

Past-paper walk-through

Survivorship Curves ■ 3.3

eXercise

Questions in this set

- 2024 Set 1 Q2
- 2021 Set 2 Q1

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 2

2024 Set 1 ■ Q2

As the human population continues to grow, the demand for animal protein is expected to double by 2050. Animal protein can be obtained from conventional livestock and other sources. The production of all animal protein has environmental costs, as shown in the following graphs. In Figure 1, global warming potential (GWP) is measured in kilograms of carbon dioxide equivalent (kg CO₂-eq). Carbon dioxide equivalent is a measure of the warming effect of a gas relative to that of carbon dioxide. In Figure 2, land use is measured in meters squared (m²).

****Global Warming Potential and Land Use from Animal Protein Production****

[Figure 1: bar graph titled "Figure 1". Y-axis "Global Warming Potential (kg CO₂-eq.)" from 0 to 140 in increments of 20. X-axis "Production of 1 kg of Animal Protein" with four bars: Mealworms (10), Chicken (27), Pork (37), Beef (120).]

Question 2

[Figure 2: bar graph titled "Figure 2". Y-axis "Land Use (m^2)" from 0 to 200 in increments of 20. X-axis "Production of 1 kg of Animal Protein" with four bars: Mealworms (18), Chicken (50), Pork (53), Beef (188).]

(a) Based on the data in the graphs, **identify** the amount of land required to produce 1 kilogram of chicken protein.

Mealworms, the larvae of the darkling beetle, consume grains and decaying plant material. Darkling beetles are an *r*-selected species, and the entire mealworm can be consumed by humans for protein.

Question 2

Figure 1

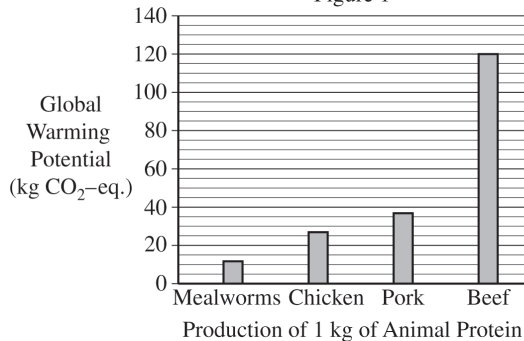
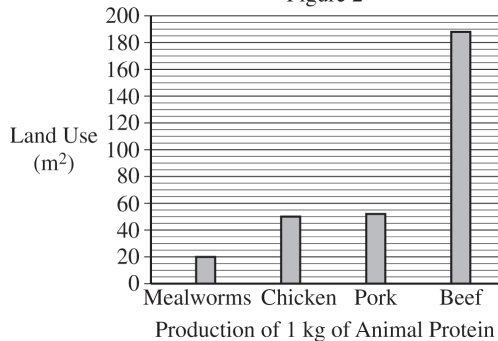


Figure 2



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2024 Set 1 ■ Q2

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Question 2

(b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle.

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Question 2

(c) Explain why the reproductive strategy of the darkling beetle is an advantage for using mealworms as an alternative protein source for the rapidly growing human population.

An individual's diet choices affect greenhouse gas emissions and land use.

Question 2

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Question 2

(d) Based on the data in the graphs, **explain** whether producing 1 kilogram of chicken protein or 1 kilogram of pork protein would cause less environmental damage. Cattle emit methane from fermentation in their digestive systems. The other animals do not emit methane.

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Question 2

(e) Based on the data in the graphs, **explain** why the production of 1 kilogram of beef protein has a different impact on global warming than the production of 1 kilogram of protein from any of the other animals studied would have.

Agricultural practices can have negative impacts on rivers and streams.

Question 2

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Question 2

(f) Describe how water quality can be altered by cattle grazing that occurs near a stream or river.

Question 2

2024 Set 1 ■ Q2

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Question 2

(g) Propose a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze.

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Question 2

(h) Crop production can cause soil erosion. **Describe** a sustainable agricultural practice used to reduce soil erosion.

Question 2

2024 Set 1 ■ Q2

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Question 2

(i) Justify the use of the sustainable practice described in part (h) by describing an additional advantage, other than the reduction of soil erosion.

Question 2

2024 Set 1 ■ Q2

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Question 2

(j) Crop production around the world is affected by climate change. **Describe** how crop production could be negatively affected by climate change.

Solution 2

(a)

Mark scheme

- 50 m² of land is required to produce 1 kilogram of chicken protein (read from the graph).

Solution 2

(b)

Mark scheme

- The darkling beetle exhibits a Type III survivorship curve (high mortality early in life, few survivors reach old age — consistent with an r-selected species).

Solution 2

(c)

Mark scheme

- Darkling beetles are r-selected and reproduce quickly with many offspring, which allows a large amount of protein (mealworm biomass) to be produced in a short period of time — an advantage for feeding a rapidly growing human population.

Solution 2

(d)

Mark scheme

- Producing 1 kg of chicken protein causes less environmental damage than producing 1 kg of pork protein: chicken production has a lower global warming potential (releases less greenhouse gas) than pork, and/or chicken has lower land use than pork, so it causes less deforestation/habitat destruction/soil erosion/fossil fuel use.

Solution 2

(e)

Mark scheme

- Beef production has a larger impact on global warming than the other animals studied because cattle emit methane from digestive (enteric) fermentation, and methane is a greenhouse gas with a high global warming potential; beef also requires much more land use, which causes loss of forests/habitat/grasslands and releases stored CO₂ (reducing carbon storage).

Solution 2

(f)

Mark scheme

- Cattle grazing near a stream or river can alter water quality by: causing erosion that increases sedimentation/turbidity in the water; adding nutrients (nitrogen/phosphorus) to waterways via feces; and/or contaminating waterways with bacteria from feces.

Solution 2

(g)

Mark scheme

- A solution that reduces waterway damage while still allowing grazing: practice rotational grazing (alternate grazing parcels so land can recover); reduce dietary reliance on meat/beef; fence/barricade the riparian zone to keep cattle out of the waterway; or provide alternative water sources for the cattle away from the stream.

Solution 2

(h)

Mark scheme

- A sustainable agricultural practice to reduce soil erosion: switch crops to perennial plants; plant crops on terraces; implement contour plowing/farming; or use no-till farming/cover crops.

Solution 2

(i)

Mark scheme

- Justify the practice named in part (h) with an advantage beyond reduced erosion. Matching the scoring table: perennial crops or no-till/cover crops → reduce fossil fuel use, reduce farming costs, increase/maintain soil carbon storage, and preserve soil habitat for organisms (cover crops can also serve as green manure); terracing or contour plowing → allows otherwise-too-steep areas to be farmed and increases groundwater absorption (terracing also lets sediment/contaminants settle out behind the ridge, further reducing runoff).

Solution 2

(j)

Mark scheme

- Climate change could negatively affect crop production/yields through: increased drought; increased flooding; increased insect infestation due to warmer temperatures; increased temperature generally; changes in seasonal rain patterns; expansion of the geographic range of invasive pests/species; or climate conditions moving outside crops' range of tolerance.

Question 1

2021 Set 2 ■ Q1

Soil erosion is one of the most serious soil-degrading processes. Each year tons of soil erode from cropland, pastures, forests, and other places. The amount of erosion varies dramatically among various land-use types. The figure above shows the effects of different agricultural practices and slopes on annual erosion rates.

[Line graph titled “EFFECT OF PERCENT SLOPE ON ANNUAL EROSION FOR FOUR AGRICULTURAL PRACTICES”; x-axis “Slope (%)” from 0 to 30 (gridlines at 0, 5, 10, 15, 20, 25, 30); y-axis “Annual Erosion (tons/acre)” from 0 to 30 (gridlines at 0, 5, 10, 15, 20, 25, 30). A dashed horizontal line at about $y = 4$ is labeled “T = tolerable loss”. Four curves, all starting near (0,0): “Tillage” (solid thick line) rises steeply, reaching about 12 tons/acre at 5% slope and about 30 tons/acre at roughly 7-8% slope (curve goes off the top of the chart just past slope 7%); “No-till” (dotted line) rises more gradually, crossing the tolerable-loss line around 10% slope and

Question 1

reaching about 29 tons/acre at 30% slope; “No-till + cover crop” (dashed line) rises even more gradually, crossing the tolerable-loss line around 15% slope and reaching about 20 tons/acre at 30% slope; “Crop rotation” (thin solid line) rises the most gradually, staying below the tolerable-loss line until about 20% slope and reaching only about 8 tons/acre at 30% slope.]

(a)(i) Identify the scientific question that resulted in the data presented in the graph.

(a)(ii) Identify the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil.

(a)(iii) Describe the effect of adding a cover crop compared to using the no-till method.

(a)(iv) Identify one natural mechanism of soil erosion.

Question 1

