



## Module 6: Agri-Systems Across the City-Rural Gradient

### Student Notes

These notes are designed to help you understand the main ideas, vocabulary, and concepts from Module 6. Each section matches the learning outcomes and activities discussed in class. Use these notes to study for quizzes, complete projects, and participate in discussions.

**Note:** Vocabulary words marked with an asterisk (\*) are required knowledge. Unmarked words are included for personal enrichment.

#### Lesson A – From the Balcony to Back-Forty

##### Learning Outcomes:

- Define and distinguish urban, peri-urban, and rural food-system contexts, and describe how food miles, land cost, and labor differ across the gradient. (Remember/Understand)
- Classify and analyze farming systems from visual/text examples, noting trade-offs in productivity, sustainability, and logistics. (Apply/Analyze)
- Design and justify a modified city-region food layout that optimizes space and labor under real-world constraints. (Create/Evaluate)

##### Key Concepts:

- **Urban–Peri-Urban–Rural Gradient**
- Urban = dense cities with rooftop/container farms; Peri-Urban = fringe zones with greenhouse belts; Rural = large orchards and field farms
- **Land Costs vs. Food Miles**
- Urban farms → expensive land but low food miles; Rural farms → cheap land but long transport distances; Peri-Urban = middle ground
- **Labor Models**
- Urban: volunteer or community labor.
- Peri-Urban: family or small crews with modest pay.
- Rural: seasonal/migrant labor, heavy mechanization, often low wages
- **California Spotlight**
- Rooftop farms in LA/SF, greenhouse belts around Salinas/Ventura, and orchards in Central Valley show how all zones fit together
- **Planning Tools**
- Tools like the Transect and SmartCode (from New Urbanism) help design city–region food layouts that optimize space and logistics

##### Think About:

- What are the environmental trade-offs of growing lettuce on a rooftop vs. a distant rural farm?
- Please consider: How do zoning policies and housing density impact food production?
- How can city planning better support peri-urban farms?

##### Important Vocabulary to understand and use:

- A. Agri-System
- B. Urban Agriculture\*
- C. Peri-Urban\*
- D. Rural Agriculture\*
- E. Food Desert
- F. Food Miles
- G. Food Sovereignty
- H. Zoning

## Vocabulary in Context- Fill in the Blanks using Word Bank

A system composed of the physical environment, human labor, and technology used to grow, process, and deliver food \_\_\_\_\_

The area just outside city boundaries where urban and rural land uses mix \_\_\_\_\_

Laws and regulations that govern land use, including what kinds of farming can take place in different areas \_\_\_\_\_

Farming or gardening within city environments. Often small-scale and used for local consumption or education \_\_\_\_\_

A region where people have limited access to affordable and nutritious food \_\_\_\_\_

The distance food travels from where it is produced to where it is consumed \_\_\_\_\_

Traditional farming that takes place in the countryside, usually on larger plots of land \_\_\_\_\_

The right of people to have access to healthy and culturally appropriate food produced through ecologically sound and sustainable methods \_\_\_\_\_

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### Self-Test Using Word Bank:

1. The three types of urban-rural zones in agri-systems are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ zones.
2. Urban agriculture often includes growing food on \_\_\_\_\_, balconies, and community lots.
3. A key benefit of peri-urban agriculture is that it often supplies \_\_\_\_\_ food to nearby cities.
4. Rural agriculture typically involves \_\_\_\_\_-scale production and longer food distribution distances.
5. "Food miles" refers to the \_\_\_\_\_ food travels from farm to consumer.
6. A key trade-off in urban agriculture is \_\_\_\_\_ productivity versus high sustainability and community benefit.
7. Rooftop farms help reduce the \_\_\_\_\_ effect in cities by adding green space.
8. Peri-urban farms are often located at the \_\_\_\_\_ of cities and can integrate with both urban demand and rural land access.

9. One challenge of rural farms near urban markets is limited access to \_\_\_\_\_ and longer transportation distances.
10. \_\_\_\_\_ agriculture can help reduce food miles and greenhouse gas emissions by producing food closer to where people live.

### Reflection Questions

How can farms in urban, peri-urban, and rural areas work together to reduce food miles and make sure everyone has access to fresh food, while also protecting the environment and using land wisely?

If you were planning a new food farm operation, how would you delegate where to spend more money? For land that is closer to your customers to be able to reach your customers easily?, or Land that is cheap far away, but spends more on transportation?

### Lesson B – Climate-Smart Growing Spaces

Learning Outcomes:

- Identify and explain climate-smart techniques used in each zone (urban, peri-urban, rural) and how they conserve water, reuse waste, or minimize energy. (Remember/Understand)
- Match and deconstruct techniques to zone-specific conditions, showing how they form circular resource loops. (Apply/Analyze)
- Design and defend a hybrid system that integrates strategies from at least two zones to close resource loops and increase long-term sustainability. (Create/Evaluate)

### Key Concepts:

Climate-Smart Agriculture (CSA)

- Defined as practices that increase productivity, adapt to climate change, and reduce GHG emissions at the same time
- Increase productivity (more food with fewer inputs).
- Enhance resilience (withstand droughts, floods, heat).
- Reduce emissions (lower CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O from fertilizers, fuel, and transport)

Urban Closed-Loop Farms

- Use wicking beds, compost, and food scraps to recycle water and nutrients, cutting waste and water use by up to 40%

Peri-Urban Compost-Heat Greenhouses

- Divert city food waste into compost-generated heat and stormwater irrigation, reducing fossil fuel heating and water demand

Rural Smart Irrigation

- Tech like soil-moisture probes, wind-powered pumps, and pulse drip irrigation reduce diesel use and save ~30% water

Seeing the Loops

- Urban sack gardens recycle rooftop water & scraps → greens. Peri-Urban greenhouse clusters use compost heat & biochar loops. Rural wind-powered citrus farms return prunings as biochar → soil health

### Think About:

- Which system (urban, peri-urban, rural) do you think has the most potential to scale?
- What trade-offs exist between high-tech systems and affordability?
- How can communities prevent green gentrification or land speculation?
- How could tech from one zone transfer to another (ex: wind-powered pumps in peri-urban)?

### Important Vocabulary to understand and use:

- A. Climate-Smart Agriculture (CSA)
- B. Wicking Bed

- C. NFT (Nutrient Film Technique)
- D. Compost-Heat Greenhouse
- E. Pulse Drip Irrigation\*
- F. Soil Moisture Probe\*
- G. Variable-Frequency Drive (VFD)
- H. Circular Agriculture
- I. Biochar
- J. Food Miles
- K. Gentrification
- L. Digital Divide

**Vocabulary in Context- Fill in the Blanks using Word Bank**

Farming practices that increase productivity, improve climate resilience, and lower emissions \_\_\_\_\_

A hydroponic system where a thin film of water carrying nutrients flows over plant roots \_\_\_\_\_

Short, frequent watering cycles that reduce water loss and improve efficiency \_\_\_\_\_

A garden bed that uses capillary action to pull water from a reservoir below the soil \_\_\_\_\_

A greenhouse heated using the warmth generated by decomposing organic matter nearby \_\_\_\_\_

A farming approach where waste is reused as input (fertilizer, energy, water), mimicking natural ecosystems \_\_\_\_\_

Charcoal-like substance made from organic waste that improves soil and stores carbon \_\_\_\_\_

The distance food travels from farm to table; fewer miles means lower emissions \_\_\_\_\_

When urban development raises property values, often displacing existing residents or farmers \_\_\_\_\_

A pump controller that adjusts water flow based on real-time needs, saving energy and water \_\_\_\_\_

A sensor that detects how much water is available in the soil for plants \_\_\_\_\_

The gap in access to technology between well-resourced and under-resourced communities \_\_\_\_\_

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**Self-Test Using Word Bank:**

1. \_\_\_\_\_ farming reuses food scraps and wicking beds to grow crops in cities.
2. Peri-urban greenhouses use \_\_\_\_\_ piles to passively heat crops and save energy.
3. \_\_\_\_\_ irrigation systems water plants only when soil moisture reaches stress levels.
4. Wind-powered pumps and VFDs eliminate \_\_\_\_\_ use in rural irrigation.
5. Circular systems aim to close resource \_\_\_\_\_ by reusing waste as inputs.
6. The hydroponic method where nutrients flow over roots in a thin stream is called \_\_\_\_\_.
7. \_\_\_\_\_ is a carbon-rich soil additive made from burned crop waste.

8. One challenge of CSA in urban zones is rising land prices due to \_\_\_\_\_.

### Reflection Questions

How can Climate-Smart Agriculture (CSA) be used in different areas (urban, peri-urban, and rural) to grow food sustainably, and what challenges do communities face in making these systems fair and affordable for everyone?

Think about our own community. If we set up community composts, and collected food scraps for a rooftop greenhouse, which technology—biofilters, UV treatment, or heat recovery—would you prioritize first, and why? How would it help make the system safe and productive?

### Lesson C – Tech & Metrics That Matter

Learning Outcomes:

- Define and explain key efficiency metrics (e.g., L/kg, biomass per kWh, input–output ratio) and their purpose. (Remember/Understand)
- Calculate and interpret resource-use metrics (e.g., water per yield) from provided or classroom data to compare systems. (Apply/Analyze)
- Recommend and justify a food production model using sustainability metrics, clearly defending trade-offs and resource constraints. (Evaluate/Create)

### Key Concepts:

Why Metrics Matter

- Metrics reveal true efficiency, guide design and investment, and allow fair comparisons across urban, peri-urban, and rural systems

Water Use Efficiency (L/kg)

- Hydroponic lettuce needs ~25 L/kg vs. ~100 L/kg for soil-grown lettuce. Hydro saves water but often uses more energy

Energy Efficiency (Biomass per kWh)

- Vertical LED farms = high yields but high energy use.
- Field crops = low energy input but dependent on weather

Trade-Offs & Balanced Design

- Low water use can raise energy costs. Best design depends on local context, balancing water, energy, yield, and resilience

Case Studies

- Container citrus: 90% less water with biochar + precision drip
- Smarter citrus: sensors + biochar soil + precision drip → ~90% water savings, higher biomass per kWh

Better, Not Perfect

- No one-size-fits-all system. Metrics help explain trade-offs and justify choices (maximize yield, cut water, reduce energy, or improve circularity)

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### Think About:

- Which metric would you prioritize — water use, energy use, or yield? Why?
- How can design improve light access and reduce energy in vertical systems?
- When comparing two systems, which metric is most fair or relevant?
- Could a high water-use system still be sustainable if powered by renewable energy?

### Important Vocabulary to understand and use:

- A. Liters per Kilogram (L/kg)
- B. Biomass per kWh
- C. Input-Output Ratio
- D. Hydroponics\*
- E. Vertical Farming

- F. Biochar
- G. Controlled Environment Agriculture (CEA)
- H. Electrical Conductivity (EC)
- I. pH

**Vocabulary in Context- Fill in the Blanks using Word Bank**

Water efficiency is often measured using \_\_\_\_\_, which tells us how much water is needed to grow each kilogram of food.

When designing a farming system, comparing how much you invest versus how much yield you get is known as analyzing the \_\_\_\_\_.

In cities, farms are being built upward — stacked in layers — using a technique known as \_\_\_\_\_ to save space and control growing conditions.

Some farmers aim to increase their \_\_\_\_\_ by producing more plant mass for every unit of energy consumed.

Growing plants in nutrient-rich water without any soil is a method called \_\_\_\_\_.

Because it allows for complete control over lighting, humidity, and nutrients, \_\_\_\_\_ is common in urban and high-tech agriculture settings.

Since certain nutrients are only available at specific acidity levels, monitoring the \_\_\_\_\_ of water near the roots is essential.

Adding \_\_\_\_\_ to soil can boost fertility, store carbon, and help retain nutrients.

Farmers use tools to measure \_\_\_\_\_, which helps them track the concentration of nutrients or salts in irrigation water.

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**Self-Test Using the Word Bank:**

1. A system that uses less water to grow more food is considered more \_\_\_\_\_ efficient.
2. Hydroponics can use up to \_\_\_\_\_% less water than soil-based systems.
3. The metric that shows how much food is produced per energy unit is called \_\_\_\_\_.

4. Top layers in a vertical farm get more light than lower layers due to \_\_\_\_\_ decay.
5. A \_\_\_\_\_ environment system uses tech to control light, nutrients, and water.
6. If a system uses 500 L of water and produces 25 kg of food, its water-use efficiency is \_\_\_\_\_ L/kg.
7. The Vidalakis Lab citrus system saved ~90% of \_\_\_\_\_ compared to traditional farming.
8. A farm with high yield but very high energy use would have low \_\_\_\_\_ per kWh.
9. There is no perfect system — the best choice depends on \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.

### Reflection Questions

How can we use efficiency metrics like water per kilogram and biomass per kilowatt-hour to decide which food systems are truly sustainable, and what trade-offs might we face when trying to save one resource, like water, but end up using more of another, like energy?

If you were designing a vertical farm, would you prioritize more produce with more resources or fewer produce for minimum resources? Why?