10 minutes for students to look up vocabulary, and 10 minutes to teach essential concepts. Assume 10 minutes

After the video, the students break into three groups: the *Gasmet* group, the *LI-COR* group, and the *'In lab gas chromatography'* group. Each group brainstorms their area and explain to the class the pros and cons of the testing method they have. Have students in the class decide which testing method overall is the best.

for reflection and discussion after the video.

Elicit:

Do a KWL Chart about agricultural sampling methods. What needs to be sampled in a field and why? How does one measure those samples? What are the advantages of measuring samples in real time versus taking the samples back to a lab? How can these practices help farmers ecologically and economically? Where do you think farmers could get help with these practices?

Engage:

Tell the students that they are going to watch a video titled

'The Science Behind Discovery Farm-Based Water and Soil Conservation Practices Field Trip.' Before the video, the students will break into groups to define the following words:

Biochar
 Greenhouse gases
 N_2O , (Nitrous Oxide) water vapor,
 CO_2 , CH_4 (Methane)
 Cover crops
 Gas
 Chromatography
 Buffer strips
 No Tillage
 Polypipe irrigation
 Soil health
 Crop rotation
 LI-COR Analyzer
 Gasmet Analyzer

Explain:

BEFORE THE VIDEO,
 be sure the students understand that real-time testing in agriculture not only

benefits the environment, but also farmers. Farmers need to learn that testing during agricultural conservation of water and nutrients can translate into more profit for them.

Biology Teachers:

This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology and economics.

Chemistry Teachers:

Cover how today's technology is helping to preserve water and nutrients in our ecosystem.

Environmental Science Teachers:

This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology and economics.

AG Teachers: This is a good time to cover/review human impact on ecological systems and how population dynamics/agriculture affect the local ecology, and the economics of farming profitability by using continuous testing during agricultural improvement.

Explore:

Farmers must be constantly aware of the resources they

use to grow their crops. Practicing conservation in the field means less water and chemical (herbicide and insecticide) treatments. This translates into more profit for farmers and is environmentally friendly. To be successful at growing healthy crops all while protecting our environment from greenhouse gases, and decreasing water and nutrient loss on those crops, farmers need to do nutrient and moisture testing on a regular basis to determine what is needed in real time. This helps to decrease water and nutrient usage and

helps farmers to also decrease greenhouse gas emissions.

Many farmers are learning that by continuously improving agricultural conservation, they can not only improve their overall economic gain but also the environment.

Show the video '*The Science behind Discovery Farm-Based Water and Soil Conservation Practices Field Trip*'.

Elaborate:

After the video, the students break into three groups: the *Gasmet* group, the *LI-COR* group, and *In lab gas*

chromatography'
group. Each group
brainstorms their
area and explain to
the class the pros
and cons of the
testing method they
have. Have the class
decide which
testing method
overall is the best.

Evaluate:

Students will turn
in a two-paragraph
reflection paper on
what they learned
and how these
testing methods can
make a difference in
ecology.

Extend:

End the lesson with
how the
conservation
practices of farmers
decrease their
dependence on
water and
chemicals and has a
huge impact on our

personal lives through the water we use and the food we eat. Reiterate how our concern for the local ecology can, in turn, drive how farmers approach production.

Assign a brainstorming project that allows students to design their own alternate testing method or have students research cutting edge testing practices and how they could benefit local farmers.

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



Soil AND 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

Formative Assessment for Student Learning

Elicit Evidence of Learning: This box is the individual communication performance from the student prompts in Appendix A

Evidence of Student Proficiency

Students will understand the importance of soil and water sampling to produce healthy crops with the least amount of water and added nutrients.

Students will learn that the results of these tests have a major impact not only on plant growth but on the environment as well, as farmers use this information to decrease greenhouse gases and improve the ecological stance of the farming area, all while producing a viable crop.

Students will learn that testing during current conservation methods can make a difference not only ecologically but also economically to a farmer.

Range of Typical Student Responses

This section provides a range of typical student responses. A three-point scale is often used.

Descriptors of grade-level appropriate student responses:

- Full understanding: Student will have all the vocabulary defined and participate fully in the post-video discussion. Reflection paper will show a full connection between what they experienced and understanding.
- Partial understanding: Student will have 75% of the vocabulary defined. The reflection paper will only show a partial connection between what they experienced and what they understood.
- Limited understanding: Student will have 50% or less of vocabulary defined 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 a 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 students who display full understanding: Assign a brainstorming project that allows students to design their own technology to help farmers. Students could also interview local agencies as to the collaboration they have done with local farmers.

SEP, CCC, DCI Featured in Lesson

Science Essentials (Student Performance Expectations From Appendix C, D, E)

Science Practices

Developing and Using Models (B16-ETS1-3) (EVS-LS4-6)

Constructing Explanations and

- 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.

Designing Solutions (BI-LS1-5) (BI-ESS3-1) (BI-ESS3-4) (EVS-ETS1-2) (EVS-ESS3-1) (EVS-LS2-7) (CI1-ETS1-2) Planning and Carrying Out Investigations (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)	- Plan and investigate 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.
Crosscutting Concepts Energy and Matter (EVS-ESS2-6) Stability and Change (BI-ESS2-2) (BI-ESS3-4) (EVS-ESS3-3) (EVS-LS2-7) 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)	- The total amount of energy and matter in closed systems is preserved. - Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. - 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	
ETS1.B: Developing Possible Solutions ESS3.A: Natural Resources 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	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for an energy source that minimizes pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. • 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: Agricultural Sustainability and testing technology are the keys to a healthy ecosystem, plus increase productivity and profitability for farmers.

Group Performances:

1. **Ask questions to plan an investigation** for understanding that by learning about and practicing agricultural sustainability through real time testing, farmers and the ecosystem benefit.
2. **Plan an investigation** by defining the necessary words and preparing for group collaboration.
3. **Construct an explanation** by forming groups and discussing how using real time data testing and conservation efforts can affect where they live.
4. **Use a model to** explain how testing agricultural sustainability can decrease mineral loss, greenhouse gases, erosion, and help both crop productivity and the local ecology.

Class Discussion

Individual Performances:

1. **Develop an argument** that shows how farmers working toward agricultural sustainability can and do help the economy and ecology in our local area.

Appendix B - Materials, Preparation and Time Duration.

To watch the recorded 'The Science behind Discovery Farm-Based Water and Soil Conservation Practices Field Trips':

- Go to www.uaex.uada.edu/soywhatsup and click on the 'Virtual Field Trips and Lessons' link on the left-hand side of the page. This will take you to the video archive webpage.
- Paper writing utensils for students (if in class).

Preparation:

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

Time Duration: One to two class periods.

The video is about 60 minutes long (45 minutes plus any questions). Assume about 10 minutes for students to look up vocabulary, 10 minutes to teach essential concepts, and about 10 minutes for group discussion and reflection after the video.

Appendix C – Resources

Below are good resources for understanding the science used in this VFT.

www.uaex.uada.edu/publications/pdf/FSA2217.pdf

<https://www.uaex.uada.edu/media-resources/news/2022/april/04-01-2022-ark-greenhouse-gas-reduction-rice.aspx>

<https://www.uaex.uada.edu/media-resources/news/2024/june2024/06-14-2024-pesticides-sustainability.aspx>

<https://www.uaex.uada.edu/environment-nature/air-quality/default.aspx>

www.uaex.uada.edu/publications/pdf/FSA2217.pdf



Pursuant to 7 CFR § 15.3, the University of Arkansas System Division of Agriculture offers all its Extension and Research programs and services (including employment) without regard to race, color, sex, national origin, religion, age, disability, marital or veteran status, genetic information, sexual preference, pregnancy or any other legally protected status, and is an equal opportunity institution.