

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
- (b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle. **1 point**
- Type III
- (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.
- (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.
- (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.

- (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	