Module 6: Agri-Systems Across the City-Rural Gradient
Think Pair Share: Scenario Optimization

Lesson C
Grouping: Pairs or small groups (3–4)
Time: 25-30 minutes

Materials:
- Printed worksheet or digital copy
- Pencils or pens
- Calculator (or spreadsheet)
- Poster paper or whiteboard (for group sharing, optional)

Objective:
Design a 1-acre sustainable farm by choosing components from the menu below.
Your goal: maximize food yield while staying within these resource limits:
- Water Budget: 20,000 L per season
- Energy Budget: 2,500 kWh per season

This challenge will help you practice systems thinking, efficiency trade-offs, and sustainability-focused farm design.

Instructions:
1. **Plan Your Farm**
    a. Choose components from the farm **menu**.
    b. You may reuse items (e.g., 2x lettuce beds = 0.5 acre).
    c. Total area cannot exceed 1 acre.
2. **Do the Math**
    a. Record **acreage, water, energy, and yield** for each component.
    b. Add totals for your design.
    c. Check: Do not exceed 20,000 L or 2,500 kWh.
3. **Optimize Your Design**
    a. If over budget, revise choices.
    b. Aim for **high yield per unit of water/energy**.
4. **Calculate Efficiency**
    a. **Water-Use Efficiency = Total Water ÷ Total Yield (L/kg)**
    b. **Energy-Use Efficiency = Total Energy ÷ Total Yield (kWh/kg)**
5. **Prepare Your Pitch**
    a. Present your design to peers in 2–3 minutes.
    b. Include: why your system is sustainable, efficiency compared to “business as usual,” and any trade-offs you faced.

You may use the internet to explore additional data sources like USDA, FAO, or local extension services. This can help you validate your numbers and add credibility to your final pitch.

Skills You’ll Use:
- Data organization and unit comparison
- Collaborative problem solving
- Sustainability system design
- Mathematical reasoning with real-world data
- Understanding efficiency trade-offs

Your task:

Plan Your Farm

- Use the 1-acre “menu” of farm components. Select crops and systems that fit within the 20,000 L water budget and 2,500 kWh energy budget. You can repeat components if you want (e.g., 2 lettuce beds = 0.5 acre).

Do the Math

- Add up total water, total energy, and total yield for your design. Make sure you do not exceed your limits. Calculate efficiency: Water-Use Efficiency = Total Water ÷ Total Yield Energy-Use Efficiency = Total Energy ÷ Total Yield

Optimize Your Design

- If you’re over budget, revise your choices. Try to balance high yield with smart resource
- use.

Prepare Your Pitch

- Create a short explanation of your design: What crops/systems you chose, why your design is sustainable, how your efficiency compares to “business as usual” farming (Optional) Sketch or show your design on poster paper or a whiteboard.

System Component Menu:

Component	Acreage	Water Use	Energy Use	Yield	Notes
Drip-Irrigated Lettuce	0.25 ac	2,000 L	150 kWh	200 kg	Low water, high efficiency
Hydroponic Greens	0.25 ac	1,500 L	300 kWh	180 kg	Higher energy, very efficient
Outdoor Soil Veggies	0.25 ac	3,000 L	120 kWh	150 kg	Basic but reliable
Vertical Indoor Greens	0.25 ac	1,200 L	600 kWh	240 kg	High-tech yield
Solar Irrigation	0.25 ac	—	-250 kWh	0	Offsets other energy
Rain Catchment	0.25 ac	-1,000 L	0	0	Offsets water use
Fruit Trees	0.5 ac	6,000 L	200 kWh	350 kg	Seasonal, high reward
Greenhouse Peppers	0.25 ac	2,500 L	400 kWh	220 kg	Moderate efficiency
Polyculture Bed	0.25 ac	2,800 L	200 kWh	260 kg	Diverse crops, good yield

Design Planner:

Component	Acres	Water (L)	Energy (kWh)	Yield (kg)

Total:

Final Calculations:

- Total Yield: _____ kg
- Total Water: _____ L
- Total Energy: _____ kWh
- Water-Use Efficiency (L/kg): _____
- Energy-Use Efficiency (kWh/kg): _____

Sketch or Layout Map (Optional):

Use this space to draw a simple map of your farm layout. Label each component and how much space it uses. You can divide your acre into quarters (0.25 ac), halves (0.5 ac), etc.

Reflection: What component gave you the highest yield per unit of water? Energy? What trade-offs did you make between water and energy? Could your system support a community or market goals? If you had to lower your carbon footprint, what would you change?

Optional: Explore Other Metrics

Experts use many ways to measure efficiency. Some examples:

- CWP (kg/m³): Yield per total water
- IWU: Incremental yield from added irrigation
- Intrinsic WUE: Plant-level water use efficiency
- Energy Use Index (EUI): kWh per hectare or per kg
- Carbon Footprint: CO_2 from energy use
- Energy Balance: Input vs. output energy