Module 2: Waste-to-Resource Strategies in Agri-Food Systems

Differentiated Content Lecture & Speaker Notes - Activity Worksheet

Red Notes

Reading a Graph – Soil Microbial Diversity & Bokashi
Grouping: Pairs or small groups (3–4)
Time: 25-30 minutes

Materials:

- Activity worksheet with a simplified bar graph based on the acid rain study, showing Shannon Index for:
  - Control (CK) – baseline diversity
  - Moderate Acid (T1 & T2)
  - High Acid (T3) – noticeably lower diversity
- Access to lesson notes or optional slides

Objective:

In this activity, students will explore how bokashi influences soil microbes, fertility, and crop growth while building their skills in reading and interpreting scientific graphs. By analyzing a simplified figure that presents real agricultural data, students will practice connecting graph-based evidence to biological processes and apply their understanding to predict how bokashi can improve soil health in real-world contexts.

Your Task:

You will examine a scientific figure showing how different soil treatments (including Bokashi) affect microbial diversity, measured by the Shannon Index and alpha diversity. First, learn what these metrics mean and how to interpret them. Then, analyze the graph to determine which treatment supports the most diverse and balanced microbial community, and explain why. Finally, connect your findings to what you know about Bokashi's microbial richness and predict its benefits for soil health in a real-world farming or gardening context.

Preparations:

Shannon Index

- A measure of both richness (how many species are present) and evenness (how evenly individuals are distributed among those species).
- Higher value = greater variety and balance of species in the sample.
- Commonly used in microbiome studies to compare biodiversity between treatments.

Alpha Diversity

- A measure of the diversity within a single sample or environment.
- Can be calculated using metrics like Shannon Index or species richness.
- Higher alpha diversity means a healthier, more stable microbial community.

Bokashi (Anaerobic Fermentation)

- A fermentation-based composting method that uses inoculated bran or other carriers to add beneficial microbes (especially lactic acid bacteria).
- Converts organic waste into a microbe-rich soil amendment in weeks, without high temperatures.
- In the citrus nursery study (BioRxiv & ResearchGate), Bokashi treatments:
  - Increased microbial activity and soil fertility.
  - Enhanced root growth, chlorophyll levels, and biomass compared to chemical fertilizers.
  - Likely increased Shannon Index and alpha diversity, due to adding a variety of beneficial microbes that improve soil biodiversity.

Community dynamics within microbial communities and microbiomes

- Refers to the interactions, competition, cooperation, and succession patterns among microbes in a given environment.
- Influenced by environmental factors (pH, temperature, nutrient availability), biotic factors (predation, symbiosis), and human interventions (fertilizers, probiotics, waste management).

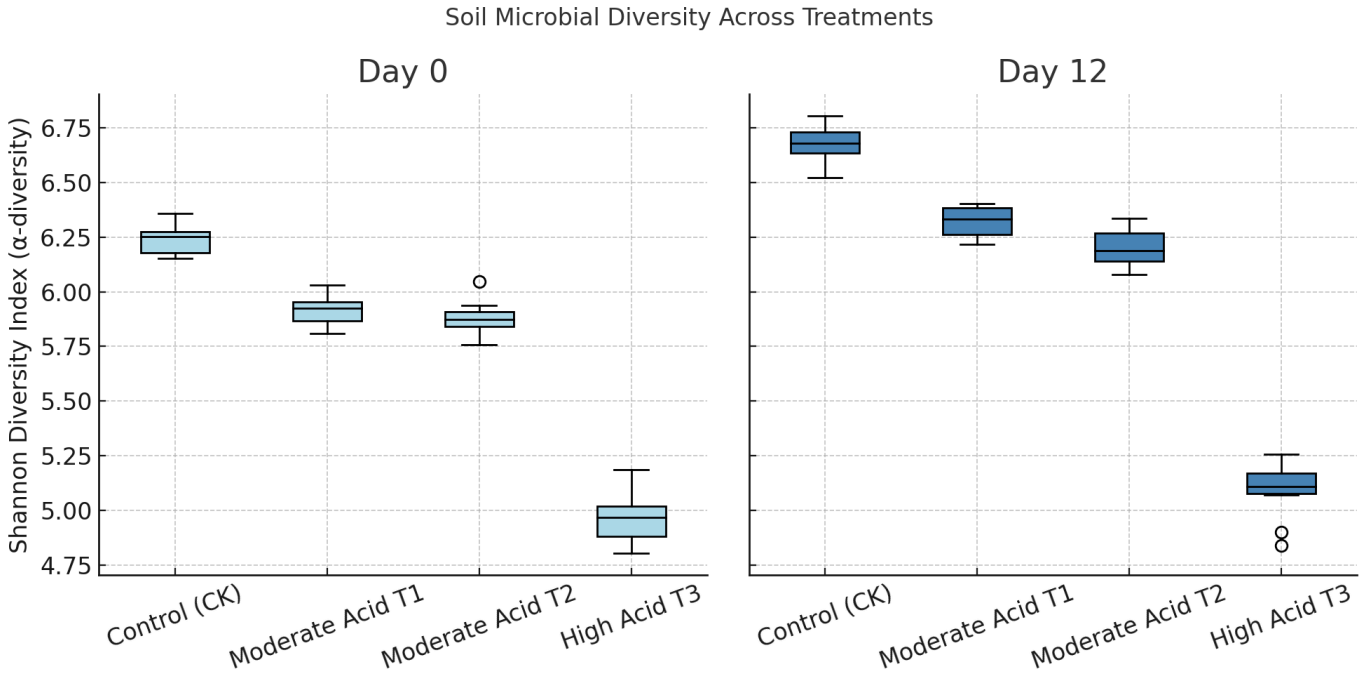
- Dynamics can shift rapidly — for example, when new microbes are introduced (as with bokashi) or when stressors disrupt balance (e.g., antibiotic use in gut microbiomes).
- Understanding these dynamics helps predict stability, resilience, and functional outcomes of microbial communities.

Instructions:

1. Interpret the Graph: Identify which treatment has the highest and lowest Shannon Index and explain what that means for soil health.
2. Discuss Implications: Describe why extreme acid lowers microbial diversity and how that affects the soil ecosystem.
3. Relate to Bokashi: Compare the acid impact with Bokashi and explain how Bokashi can improve soil diversity and stability.

Step 1: Interpret the Graph

Identify which treatment (e.g., T3) shows lower Shannon diversity and discuss what that means for soil health.



Observations:

1. Which treatment has the highest Shannon Index? Control (CK) shows the highest (baseline diversity
2. Which treatment has the lowest Shannon Index? T3 (High Acid) has the lowest diversity
3. What does a higher Shannon Index mean for soil health? It means the soil has a richer and more balanced microbial community, which makes it healthier and more resilient.

Step 2: Implications of Acid Stress

Explain in one sentence why high acid levels lower microbial diversity and what that means for soil health.

Why would extreme acid lower microbial diversity?

High acid kills or stresses many microbes, leaving only a few acid-tolerant species.

What might happen to the soil ecosystem when diversity decreases?

The soil loses functions like nutrient cycling and disease resistance, making it less fertile and less stable for plant growth.

Step 3: Connecting to Bokashi
Contrast the acid impact with what we expect from bokashi: a diverse microbial input that enriches and stabilizes soil communities.

While acid stress reduces diversity, Bokashi adds new beneficial microbes, increasing richness and balance. This helps soils recover fertility and stability instead of degrading them.

Reflection
What might the Shannon Index look like in bokashi-amended soil versus control?

It would likely be higher than the control, because Bokashi introduces many beneficial microbes that enrich diversity.

How does this graph support the idea that waste-to-resource solutions like Bokashi can be better than traditional chemical inputs?

The graph shows that stress (like acid) lowers diversity and harms soil health, while Bokashi increases diversity, strengthens microbial communities, and supports better crop growth. This suggests Bokashi is a more sustainable alternative.

Skills You'll Use:

- Data analysis with interpreting graphs, understanding biodiversity metrics
- Linking evidence (graph results) to biological processes
- Systems thinking with seeing how waste-valorization methods affect soil ecosystems
- Evaluating treatments based on multiple indicators