Module 1 – Foundations of Sustainable Agri-Food Systems & Circular Economy

Overview and Standards Alignment

Module Overview

Foundations of Sustainable Agri-Food Systems & the Circular Economy

This module introduces students to the core concepts of sustainable agri-food systems and the principles of the circular economy in agriculture. Through three lessons, students examine why our food system needs to change, explore new models for production that convert waste into resources, and consider actions at various levels (personal, technological, and policy) to build a more sustainable future. Real-world challenges are used to highlight the stakes – for example, agriculture already uses almost half of the world's vegetated land and generates about a quarter of global greenhouse gas emissions. By the end of Module 1, students will understand what a "sustainable food system" means, recognize key global issues (climate change, resource depletion, waste) affecting food security, and be equipped with foundational ideas of how circular and agroecological approaches can transform food production for the better. The module emphasizes systems thinking, inquiry-based learning, and hope through solutions, laying a foundation for all subsequent modules on sustainable agri-food systems.

Standards Alignment:

Next Generation Science Standards (NGSS) – Performance Expectations:

Disciplinary Core Ideas (DCIs) – This module ties into several DCIs by contextualizing science concepts within food systems:

- **HS-ESS3-1 Earth and Human Activity:** 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 Earth and Human Activity:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- **HS-ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- **HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems.
- **ESS3.A: Natural Resources** – Food systems rely on natural resources (land, water, energy). Overuse and mismanagement create sustainability challenges.
- **ESS3.C: Human Impacts on Earth Systems** – Agriculture contributes to greenhouse gas emissions, biodiversity loss, and nutrient pollution, but sustainable practices can mitigate impacts.
- **LS2.B: Cycles of Matter and Energy in Ecosystems** – Circular economy and agroecological practices illustrate nutrient cycling and energy flow in ecosystems.
- **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** – Students examine how sustainable practices improve system resilience.
- **ETS1.B: Developing Possible Solutions** – Students engage in solution design, evaluating innovations and policies that reduce agricultural impacts.

Science and Engineering Practices (SEPs):

- **Asking Questions and Defining Problems:** e.g. "What makes a food system unsustainable?" or "How might we reuse this waste product?" are guiding questions that students tackle through inquiry and activities.
- **Analyzing and Interpreting Data:** Students work with data on carbon emissions of foods, global resource use charts, and possibly school waste audit data. They interpret graphs (like a planetary boundaries radar chart or diet carbon bar graph) to draw conclusions.
- **Constructing Explanations and Designing Solutions:** Core to Lesson B and C – students explain differences between farming models and actively design solutions (mini design sprint on packaging, entrepreneurship pitches, etc.).
- **Engaging in Argument from Evidence:** Students defend their chosen sustainability actions or waste-to-resource proposals using evidence (data from carbon calculations, examples from case

studies). Class discussions (e.g. myth-busting the need to double food production) also require evidence-based argumentation.
- **Using Mathematics and Computational Thinking:** The carbon footprint calculations and possibly quantifying school waste in Lesson C involve mathematical reasoning. Students compute differences in CO_2e or track waste weights, linking numbers to sustainability outcomes

Crosscutting Concepts (CCCs):

- **Systems and System Models:** The food system is presented as a complex system. Students map how components (production, consumption, waste) interrelate. By mapping a meal to SDGs, they engage in system modeling at a high level.
- **Energy and Matter:** Flows of energy and cycling of matter are central, especially in Lesson B. Concepts like "nutrient loop", "embedded energy in food", and "closing the loop" illustrate matter and energy conservation in redesigned systems.
- **Cause and Effect:** Students examine cause-effect relationships, such as how certain farming practices cause environmental impacts, and how specific changes (e.g. using compost instead of chemical fertilizer) can reduce those impacts.
- **Stability and Change:** The idea of planetary boundaries conveys thresholds for stability. Students discuss what changes when those thresholds are exceeded (instability in climate, ecosystems) and explore changes needed in human behavior to restore balance.
- **Influence of Science, Engineering, and Technology on Society and the Natural World:** By highlighting sustainable innovations and policy, the module shows how science and engineering solutions (like new farming techniques or recycling technologies) can positively influence society and the environment.

California CTE Standards (Agriculture & Natural Resources Pathway):

Module 1 reinforces Foundation Standards from the Agriculture & Natural Resources (ANR) sector framework by embedding sustainability into real-world agricultural contexts:

- **Foundation Standard 5:** Problem Solving and Critical Thinking – Students investigate issues such as food waste, land/water use, and resource efficiency, then evaluate and design circular solutions (e.g., planetary boundary mapping, food system redesign activities).
- **Foundation Standard 9:** Leadership and Teamwork – Collaborative activities (meal sustainability mapping, group solution presentations) strengthen teamwork, peer dialogue, and applied problem-solving.
- **Foundation Standard 11:** Demonstration and Application – Learners apply environmental science concepts (nutrient cycling, climate impacts, biodiversity) to practical challenges like Jenga-based ecological threshold simulations and carbon footprint experiments.
- **Sustainable Agriculture Pathway Standard:** Module 1 cultivates student capacity to "understand the environmental, social, and economic impacts of decisions" in farming systems by linking planetary boundaries to agricultural practices and trade-offs.
- **Innovation & Resource Management:** By comparing waste reduction strategies and evaluating resource trade-offs, students assess innovations in agriculture and practice evidence-based resource management.

UC A–G "D" Lab Science Alignment:

This module is designed to meet UC/CSU A–G "D" Laboratory Science requirements as part of an approved science course.

- **Inquiry & Hands-On Activities:** At least 20% of instructional time is teacher-supervised lab-style work, including planetary boundary mapping, a Jenga-based ecological thresholds simulation, carbon footprint experiments, and micro-ecosystem design.
- **Scientific Practices:** Students pose scientific questions, design investigations, collect and analyze quantitative data (e.g., CO_2e calculations, waste tracking), and draw evidence-based conclusions, consistent with UC's emphasis on inquiry and NGSS practices.

- **Interdisciplinary Science:** Module 1 integrates biology (ecosystem resilience, biodiversity), earth science (resource use, climate change), and chemistry (nutrient cycles, composting), ensuring breadth and depth of scientific foundations.
- **Rigor & Depth:** Reflection exercises, peer assessments, and group solution design activities emphasize higher-order thinking and science communication skills, aligning with the requirement for rigorous, college-prep laboratory science.

Content supports NGSS disciplinary core ideas ESS3 (Human Impacts on Earth Systems) and LS2 (Ecosystem Dynamics, Interactions, and Biodiversity), while also engaging students in cross-cutting science and engineering practices such as modeling, data analysis, and designing solutions.