Agriculture connections

Focus questions	How are modern agricultural practices and technologies shaping food production, environmental quality, and sustainability?
Learning target	Students will research the benefits and potential risks of the modern tools used in agriculture.
Vocabulary	Seed/foliar treatments, tillage, precision agriculture

HS-ESS3 Earth and Human Activity

Performance expectation HS-ESS3-2 HS-ESS3-4	**Classroom connection:** Students evaluate various agriculture tools to determine how they impact natural ecosystems based on cost-benefit analysis (i.e. inputs: fertilizers, pesticides, tillage, equipment, and outputs: yield, soil health, water quality, resistance, etc) and suggest ways to reduce impacts of human activities on natural systems.

Science and engineering practices

Constructing Explanations and Designing Solutions	**Classroom connection:** Groups explain how these practices have changed agriculture and suggest future improvements or directions to increase sustainability.
Engaging in Argument from Evidence	**Classroom connection:** Students use credible sources, evaluate claims, and communicate findings via posters and presentations.

Disciplinary core ideas

ESS3.C: Human Impacts on Earth Systems	**Classroom connection:** Students discover that all of these tools have benefits, and there may also be costs to ecosystems if they are overused or not used (i.e., tillage, chemical inputs, and equipment can both harm and help ecosystems).
ESS3.A: Natural resources	**Classroom connection:** Students understand that successful agricultural systems depend on soil, water, nutrients, and energy.

Cross-cutting concepts

Stability and Change **Cause and Effect**	**Classroom connection:** Students consider how long-term use of these practices affects soil health, water systems, and farm longevity.
Influence of Science, Engineering, and Technology on Society and the Natural World	**Classroom connection:** Students evaluate the effects of technological improvements and suggest additional modifications to protect ecosystems.

Background

Modern agriculture has many tools that come with benefits but also risks. Farmers use **seed and foliar treatments** to protect their crops. These treatments include helpful microbes, insecticides to kill bugs, and herbicides to kill weeds. While these treatments help protect crops and increase how much food farmers can grow, scientists worry about some problems they can cause. Pests might become resistant to these chemicals over time, which means the treatments stop working. The chemicals can also harm helpful insects and animals that farmers don't want to hurt, and they can pollute the soil and water.

Farmers also practice **nutrient management** to feed their crops the right amount of fertilizer. They use prescriptions prepared by agronomists for fertilizers and manure to give plants exactly what they need to grow. This careful planning helps reduce waste so that extra nutrients don't wash into rivers and streams or escape into the air.

Different **tillage practices** help farmers prepare their soil for planting. No-till farming means not disturbing the soil at all, while reduced till and vertical tillage disturb it just a little bit. Conventional tillage involves turning over the soil completely. Each method has trade-offs. Some methods control weeds better and create better conditions for seeds, but they might cause more soil erosion. Other methods protect the soil better and keep it healthier.

Soil health strategies help farmers build stronger, more resilient soil. By using cover crops, rotating different crops each season, and improving soil structure, farmers can create healthier soils that need fewer chemical inputs and can better handle droughts and heavy rains.

Precision agriculture technologies use computers and GPS to help farmers work more efficiently. GPS-guided tractors drive themselves in perfectly straight rows, variable-rate equipment applies different amounts of seeds or fertilizer to different parts of a field, yield monitors track how much crop each area produces, and drones fly overhead to spot problems. These technologies help farmers avoid waste and grow more food.

Water quality management practices protect rivers, lakes, and groundwater from pollution. Farmers use better tillage methods, time their fertilizer applications carefully, plant cover crops, create buffer strips along waterways, and manage irrigation systems wisely to keep nutrients and chemicals out of the water.

Equipment innovation has given farmers access to modern planters, sprayers, combines, and drones that can do precision work. These machines help farmers be more accurate and efficient, but they are expensive to buy and require farmers to learn new skills and technology.

Sustainability practices focus on taking care of the land for the future. Regenerative farming rebuilds soil health, carbon sequestration stores carbon in the soil to fight climate change, and pollinator support protects bees and butterflies. These practices help ensure that farms stay productive and ecosystems stay healthy for many years to come.

Prior knowledge

In order to successfully complete this activity, students should:

- Understand basic nutrient cycles (nitrogen, phosphorus) and ecosystem interactions.
- Recognize that human activities can both positively and negatively affect environments.
- Have some experience reading informational texts and interpreting simple graphs/maps.

Suggested timing

- 2 class periods (45–55 minutes each), plus optional extension

Materials

- *Agriculture connections* student worksheet (one per student)
- Chart/poster paper and markers for each group
- Devices or printed resources for research
- Projector or document camera for student presentations

Teacher preparation

1. Review the background and determine how to define the eight categories.
2. Find a list of credible sources or review the process for determining a credible resource for agriculture information (.edu sites, USDA, FDA, .org sites without a bias, etc.).

Procedure

Day 1: Engage and explore (45–55 min)

1. Introduce the phenomenon (local agriculture productivity vs. sustainability concerns).
2. Pose the focus question.
3. Briefly define the eight categories and assign one to each group.
4. Review expectations for credible sources and discuss the worksheet.
5. Divide students into groups; allow group research time: students gather information, fill in key terms, key points, and list positives/negatives for their category.

Day 2: Explain, connect, and evaluate (45–55 min)

1. Groups finalize posters and prepare brief presentations (3–5 minutes each).
2. Each group presents. Audience members complete the “Notes from Other Groups’ Presentations” section of their worksheet.
3. Whole-class debrief:
    a. Discuss common themes across categories (e.g., tradeoffs between yield and environmental impact).
    b. Revisit focus question and connect to PEs, SEP, DCI, and CCC.
4. Exit ticket or self-assessment: students reflect on how agricultural technology can both solve and create environmental challenges.

Differentiation

Other ways to connect with students with various needs:

- **Local community:**
    - Guest speakers, field experiences, or community action
    - Schedule virtual Q&A sessions with professionals from local ag cooperatives or soil conservation districts.
    - Connect with nearby university agricultural programs or extension offices for expertise.
    - Lead field trips to local farms or urban gardening centers.
    - Partner with local soil and water conservation districts for restoration projects.

    - Research agricultural traditions and practices of Indigenous peoples in your area.
- **Students with special needs (auditory/visual/language/reading):**
    - ELL/multilingual learners:
        - Pre-teach key vocabulary with visual supports (photos of tractors, cover crops, tillage methods).
        - Share videos with captions showing agricultural practices in action.
        - Allow oral responses recorded on video instead of written work; encourage diagrams.
    - Reading support:
        - Use text-to-speech software for digital resources.
        - Provide graphic organizers (T-charts, Venn diagrams, cause/effect chains).
        - Give students question stems to guide their reading: *"What is this practice?" "Why do farmers use it?" "What are the good things about it?" "What problems might it cause?"*
        - Provide checklists for each phase of the project.
        - Provide bookmarked websites at appropriate reading levels.
        - Offer a poster template with clearly-labeled sections and space requirements.
- **Extra Support:** Scaffold the research process by providing guided practice, a curated list of 3–5 pre-approved sources per category, and a research guide with specific questions to answer:
    - "What is [your category]?"
    - "Name 2–3 specific examples of [your category]."
    - "How does this help farmers?"
    - "What problems could this cause for the environment?"
    - Provide sentence starters for a student note sheet:
    - "The main purpose of _____ is to _____."
    - "One benefit is _____ because _____."
    - "One concern is _____ which could lead to _____."
- **Extensions:**
    - Compare two competing technologies (e.g., conventional tillage vs. no-till) using quantitative data.
    - Create cost-benefit analyses with actual economic data.
    - Compare agricultural practices in different climate zones or countries.
    - Analyze how agricultural practices must adapt to climate change in various regions.
    - Examine the role of government policies and subsidies in promoting certain practices.
    - Map the interconnections between all 8 categories showing how they affect each other, either by vocabulary or ecosystem interaction.
    - Analyze feedback loops (positive and negative) in agricultural systems.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Use of evidence and reasoning (SEP)	Statements are mostly opinions with limited or vague evidence.	Uses information from credible sources to support positives/ negatives and claims.	Integrates multiple sources, clearly explains tradeoffs, and justifies claims with strong reasoning.
Systems and cause–effect thinking (CCC)	Mentions effects but does not clearly connect to causes or broader system.	Describes cause/ effect relationships and shows how the category fits in the farm system.	Clearly maps out system interactions and long-term stability/change, including unintended consequences.
Communication and collaboration (SEP)	Poster or presentation is incomplete or unclear; uneven group participation.	Presentation is organized and legible; presentation is clear; all members contribute.	Highly engaging visual and oral presentation; group collaborates smoothly and responds thoughtfully to questions.

Rubric for self-assessment

Skill	Yes	No	Unsure
I can describe at least one modern agricultural practice and explain both a positive and a negative impact it can have.			
I can explain how my assigned category connects to soil health, water quality, or sustainability.			
I can identify one way agricultural technology might change in the future to be more sustainable.			