Module 6: Agri-Systems Across the Urban-Rural Gradient
Lesson Plan Overview and Standards Alignment

Agri-Systems Across the Urban–Rural Gradient
This module explores how agricultural systems vary across an urban-to-rural gradient, from rooftop gardens and container farming in dense cities to large-scale orchards and open-field production in rural areas. Students examine how land use, productivity, water and energy efficiency, and access to resources differ depending on location. Through systems thinking and quantitative analysis, they evaluate the trade-offs and sustainability strategies unique to each setting. The module emphasizes climate-smart innovations and encourages learners to design solutions that improve sustainability, equity, and resource efficiency across spatial zones.

Next Generation Science Standards (NGSS) – Performance Expectations:
- HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, the occurrence of natural hazards, and changes in climate have influenced human activity.
- 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.
- HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-ETS1-3 – Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Disciplinary Core Ideas (DCIs):
- ESS3.C – Human Impacts on Earth Systems: This module examines how agriculture, land use, and resource efficiency vary by region and impact ecosystems.
- LS2.A – Interdependent Relationships in Ecosystems: Students analyze how farms function as interrelated systems with resource flows and dependencies.
- ETS1.A – Defining and Delimiting Engineering Problems: Students engage in identifying challenges and constraints of food production in various environments.

Science and Engineering Practices (SEPs):
- Analyzing and Interpreting Data – Students calculate and interpret efficiency metrics and resource flows.
- Designing Solutions – Students propose agricultural systems tailored to spatial zones with measurable goals.
- Engaging in Argument from Evidence – Learners use data to support design choices and policy recommendations.

Crosscutting Concepts (CCCs):
- **Cause and Effect** – Students connect spatial decisions to outcomes in emissions, food miles, and efficiency.
- **Systems and System Models** – Agriculture is viewed as a dynamic system with interacting inputs, outputs, and feedback loops.
- **Energy and Matter** – Students trace flows of energy, water, and biomass through designed systems to evaluate sustainability.

California CTE Standards – Agriculture & Natural Resources Pathway
Module 6 reinforces Foundation Standards from the Agriculture & Natural Resources (ANR) sector framework by applying systems thinking to food production across urban, peri-urban, and rural zones:

- Foundation Standard 5: Problem Solving and Critical Thinking – Students evaluate trade-offs in land use, food miles, and resource efficiency across urban-to-rural systems. They apply quantitative tools (e.g., liters per kilogram, biomass per kWh) to assess and design sustainable food layouts.
- Foundation Standard 9: Leadership and Teamwork – Group projects such as designing hybrid food production systems and presenting climate-smart solutions emphasize collaboration, communication, and applied reasoning.
- Foundation Standard 11: Demonstration and Application – Learners apply environmental science principles (energy/water cycles, sustainability metrics, biodiversity impacts) to hands-on challenges like urban vs. rural system design and efficiency comparisons.
- Sustainable Agriculture Pathway Standard – Module 6 develops student capacity to "understand the environmental, social, and economic impacts of decisions" in food systems by analyzing zone-based trade-offs and proposing innovative solutions that increase resilience and equity.
- Innovation & Resource Management – By comparing rooftop gardens, hydroponics, and closed-loop resource reuse with large-scale rural practices, students assess climate-smart innovations and apply evidence-based resource management across spatial contexts.

UC A–G "D" Laboratory Science Requirements

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 mapping urban-to-rural food systems, analyzing water and energy efficiency datasets, designing hybrid closed-loop systems, and testing trade-offs in simulated farm models.
- **Scientific Practices** – Students pose scientific questions about sustainability (e.g., "Which system minimizes water per yield?"), collect and analyze data (resource efficiency calculations, drone imagery overlays), and construct evidence-based recommendations, consistent with UC's emphasis on NGSS practices.
- **Interdisciplinary Science** – Module 6 integrates biology (ecosystem dependencies, biodiversity in farm systems), earth science (climate impacts, resource availability, land use), and environmental/engineering science (designing efficient agro-systems, applying metrics), ensuring scientific breadth and rigor.
- **Rigor & Depth** – Reflection exercises, comparative analyses, and collaborative system design projects develop higher-order skills in quantitative reasoning, sustainability assessment, and science communication, aligning with the requirement for rigorous, college-prep laboratory science.

NGSS Alignment: Module 6 supports core ideas in ESS3 (Human Impacts on Earth Systems), LS2 (Interdependent Relationships in Ecosystems), and ETS1 (Engineering Design), while engaging students in crosscutting practices of modeling, systems thinking, data analysis, and designing solutions.

Under UC A-G requirements for Laboratory Science ("D"):

- Students must take 2 years of laboratory science, covering at least two of these: biology, chemistry, and physics. One year may be Earth or space science
- NGSS-based courses, such as those integrating biology with earth & space sciences, or environmental science courses aligned to NGSS, can satisfy the area D requirement