

**AP[®] ENVIRONMENTAL SCIENCE
2009 SCORING GUIDELINES**

Question 4

(a) Reply to the following questions based on the data in the graph.

Four points can be earned: 1 point for the correct answer in each section.

- (i) **Calculate the increase in the area of land used for growing GM [genetically modified] crops in developing countries from 1999 to 2003. Express your answer as a percentage of the 1999 value.**

1999 (10 million hectares) to 2003 (20 million hectares)
Increase of 10 million hectares = 100 percent increase

- (ii) **Calculate the annual rate of increase in land area used for growing GM crops in industrialized countries from 1997 to 1999.**

1999	30 million hectares	
1997	10 million hectares	
2 years	20 million hectares	20 million ha/2yr = 10 million ha/yr

Must have units of "hectares" or "hectares/yr"

Note: Percentage answer accepted only if both years are calculated as independent percentages.

First year 100 percent Second year 50 percent Ave. Ann. 75 percent

- (iii) **Using the rate you calculated in part (ii), project the area of land that would have been expected to be used for GM crops in industrialized countries in 2004.**

1999	-----	30 million hectares
5 years	10 million hectare increase/yr	50 million hectares
2004		80 million hectares (<i>must have units</i>)

Note: Students who incorrectly calculate (ii) can still get points if the solution is correct in (iii).

For example: 5 million hectares/year in (ii)

5 years @ 5 million hectares/year = 25 million hectares, for a total 55 million hectares.

- (iv) **Identify one likely cause for the difference between the projected land area for GM crops in industrialized countries in 2004 and the actual land area for GM crops in industrialized countries in 2004.**

Genetically modified crops faced:

- Increased public resistance (toward perceived risks, due to increased awareness following labeling of products)
- Decreasing market demand for products containing genetically modified organisms (GMOs)
- Governmental regulation/controls/limitations/bans that limited the planting/use of GM crops

Note: "Decrease in available land" is not acceptable.

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Question 4 (continued)

(b) Describe one environmental advantage and one environmental disadvantage of using GM crops.

Two points can be earned: 1 point for a description of a viable advantage and 1 point for a description of a viable disadvantage.

**Environmental Advantages: 1 point
(Score only the first advantage provided by student)**

Higher yields per acre and hence less acreage needed/impacted by agriculture

Permits low-tillage agriculture (due to herbicide resistance in GM crops), which:

- Reduces soil exposure/erosion
- Reduces energy consumption associated with farm machinery (plowing, harrowing, etc.)
- Can reduce evaporative water loss

GM crops may exhibit:

- Lower fertilizer requirements, which reduces negative impacts of fertilizers
- Insect resistance and the associated reduced impact of insecticide/pesticide use/production/exposure
- Drought resistance and the associated decreased need for irrigation
- Disease resistance and the associated decreased need for fungicide applications
- Salinity tolerance, which decreases the need for flushing of soils with water
- Frost resistance, which extends seasonal productivity and decreases crop loss
- Perennial life span (rather than annual), which reduces the need for tillage (see above)
- Firmer tissues/peels/shells reduce waste as a result of increased shelf life and reduced spoilage

