Visual Aids

California Education and the Environment Initiative

B

Biology Standard B.5.c.

High-Tech Harvest: Genetic Engineering and the Environment

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Initiative Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency

California Natural Resources Agency

California State Board of Education

California Department of Education

Department of Resources Recycling and Recovery (CalRecycle)

Key Partners:

Special thanks to **Heal the Bay,** sponsor of the EEI law, for their partnership and participation in reviewing portions of the EEI curriculum.

Valuable assistance with maps, photos, videos and design was provided by the **National Geographic Society** under a contract with the State of California.

Office of Education and the Environment

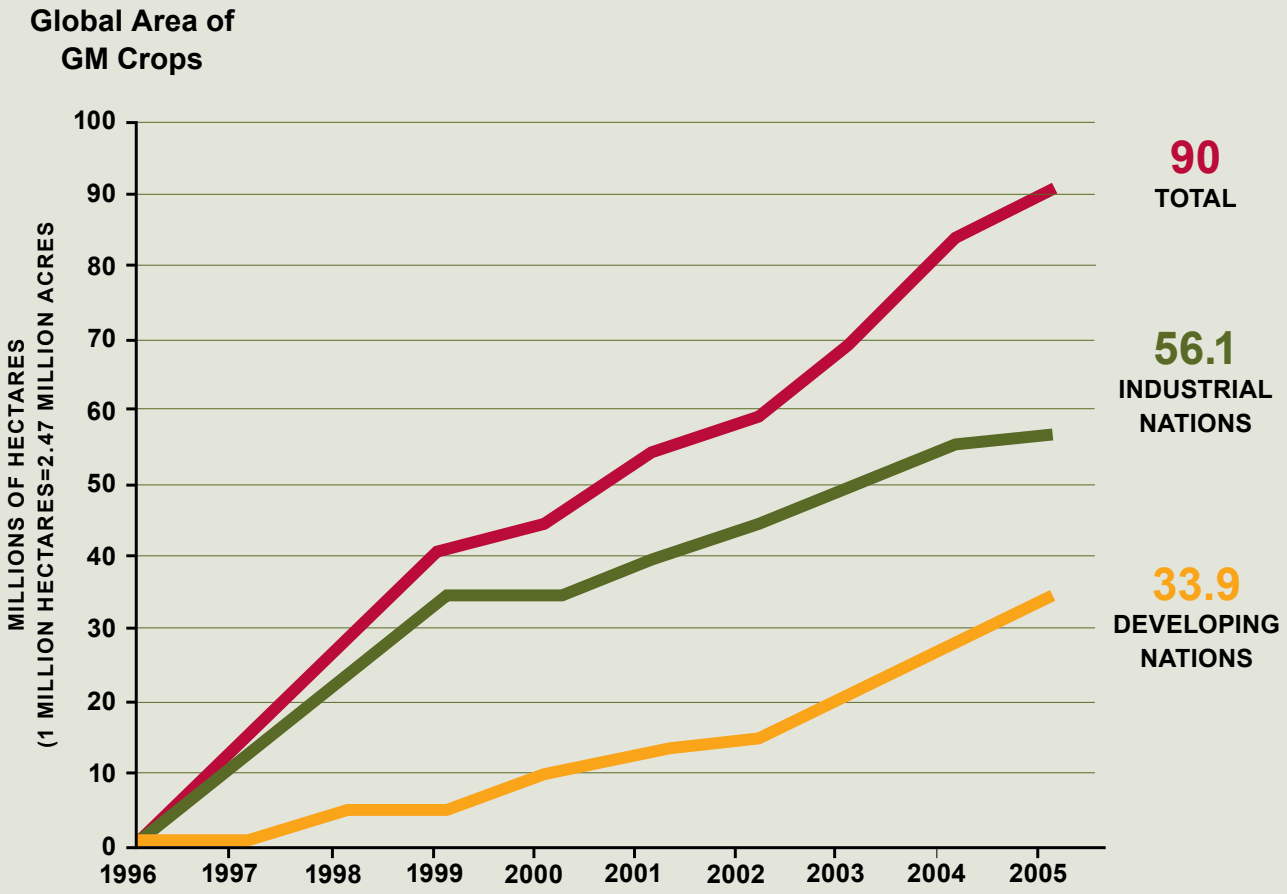
1001 I Street • Sacramento, California 95814 • (916) 341-6769

http://www.CaliforniaEEI.org

Contents

VA #1 Growth of Genetically Modified Crops Since 1996

The year 2005 marked the 10th anniversary of the commercialization of genetically modified (GM) crops. More than half of the biotech harvest is grown in the U.S.



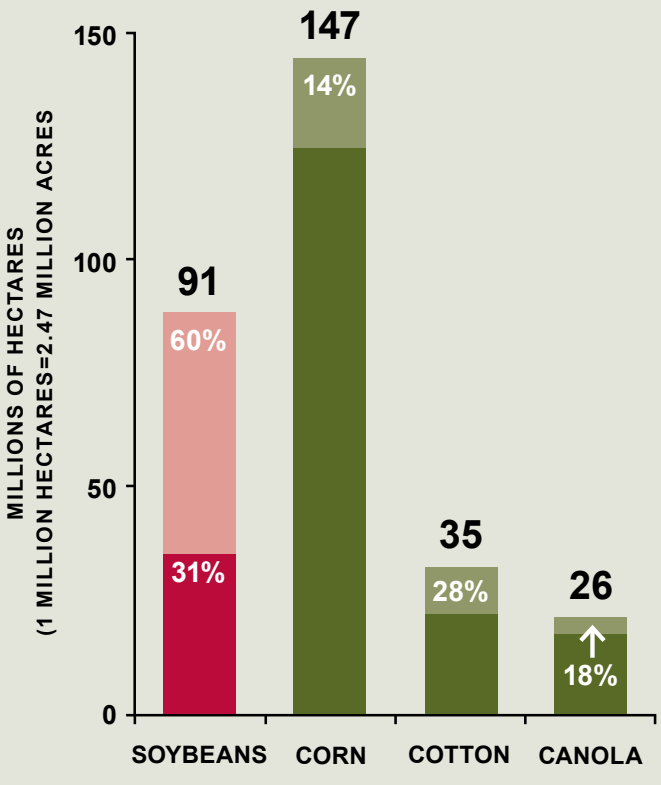
Source: Clive James, ISAAA Briefs No. 34, Global Status of Commercialized Biotech/GM Crops: 2005; www.isaaa.org

VA #2 Types of Genetically Modified Crops

The Most Common GM Crops

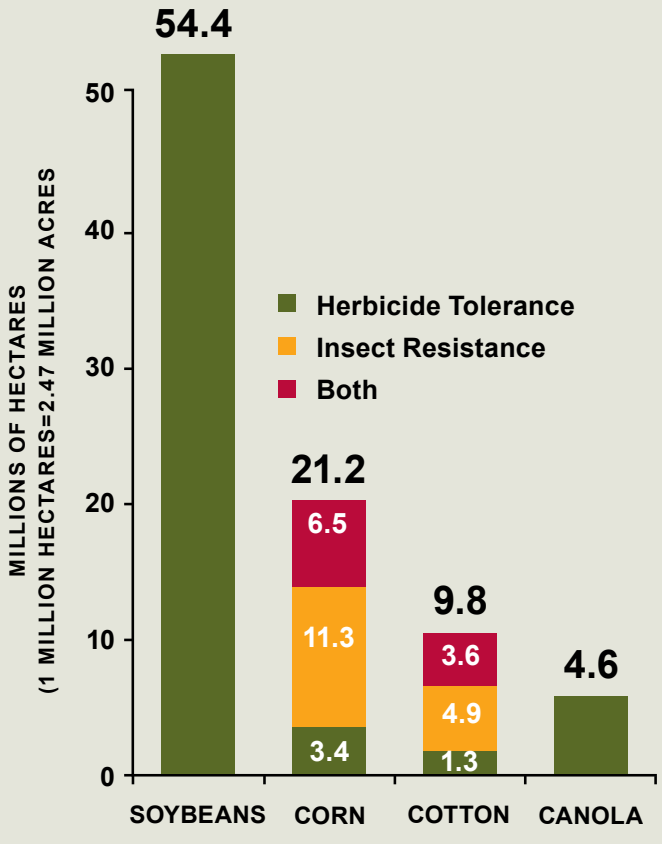
Soybeans, corn, cotton, and canola were the dominant GM crops in 2005, covering 30% of the 299 million hectares devoted to these four commodities.

Lighter colors and percentages indicate the portion of the crop that is genetically modified.



How They Are Modified

Virtually all GM soybeans and canola planted in 2005 were herbicide-tolerant; corn and cotton were herbicide-tolerant or insect-resistant, or both.



Source: Clive James, ISAAA Briefs No. 34, Global Status of Commercialized Biotech/GM Crops: 2005; www.isaaa.org

VA #3 Selective Breeding for Mini-Watermelons

First generation of watermelons: Includes a variety of sizes; some are large, some are medium sized, and some are small.

Breeders plant only the seeds from the mini-watermelons.

Second generation of watermelons: Produces a crop that is tending toward smaller melons but still has a few large watermelons.

Breeders again plant seeds from only the mini-watermelons.

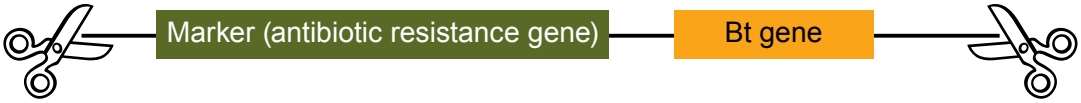
Third generation crop: Consists almost entirely of mini-watermelons.

And so on…

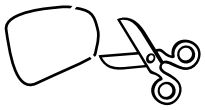
VA #4 Genetically Engineered Corn 1

Step 1: Select the Bt gene from the bacterium *Bacillus thuringiensis* (Bt).

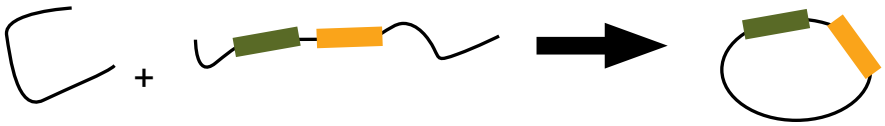
Step 2: Add a marker gene (such as a gene for resistance to antibiotics) to the Bt gene. Cut the ends with a restriction enzyme.



Step 3: Use a restriction enzyme to cut open a plasmid, creating a place to insert the marker/Bt genes.



Step 4: Mix the marker/Bt genes with the open plasmids. Use ligase to connect the DNA.

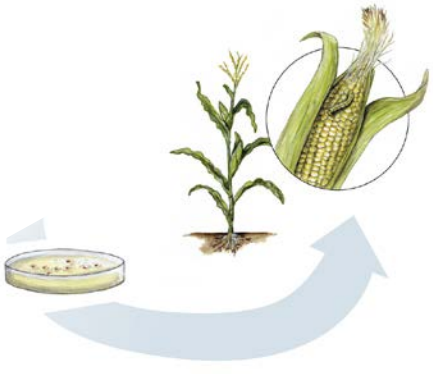


VA #5 Genetically Engineered Corn 2

Step 5: Insert the plasmids into corn cells.

Step 6: Test the treated cells with an antibiotic. Only cells that have been transformed, or contain the marker gene and the Bt gene, will survive.

Step 7: Grow the surviving transgenic cells into plants. The plants produced from the seeds of these plants will produce the Bt toxin that kills insects.



VA #6 Influences of Genetically Engineered Products

Genetically Engineered Product	Natural Systems	Biological Diversity	Human Health
Bt corn			
Malaria-resistant mosquitoes			

VA #7 Going Beyond the Field: Group Instructions

Read the information provided describing a modern genetically engineered product. Then discuss the following with your group members:

- Describe the genetically engineered product. How is it different from a non-genetically engineered organism?
- What was the reason, or rationale, for genetically engineering this organism?
- What are the effects of this product on natural systems, biological diversity, and human health?

Create a two- to three-minute presentation for the rest of the class that addresses these points.

VA #8 Going Beyond the Field

Genetically Engineered Product	Natural Systems	Biological Diversity	Human Health
Biofuels/ Microdiesel			
Toxic- avenger trees			
Vaccines in food			
Anthrax vaccine from tobacco			
Animals			
Golden rice			

VA #9 Discussion/Notes Guide

Use the reading to discuss these topics with your group:

- the current status of genetically engineered rice in California
- how genetically engineered rice influences natural systems
- the environmental, economic, and health benefits of genetically engineered rice
- the environmental, economic, and health concerns about genetically engineered rice
- ways to prevent genetic contamination

Take notes to use as a reference for the homework assignment.

VA #10 Making Decisions about Pharm Rice

Factor to be considered	Stakeholders

California STATE BOARD OF EDUCATION

California Education and the Environment Initiative