“Solutions-Oriented Learning” Storyline

HS-Regenerative Agriculture

Storyline introduction and overview:

Students will be learning about the practices of regenerative agriculture and how regenerative agriculture is a solution to climate change. Embedded in the storyline are scientific concepts relating to carbon cycling and soil microbial activity. The storyline culminates with students creating an infographic that is intended for educating the community about regenerative agricultural practices.

NGSS Learning Progression for this Storyline: The high 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 high school performance expectations fit in a continuum of learning for your students.

Placemaking:

The Inland Northwest is home to Nez Perce and Palouse tribes that harvest plants and animals from the land. 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:

Show samples of soil from different fields OR, use images from Fields with different agriculture practices. Post the statement: Soils from fields that use different agricultural practices have a different impact on climate change.*

*Students may be confused at this point about how soil emits carbon dioxide AND is also a solution for climate change. Soil is a critical part of the carbon cycle.

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):

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

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Estimated time required to implement this storyline: 3 to 4 weeks

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Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles and theories. Design or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	**For HS-ESS3-4** **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.
Using Mathematical and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena or design solutions to support claims.	**For HS-LS2-4.** **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.	**Energy and Matter** Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9– 12 builds on K–8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**For HS-ESS3-6** **ESS3.D: Global Climate Change** Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**Systems and System Models** 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.

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Learning Session:	Materials List
2	Soil samples
5	Bromothymol Blue

1.	**Grounding Native Ways of Knowing**	Estimated time: 50 minutes
	Show Robin Kimmerer’s Ted Talk about how Indigenous people treat the harvesting of food [Reclaiming the Honorable Harvest]	

2.	**Examine phenomena: Soils from fields that use different agricultural practices have a different impact on climate change.**	Estimated time: 30 minutes
	Show samples of soil from different fields OR use [Fields with different agriculture practices]. Students may be confused at this point about how soil emits carbon dioxide AND is also a solution for climate change through carbon storage.	

3.	**Pre Assessment:**	Estimated time: 30 minutes
	HS-Regenerative Ag Pre-Assessment **HS-Regenerative Ag Assessment Rubric**	

4.	**Guiding question: What does agriculture look like in Washington state and how has it changed over time?**	Estimated time: Two 50 minute periods
	1. Students name their favorite food and trace back to the source of that food. Guide the discussion to local crops and the kind of food that is made from those crops. Ask students to write down as many crops grown in Washington as they can. Show Washington state infographics on crops. 2. Show Washington State Agriculture - approximately 3 minutes 3. What was the land like before agriculture; pre-pioneer? Although Indigenous peoples in the West did not practice traditional agriculture, their practices did care for the land that produced the food they gathered. The tribes in the northeastern part of the US did	

	practice traditional agriculture. Students read Native American Culture of the Northeast to discover what agriculture looked like pre-pioneer. Students explore WHY the "three sister" farming of squash, beans, and corn makes so much sense from a biological standpoint. Students complete the Three Sisters activity. 4. The Industrialization of Agriculture gives some background on the changes in agricultural practices and the reasons why. Students jigsaw this article and report to the class. 5. For students in Eastern Washington, Unit-2-Cropping-Systems-Sustainability ppt. Slides 23-24 have an activity that allows students to explore crops grown in the Inland Northwest. The file in the zip drive is called Commodity Cards.

5.	Guiding question: What is the role of soil in agriculture?	Estimated time: Three 50 minute period
	1. Discuss the term "ecosystem services" while showing Forests and Family Farms infographic. Then, direct students to Soils and Biodiversity infographic. Using these two resources, students list the ecosystem benefits that a field of _____________ (name a local crop) provide. Be sure that students consider the soil in the ecosystem services. 2. Students bring in soil samples and set up a closed system with a carbon dioxide indicator (Bromothymol Blue). Based on the color change of the indicator, students will make a claim about the living component of the soil. Use the protocol in Soil Microbial Lab (Soil Respiration). This lab requires a 24 hour period. The background information is a good introduction for students. 3. Students perform the lab in #2 again using different kinds of soils that the students bring in. Students collect data on the different rates of soil respiration and graph the results. Students make a claim about the amount of carbon in the soil using the data on soil respiration. Soil Respiration from Science Direct has a graphic that shows the relationship between carbon and respiration rate. 4. Students use Top Crop Interactive game (National Geographic) to explore how farming decisions impact the health of the soil and therefore the crops. To engage the students, make the game a competition and post the top scores. 5. Students complete this session by responding to the question "How does the growing world population influence farming decisions?" The future of food and agriculture: Trends and Challenges, Figure 14.1 and Challenge 1 on page 135 are good resources to inform discussion.	

6.	Guiding question: How does increasing soil health pose	Estimated time:

	solutions to climate change?	Three 50-minute periods
	1. Students complete the Earth Lab: Soil Carbon. Students watch short videos and discuss the information in small groups. Students learn how farmers can build carbon rich soil and how these practices connect to climate change. Review the Carbon cycle and the role of photosynthesis using the REACCH ppt Ecological Cycles, Carbon cycle, Photosynthesis, and Respiration ppt. 2. Students explore the difference between carbon store, carbon sequestration, and carbon emission. Students go to an area outside and sketch what they see. They then label their sketch with; a. C = carbon store b. S= carbon sequestration c. E= carbon emitting 3. Students design and carry out a lab that evaluates the impact of tilled versus low or no-till farming practices on soil carbon storage.	

7.	**Guiding question: What is regenerative ag and how is it a solution to climate change?**	Estimated time: 60 minutes
	Students begin to collect information for their Infographic at this point in the storyline. 1. Students read Project Drawdown: Reg ag 2. Show the videos from REACCH Unit 1 of the farmers in the NW starting to use no-till and the results. Farmer Case Studies 3. Students read Kiss the Ground Regenerative Agriculture and define the term “regenerative”. 4. Students research the 5 principles of regenerative agriculture using the resource Regen Ag: Solid Principles, Extraordinary Claims • McGuire presents an argument that Brown’s (Kiss the Ground) data is extraordinary. Based on the argument have students make a claim either refuting or supporting Brown’s data. Research current regenerative ag studies to find evidence to support the students’ claim. 5. This is an excellent place in the unit to arrange a local farm tour or to have an agriculture professional come to your class to speak about the new technologies 6. Students revisit the phenomenon and explain how soils from different fields that have	

	been farmed with different practices can have a different impact on climate change through carbon storage. *For students in the Inland Northwest, Precision Agriculture gives additional information on regenerative practices. Farm economics plays, and will play, a huge role in the application of precision agriculture and regenerative practices.

8.	Guiding question: What can I do to show how regenerative agriculture is a solution to climate change?	Estimated time: 50 minutes
	Final Cumulative Project Students create an infographic to inform the local community about the importance of regenerative agriculture practices in sequestering and storing carbon in the soil. The infographic will include the following information: ● The role of soil in carbon storage ● The practices of regenerative agriculture ● A description of how each practice increases the carbon stored in the soil ● A description of how Indigenous people care and have always cared for the land The link Infographics as a Creative Assessment provides students with samples, online tutorials, and the steps to create an infographic.	

9.	Possible next steps/off-ramps/actions:	Estimated time:
	● Students explore career opportunities in Careers in Agriculture and Natural Resources ● Future of Agriculture resource focuses on new careers in agriculture ● Soil microbes plating in a starch medium using iodine to observe the microbe activity	

10.	Post Assessment:	Estimated time: 50 minutes
	HS-Regenerative Ag Post Assessment HS-Regenerative Ag Assessment Rubric	

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Teacher Resources

[OER Tracker]

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