SOIL & WATER

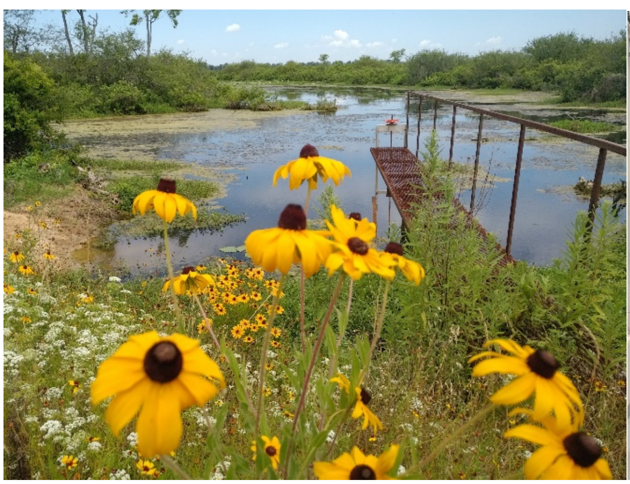
CONSERVATION VIRTUAL FIELD TRIP

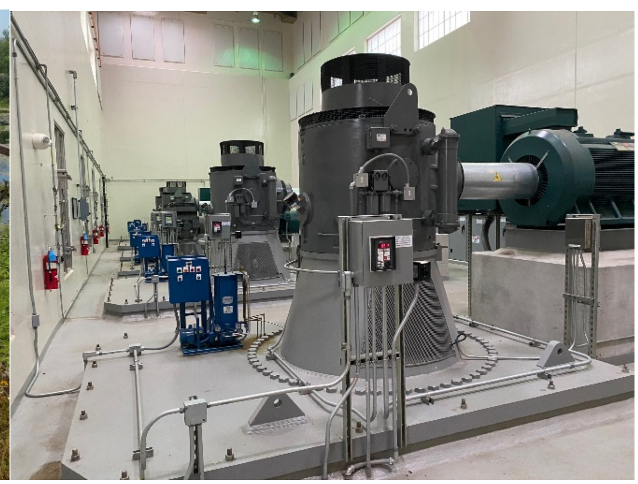
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

USDA United States Department of Agriculture
Natural Resources Conservation Service

7E and GRC-3D Lesson Guides for the

Farm Surface Water Irrigation Aquifer Issues Virtual Field Trip





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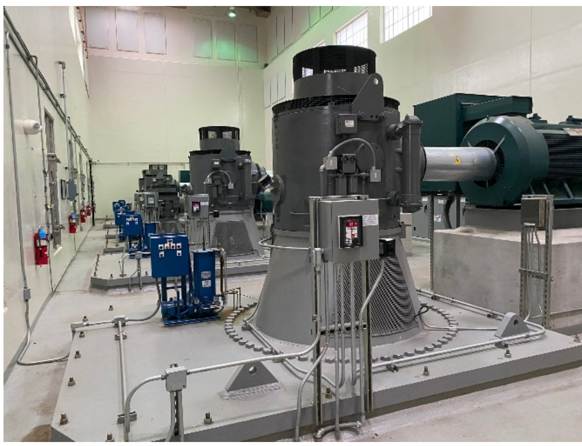
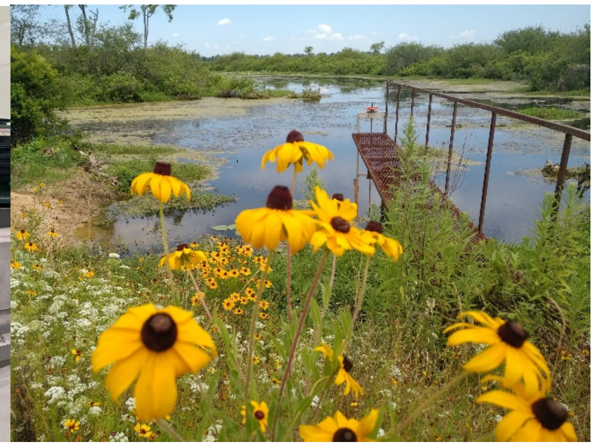
DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System | USDA United States Department of Agriculture Natural Resources Conservation Service

By Diedre Young, Soybean Science Challenge Coodinator

Farm Surface Water Irrigation Aquifer Issues Virtual Field Trip

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

Arkansas NGSS Suggestions:

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

1 Farm Surface Water Irrigation Aquifer Issues VFT: Teacher Lesson Plan

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 (EVS-ESS2-5)

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

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

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

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

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

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

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

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

Topic 4: Sustainability

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

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

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

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

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

Connections to the Arkansas Mathematic Standards: MP.2

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Connections to the Arkansas Mathematic Standards: MP.2

Physics:

Topic 1: Motion

P-PS1-1AR: Create a model of motion and forces, including vectors graphed on the coordinate plane, to describe and predict the behavior of a system.

Science and Engineering Practices: Developing and Using Models (P-PS1-1AR), Using Mathematics and Computational Thinking (P-PS1-2AR)

Crosscutting Concepts: System and System Models (P-PS1-1AR)

Disciplinary Core Ideas: PS2.A: Forces and Motion

Connections to the Arkansas Disciplinary Literacy Standards: RST.9-10.7

Connections to the Arkansas English Language Arts Standards: SL.11-12.2

Connections to the Arkansas Mathematic Standards: HSN.VM.A.1, HSN.VM.B.4

P-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

Science and Engineering Practices: Analyzing and Interpreting Data (P-PS2-1)

Crosscutting Concepts: Structure and Function (P-PS2-1)

Disciplinary Core Ideas: PS2.A: Forces and Motion

Connections to the Arkansas Disciplinary Literacy Standards: RST.11-12.1, RST.11-12.7, WHST.9-12.9

Connections to the Arkansas Mathematic Standards: MP.2, MP.4, HSN.Q.A.1-3, HSN.VM.A.1,3, HSN.VM.B.4, HSA.SSE.B.3

P1-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 (P1-ETS1-2)

Crosscutting Concepts: Interdependence of Science and Technology (P1-ETS1-2)

Disciplinary Core Ideas: PS2.A: Forces and Motion, ETS1.C: Optimizing the Design Solution.

Connections to the English Language Arts Standards: SL.11-12.2

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

Topic 2: Work and Energy

P-PS2-5AR: Use mathematical representations to support the claim that the change in kinetic energy of a system is equal to the net work performed upon the system.

Science and Engineering Practices: Using mathematics and computational thinking (P-PS2-5AR).

Crosscutting Concepts: Energy and Matter (P-PS2-5AR).

Disciplinary Core Ideas: PS3.C: Relationship between energy and forces.

Connections to the English Language Arts Standards: SL.11-12.4

Connections to the Arkansas Mathematic Standards: MP.2, MP.4, HSN.Q.A.1-3, HSF.IF.C.7

Topic 3: Heat and Thermodynamics

P-PS3-3AR: Use mathematical representations to model the conservation of energy in fluids.

Science and Engineering Practices: Using mathematics and computational thinking (P-PS3-3AR)

Crosscutting Concepts: Energy and Matter (P-PS3-3AR)

Disciplinary Core Ideas: PS3.B: Conservation of Energy and Energy Transfer

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

Objective: Students will understand the importance of irrigation watering with regards to conservation of water. Students will understand the current concerns with reference to the decreasing aquifer stores in the Alluvial Aquifer. Farmers are addressing this shortage though crop rotation, surface water storage, precision and zero leveling, ditch water recycling and underground pipelines for surface water movement.

Assessment: Students will turn in a two-paragraph reflection paper on what they learned and how these water conservation efforts can affect where they live. They also need to give the answers to their two questions from the *Farm Surface Water Irrigation Issues Virtual Field Trip video.*

Key Points: Definition of an aquifer. Alluvial water shortage in Arkansas. Surface water storage through rain and river winter/spring overflow. Water conservation through precision field leveling, ditch water recycling, row rice and crop rotation. Technology being used to help with water conservation such as underground pipelines for channeling surface water, VFD electric pumps, moisture sensors and the Pipe Planner application for Poly-pipe Irrigation. Benefits of irrigation conservation (wildlife and aquatic flora and fauna).

Materials:

- You will need to register online if you plan to watch the field trip 'live' on March 19. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you.
  If you register during the live feed, you will be automatically directed to the site and 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 *Farm Surface Water Irrigation Issues Virtual Field Trip* video after March 19, go to www.uaex.uada.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.
- Paper writing utensils for students.

Preparation:

It is highly recommended that you, the teacher, do research on the key words given below.

While the video covers the aquifer, it is recommended that you also do a quick review of the basis and history of the Alluvial Aquifer in Arkansas, including the decline in water levels.

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 irrigation. How do farmers water their crops? Where does the water that farmers use come from? Why would this water consumption be an issue in Arkansas? (mainly AG state, lots of crops, rice takes a lot of water to grow, etc). Considering the properties of water and the interaction water has on the environment, how could farmers decrease water usage from the Alluvial Aquifer yet still give adequate moisture to their crops?

Engage:

Tell the students that they are going to watch a video titled '*Farm Surface Water Irrigation Issues Virtual Field Trip*'. Before they start the video, have the students break into groups to define the following words:

- Definition of an Aquifer; how they form, etc.
- Alluvial Aquifer
- Surface water storage
- Precision field leveling
- Zero incline fields
- Row rice for water conservation
- Crop Rotation
- VFD Electric vs Diesel pumps
- Moisture Sensors
- Pipe Planner Application

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 irrigation water is a precious commodity both economically and ecologically. Already the Alluvial Aquifer is showing a water deficit and it is becoming both ecologically and economically expensive to continue to use this aquifer for irrigation in Arkansas. This video shows how our farmers are using innovative ways to decrease their reliance on the Alluvial by using rain and recycled irrigation groundwater, plus water reservoir storage from river overflows.

If you are in chemistry, this is a good time to discuss the water cycle, the physical/chemical properties of water and the structure and function of the dipole molecule and how it plays into an aquifer. You could also cover how sensors measure moisture.

Environmental Science concepts could involve ecosystem dynamics, natural resources, human impact and the role of water in surrounding systems.

Physics teachers: This video covers the physics of flow (open and closed channel) involving volume, height, pressure flow, and velocity of water dependent on ground elevation and pipe diameter. Consider developing some problems beforehand for your students to work on after the video.

Explore:

Farmers have to be constantly aware of the amount and origin of the water they use to irrigate their crops. Aquifer water availability has dropped over the years so farmers are always looking for ways to use alternate sources of water; alternate water usage means less cost, better sustainability and is better for the environment.

Show the video '*Farm Surface Water Irrigation Issues Virtual Field Trip'*.

Elaborate:

After the video, break the students into four groups; the *Irrigation runoff capture* group, the *River overflow reservoir* group, the *Crop variation (row rice, crop rotation)* group and the *Precision leveling/Zero grade* group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come up with at least six ways total and then report them to the rest of the class. The class can debate how to 'mix and match' these different practices to fit where they live.

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 the Alluvial Aquifer has also had a huge impact on our personal lives through the water we use and the food we eat.

Assign a brainstorming project that allows students to design their own alternate irrigation methods, moisture sensor equipment or calculate flow based on different ground elevations.

Have an extension agent or local farmer come to your classroom and talk about irrigation of crops in your local community.

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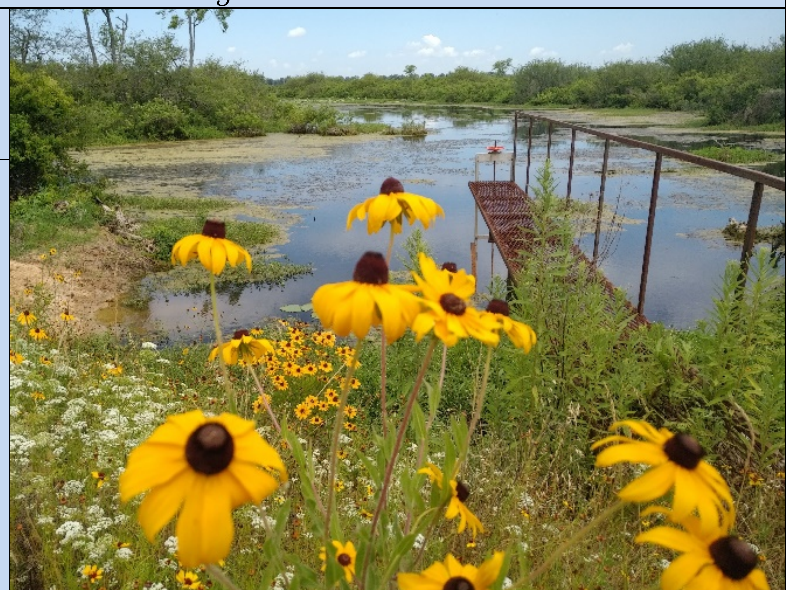
DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System | USDA United States Department of Agriculture Natural Resources Conservation Service

3D-Student Science Performance
Author: Diedre Young, Soybean Science Challenge Coordinator

Grade: 9-12 Integrated Chemistry, Environmental Science, Physics and Agricultural Science



Lesson Topic:

- **Aquifer Water Shortage**
- **Surface Water Collection**
- **Water Conservation in Farming**
- **Technology in Water Conservation**
- **Benefits of Surface Water Irrigation**

Farm Surface Water Irrigation Aquifer Issues Virtual Field Trip

Performance Expectations (Standard) from State Standards or NGSS:

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.]

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. [AR Clarification Statement: Examples of real-world problems could include wastewater treatment, production of biofuels, and the impact of heavy metals or phosphate pollutants on the environment.]

Connections to the Arkansas Disciplinary Literacy Standards:

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

Connections to the Arkansas Mathematic Standards:

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

MP.4: Model with mathematics.

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. [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.]

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.]

Topic 4: Sustainability

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).]

EVS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. [AR Clarification Statement: Examples of data on the impacts of human activities could include the sequencing of traffic lights, adding lanes to main traffic arteries, docking and dredging of waterways, transportation of goods to market, use of drones, and use of alternate energies.]

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.)]

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.]

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

Connections to the Arkansas Disciplinary Literacy Standards:

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

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

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

RST.11-12.9: Synthesize information from a range of sources into a coherent understanding of a process, phenomenon or concept, resolving conflicting information when possible.

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.

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.

WHST.9-12.7: Conduct short and well as more sustained research projects to answer a 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.

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.

Connections to the Arkansas Mathematic Standards:

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

MP.2: Reason abstractly and quantitatively.

MP.4: Model with mathematics.

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.

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

Physics:

Topic 1: Motion

P-PS1-1AR: Create a model of motion and forces, including vectors graphed on the coordinate plane, to describe and predict the behavior of a system. [Clarification Statement: Emphasis is on vector addition for 1-D (frame of reference), 2D motion (projectile, rotational motion), vectors applied to force diagrams, and vector direction for gravitational forces.]

P-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables and graphs of position or velocity as functions of time for objects subject to a net unbalanced force (falling object, object rolling down a ramp, moving object being pulled by a constant force.]

P1-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: Problems could include acceleration factors (one–dimensional motion), vectors (two dimensional motion), and gravity (Newton's laws).]

Topic 2: Work and Energy

P-PS2-5AR: Use mathematical representations to support the claim that the change in kinetic energy of a system is equal to the net work performed upon the system. [Clarification Statement: Emphasis is on quantitative kinetic energy in interactions.]

Topic 3: Heat and Thermodynamics

P-PS3-3AR: Use mathematical representations to model the conservation of energy in fluids. [Clarification Statement: Emphasis is on fluid dynamics as expressed in Bernoulli's equation and Pascal's principle.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

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.

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.

WHST.9-12.9: 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.

Connections to the Arkansas English Language Arts Standards:

SL.11-12.2: Integrate multiple sources of information that is gained by means other than reading (e.g., texts read out loud, oral presentations or charts, graphs, diagrams, speeches) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11-12.4: present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively.

MP.4: Model with mathematics.

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.

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

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

HSN.VM.A.1: Recognize vector quantities as having both magnitude and direction; represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes.

HSN.VM.A.3: Solve problems involving velocity and other quantities that can be represented by vectors.

HSN.VM.B.4: Add and subtract vectors: add vectors end-to-end, compound-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes; given two vectors in magnitude and direction form, determine the magnitude and direction of their sum; understand vector subtraction ***v-w as v+(-w),*** where ***–w*** is the additive inverse of ***w***, with the same magnitude as ***w*** and pointing in the opposite direction; represent vector subtraction graphically by connecting the tips in the appropriate order; perform vector subtraction component-wise.

HSA.SSE.B.3: Choose and produce an equivalent form of expression to reveal and explain properties of the quantity represented by the expression.

HSA.CED.A.3: Represent and interpret constraints by equations or inequalities, and by systems of equations and/or inequalities.

HSA.CED.A.4: Rearrange literal equations using the properties of equality.

HSF.IF.C.7: Graph functions expressed algebraically and show key features of the graph, with and without technology; graph linear and quadratic functions and, when applicable, show intercepts, maxima, and minima; graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions; graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior; graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior; graph exponential and logarithmic functions, showing intercepts and end behavior, graph trigonometric functions, showing period, midline, and amplitude.

Lesson Performance Expectations:

- **Students will understand the importance of irrigation conservation in farming.**
- **Students will understand the importance of conservation of the Alluvial Aquifer.**
- **Students will understand how irrigation conservation though surface water retention impacts their lives.**

Objective / Assessment	Student Science Performance
Objective: Students will understand the importance of irrigation watering with regards to conservation of water. Students will understand the current concerns with reference to the decreasing aquifer stores in the Alluvial Aquifer. Farmers are addressing this shortage though crop rotation, surface water storage, precision and zero leveling, ditch water recycling and underground pipelines for surface water movement. **Assessment:** Students will turn in a two-paragraph reflection paper on what they learned and how these water conservation	**Student Science Performance** ***Phenomenon: Conventional irrigation has caused a deficit in the Alluvial Aquifer. New water retention techniques using surface water and river overflow means little to no dependence on Arkansas aquifers which improves our ecosystem.*** ***Gather*** 1. Students will break into groups and define the following words: • Definition of an aquifer; how developed, etc. • Alluvial Aquifer • Surface water storage • Precision field leveling • Zero Incline fields • Row rice for water conservation • Crop Rotation • VFD Electric vs Diesel pumps • Moisture Sensors • Pipe Planner Application *(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 is located in the appendices). When materials for the investigation are needed we recommend that you include them in 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.

efforts can affect where they live. They also need to give the answers to their two questions from the *Farm Surface Water Irrigation Issues Virtual Field Trip video.*

Key Points:
Definition of an aquifer. Alluvial water shortage in Arkansas. Surface water storage through rain and river winter/spring overflow. Water conservation through precision field leveling, ditch water recycling, row rice and crop rotation. Technology being used to help with water conservation such as underground pipelines for channeling surface water, VFD electric pumps, moisture sensors and the Pipe Planner application for Poly-pipe Irrigation.

Class Discussion:
Questions to initiate Discussion:

Q: How do farmers water their crops?
Q: Where does that water come from?
Q: Is this an issues in Arkansas and why?
Q: Considering the properties of water and the interaction water has on the environment, how could farmers decrease water usage in the Alluvian yet still give adequate moisture to their crops?

Teaching Suggestion:

Do a KWL Chart about irrigation. How do farmers water their crops? Where does the water that farmers use come from? Why would this water consumption be an issue in Arkansas? (mainly AG state, lots of crops, rice takes a lot of water to grow, etc). Considering the properties of water and the interaction water has on the environment, how could farmers decrease water usage from the Alluvial Aquifer yet still give adequate moisture to their crops?

Tell the students that they are going to watch a video titled '*Farm Surface Water Irrigation Issues Virtual Field Trip*'. Before they start the video, have the students break into groups and tell them they need to define the word located on page seven.

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 irrigation water is a precious commodity both economically and ecologically. Already the Alluvial Aquifer is showing a water deficit and it is becoming both ecologically and economically expensive to continue to use this aquifer for irrigation in Arkansas. This video shows how our farmers are using innovative ways to decrease their reliance on the Alluvial by using rain and recycled irrigation groundwater, plus water reservoir storage from river overflows.

Benefits of irrigation conservation (wildlife and aquatic flora and fauna). **Materials:** • You will need to register online if you plan to watch the field trip 'live' on March 19. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you. If you register during the live feed, you will be automaticall	*If you are in chemistry*, this is a good time to discuss the water cycle, the physical/chemical properties of water and the structure and function of the dipole molecule and how it plays into an aquifer. You could also cover how sensors measure moisture. *Environmental Science* concepts could involve ecosystem dynamics, natural resources, human impact and the role of water in surrounding systems. *Physics teachers:* This video covers the physics of flow (open and closed channel) involving volume, height, pressure flow, and velocity of water dependent on ground elevation and pipe diameter. Consider developing some problems beforehand for your students to work on after the video. ***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 four groups; the *Irrigation runoff capture* group, the *River overflow reservoir* group, the *Crop variation (row rice, crop rotation)* group and the *Precision leveling/Zero grade* group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come up with at least six ways total and then report them to the rest of the class. The class can debate how to 'mix and match' these different practices to fit where they live. 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.

y 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 *Farm Surface Water Irrigation Issues Virtual Field Trip* video after March 19, go to www.uaex.uada.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. • Paper	

writing utensils for students. **Preparation:** It is highly recommended that you, the teacher, do research on the key words given below. While the video covers the aquifer, it is recommended that you also do a quick review of the basis and history of the Alluvial Aquifer in Arkansas, including the decline in water levels. **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 irrigation. How do farmers water their crops? Where does the water that farmers use come from? Why would this water consumption be an issue in Arkansas? (mainly AG state, lots of crops, rice takes a lot of water to grow, etc). Considering the properties of water and the interaction water has on the environment, how could farmers decrease water usage from the Alluvial Aquifer yet still give adequate moisture to their crops? **Engage:** Tell the students that they are going to watch a video	

titled '*Farm Surface Water Irrigation Issues Virtual Field Trip'*. Before they start the video, have the students break into groups to define the following words: • Definition of an Aquifer; how they form, etc. • Alluvial Aquifer • Surface water storage • Precision field leveling • Zero incline fields • Row rice for water conservation • Crop Rotation • VFD Electric vs Diesel pumps • Moisture Sensors • Pipe Planner Application 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 irrigation water is a precious commodity both economically and ecologically.	

Already the Alluvial Aquifer is showing a water deficit and it is becoming both ecologically and economically expensive to continue to use this aquifer for irrigation in Arkansas. This video shows how our farmers are using innovative ways to decrease their reliance on the Alluvial by using rain and recycled irrigation groundwater, plus water reservoir storage from river overflows. If you are in chemistry, this is a good time to discuss the water cycle, the physical/chemical properties of water and the structure and function of the dipole molecule and how it plays into an aquifer. You could also cover how sensors measure	

moisture. Environmental Science concepts could involve ecosystem dynamics, natural resources, human impact and the role of water in surrounding systems. Physics teachers: This video covers the physics of flow (open and closed channel) involving volume, height, pressure flow, and velocity of water dependent on ground elevation and pipe diameter. Consider developing some problems before hand for your students to work on after the video. **Explore:** Farmers have to be constantly aware of the amount and origin of the water they use to irrigate their crops. Aquifer water availability	

has dropped over the years so farmers are always looking for ways to use alternate sources of water; alternate water usage means less cost, better sustainability and is better for the environment. Show the video '*Farm Surface Water Irrigation Issues Virtual Field Trip*' **Elaborate:** After the video, break the students into four groups; the *Irrigation runoff capture* group, the *River overflow reservoir* group, the *Crop variation (row rice, crop rotation)* group and the *Precision leveling/Zero grade* group. Have each group brainstorm their area of study's good and bad points. Tell students they need to come	

up with at least six ways total and then report them to the rest of the class. The class can debate how to 'mix and match' these different practices to fit where they live. **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 the Alluvial Aquifer has also had a huge impact on our personal lives through the water we use and the food	

we eat. Assign a brainstorming project that allows students to design their own alternate irrigation methods, moisture sensor equipment or calculate flow based on different ground elevations Have an extension agent or local farmer come to your classroom and talk about irrigation of crops in your local community.	

Formative Assessment for Student Learning

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

Evidence of Student Proficiency	Range of Typical Student Responses	Acting on Evidence of Learning
Students will understand the importance of irrigation watering with regard to conservation of water and how using surface water runoff is good for both the ground water and ecosystem. Students will understand that these innovative techniques involve recycling of irrigation runoff and the usage of river overflow.	*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, coming up with six different ways their*	*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*

	irrigation technique has good and bad points. Reflection paper will show full connection between what they experienced and understand. ● *Partial understanding: student will have 75% of the vocabulary defined, one question for the video and an average of three questions from the post video group. 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.*	*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 alternate irrigation method.*

SEP, CCC, DCI Featured in Lesson	**Science Essentials** *(Student Performance Expectations From Appendix C, D, E)*
Science Practices	• 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. • 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 complex real world-problems by specifying criteria and constraints for successful solutions. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors. • Create a computational model or simulation of a
Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions Asking Questions and Defining Problems Engage an Argument from Evidence Using Mathematics and	

Computational Thinking Developing and Using Models Analyzing and Interpreting Data	phenomenon, designed device, process, or system. • Use mathematical representations of phenomena to support claims. • Use a model to predict the relationships between systems or between components of a system. • Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.
Crosscutting Concepts	• 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. • 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. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • 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. • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. The total amount of energy and matter in closed systems is preserved.
Structure and Function Influence of Engineering, Technology and Science on Society and the Natural World Science Addresses Questions About the Natural and Material World Stability and Change Cause and Effect Systems and System Models Interdependence of Science and Technology Energy and Matter	
Disciplinary Core Ideas	• 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
ESS2.C: The roles of water in Earth's Surface Processes ETS1.C: Optimizing the Design Solution	

ETS1.A: Defining and Delimiting Engineering Problems ESS3.A: Natural Resources ETS1.B: Developing Possible Solutions ESS3.C: Human Impacts on Earth Systems LS4.C: Adaptation LS4.D: Biodiversity and Humans PS2.A: Forces and Motion ETS1.C: Optimizing the Design Solution PS3.C: Relationship between energy and forces PS3.B: Conservation of Energy and Energy Transfer	and melting points of rocks. • Criteria may need to be broken down into simpler ones that can be approached systematically, and decision about the priority of certain criteria over others may be needed. • 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. • Resource availability has guided the development of human society. • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical, and in making a persuasive presentation to a client about how a given design will fit his or her needs. • Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. • Changes in the physical environment whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-and sometimes the extinction of some species. • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction to invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. • Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. • When two objects interacting through a force field change relative position, the energy stored in the force field is changed. • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration and how kinetic energy depends on mass and speed, allow the concept

	conservation of energy to be used to predict and describe system behavior. • 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.

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: Conventional irrigation has caused a deficit in the Alluvial Aquifer. New water retention techniques using surface water and river overflow means little to no dependence on Arkansas aquifers which improves our ecosystem.

Group Performances:

1. Ask questions to plan an investigation for understanding that surface water irrigation can save water taken from the Alluvial Aquifer and benefits the local ecology.

2. Plan and an investigation by defining the words necessary and having questions ready for the video.
3. Construct an explanation by forming groups and discussing how conservation irrigation can affect a person's everyday life.

4. Use a model to explain how using surface water (rain runoff, irrigation recycling and river overflow) can improve water supplies in the Alluvial Aquifer, thus protecting our drinking water, and overall landscape from sink holes.

Class Discussion

Individual Performances:

1. Develop an argument for how surface water irrigation can and does help our economy and ecology.

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 sequences to discuss things like "Good Questions to Find Resources" or "Class Debate" or "Discussion of Science Language Student Should Use".

Appendix B –

Materials:

- You will need to register online if you plan to watch the field trip 'live' on March 19. Once you have registered, you will receive a registration link via Constant Contact. If you do not have a link, email dyoung@uada.edu and one will be emailed to you.
  If you register during the live feed, you will be automatically directed to the site) you will receive an automated email with the link to the live feed and a reminder email with a link one hour before the VFT begins.
- If you plan to watch the recorded *Farm Surface Water Irrigation Issues Virtual Field Trip* video after March 19, go to www.uaex.uada.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.
- Paper writing utensils for students.

Preparation:

It is highly recommended that you, the teacher, do research on the key words given above.

While the video covers the aquifer, it is recommended that you also do a quick review of the basis and history of the Alluvial Aquifer in Arkansas, including the decline in water levels.

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 irrigation conservation better.*

https://www.youtube.com/watch?v=FnmQuxLhTSA&feature=youtu.be

https://www.youtube.com/watch?v=hZFKbkLjOwo&feature=youtu.be

http://www.pipeplanner.com/

https://www.uaex.uada.edu/environment-nature/water/docs/IrrigSmart-3241-B-Variable-frequency-drives.pdf

https://www.uaex.uada.edu/environment-nature/water/docs/IrrigSmart-3241-K-Tips-for-conserving-irrigation-water-in-southern-region.pdf

https://www.forrestcitywater.com/FCWUWebsite/information_links/2002.MississippiRiverValley.pdf

Soybean science challenge™

Our Soy Checkoff™ Progress Powered by U.S. Farmers

www.uaex.uada.edu/soywhatsup

UofA DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System

ARKANSAS SOYBEAN PROMOTION BOARD

Free Educational Resources and Materials Available from the Soybean Science Challenge at www.uaex.uada.edu/soywhatsup

The Arkansas Soybean Science Challenge is a science enrichment program open to students in grades 6-12.

The Arkansas Soybean Science Challenge research program includes:

- $300 cash awards for high school student science projects impacting sustainability at Arkansas regional science fairs and Arkansas FFA Agriscience Fair; $1000 first place, $500 second place and $250 Honorable Mention at the Arkansas state science fair.
- $200 cash awards for junior high (6-8th grade) student science projects impacting sustainability at Arkansas regional science fairs and Arkansas FFA Agriscience Fair.
- $200 cash awards to teachers whose students win the Soybean Science Challenge at regional. Teacher awards at state are $300 for first place, $200 for second place and $100 for Honorable Mention. $100 for junior level Soybean Science Challenge teacher awardees at regional.

STUDENT ONLINE COURSE – 6 MODULES

- The Science of Soybean Production
- The Miracle Bean: Food
- The Miracle Bean: Fuel
- The Miracle Bean: Feed
- The Faces & Challenges of Farming: Emerging Issues
- Ready…Set…Research!

6-12th grade students who successfully complete the Soybean Science Challenge online course and enter a soybean related project in one of the Arkansas regional and state science fairs, and FFA Agriscience Fair are eligible to have their projects judged for cash awards.

For more information about the Soybean Science Challenge Program, contact:
Dr. Julie Robinson (jrobinson@uada.edu)
Diedre Young (dyoung@uada.edu)
Phone 501-671-2086

FREE CLASSROOM RESOURCES

Teacher In-Service Online Course
7 Hours ADE Approved – 6 Modules
1 Hour ADE Approved: Science Fair 101

Teacher Resources Course for Classroom Use
6 Modules, Tests, Answer Keys and over 50 other soybean-related articles and resources

Teacher Classroom Lessons in 7E & GRC-3D (NGSS Aligned) Format covering multiple subjects.

5-10-minute NGSS aligned agriculturally based mini-lesson videos for the virtual and face to face classroom. Video lessons cover a multitude of subjects with accessible Power Points.

High School Science Curriculum Resource Guide

Arkansas High-School Science Project Development Guide

Soybean Science Challenge Brochure

Free Soybean Science Challenge Seed Store for Student Research Projects

Several Virtual Field Trip videos that include Teacher Guides