



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

### Hands-On Activity Rubric: Urban/Peri-Urban Light BioLab

#### Teacher Guide (Page 1-3) & Rubric (4-5) for Module 6 HOA B

##### Teacher Guidance:

- *Expected Trends:* Generally, **lettuce under blue light** may exhibit strong leaf development and potentially higher water-use efficiency (less water loss) compared to red light. **Lettuce under red light** often grows taller or more leggy, which might result in higher water use per growth gained. The **blue+red combination** tends to provide balanced growth (blue for compactness, red for size) and may show intermediate water-use efficiency. Use these trends as talking points – actual results may vary, and students should reason about any differences.
- *Class Data Sharing:* Since each group is focused on one light treatment, have groups share their results with the class. This allows students to compare all three light conditions. For example, one group's data might show the highest WUE under blue light, another under combined light – discussing these outcomes can deepen understanding.
- *Focus on Lettuce:* If any students refer to kale (from earlier versions of the activity), remind them that this trial was refocused on **lettuce only**. All comparisons and conclusions should center on differences in systems and lights, not plant species.
- *Why did it happen?* Encourage students to think about **why** they got the results they did. Prompt them with questions: “*What might blue light do to the plant’s pores (stomata) that could save water?*” “*Why would a hydroponic system potentially use water more efficiently than soil?*” This helps them connect data to mechanisms.
- *Quality of Recommendations:* When evaluating design proposals, look for realistic applications of their data. Great answers will not only choose the “best” conditions but also mention how to implement them (e.g., using captured rainwater in a hydroponic setup, using solar panels to power LED lights, etc.). Encourage creativity balanced with scientific reasoning.
- *Using the Rubric:* Provide students with feedback for each category above. Highlight what they did well (perhaps they were very precise in data collection or gave an innovative design idea) and point out how they could improve (maybe they didn’t consider a trade-off, or their data analysis missed a key point). This holistic feedback will help them in future investigations.

##### During the Activity:

Circulate and check measurements on Day 0 to ensure everyone’s on track (e.g., correct units, initial water amounts equal where needed). Encourage teams to talk out loud about what they see (“This soil is already dry after one day!” or “These leaves look thicker under blue light”) – this verbal processing helps them formulate design ideas later.

Prompt students to notice **leaf morphology under the different LED spectra**. For example, you might ask:

- “Under red light, do your lettuce leaves look longer or more stretched?”
- “Under blue light, do they look more compact or darker green?”
- “What about under the red+blue mix – does it look like a ‘middle ground’ between the two?”

If a plant shows extreme stress (e.g., wilting heavily under red light by Day 2–3), this is a learning moment: ask “What might this tell us about real gardens in heat or under different light conditions?” It’s okay if a plant “fails” – that evidence is valuable. Allow teams to make mitigations as part of design thinking (maybe they decide to give a little extra water, adjust light distance, or soften the intensity – have them note such tweaks as part of their design iteration).

**Time management:** The data collection each day should only take ~5–10 minutes. You can integrate it as a bell-ringer or exit ticket activity over the 3–5 days of measurements.

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### After the Activity (Discussion):

Use guiding questions to debrief. Example:

- “Which condition would you prefer for growing lettuce in July – and why?”
- “Under which light did your lettuce leaves look thickest or healthiest? How might that relate to water use?”

Expect answers linked to their experiment (e.g., “Indoors with hydroponics because we saw it used water efficiently and the plant didn’t wilt,” or “The red+blue mix gave us balanced, sturdy leaves and good growth.”).

Highlight diversity of designs: some groups may champion hydroponics with blue or red+blue LEDs; others might suggest a hybrid (soil beds with shade cloth and supplemental LEDs at night). Emphasize that in design thinking there’s no single “right” answer – it’s about **reasoning from evidence**, including both growth data and leaf traits.

Bring it back to the real world: mention how urban farming initiatives use hydroponics and tailored spectra in buildings to save water and optimize leaf quality, while peri-urban farms might use agroforestry, mulch, or shade structures for resilience. Students should see their small experiment’s connection to global practices of climate-smart agriculture and controlled-environment agriculture (CEA).

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### Common Results & Insights:

- **Hydroponic vs. Soil WUE:**  
Often, the hydroponic system yields a higher WUE (less water loss overall, since soil can lose water to runoff or evaporation). Many students find the hydro plant stays more consistently watered, whereas the soil plant might experience dry–wet cycles. Use this to discuss why **closed-loop** water systems matter in drought-prone regions.
- **Light Spectrum & Leaf Morphology (Blue vs. Red vs. Red+Blue):**  
Blue light often encourages **compact, sturdy growth** with slightly thicker, darker green leaves. Red light can spur **faster vertical growth** but may make plants look more “leggy,” with longer, thinner leaves that may wilt more easily. The **red+blue mix** often produces a more **balanced morphology** – not as short and compact as pure blue, not as stretched as pure red.

Ask students to connect what they saw to function:

- Thicker, more compact leaves may **lose water more slowly** and handle stress better.
- Very thin, elongated leaves may **dry out faster** and show stress sooner.  
Have them consider how this affects their climate-smart design choices (e.g., blue or red+blue for leafy greens in hot, dry cities).

- **Surprises:**

If some hydro setups grew algae, overheated, or showed root issues, those are great observations for design – maybe insulation, opaque reservoirs, or better aeration are needed.

If soil setups had fungal growth, pests, or uneven moisture, that can lead to IPM (Integrated Pest Management) and soil-management discussions. Embrace these tangents; they reinforce the interconnected nature of systems (light–water–soil–pests–energy).

## Integration with Lesson B Objectives:

- **Connect to Climate Resilience:**

Ensure students explicitly connect to climate resilience: ask “How would your design handle a drought? A heat wave? A week of cloudy weather?” in their presentations. Look for answers that mention things like water saving, shading, drainage, and spectrum choices (e.g., “We’d use blue+red LEDs indoors during heat waves because our data showed sturdy leaves and good water-use efficiency.”).

- **Tie Back to Circular Systems:**

Did anyone mention compost or runoff reuse? If not, ask who collected the runoff water – could it be used to water other plants (a simple loop)? How about plant waste – can it return to soil via composting or Bokashi? This solidifies the **circular economy mindset** and links back to Modules 1–2.

- **Connect to TPS Frame:**

Use the term “**Think-Pair-Share: Climate-Smart Strategy**” from the lesson framing to remind them this experiment feeds into a larger strategy session. For instance, after the lab, you might have them do a quick TPS where they:

- Share their design and key data with a partner,
- Compare leaf morphology and WUE outcomes under different spectra, and
- Combine the best ideas into a stronger, co-designed climate-smart system.

## Troubleshooting Tips:

- **Subtle Differences in 7–10 Days:**

If LEDs are too weak or the timeframe is short and differences are subtle, emphasize that even **not seeing a big change is data** – perhaps light color doesn’t hugely affect water use in that timeframe, or the plants were still in an early growth stage. Students can then lean more on hydro vs. soil differences and their qualitative notes on leaf morphology.

- **Messy Data / WUE Calculations:**

If a team’s data seems very off (e.g., negative growth, impossible WUE values), sit with them to review. Often it’s a unit mistake or a mis-recorded number. Use it as a learning moment for **data validation** – something real scientists do. Have them recalc WUE and interpret again.

- **Engagement & Purpose:**

Keep an eye on engagement: this activity blends concrete tasks with abstract planning. If a group is lost in the numbers, refocus them on the “why”:

“We’re measuring water, growth, and leaf traits so we can decide the best way to farm in future climates. Based on what you see, what would *you* do differently in a real rooftop garden or peri-urban farm?”

A quick real-world hook can reignite their sense of purpose.

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Finally, celebrate the innovative ideas your students come up with. Labtofarm’s philosophy is to “**empower students to be solutionaries.**” By the end of this activity, they should feel that, yes, even as students, they can design farm systems, choosing spectra, systems, and circular practices, that help fight climate challenges. Encourage them to carry that confidence forward into the rest of Module 6 and beyond.

### Grading Rubric for Module 6 HOA B:

Use the following expectations rubric to evaluate calculations, data collections, data analysis, short-response, short-essay, and design-based responses:

Criteria	Exemplary (4 pts)	Proficient (3 pts)	Developing (2 pts)	Beginning (1 pts)
Setup and Organization Neat, labeled, and correctly prepared experiment.	Hydroponic and soil+compost systems both set up correctly and labeled; assigned LED spectrum (Blue / Red / Blue+Red) applied correctly to both; starting water volumes measured accurately; safety with water/electricity followed; setup is neat and easy to follow.	Mostly correct setup with minor mistakes (labels a bit unclear, lights slightly mis-positioned, small inconsistencies in starting water); overall still usable.	Multiple errors in setup (e.g., missing labels, wrong light on one system, no runoff tray); organization is confusing and may affect results.	Setup not completed, unsafe, or unusable for data collection.
Data Collection All required measurements recorded with units.	All required measurements (height, leaf count, water added, runoff, etc.) recorded for each monitoring day with correct units; includes clear notes on leaf color, wilting/turgor, and basic leaf shape under the LED treatment.	Most measurements recorded; a few small omissions or occasional missing units; some qualitative observations noted but not consistent.	Incomplete or inconsistent records; multiple data gaps or missing days; little or no attention to leaf condition.	Very little usable data collected.
Accuracy and Consistency Measurements done carefully and the same way each day.	Measurements are taken carefully at consistent times with the same methods each day (same ruler, equal water to both systems, runoff measured properly); data reliable and comparable.	Minor inconsistencies in timing or technique, but overall trends still trustworthy.	Frequent inconsistencies in timing or methods (unequal water, different people measuring differently); data reliability is questionable.	Data unreliable due to poor measurement practices (guessing, obviously impossible values, or not actually measuring).

<p>Data Analysis and Calculations Correct math and clear comparisons between systems and light spectra.</p>	<p>Correctly calculates water use, growth, and water-use efficiency (WUE) for both hydroponic and soil systems; makes clear comparisons hydro vs. soil and across Blue / Red / Blue+Red; explicitly describes leaf morphology differences and connects them to water use and stress tolerance.</p>	<p>Mostly correct calculations with small errors; compares hydro vs. soil and at least two light treatments; mentions some leaf differences but only partially links them to WUE or resilience.</p>	<p>Several mistakes in calculations or units; comparisons between systems or light treatments are vague; leaf morphology is barely mentioned or not connected to function.</p>	<p>Calculations missing or mostly incorrect; no meaningful comparison between systems or light spectra; no discussion of leaf traits.</p>
<p>Reasoning and Conclusions Explains results using data and plant science ideas.</p>	<p>Explains results using evidence from the experiment (growth, WUE, runoff, leaf traits) and relevant plant science concepts (light effects, transpiration, stomata, closed-loop hydroponics, soil water loss); provides a clear climate-smart design recommendation for urban and/or peri-urban farming supported by data.</p>	<p>Conclusion is based on data and mentions some plant science ideas, but explanation is somewhat general; design recommendation is reasonable but not fully justified with specific numbers or observations.</p>	<p>Conclusions are weak, vague, or only loosely tied to data; design ideas are generic or disconnected from actual findings.</p>	<p>No clear conclusion or design recommendation, or statements are not connected to the collected data.</p>
<p>Collaboration and Communication Worked well as a group, shared tasks fairly.</p>	<p>Group worked cooperatively; roles for measuring, recording, watering, and managing lights were shared fairly; data sheet and explanations reflect input from all members.</p>	<p>Some uneven participation, but group completed the work; communication in notes and/or presentation is mostly clear.</p>	<p>Group had difficulty working together (one person did most work or conflicts slowed progress); notes or explanations are unclear or incomplete.</p>	<p>Group did not work well together; lack of participation or coordination prevented effective completion or communication of the activity.</p>