



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

Think-Pair-Share Activity B: Toolkit Trade-Offs Discussion

Lesson B

Grouping: Pairs or small groups (3–4)

Time: 25-30 minutes

Materials:

- One worksheet per student (or one per pair) — this page.
- $\Delta\text{CO}_2\text{-eq}$ quick reference (post on board or handout):
- Pens / markers; whiteboard or chart paper for class synthesis; sticky notes (optional).

Objective:

Students will learn to use $\Delta\text{CO}_2\text{-eq}$ values to compare waste-to-resource pathways. They will evaluate each option across five trade-off criteria (Energy Input, Cost/Complexity, Processing Time, Main Benefits, Key Limitations) and decide which pathway is best for a cafeteria-scale scenario. Students will justify their choice using both carbon math and one practical criterion.

Instructions:

1. Assign pathways: Each group member takes 1–2 pathways. Skim the $\Delta\text{CO}_2\text{-eq}$ quick reference and jot 2–3 quick notes.
2. Group synthesis: In groups of 3–4, combine notes to complete the full table (all five pathways, one row each). Keep notes short — 1–2 points per cell.
3. Decision: As a group, rank the pathways and choose the best option for the cafeteria.
4. Justification: Prepare a 1-minute defense citing:
 - a. $\Delta\text{CO}_2\text{-eq}$ carbon math
 - b. One practical criterion (cost, space, time, social acceptability).
5. Share out: Each group posts a sticky note with their top choice and a 2-line justification. The teacher compiles results and leads a short discussion.

Provided Data (Quick Reference)

Pathway	$\Delta\text{CO}_2\text{-eq}$ (g/kg)	Key Process Gas	Conversion Factor (to CO_2e)	Notes
Landfill	+500	CH_4 release	1 g CH_4 = 28 g CO_2e	High emissions from methane
Composting	-100	CO_2 + N_2O	1 g N_2O = 265 g CO_2e	Low-tech, soil benefits
Bokashi/Digester	-200	Captured CH_4	Avoided 28 g CO_2e per g CH_4	Produces biogas
Biochar Pyrolysis	-450	Carbon storage	Long-term sequestration	Requires high heat
Insect Bioconversion	-300	Avoided feed emissions	—	Produces animal feed

Your Task:

Your task is to compare, rank, and justify. Work together to complete the table below, then decide on the single best option for the cafeteria.

Step 1: Assign Pathways

Each group member takes 1–2 pathways. Use the quick reference to jot short notes (inputs, outputs, $\Delta\text{CO}_2\text{-eq}$, one strength, one limitation).

Pathway	Energy Input / $\Delta\text{CO}_2\text{-eq}$	Cost Complexity /	Time (processing)	Main Benefits	Key Limitations
Landfill					
Composting					
Bokashi / Digester					
Biochar Pyrolysis					
Insect Bioconversion					

Step 2: Rank and Decide

As a group, rank all 5 pathways (1 = best, 5 = worst).

1.

2.

3.

4.

5.

Step 3: Justification

Justify your top choice with carbon math evidence and one practical factor. ($CO_2\text{-e} = \text{Mass of waste (kg)} \times \text{emission factor (kg } CO_2\text{-e/kg waste)}$) Note: Make up a feasible mass of waste (kg) for a week.

1. Carbon math evidence ($\Delta CO_2\text{-eq}$) per week:

2. One practical factor (cost, space, time, etc.):

Reflection:

1. Based on your calculations, which pathway gave the largest climate benefit? Why might this pathway not always be the best choice in a real cafeteria?

2. If the school wanted to use two pathways in combination, which pair would you recommend and why? Consider trade-offs such as cost, space, time, and social acceptance.

3. Which trade-off (carbon benefit, cost, processing time, or social acceptability) was the hardest to balance in your group's decision? Why?

Skills You'll Use:

- Systems thinking (balancing multiple criteria)

- Reading scientific data (using $\Delta\text{CO}_2\text{-eq}$ values)
- Design & evaluation reasoning (choosing solutions under constraints)
- Collaboration & justification (explaining choices with evidence)

Carbon-math worked example:

Use this example in class to show how to use the $\Delta\text{CO}_2\text{-eq}$ numbers.

- Scenario: school cafeteria generates 50 kg of food waste per day.
- Landfill: $+500 \text{ g CO}_2\text{-eq/kg} \rightarrow 50 \text{ kg} \times 500 \text{ g} = 25,000 \text{ g} = 25 \text{ kg CO}_2\text{-eq per day}$
- Compost: $-100 \text{ g CO}_2\text{-eq/kg} \rightarrow 50 \text{ kg} \times (-100 \text{ g}) = -5,000 \text{ g} = -5 \text{ kg CO}_2\text{-eq per day}$
- Anaerobic digester (optimistic -200 g/kg): $50 \text{ kg} \times (-200 \text{ g}) = -10,000 \text{ g} = -10 \text{ kg CO}_2\text{-eq per day}$