

Question 2: Analyze an Environmental Problem and Propose a Solution 10 points

- (a) Based on the data in the graphs, **identify** the amount of land required to produce 1 kilogram of chicken protein. **1 point**
- 50 m²
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- (b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle. **1 point**
- Type III
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- (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. **1 point**
- Accept one of the following:
- Darkling beetles reproduce quickly, which allows for a large amount of protein to be produced in a short period of time.
 - Darkling beetles have many offspring, which allows for a large amount of protein to be produced in a short period of time.
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- (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. **1 point**
- Accept one of the following:
- Chicken production has a lower global warming potential than pork production, so it would cause less environmental damage because chicken production releases less greenhouse gas.
 - Chicken production has a lower land use than pork production, so it would cause less environmental damage because there would be less deforestation/habitat destruction/soil erosion/fossil fuel use.
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- (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. **1 point**
- Accept one of the following:
- Beef has a larger impact because methane has a high global warming potential.
 - Beef has a larger impact because methane is a greenhouse gas.
 - Beef requires more land use, which results in loss of forests/habitat/grasslands leading to release of CO₂/reduction in carbon storage.
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(f)	Describe how water quality can be altered by cattle grazing that occurs near a stream or river.	1 point
	Accept one of the following:	
	• Cattle cause erosion, which increases sedimentation/turbidity in water. • Cattle feces can add nutrients/nitrogen/phosphorus to waterways. • Cattle feces may contaminate waterways with bacteria.	
(g)	Propose a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze.	1 point
	Accept one of the following:	
	• Practice rotational grazing/alternate grazing parcels. • Eat a diet with less meat/beef. • Fence/barricade the riparian zone. • Provide other water sources for the cattle.	
(h)	Crop production can cause soil erosion. Describe a sustainable agricultural practice used to reduce soil erosion.	1 point
	Accept one of the following:	
	• Switch crops to perennial plants. • Plant crops on terraces. • Implement contour plowing/farming. • Use no-till farming/cover crops.	

- (i) **Justify** the use of the sustainable practice described in part (h) by describing an additional advantage, other than the reduction of soil erosion. **1 point**

Accept one of the following:

Solution proposed in (h)	Justification of solution with additional advantage other than the reduction of soil erosion
Switch to perennial plants	- Reduces the use of fossil fuels. - Reduces the cost of farming. - Increases/maintains carbon storage in soils. - Preserves habitats for organisms in soils.
Plant crops on terraces	- Allows areas to be farmed that are otherwise too steep. - Sediments and other contaminants settle out behind the terrace ridge reducing the amount of soil that runs off. - Increases groundwater absorption.
Implement contour plowing/farming	- Allows areas to be farmed that are otherwise too steep. - Increases groundwater absorption.
Use no-till farming/cover crops	- Reduces the use of fossil fuels. - Reduces the cost of farming. - Increases/maintains carbon storage in soils. - Preserves habitats for organisms in soils. - Cover crops can be used as green manure.

- (j) Crop production around the world is affected by climate change. **Describe** how crop production could be negatively affected by climate change. **1 point**

Accept one of the following:

- Crop production/yields could decrease because of:
 - Increased drought
 - Increased flooding
 - Increased insect infestation from warmer temperatures
 - Increased temperature
 - Changes in seasonal rain patterns (or temperatures)
 - Expansion of geographic range of invasive pests/species
 - Climate may be outside range of tolerance of crops

Total for question 2 10 points

Question 1: Design an Investigation**10 points**

(a) (i) Identify the scientific question that resulted in the data presented in the graph. **1 point**

Accept one of the following:

- What is the relationship between slope and annual erosion rate for four different land use types?
- Does crop rotation/tilling/not tilling/using cover crops on various slopes increase/decrease/change erosion rates?

(ii) Identify the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil. **1 point**

- Crop rotation

(iii) Describe the effect of adding a cover crop compared to using the no-till method. **1 point**

Accept one of the following:

- Adding a cover crop reduces the annual rate of soil erosion compared to using the no-till method.
- Adding a cover crop allows planting on greater sloped land before reaching tolerable loss as compared for the no-till method.

(iv) Identify one natural mechanism of soil erosion. **1 point**

Accept one of the following:

- Moving/flowing water
- Rainfall
- Wind

Total for part (a) 4 points

(b) (i) Identify the dependent variable stated in the hypothesis. **1 point**

Accept one of the following:

- The amount of sediment discharge
- The amount of sediment run-off

(ii) Describe one way to add a control to improve the design of the study. **1 point**

Accept one of the following:

- Add a plot that is bare/does not have straw bales or grass (no ground cover).
- Measure sediment discharge/runoff prior to placing straw bales or planting grass compared to discharge after the bales/grass are in place (pre-/post-tests).

(iii) **Identify** one variable that was not discussed that could affect the results of the study. **1 point**

Accept one of the following:

- Slope of the plots
- Amount of rainfall
- Composition of the roads
- Distance of the plots from road/stream
- Size of the plots
- Type of soil at the plots
- When the data are collected at the plots (how quickly after rainfall)

(iv) Based on the data in the table above, **make a claim** about the stated hypothesis. **1 point**

Accept one of the following:

- The stated hypothesis is rejected as more sediment resulted from straw bale plots (plot A) than grass planted plots (plot B).
- The data in the table shows that the grass is more effective at reducing sediment runoff. The hypothesis should be rejected.

Total for part (b) 4 points

(c) (i) **Describe** the type of survivorship curve expected for these fish species. **1 point**

Accept one of the following:

- Low survival rate in early life, followed by increased chances of survival as the organism matures.
- Most offspring die at a very young age and few reach maturity.

(ii) **Explain** why the input of sediment to a stream can negatively affect reproduction of fish that lay their eggs in the gravel of the streambed. **1 point**

Accept one of the following:

- Sediment can cover/bury eggs, which reduces the amount of oxygen, causing them to die.
- Sediment takes away usable habitat/space resulting in fewer areas for them to lay eggs causing fewer eggs to survive.
- Sediments can carry toxic/poisonous chemicals, which can negatively impact the eggs and decrease egg survival.
- An increase in sediment can increase the water temperature and result in less dissolved oxygen/too warm water, which can decrease the viability of the eggs that have already been laid.
- Sediment can increase water turbidity, which decreases fish navigation/ability to forage/efficiency of oxygen use which decreases the amount of eggs laid.

Total for part (c) 2 points

Total for question 1 10 points