

Feed the Field, Keep the Pond: Choosing a Fertilizer Plan

Investigation question: Which of five fertilizer plans best meets the garden club's criteria for crop yield and pond health while staying inside its budget and labor limits, and what trade-off does the best plan still accept?

Data-driven decision

Groups of 4

1 session

Setup 5 · Activity 45 · Cleanup 3 min

MS-ETS1-2 · assesses

MS-LS2-3 · practice

MS-LS2-4 · supports

Name _____

Group _____

Date _____

Your role today

- ☐ **Data reader:** Reads each plan's numbers aloud from the dataset and checks every entry the group writes in the matrix against the table.
- ☐ **Matrix keeper:** Fills in the pass/fail matrix and the weighted-score table, and does the arithmetic with a second group member checking.
- ☐ **Cycle tracer:** Keeps the nitrogen-cycle map in view and explains, for each plan, which arrow the plan changes (amount applied, timing, runoff path).
- ☐ **Spokesperson:** Drafts the group's recommendation and the trade-off sentence, and presents it to the class in the debrief.

Safety

- Paper-and-pencil activity; no hazards beyond ordinary classroom use.
- If the optional fertilizer jar is used, only the teacher handles the fertilizer, the jar is labeled and kept away from food, and hands are washed afterward.

Procedure

1. Read the scenario and the dataset. In your group, say in one sentence what each column measures and which direction is 'good' for the pond and which for the field. Note that the nitrate and oxygen values are for the wet year unless the column says otherwise.
2. Copy the criteria and constraints from the scenario into the top of the matrix. Decide as a group which items are constraints (hard limits that a plan either meets or does not) and which are criteria (goals that can be met more or less well).
3. Fill in the pass/fail matrix: for every plan and every criterion or constraint, write pass or fail using the wet-year numbers for the pond. Highlight fails.
4. Fill in the weighted-score table: give each plan 2 points on a criterion it meets, 1 point if it misses by 10 percent or less, and 0 if it misses by more. Multiply by the weight and add across to get a total for each plan.

5. Rank the plans by total. Then apply the constraints as a filter: any plan that fails a constraint cannot be chosen as it stands, whatever its score. Write which plans survive.
6. Use the nitrogen-cycle map to explain, for plans B, C and D, which arrow of the cycle each plan changes and why that changes the pond nitrate in the data.
7. Write the group's recommendation: the plan you choose, the criterion it falls short on, and what you would change (a weight, a constraint or a combination of plans) to do better. Record the trade-off in one sentence that starts 'We accept...'.
8. Report your ranking to the class chart. Compare with other groups; where rankings differ, find the weight or the pass/fail call that caused it.
9. Answer the analysis questions on your own.

Record your observations

Lab 3 recording sheet: Feed the field, keep the pond

Scenario. Your garden club grows vegetables on a sloping field above the school pond. Last spring the pond turned green after a storm and several fish died. The club wants a fertilizer plan for next year. A university extension office ran a three-year trial of five plans on plots like yours, with a pond downhill of each plot. The numbers below are a teaching dataset: they were invented for this activity, but the patterns follow what field trials of fertilizer timing and buffer strips find.

Criteria and constraints set by the club — Criteria (goals): yield of at least 70 kg per plot; wet-year pond nitrate of 10 mg/L or less (the U.S. drinking-water limit for nitrate measured as nitrogen, used here as the pond target); dawn oxygen in midsummer of at least 5 mg/L (below this, many fish are stressed).
Constraints (hard limits): cost of \$80 or less per season; labor of 6 hours or less per season.

Three-year trial of five fertilizer plans (per 100 square meter plot; pond measured downhill of each plot)

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

Plan	Nitrogen applied (kg per plot per season)	Average yield (kg)	Pond nitrate after spring storms, wet year (mg/L as N)	Pond nitrate, dry year (mg/L as N)	Algae cover in mid-July (%)	Dawn oxygen in mid-July (mg/L)	Cost per season (\$)	Labor per season (hours)
A: no fertilizer	0	42	1.5	1.0	5	7.5	0	2
B: one full dose in early spring	2.0	78	18.0	7.0	60	2.5	60	3
C: full dose split into two half doses (spring and early summer)	2.0	80	9.0	4.0	30	4.5	60	5
D: one full dose plus a 10 m grass buffer strip above the pond	2.0	72	4.0	2.0	12	6.5	95	6
E: one half dose plus the grass buffer strip	1.0	68	3.0	1.5	8	7.0	65	6

Simulated teaching dataset. Nitrate is reported as nitrogen. Dawn oxygen is the lowest point of the day, after a night with no photosynthesis.

Pass/fail matrix (use wet-year nitrate)

Plan	Yield at least 70 kg	Wet-year nitrate 10 mg/L or less	Dawn oxygen at least 5 mg/L	Cost \$80 or less (constraint)	Labor 6 h or less (constraint)	Survives the constraints?
A						
B						
C						
D						
E						

Weighted-score table (2 = meets, 1 = misses by 10 percent or less, 0 = misses by more; multiply by the weight)

Plan	Yield (weight 3)	Nitrate (weight 3)	Oxygen (weight 2)	Cost (weight 1)	Labor (weight 1)	Total	Rank
A							
B							
C							
D							
E							

Which arrow of the nitrogen cycle does each plan change?

Plan	What the plan changes (amount, timing, path of runoff)	Why the pond nitrate changes, using the cycle
B		
C		
D		
E		

1. Group recommendation: which plan do you choose, which criterion does it fall short on, and what would you change to do better? Finish with one sentence that starts 'We accept...'.

2. Another group ranked a different plan first. Name one weight or one pass/fail call that could explain the difference.

Analysis questions

3. Compute the weighted total for plan C and for plan D, showing each criterion's points times its weight. Which plans tie or come close, and what breaks the tie?

4. By what percentage does splitting the dose (plan C) reduce wet-year pond nitrate compared with the single dose (plan B)? Show the calculation. Then do the same for the buffer strip (plan D versus plan B).

5. Plans B, C and D all apply the same 2.0 kg of nitrogen, yet their pond nitrate values differ. Use the nitrogen cycle to explain what happens to the nitrogen that does not reach the pond in plans C and D.

6. Compare yield per dollar for plans B, C, D and E. Which plan gives the most crop for the money, and why might the club still not choose it?

7. Explain the pattern across the plans between pond nitrate, algae cover and dawn oxygen. Why is oxygen lowest at dawn, and which living things are using it up?

8. The club can only afford to measure one thing in its own pond next summer. Which column of the dataset would you measure, and why is it the best single warning sign for the fish?

9. Propose a plan F that combines features of C and E, estimate its values for yield, wet-year nitrate, cost and labor from the data, and say whether it would pass all the criteria and constraints.
