

Saving the Store Banana: A Jigsaw on Biodiversity and Disease

Learning target: I can teach my group evidence about bananas, diseases and wild relatives, and use that evidence to evaluate competing solutions for protecting a food supply while maintaining biodiversity.

Collaborative investigation

About 55 min

Jigsaw

MS-LS2-5 · assesses

MS-ETS1-2 · practice

collaboration

discussion

reading

Name _____

Date _____

Period _____

Directions

You will work in two groups. First, in an expert group, read your three cards closely and agree on what matters most in each. Then return to your home group, where every member is an expert on a different set. Teach your cards without reading them aloud, build the decision matrix together, and use the teaching dataset. Finish Part C on your own; it shows what you understand.

You will need: One set of twelve cards per home group (cut apart), This worksheet, Pencil, Calculator, Timer

The problem

Nearly every banana sold in U.S. stores is one variety, the Cavendish, and a soil fungus is spreading through Cavendish farms around the world. Banana growers, scientists and governments are arguing about what to do. Your team will weigh the evidence and evaluate three competing solutions.

Twelve expert cards (teacher cuts these apart; expert groups A, B, C and D take three cards each)

1 Card A1: One plant, many copies

Cavendish bananas, the kind sold in almost every U.S. grocery store, have no working seeds. Farmers start new plants from shoots that sprout at the base of a parent plant, or from tiny pieces of plant tissue grown in a lab. So the Cavendish plants on farms around the world are near-identical genetic copies, called clones.

2 Card A2: Why breeding bananas is slow

Most bananas people eat have three sets of chromosomes instead of the usual two. That is why they make few or no seeds: good for eating, bad for breeding. Crossing them with other bananas rarely produces seeds that grow, so developing a new variety by crossing can take many years.

3 Card A3: The banana before Cavendish

Until the mid-1900s the main banana sold in the United States and Europe was a variety called Gros Michel. A soil fungus that causes Panama disease, a wilt that kills the plant, spread through Gros Michel plantations in Central America. By the 1960s exporters had switched to Cavendish, which resisted that strain. Gros Michel did not go extinct; small farmers in some countries still grow it.

4 Card B1: A new strain arrives

A newer strain of the same fungus, called Tropical Race 4 (TR4), does attack Cavendish. It blocks the tubes that carry water inside the plant, so the leaves yellow and the plant wilts and dies. TR4 was found in Asia, later spread to Australia, Africa and the Middle East, and reached South America in 2019.

5 Card B2: Hiding in the soil

TR4 can survive in soil for decades. It travels in mud on boots, tools and vehicles, in moving water, and in infected planting material. No fungicide cures an infected plant. Farms use boot-washing stations, fences and strict rules for moving plants, which slow the spread but have not stopped it.

6 Card B3: A leaf disease too

Black Sigatoka, also called black leaf streak, is a fungus that kills patches of banana leaves. With less leaf area, plants make less sugar by photosynthesis and grow smaller bunches. Large Cavendish plantations often spray fungicides many times a year to control it, in some places dozens of times, which is costly and can harm workers and streams if not handled carefully.

7 Card C1: Wild bananas

Wild bananas grow in forests and forest edges of Southeast Asia and nearby regions. They are packed with hard seeds, so they are not good to eat, but they reproduce from seed and their populations are genetically varied. Some wild bananas carry genes that help them resist TR4 and other diseases. Some wild banana populations are shrinking as forests are cleared.

8 Card C2: A library of living bananas

An international gene bank in Belgium keeps well over a thousand kinds of bananas, wild and cultivated, as living plant tissue in test tubes. Breeders and researchers around the world can request samples to search for useful traits. A gene bank holds only the kinds someone has already collected, so it cannot replace wild populations that keep changing in nature.

9 Card C3: Borrowing a gene

Researchers in Australia gave Cavendish plants a disease-resistance gene from a wild Southeast Asian banana. In years of field trials the modified plants resisted TR4, and in 2024 Australian regulators approved the banana, although it was not yet being grown on a large scale. Some shoppers and countries are cautious about genetically modified foods.

10 Card D1: Many kinds on one farm

In parts of East Africa and Southeast Asia, many small farms grow several banana varieties side by side: some for cooking, some for eating fresh, some for brewing. When a disease hits one variety, the others often survive, so the family still has bananas. Many of these varieties bruise more easily or ripen less evenly than Cavendish, so they are harder to ship long distances.

11 Card D2: Built for shipping

Cavendish bananas are picked green, travel thousands of kilometers by ship without bruising badly, and ripen evenly when they are treated with ethylene, a natural ripening gas. Ships, ripening rooms and supermarkets are set up for this one kind. Switching to other varieties would mean changes for growers, shippers, stores and shoppers.

12 Card D3: Who depends on bananas

Bananas, including cooking bananas and plantains, are among the world's most important food crops. In some countries of East and Central Africa they are a staple food that many families eat every day. Most bananas grown in the world are eaten in the countries where they are grown rather than shipped abroad.

Teaching model: disease spread in two 1,000-plant plots (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Plot A: plants infected (of 1,000)	Plot B: plants infected (of 1,000)
0	5	5
1	40	12
2	150	30
3	400	65
4	720	110
5	940	160

Simulated results from a simple computer model, for teaching. Plot A has one variety, and every plant can be infected. Plot B has four varieties of 250 plants each, mixed together; only one variety can be infected. The disease starts in 5 plants in each plot.

Three competing solutions — Solution 1, Hold the line: keep growing only Cavendish; slow TR4 with quarantine, cleaning stations and strict plant-moving rules, and keep spraying for leaf disease. **Solution 2, Borrow from the wild:** protect forests where wild bananas grow and fund gene banks; use wild genes to breed or engineer resistant bananas that ship like Cavendish. **Solution 3, Mix it up:** grow several varieties on each farm and in each region, including resistant ones, and help shippers, stores and shoppers accept new kinds.

Part A: Expert round

1. Your expert set (A, B, C or D): _____. For each of your three cards, write the single most important fact in your own words and one sentence explaining how it connects to biodiversity or to disease.

Part B: Home group task

1. Teach in order A, B, C, D. Each expert gets two minutes and may not read the cards aloud; explain them in your own words.
 2. As each expert teaches, everyone notes which solution each card helps or hurts.
 3. Score each solution from 1 (poor) to 3 (strong) on each criterion in q2. Agree on every score and write the card numbers that support it.
 4. Use the teaching dataset to answer q3 together.
 5. Choose the solution, or combination, your group would recommend. Every member must be able to explain why.
2. Group answer: complete the decision matrix.

Solution 1: Hold the line	Solution 2: Borrow from the wild	Solution 3: Mix it up
Keeps bananas in stores over the next 10 years (1-3)		
Maintains biodiversity (1-3)		
Cost and time to put in place (3 = cheapest and fastest)		
Still works if a brand-new disease appears (1-3)		
Total		
Card numbers that support our scores		

3. Group answer: at year 5, what percent of all plants are infected in Plot A and in Plot B? What percent of the 250 susceptible plants in Plot B are infected? Use the numbers to explain two ways that mixing varieties protected Plot B.

4. Group answer: which card or result changed your group's thinking the most, and how?

Part C: Individual accountability (complete alone)

5. Using cards A1 and C1, explain why a field of Cavendish plants is more at risk from a new disease than a population of wild bananas.

6. Solution 2 depends on wild bananas. Explain why protecting the forests where they grow is a way of maintaining an ecosystem service. Which category of service is it?

7. Card A3 shows that switching from Gros Michel to Cavendish solved one problem. Using card B1, explain why replacing one uniform variety with another uniform variety is not a lasting fix.

8. Write your own recommendation: one solution or a combination. Use evidence from at least three cards from at least two different expert sets, including one card that argues against your choice, and explain how your choice maintains biodiversity. You may disagree with your group.

Teaching frame for experts

When it is your turn to teach, use this frame for each card: 'The big fact is _____. This matters because _____. It helps (or hurts) Solution _____ because _____.' Listeners write one question for each expert. If your group gets stuck on a score, ask: 'What would have to be true for this solution to work, and does any card say that is true?'

The next uniform crop

Bananas are not the only crop grown as near-identical plants over huge areas. Choose another crop that is often propagated as clones, such as potatoes grown from seed pieces or apples grown by grafting, and research one disease outbreak that affected it. Write a one-page brief that names the crop, explains why uniformity raised the risk, and describes one way wild relatives or crop diversity helped, or could help, the recovery.