

What Is a Bee Visit Worth? Orchard Data and Replacement Cost

Learning target: I can graph and analyze orchard data to find how pollination affects a harvest, and use replacement-cost reasoning to estimate what a pollination service is worth and what that number leaves out.

Data and graphing

About 50 min

Individual

MS-LS2-5 · practice

MS-LS2-1 · supports

data analysis

independent practice

Name _____

Date _____

Period _____

Directions

This sheet uses two teaching datasets. The numbers are invented to be realistic for a California almond orchard, but they were not measured on a real farm. In Part A, graph the harvest data and calculate what each extra colony of bees is worth. In Part B, calculate what it would cost to do the bees' job by hand, then think about what that number does not capture. Show every calculation with units.

You will need: This worksheet, Pencil, Ruler, Calculator

Part A: More bees, more almonds?

A grower divided her orchard into eight test blocks of the same almond varieties, soil and watering. During bloom she placed a different number of rented honey bee colonies per acre in each block, keeping the blocks far enough apart that bees mostly stayed in their own block. The block with no colonies still received a few visits from wild bees that nest nearby. At harvest she recorded how many flowers had become nuts and how many pounds of almond kernels each acre produced.

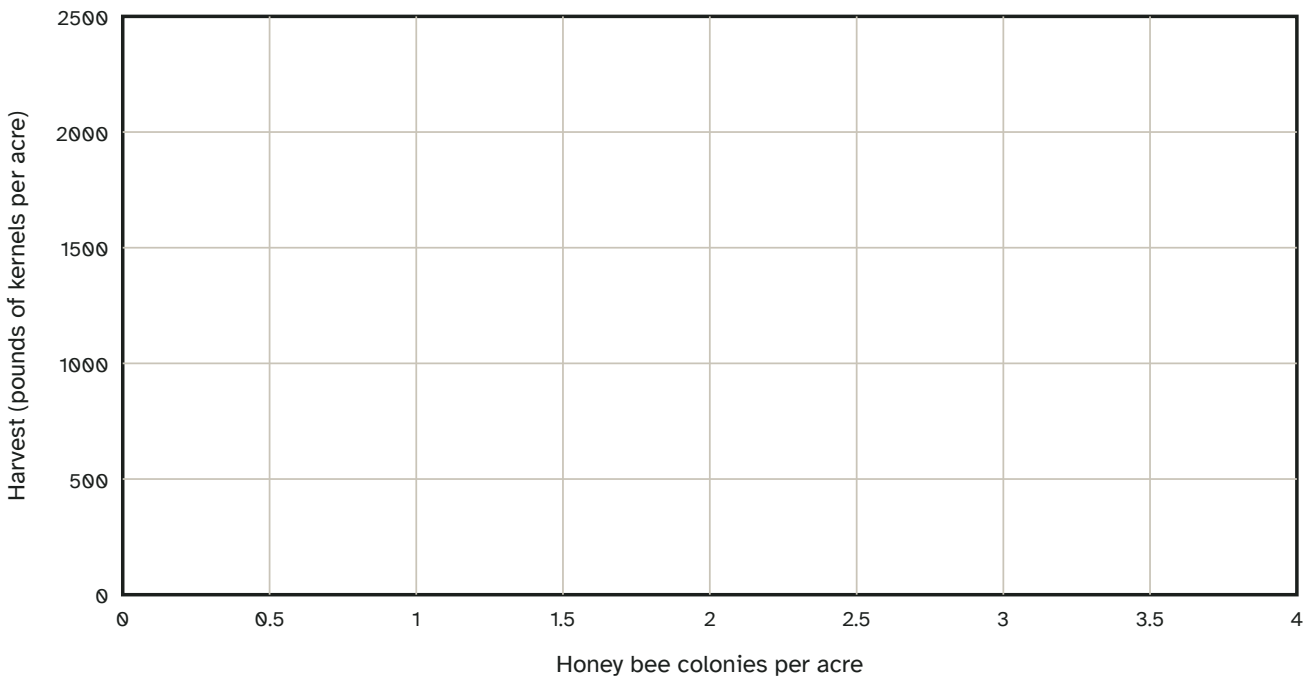
Honey bee colonies per acre and almond harvest in eight test blocks (teaching dataset)

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

Colonies per acre	Flowers that became nuts (%)	Harvest (pounds of kernels per acre)
0	4	350
0.5	14	1050
1.0	21	1550
1.5	26	1900
2.0	29	2100
2.5	30	2180
3.0	30	2200
4.0	31	2220

Simulated data for teaching. The shape of the pattern, rising fast and then leveling off, is realistic; the values are invented.

Almond harvest and honey bee colonies per acre



1. How many more pounds per acre did the block with 2.0 colonies produce than the block with none? By what percent did the harvest increase? Show the calculation.
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2. Describe the shape of your graph. Between which two neighboring blocks did one extra half colony per acre add the most harvest? After which point did extra colonies add almost nothing? Suggest one reason the harvest stops rising even though more bees are added.

3. In this scenario the grower earns \$2.50 per pound of kernels and pays \$200 to rent one colony for the bloom. Complete the table. Extra income = extra harvest $\times$ \$2.50. Extra rent = extra colonies $\times$ \$200. Net = extra income – extra rent.

Extra harvest (lb per acre)	Extra income (\$ per acre)	Extra rent (\$ per acre)	Net gain or loss (\$ per acre)
From 1.5 to 2.0 colonies			
From 2.0 to 3.0 colonies			
From 3.0 to 4.0 colonies			

4. Using your table, how many colonies per acre would you recommend for this orchard? Give a reason based on the numbers and one reason a grower might choose a little more than that.

Part B: What if there were no bees to rent?

Imagine honey bees could not be rented at all. A crew could still pollinate almond flowers by hand, dabbing pollen from the second variety onto each flower with a small brush or puffer. The cost of doing a natural job with human labor or machines is called its **replacement cost**. Use the teaching numbers below.

Teaching numbers for hand pollination (teaching dataset)

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

Quantity	Value
Almond trees per acre	110
Trees one trained worker can hand-pollinate in an 8-hour day	4
Labor cost per worker per hour	\$25
Pollen collected and prepared for hand use, per acre	\$150
Working days during bloom	15
Honey bee rental: colonies per acre and price per colony	2 colonies at \$200 each
Price the grower receives for kernels	\$2.50 per pound

Simulated values for teaching. Real hand-pollination rates depend on tree size and flower number and would vary widely.

5. Calculate the cost of hand-pollinating one acre. First find the worker-days per acre, then the worker-hours, then the labor cost, then add the pollen.

6. How many times more does hand pollination cost per acre than renting 2 colonies per acre? Round to one decimal place.

7. Bloom lasts 15 working days. How many hand-pollination workers would a 100-acre orchard need every day of bloom to finish in time? Round up to a whole worker and explain why you round up.

8. At 2.0 colonies per acre the orchard produced 2,100 pounds per acre. Calculate the income from one acre and compare it with your answer to q5. What does the comparison tell you about the value of the pollination service?

9. A grower says, 'Bees are worth exactly \$400 an acre to me, because that is what I pay.' Explain why the rent is not the full value of the pollination service. Then give two things that a replacement-cost number also leaves out.

Calculation path for Part B

Worker-days per acre = trees per acre $\div$ trees per worker per day. Worker-hours = worker-days $\times$ 8.

Labor cost = worker-hours $\times$ \$25. Add \$150 for pollen. For q7, total worker-days for the orchard = worker-days per acre $\times$ 100, then divide by the number of days in bloom. Check that every number you write has a unit (trees, days, hours, dollars).

Wild bees in the budget

Suppose planting strips of native wildflowers along the orchard edges costs \$25,000 to establish and \$2,000 a year to maintain, and lets the grower rent 1.5 colonies per acre instead of 2.0 with the same harvest, because native bees nesting in the strip do some of the pollinating. For a 100-acre orchard, how many years would it take for the rent savings to pay for the strips? Then describe one benefit of the strips that does not show up in your calculation and one risk the grower takes by relying on wild bees.