

Sun, Shade or Forest? Choosing a Coffee Farm Design

Learning target: I can write a claim, evidence and reasoning argument that evaluates competing farm designs for how well they maintain biodiversity and ecosystem services while meeting economic and social needs.

Claim, evidence, reasoning

About 45 min

Individual

MS-LS2-5 · assesses

MS-ETS1-2 · practice

writing

data analysis

independent practice

Name _____

Date _____

Period _____

Directions

Read the scenario and the four criteria the cooperative agreed on. The trial results are a teaching dataset. Complete Parts A and B first, because your argument in Part C must use them. Your claim may depend on a condition (for example, 'if the cooperative gets a buyer's contract'); if it does, say so clearly. There is more than one defensible answer, but every claim must be backed by the evidence.

You will need: This worksheet, Pencil, Calculator

The scenario

Las Nubes is a coffee cooperative of 40 families in the mountains of Central America (the cooperative is invented for this worksheet). Each winter, black-and-white warblers and other songbirds that nest in North American forests and parks fly south and spend the winter in forests and shaded farms like these. The cooperative must replant 50 hectares of old coffee and is choosing among three designs. **Design A, full sun:** coffee plants alone in rows, with more fertilizer and pest control. **Design B, light shade:** coffee under one kind of planted shade tree, *Inga*, a fast-growing tree that adds nitrogen to the soil. **Design C, diverse shade:** coffee under several kinds of native trees in layers, like a thinned forest. Only Design C can earn a bird-friendly certification, which pays a higher price, but only if a buyer signs a contract.

The four criteria the cooperative agreed on before seeing any results — **1. Economic:** net income of at least \$2,000 per hectare per year. **2. Scientific, biodiversity:** at least 25 bird species on the yearly survey, including wintering warblers. **3. Scientific, ecosystem services:** soil loss below 10 tonnes per hectare in the rainy season, and at least 10 bee visits to coffee flowers per 10 minutes (bees raise the number of coffee berries). **4. Social:** at least half the member families (20 of 40) willing to farm that way.

Three years of trial plots at Las Nubes, per hectare per year (teaching dataset)

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

Measurement	A: Full sun	B: Light shade	C: Diverse shade

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Coffee harvested (kg of beans)	1600	1250	950
Standard price (\$ per kg)	2.50	2.50	2.50
Certified price after the certification fee (\$ per kg, only with a buyer's contract)	not eligible	not eligible	3.20
Other products sold: fruit, firewood, timber (\$)	0	250	450
Yearly costs: fertilizer, pest control, labor (\$)	1900	1250	1150
Bird species counted	10	28	52
Wintering warblers seen per survey	0	3	9
Soil washed away in the rainy season (tonnes)	18	7	3
Bee visits to coffee flowers (per 10 minutes)	5	11	16
Families willing to farm this way (out of 40)	31	27	21

Simulated data for teaching. The direction of each difference (lower yield but more birds, less erosion and more pollinators under shade) matches published studies of coffee farms; the exact numbers are invented.

Part A: Calculate

- Calculate net income per hectare: (kg × price) + other products – costs. Do Design C twice, once at each price.

Coffee income (\$)	+ Other products (\$)	– Costs (\$)	= Net income (\$)
A: Full sun			
B: Light shade			
C: Diverse shade, standard price			
C: Diverse shade, certified price			

Part B: Check every criterion

- Write yes or no in each box. For Design C's income, write the answer for both prices.

1. Income at least \$2,000?	2. 25+ bird species and warblers?	3. Soil under 10 t and 10+ bee visits?	4. At least 20 families willing?
A: Full sun			
B: Light shade			
C: Diverse shade			

3. Describe the main tradeoff between Design A and Design C in one or two sentences. What does each design give up to get what it does best?

Part C: Make your argument

CLAIM

Claim: Which design should Las Nubes choose to maintain biodiversity and ecosystem services while meeting the families' needs? If your claim depends on a condition, state it.

EVIDENCE

Evidence: give at least three pieces of evidence from the dataset or your calculations, including at least one economic, one scientific and one social piece.

REASONING

Reasoning: explain how the evidence supports your claim. Explain how shade trees connect to the birds, the soil and the bees, and why a design that fails one agreed criterion is a weaker choice even if it wins on another.

4. A member says: 'Design A harvests the most coffee, so it is obviously the best.' Write a respectful reply that uses at least two numbers from the dataset, including one about soil.

5. Name one more piece of information that would make you more confident in your claim, and explain how it could change the decision.

Sentence frames for the argument

Claim: 'Las Nubes should choose Design ____ (if ____).' Evidence: 'Design ____ earned \$____ per hectare, which is above/below the \$2,000 criterion. It had ____ bird species compared with ____ for full sun. Soil loss was ____ tonnes...' Reasoning: 'Shade trees give birds places to feed and shelter, their roots and fallen leaves hold soil in heavy rain, and flowering trees support bees, so _____. Design ____ fails criterion ____, so _____.'

What if the climate warms?

Shade trees keep coffee plants cooler, and arabica coffee grows poorly when it gets too hot. Suppose models predict the region will warm by about 1 to 2 °C over the coming decades. Write a paragraph explaining how this new information should change how the cooperative weighs its criteria, and whether it strengthens or weakens the case for each design. Then propose one measurement the cooperative should add to its trial plots.