“Solutions-Oriented Learning” Storyline

MS Regenerative Agriculture

Storyline introduction and overview:

Students will discover the carbon component in soils, the role carbon plays in soil health, and the role that regenerative agriculture practices play in soil health and climate change.

NGSS Learning Progression for this Storyline: The middle school storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Take a look at how the middle school performance expectations fit in a continuum of learning for your students.

Placemaking: Grain growers in the inland Pacific Northwest produce over 130 million bushels of wheat annually, 85% of them without irrigation. Agriculture is a principle source of economic stability for rural communities and the region as a whole.	**Anchoring phenomena:** Observe soil burning. The teacher will burn various materials, then demonstrate burning a soil sample for students. Teacher will gather student sensemaking about why the soil burned.	**Drawdown:** Regenerative Agriculture Nutrient Management Conservation Agriculture Composting
Indigenous and other relevant cultural connections: The Spokane tribal council determined the list of 10 items others should know about the tribe. One of the 10 items talks about the Spokane Tribe’s relationship to the land. “Land is sacred. Our ancestors knew they were stewards of the land. We continue to be partners, even beyond our reservation boundary, to assist whether it’s river cleanup in Spokane or anything involving protection of the environment. We collaborate with the city of Spokane and the county to take care of the environment.” Carol Evans, Chairperson	**NGSS PEs (progress towards):** MS LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment	

“Solutions-Oriented Learning” Storyline
MS Regenerative Agriculture

Estimated time required to implement this storyline: 2 to 3 weeks

NGSS PEs:
MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**For MS - LS2-4** **LS2.C Ecosystem Dynamics, Functioning, and Resilience** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** Small changes in one part of a system might cause large changes in another part.
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles to design an object, tool, process or system.	**For MS-ESS3-3** **ESS3.C: Human Impacts on Earth Systems** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.	**Cause and Effect;** Influence of Science, Engineering, and Technology on Society and the Natural World

Learning Session:	Materials List
2	Paper to burn, soil sample to burn
8	Plastic 2-liter bottles (3 per group) Wheat seeds (or any grain) 40 seeds/group Wheat stubble Soil from a conventionally tilled versus minimally tilled ***Set up water quality lab experiments (teams of 2-4) at the beginning of this unit to give the plants time to grow.** Plant 3 half bottles: wheat

	(40 wheat seeds each) for bottle 1, wheat straw for bottle 2 (actual cut piece of stubble w/roots); bare soil for bottle 3 (see slide 4 of this PPT for two teacher resource videos). If time is limited, prepare only bottle 2 and 3. This lab shows water percolation versus run off. The minimally tilled soil will allow water to percolate extremely fast versus conventional till. It is not a filtering issue. It is a porous issue.

Learning Sessions

1.	**Grounding Native Ways of Knowing:**	Estimated time: 30 minutes
	Show the Honorable Harvest - Robin Kimmerer (about 4 minutes). Post the following questions and show the video again ● What does ethical reciprocity between humans and the natural world look like? ● How can plants ‘teach us’? ● What are ’sovereign beings’? ● What is a protocol? What is the protocol for harvesting food as presented by Ms. Kimmerer? Lead a class discussion focusing on the above questions. Invite a local tribe member to your class to speak to their stories of harvesting from the land. Contrast the indigenous ways of harvesting food to the modern ways of harvesting food. (Ms. Kimmerer is a Professor of Environmental and Forest Biology at the State University of New York College of Environmental Science and Forestry, a member of the Citizen Potawatomi Nation (an Indigenous people originally from the Great Lakes region), and a writer.	

2.	**Examine phenomena: Observe soil burning**	Estimated time: 30 minutes
	Students are familiar with the abiotic properties of soil, but may not understand the biotic properties (carbon component) of soil. Demonstrate burning paper, wood, then show the students the soil sample (previously weighed) that has begun to burn (200 mls of soil will take approximately 4 hours to burn on a propane BBQ). Take photos during the burning process to see the smoke emitted. These can be used later in the learning sessions. Also, retain a sample of unburned soil that is the same weight. A propane torch can also be used to burn the soil by putting the flame directly on the soil. Small thin layers of soil burn better whether you use the barbecue or a propane torch. Variations: Prepare a Flipgrid of the soil burning process. Use student samples of soil. Pass the burned soil around the room so that students can feel it. Add water to the burned and the unburned soil and observe the difference.	

3.	**Pre Assessment:**	Estimated time: 20 minutes
	Prior to giving the assessment, consider showing the Washington state crop graphic to show students the diversity of crops in the state and explaining the photo in the assessment. **MS-Regenerative Ag Pre- Assessment** **MS-Regenerative Ag Assessment Rubric**	

4.	**Guiding question: What is soil made of?**	Estimated time: Three 50 minute periods
	1. The abiotic components: Students use the resource Soil Basics to answer: a. What is soil? b. What is the difference between soil and dirt? 2. The biotic components: Show the burned soil sample (and photos). Students compare the sample to the unburned soil and answer the questions: a. Why are the samples different weights? (The carbon has been burned off) b. Where did the carbon in the soil come from? (From soil microbes and dead plant and animal matter) c. Take the burned soil and try to add water to it. (It does not mix) Why not? Could they use the ability of soil to hold water as a way to infer carbon content? 3. Students complete The Berlese Funnel activity to see the invertebrates living in the soil. 4. Students watch Humus Formation. In groups, students choose a microbe from The Root Cellar at Microbe Zoo in Ag Soils: The Root Cellar and prepare a short presentation for the class. There are several “Try This” outside activities in The Root Cellar for students to get first hand evidence of the microbes in the soil. 5. Students complete the soil texture activity from Soils. Include other soil health assessments (pH, water content, soil space, organic content, microbe presence).	

5.	**Guiding question: What are some ecosystem services that soil provides?**	Estimated time: Two 50 minutes
	1. Students read Soil and the Environment: Ecosystem Services and Biology Life in Soil. 2. Students participate in a Socratic discussion to explore their understanding about the ecosystem services of soil and to prepare for step 3.	

	3. Using evidence from the above readings, students construct an argument that changing the amount of soil carbon can affect the number of soil microbes that live in the soil.

6.	**Guiding question: What is the role of soil in the carbon cycle?**	Estimated time: Two 50 minute periods
	1. What is the carbon cycle and why is it important to ecosystems? Students participate in the Carbon Cycle Role Play to model how carbon moves around in the environment. 2. Introduce the term carbon sequestration (process by which carbon dioxide is removed from the atmosphere) and have students connect carbon sequestration to photosynthesis in the carbon cycle. If necessary, students read and watch What is Photosynthesis? to review photosynthesis. The 8 minute video discusses some common misconceptions in students’ understanding of this process. 3. Students discover the role of soil decomposers in the carbon cycle**:** Dead Stuff: The Secret Ingredient in our Food Chain 4. Students explore the website of Kiss the Ground’s An Introduction to Regenerative Agriculture. Students study the image titled “ Building Healthy Soil Solves Everything” that completes the soil’s role in the carbon cycle. 5. Using all the resources above, students construct their own carbon cycle incorporating the role of the soil microbes in storing and emitting carbon and 2 different ways that carbon can enter the soil.	

7.	**Guiding question: How does regenerative agriculture contribute to soil health?**	Estimated time: Three 50 periods
	1. Students continue to explore the website of Kiss the Ground’s A Closer Look: Regenerative Agricultural Practices to discover the differences between ‘degenerative vs. regenerative practices’. 2. What is Regenerative Agriculture? Students write down the 5 practices of regen ag and write how each practice results in carbon sequestration or carbon storage in the soil. 3. Explore no-till practice and how it differs from conventional tilling practices. Show No-till vs till soil video. 4. Students perform the vertical column with a clod of soil from no-till and another clod of soil from tilled. Have students explain what they observe.	

	5. RAFT activity (Instructions for RAFT). Students prepare a public service announcement about the role of Regenerative Farming in Soil, Water, and Air Health as well as Carbon Sequestration. Students can use the ppt from REACCH's Unit 2 Cropping Systems and Sustainability as an additional resource.

8.	Guiding question: What are some other benefits of regenerative agriculture? Focus: Erosion control	Estimated time: Four 50 minute periods
	1. Students explore how water infiltrates into soil in the Rain and Soil Field Investigation. 2. No-till practice also increases water quality. The increased carbon in the no-tilled soil provides structure that resists erosion. Show Erosion and Soil video. It allows for percolation versus runoff 3. Water quality lab experiment: Using the bottles prepared at the beginning of the unit, run water down soil bottles from week 1; measure & record. Compare the amount and the turbidity of the water from each bottle. This lab works better if it is used as a percolation lab versus a run- off lab. Both ways of doing the lab work well together to make students think. 4. Pose the question: a. How would you advise the farmer to reduce the erosion on this field and protect the water in the creek? Erosion Photos b. Using the results from the water quality lab, students will design a solution to decrease erosion in the field shown in the photo and a means of monitoring that solution to evaluate its effectiveness.	

9.	Guiding question: How do regenerative agriculture practices reduce climate change?	Estimated time: Three 50 minutes periods
	1. Students make a claim answering the question and then use the above activities to provide evidence to support the claim. 2. Students choose a piece of land either outside their school or home and design a method to increase the carbon content of the soil on that piece of land. Their design would include soil's role in storing carbon, how that carbon gets to the soil, and how they will measure whether their design was successful.	

10.	Possible next steps/off-ramps/actions:	
	• Students explore career opportunities in Careers in Agriculture and Natural Resources	

	• Future of Agriculture resource focuses on new careers in agriculture • Crop wheat from soil bottles and spread all three soils to dry thoroughly. Burn off the organics from the three dried soils. Quantify the % organic (Carbon) from each sample (this will take a substantial amount of time.) • Soil is a living entity and all living things contain organic and inorganic material. You can burn off organic (Carbon) from a variety of pre-dried tissues; carrots, potato, watermelon,... and quantify it also. What is left after burning are inorganic materials (minerals) • Spend some time talking about Washington state crops and where they are grown.

11.	**Post Assessment:**	Estimated time: 30 minutes
	MS-Regenerative Ag Post-Assessment **MS-Regenerative Ag Assessment Rubric**	

Teacher Resources

THE SOIL STORY by Kiss The Ground, a middle school curriculum

OER Tracker

Pacific Education Institute would like to acknowledge and thank the writing team for their work. The team included Rebecca Hansen, Jill Fetcho, Randy James, Mike Nepean, Megan Rivard, Michelle Townshend, and Shelley Stromholt. In you have comments or questions please contact info@pacificeducationinstitute.org