Unit Title: Soil and Agriculture | **Content Area:** Science | **Grade Level:** 9-12

Unit Summary: This unit examines the physical and chemical properties of soil and how these properties affect the role of soil within an ecosystem. In this unit, students will explore the physical and chemical properties of soil and ultimately design their own "ideal" soil. By monitoring plant growth within the soil "recipe" they have created, students will evaluate the physical model of their ideal soil. In this unit, students will also explore how traditional small-scale farming has changed over time to modern agricultural practices. The environmental impacts and sustainability of modern agribusiness will be analyzed. The crosscutting concepts for this unit include patterns; cause and effect: mechanism and explanation; scale, proportion, and quantity; systems and system models; structure and function; and stability and change. In this unit, students will demonstrate a proficiency in the following science and engineering practices: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions; engaging in argument from evidence and obtaining, evaluating, and communicating information.

Unit Essential questions:

- What are the functions of soil within an ecosystem?
- How do the physical and chemical properties of soil contribute to the functions of soil within an ecosystem?
- How is modern or industrial agriculture different from agriculture in the past?
- How has industrial agriculture impacted ecosystems?
- How can industrial agriculture become more sustainable?

Unit Enduring Understandings:

- Soil is a renewable resource; however, it takes hundreds to thousands of years to form.
- Soil has multiple functions within an ecosystem. Soil horizons and properties vary depending upon the ecosystem, as a result of the parent rock, climate, topography, organisms present and time soil has been developing.
- The texture of soil is determined by the percentages of sand, silt and clay. Soil texture influences a soil's porosity, water and nutrient holding capacity and thus has a strong influence on plant growth and how soils respond to pollutants. A variety of physical and chemical tests can be performed on soil in order to predict plant growth.
- Modern industrial agriculture is dependent on energy input, machinery, chemical fertilizers, irrigation and improved crop varieties, which is known collectively as the Green Revolution. These industrial methods have been accompanied by environmental issues such as waterlogging, salinization, pesticide resistance, biomagnification and concerns about genetically modified organisms.
- In order to be sustainable, farming practices must replicate many of the processes that exist in nature. Sustainable agriculture practices include intercropping, crop rotation, contour plowing, no-till agriculture, integrated pest management and organic agriculture.

Possible Student Misconceptions: Dirt is not the same as soil. Soil profiles are similar in different biomes. Soil is a simple substance and not a complex mixture of substances. All soil is the same and has similar properties. Soil plays a minor role in ecosystems.

NJCCCS: 5.1.12.A.1-A.3, 5.1.12.B.1-B.4, 5.1.12.C.1-C.3, 5.1.12.D.1-D.3, 5.3.12.B.4, 5.3.12.C.1-C.2, 5.3.12.E.4, 5.4.12.C.1, 5.4.12.G.1-G.7

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

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

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

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

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

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

Primary CCSS ELA/Literacy Connections:

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. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts,

Primary CCSS Mathematics Connections:

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1), (HS-ETS1-3), (HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1), (HS-ETS1-2), (HS-ETS1-3), (HS-ETS1-4)

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7)

attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1), (HS-LS2-2), (HS-LS2-6), (HS-LS2-8) 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. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8) 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. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8) WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1),(HS-LS2-2) 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. (HS-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. (HS-LS2-7), (HS-LS4-6) 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. (HS-ETS1-1),(HS-ETS1-3)	HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-7) HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

Lesson Pace & Sequence

Lesson Title/Number: Soil Profiles/Lesson 1	**Learning Objective(s):** Explain the roles of soil in an ecosystem. Compare and contrast soil profiles from different ecosystems/biomes. Describe the process of soil formation and determine whether or not soil is a renewable or nonrenewable resource. Using models, describe how soil texture and composition influences water infiltration and groundwater pollution.	**Lesson Duration:** 120 -160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Think/Pair/Share: What is dirt/soil? Is soil a renewable resource? Why or why not? What is a soil profile? Utilize a graphic organizer such as a spider map for students to write down their prior knowledge. Students can explain the statements: Soil makes life. Life			ESS2.E: Biogeology, ESS3.A: Natural Resources, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect: Mechanism and Explanation, Structure and Function

	makes soil.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students can generate questions they may have about soil or related environmental issues from watching "Dirt the Movie."	• "Dirt the Movie": http://www-tc.pbs.org/independentlens/dirt-the-movie/resources/dirt_discussion.pdf	Asking Questions and Defining Problems	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems	Patterns, Cause and Effect: Mechanism and Explanation; Structure and Function
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Activity 3: Soil Organization Using three plastic columns, students create three different soil profile models by creating the C, B, A and O horizons. The students test each model by adding a drop of food coloring to the O horizon of each model and adding "rainfall" 2 mL of water at a time until water washes through the column and begins to drip into the vial beneath the plastic model. Students need to create a data table to record their observations in each model.	• Carolina Soil Formation and Properties Kit: http://mrstanley.weebly.com/uploads/1/3/4/7/13473377/soil_labs_-_act_1_and_act_3.pdf	Developing and Using Models; Planning and Carrying Out Investigations, Analyzing and Interpreting data	ESS2.C: The Roles of Water in Earth's Surface Processes, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity, Structure and Function
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Provide students with a soil profile to label. Explain how soil profiles can vary depending upon the ecosystem. Discuss which components of soil retain water (humus and clay) and which components of soil do not (sand). Introduce waterlogging and how waterlogging affects plant growth.	• Text Chapter 15 p. 414 Soil Texture PowerPoint: http://www.cvs.k12.mi.us/klolich/apes/living%20systems/lecture/soil%20info.ppt • Soil Layers Diagram: http://www.enchantedlearning.com/geology/label/soillayers/ • Soil horizons: grassland and desert soil profile: http://www.warnercnr.edu/~bobw/a/s/soils5.htm • The effect of water on soil in selected biomes: http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/Soil.html		ESS2.E Biogeology, ESS3.C: Human Impacts on Earth Systems, LS2A: Interdependent Relationships in Ecosystems, LS2.C Ecosystem Dynamics, Functioning and Resilience	Patterns, Cause and Effect: Mechanism and Explanation, Structure and Function
Elaborate: How will students apply their learning and develop a more sophisticated	Soil Formation Worksheet	• Down to Earth: http://www.soil-net.com/downloads/Down_t	Analyzing and Interpreting Data	LS2A: Interdependent Relationships in Ecosystems	Patterns, Scale, Proportion, and Quantity, Cause and Effect, Structure and Function

understanding of the concept/topic?		o_Earth.pdf • Soil Formation Worksheet: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAA&url=http%3A%2F%2Fwww.trschools.com%2Fstaff%2Fg%2Fcgirtain%2FWS%2FSoil%2520Formation%2520Worksheet.doc&ei=CiLQU7ODLoONyATbwILQAQ&usg=AFQjCNEMmDZMSdvgQaRaU1_8rQOtZDJpVg&sig2=d_9hF_TDQtveDFRnsrWY1A			
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Laboratory Report		Engaging in Argument from Evidence, Obtaining, Evaluating, and Communicating Information	LS2A: Interdependent Relationships in Ecosystems	Patterns, Cause and Effect, Structure and Function
Extend: How will students deepen their conceptual understanding through use in new context?	Students will select an ecosystem and describe its potential for groundwater contamination based upon the amount of precipitation the ecosystem receives and its soil properties.	• Earth on Edge – Agricultural Ecosystems: http://www.pbs.org/earthonedge/ecosystems/agricultural.html	Engaging in Argument from Evidence, Obtaining, Evaluating, and Communicating Information	ESS3.C: Human Impacts on Earth Systems	Cause and Effect, Structure and Function

Lesson Pace & Sequence

Lesson Title/Number: Determining Soil Texture/Lesson 2		**Learning Objective(s):** Describe how to determine a soil's textural class using the textural triangle and the soil texture by feel method. Explain why soil texture is an important physical property of soil, determining many other physical, chemical, and biological properties of soil.			**Lesson Duration:** 120 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Pre-quiz			LS2A: Interdependent Relationships in Ecosystems	Patterns; Scale, Proportion and Quantity; Structure and Function
Engage: How will you capture students' interest and get	Demonstrate the "Texture by Feel Analysis of Soil."	• Soil Tests Without a Soil Testing Kit:	Planning and Carrying Out Investigations; Analyzing and	LS2A: Interdependent Relationships in Ecosystems	Cause and Effect; Structure and Function

students' minds focused on the concept/topic?		https://www.youtube.com/watch?v=9pOJ4uVJ7qo	Interpreting Data		
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Exploring Soil Texture Activity	• Estimating Soil Texture by Feel: http://flux.aos.wisc.edu/~adesai/documents/cmn/2011/activities/Soiltexture.pdf	Planning and Carrying Out Investigations, Analyzing and Interpreting Data	ESS3.A: Natural Resources, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect; Scale, Proportion and Quantity; Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Practice problems utilizing a soil triangle with students.	• Reading a Soil Textural Triangle: https://www.youtube.com/watch?v=bAYzoVliNFQ	Using Mathematics and Computational Thinking	LS2A: Interdependent Relationships in Ecosystems	Scale, Proportion and Quantity
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Soil Triangle Activity	• Soil Triangle Activity: http://www.nbcsd.org/cms/lib/PA01001217/Centricity/Domain/116/Soil%20Texture%20Soil%20Activity.pdf	Using Mathematics and Computational Thinking, Analyzing and Interpreting Data	LS2A: Interdependent Relationships in Ecosystems	Scale, Proportion and Quantity
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Post-quiz; Activity Responses		Obtaining, Evaluating, and Communicating Information	LS2A: Interdependent Relationships in Ecosystems	Cause and Effect; Scale, Proportion and Quantity; Systems and System Models
Extend: How will students deepen their conceptual understanding through use in new context?	Students can determine the texture of their samples utilizing a graduated cylinder and compare their results with the "texture by feel" method. Students can also utilize the soil triangle to determine how a particular soil could be modified to become a better medium for plant growth.	• Soil Texture Using a Graduated Cylinder: https://www.youtube.com/watch?v=knrmCbctGEA	Planning and Carrying Out Investigations, Analyzing and Interpreting Data	LS2A: Interdependent Relationships in Ecosystems	Cause and Effect; Scale, Proportion and Quantity; Systems and System Models

Lesson Pace & Sequence

Lesson Title/Number: The Chemical Properties of Soil/Lesson/Lesson 3	**Learning Objective(s):** to quantify pH and macronutrient content of different soils and explain how these qualities and interactions relate to plant growth and agricultural practices.	**Lesson Duration:** 120-160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Minute paper - Based upon your knowledge of biogeochemical cycles, what chemical tests are performed on soil? What physical tests are performed on soil?			LS2A: Interdependent Relationships in Ecosystems	Energy and Matter: Flows, Cycles and Conservation
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Show students a video of the Texas Fertilizer Explosion in April, 2013. Ask the students to generate questions about the Fertilizer Plant Explosion that are related to science.	• Texas Fertilizer Explosion: https://www.youtube.com/watch?v=MHmrRVmWm6A	Asking Questions and Defining Problems	ESS3.C: Human Impacts on Earth Systems	Cause and Effect: Mechanism and Explanation
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Laboratory: Analysis of Free Ions S-13 to S-15	• AP Environmental Science Caroling Testing Soil Productivity Kit Student Guide: http://shaneheath.weebly.com/uploads/2/2/8/9/22896444/carolina_ap_soil_lab_book.pdf	Planning and Carrying Out Investigations; Analyzing and Interpreting Data	LS2A: Interdependent Relationships in Ecosystems	Scale, Proportion and Quantity
Explain: How will you help students connect their exploration to the concept/topic under investigation?	PowerPoint Lecture/Mini lesson: The importance of nutrients to plant growth and the effect of an acidic pH on soil quality.			ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect: Mechanism and Explanation

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can explore how soil pH can be adjusted by utilizing lime, and how soil fertilizers, such as ammonium sulfate, potash, and phosphate can be applied in agriculture to increase specific free ions.		Planning and Carrying Out Investigations; Analyzing and Interpreting Data	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Student responses to laboratory questions; Laboratory Report		Obtaining, Evaluating, and Communicating Information	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect: Mechanism and Explanation
Extend: How will students deepen their conceptual understanding through use in new context?	Students can explore the effect of acid deposition on plant growth by generating questions about the effect of acidity on plant growth, and answering the questions that are generated.	• Soil Acidity: http://www.soilquality.org.au/factsheets/soil-acidity	Asking Questions and Defining Problems	ESS2.E: Biogeology, ESS3.C: Human Impacts on Earth Systems, LS2A: Interdependent Relationships in Ecosystems	Cause and Effect: Mechanism and Explanation

Lesson Pace & Sequence

Lesson Title/Number: Exploring Soil Productivity/Lesson 4	**Learning Objective(s):** to apply gained knowledge from investigating the physical and chemical properties of soil to growing plants in soil samples that have been designed to maximize and/or minimize plant growth.	**Lesson Duration:** Experimental Set-up 160 minutes; Data collection 3 to 4 weeks

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Discussion: Provide students with the some of the materials they will be working with (fertilizers, potash, ammonium sulphate, phosphates, lime, sand, clay, humus, etc...). How can the physical and chemical properties of soil be altered to increase or decrease plant growth? Provide specific scenarios.		Planning and Carrying Out Investigations	LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	This lesson can be set up as a group competition to create an improved soil sample that promotes the most plant growth. As a class, students need to decide which plant seeds to select for this activity.		Planning and Carrying Out Investigations	ESS2.E: Biogeology, ETS1.C: Optimizing the Design Solution, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Laboratory: Exploring Soil Productivity S-21	• AP Environmental Science Caroling Testing Soil Productivity Kit Student Guide: http://shaneheath.weebly.com/uploads/2/2/8/9/22896444/carolina_ap_soil_lab_book.pdf	Using Mathematics and Computational Thinking; Constructing Explanations and Designing Solutions; Planning and Carrying Out Investigations; Analyzing and Interpreting Data; Developing and Using Models	ESS2.E: Biogeology, ETS1.C: Optimizing the Design Solution, LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity, Systems and System Models
Explain: How will you help students connect their exploration to the concept/topic under investigation?		• AP Environmental Science Carolina Testing Soil Productivity Teacher's Manual: http://www.carolina.com/pdf/manuals/180605-Teacher-Manual-Sample-pgs.pdf	Using Mathematics and Computational Thinking; Constructing Explanations and Designing Solutions; Planning and Carrying Out Investigations; Analyzing and Interpreting Data; Developing and Utilizing Models	ESS2.E: Biogeology, ETS1.C: Optimizing the Design Solution, LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity, Systems and System Models

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Based upon their laboratory results/data, students can generate additional hypotheses to test regarding increasing or decreasing plant growth.		Using Mathematics and Computational Thinking; Constructing Explanations and Designing Solutions; Planning and Carrying Out Investigations; Analyzing and Interpreting Data	ESS2.E: Biogeology, ETS1.C: Optimizing the Design Solution, LS2A: Interdependent Relationships in Ecosystems, LS2B: Cycles of Matter and Energy Transfer in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Laboratory Report; Oral Presentation		Obtaining, Evaluating, and Communicating Information	ESS2.E: Biogeology, ETS1.C: Optimizing the Design Solution, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Patterns, Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity
Extend: How will students deepen their conceptual understanding through use in new context?	Students can compare and contrast soils in different locations within the United States, or around the world.	• Dig It! – The Secrets of Soil: http://forces.si.edu/soils/	Analyzing and Interpreting Data	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation, Scale, Proportion and Quantity

Lesson Pace & Sequence

Lesson Title/Number: How can modern farming practices become more sustainable?/Lesson 5		**Learning Objective(s):** To understand ways in which different agricultural practices can alter the environment either positively or negatively; to describe how modern agricultural practices can become more sustainable.			**Lesson Duration:** 160 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Utilizing a graphic organizer (Venn Diagram; Compare and Contrast Chart), have students compare farming in the past to farming in the present. Include the problems that need or needed to be solved in agriculture.	• The Scarecrow: http://www.youtube.com/watch?v=lUtnas5ScSE	Asking Questions and Defining Problems	ESS3.C: Human Impacts on Earth Systems	Stability and Change
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students complete the "In the Good Old Days Inventory"	• Timeline of American Agriculture – How has life on the farm changed?: http://www.agclassroom.org/gan/timeline/	Asking Questions and Defining Problems	ESS3.C: Human Impacts on Earth Systems	Stability and Change
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Case Studies of Sustainable Agricultural Practices: http://www.unesco.org/education/tlsf/docs/module_15.doc	• Documentary – Food Inc. Viewing Guide: http://www.takepart.com/sites/default/files/foodinc_PDF_091008.pdf	Obtaining, Evaluating and Communicating Information, Constructing Explanations and Designing Solutions; Engaging in Argument from Evidence	ESS2.E: Biogeology, ESS3.C: Human Impacts on Earth Systems; ETS1.B: Developing Possible Solutions	Stability and Change
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Mini lesson: Sustainable Farming Practices.	• The Habitable Planet – Agriculture: http://www.learner.org/courses/envsci/unit/text.php?unit=7&secNum=9		LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Cause and Effect: Mechanism and Explanation
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	The class can be divided into groups of four students; each group must present their case study and explain how their case study is a model or is not a model of sustainable farming practices. Additional case studies can be provided to show non-sustainable farming practices.	• Water Matters for Sustainable Agriculture: http://d1jkwdgw723xjf.cloudfront.net/wp-content/uploads/2014/05/Water-Matters-for-Sustainable-Agriculture.pdf	Obtaining, Evaluating and Communicating Information, Developing and Using Models, Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Journal responses; oral and written presentations		Obtaining, Evaluating and Communicating Information, Developing and Using Models, Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models

Extend: How will students deepen their conceptual understanding through use in new context?	How might gardening make someone more aware of the natural world and of using resources in a sustainable way? If you grow some of your own food, how might that affect how you think about the food you see in grocery stores? Gardens are systems, with inputs and outputs. Name as many inputs and outputs as you can.	• City Farm Game: http://www.pbslearningmedia.org/resource/sust13.sci.eco.cityfarm/city-farm/	Constructing Explanations and Designing Solutions; Engaging in Argument from Evidence	ESS2.E: Biogeology, LS2A: Interdependent Relationships in Ecosystems, LS2C: Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models