

## PLANTS NEED TO BE *bug-proofed*

Humans aren't the only ones who eat plants. Pests like bugs that eat them. Viruses or bacteria make them sick. Some biotech crops make insecticide proteins from a naturally occurring microbe, called Bt. This protein has been used safely for backyard gardeners since the 1930s.

When insects eat the Bt plants they eat the insecticide protein that makes holes in their gut causing death.

- Use of Bt crops has reduced applications of other insecticides.
- Another commercial biotech crop helps oil refiners by allowing lower sulfur levels.

## PLANTS NEED TO *protect their turf*

Soil is a plant's home and provides a way for their roots to find water and nutrients, while anchoring the plant against wind and rain.

Planting helps control erosion that carries soil into rivers for water and treatment.

Soil using a precision soil sensor and sensor.

Some biotech crops allow weed control without plowing, tilling and relatively herbicide-free methods.

- Reduce soil erosion
- Reduce water and pesticide runoff from fields
- Limit erosion fuel use
- Lower greenhouse gas emissions in agriculture

## PLANTS NEED TO *eat less*

Plants like humans need resources to grow and need protection from insects.

Genetic engineering can help reduce the amount of food we eat by making plants more resistant to insects.

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# USING BIOTECHNOLOGY FOR SUSTAINABILITY

## WHAT IS *agricultural sustainability?*

**THE FUTURE**

**Making today's needs without compromising the future.**

- Meet 9Bn. Active Agricultural Sustainability
- Increase food production for growing populations while decreasing environmental impact
- Improve human health with safe, more nutritious food
- Increase social and economic well-being of those who produce food

**World Population Growth**

## HAVE HUMANS BEEN INVOLVED IN *modifying plants?*

Humans have modified plants for thousands of years by selecting varieties with different traits.

There are 30,000 genes in the plant's genetic information stored in the chemical language of DNA.

Over 50 years ago, scientists have been modifying using the new tools of genetic engineering.

Genetic engineering, called recombinant biotechnology, uses genetic information from the animal or different organisms to target plants with new traits.

Recent developed using genetic engineering are called GE, GM or biotech plants.

**EXAMPLES OF GENETIC ENGINEERING USES FOR FOOD**

## CAN AGRICULTURAL BIOTECHNOLOGY *contribute to sustainability?*

A critical feature in a developed and developing countries is the demand for food.

The population of the world is expected to reach 9 billion by 2050, with a significant increase in the number of people living in urban areas.

**REDUCED CO<sub>2</sub> EMISSIONS**

CO<sub>2</sub> savings were reported in planting 8.54 million acres from the rain.

**ECONOMIC SUSTAINABILITY**

Global net economic benefits in 2008 was \$4.2 billion.

- \$4.7 billion from increased productivity
- \$4.5 billion from reduced risk

**INCREASED PRODUCTION**

Global production of food.

Crop area increased by 18%  
Crop production increased by 100%  
due primarily to Bt systems.

## PLANTS NEED TO *drink less*

Plants like humans need water to survive and grow.

Percentage of water delivered to California agricultural use:

- Water requires a lot of water. Cattle may require 100 gallons of water to produce a pound of grain.
- In California, agriculture uses a significant % of the water delivered by aqueducts for other crops and uses also use water.
- Caring plants with high yields and low water needs will save water for other needs while still growing crops, food and fiber.

## PLANTS CAN MAKE US *healthier*

Research shows that eating fresh fruits and vegetables may improve human health. Increasing the amount of fruits and vegetables in your diet can help to prevent certain chronic diseases.

- Regular Cherry Tomatoes**  
Reduced Cancer
- High Anthocyanin Purple Tomatoes**  
Lower cholesterol and triglycerides, reduce blood pressure, improve insulin sensitivity, and reduce risk of heart disease.
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**FOR MORE INFORMATION**

<http://bit.ly/ucdavis>

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ucdavis.edu/sustainable



USING *BIOTECHNOLOGY* FOR

**SUSTAINABILITY**

WHAT IS

# *agricultural sustainability?*

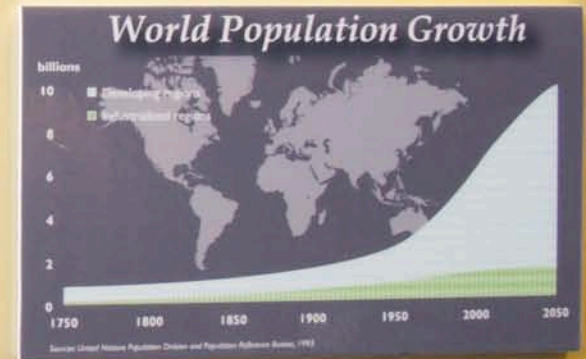
THE FUTURE



*Meeting today's needs  
without compromising the future.*

## How Can We Achieve Agricultural Sustainability?

- Increase food production for expanding population while decreasing environmental impact
- Improve human health with safer, more nutritious food
- Increase social and economic well-being of those who produce food



# HAVE HUMANS BEEN INVOLVED IN *modifying plants?*

Humans have modified plants for thousands of years by crossing varieties with different traits.

Traits are specified in the plant's genetic information, written in the chemical language of DNA.

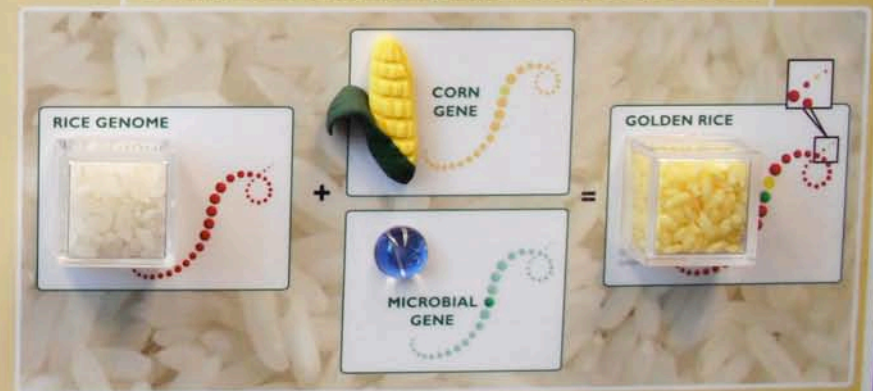
For 30 years, plant traits have been modified using the new tools of genetic engineering.

Genetic engineering, called modern biotechnology, uses genetic information from the same or different organisms to create plants with new traits.

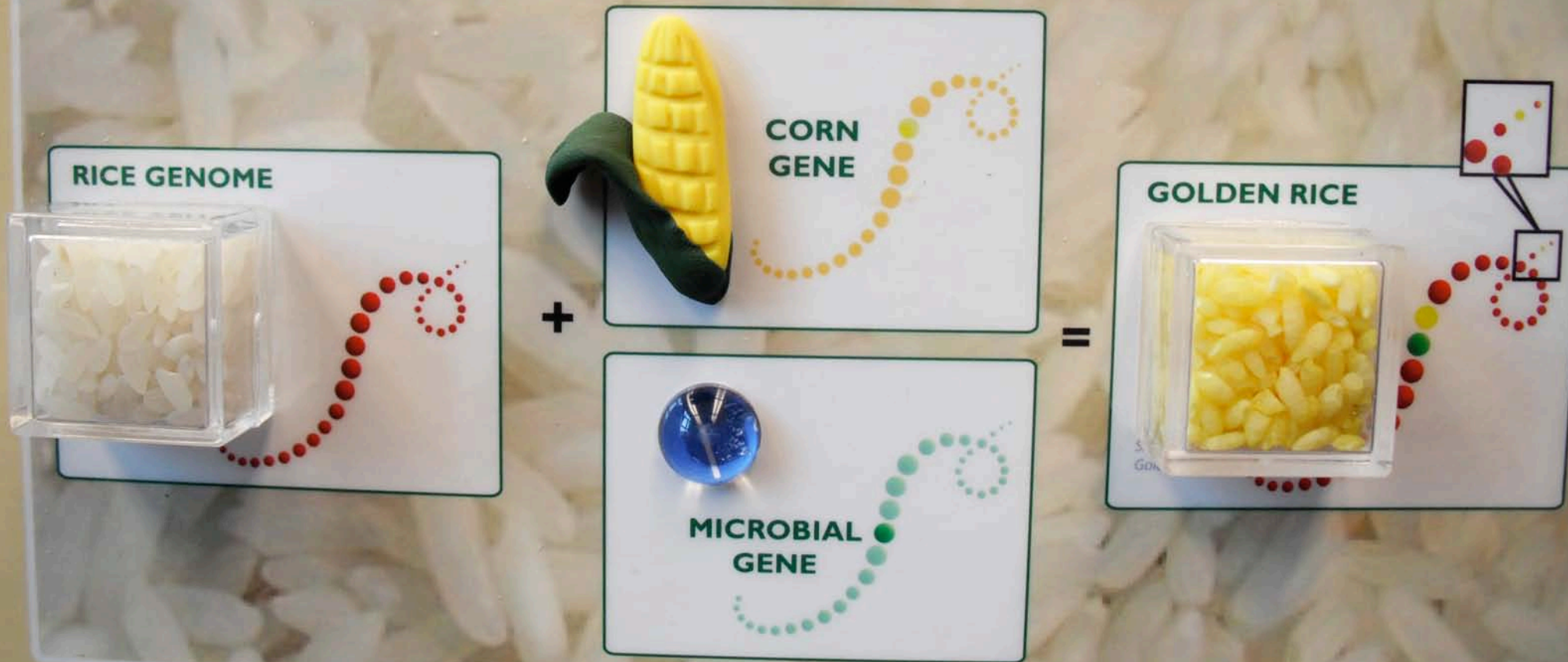
Plants developed using genetic engineering are called GE, GM or biotech plants.

*New genetic tools allow specific traits, encoded in genes, to be moved from one source to another to improve crops. For example, insertion into rice of two genes, one each from corn and a microbe, were used to increase the nutritional content of rice grains. This resulted in a new rice variety that accumulates pre-vitamin A in the grain, giving it a yellow color. A serving of this Golden Rice satisfies the minimum daily requirement for vitamin A, a deficiency associated with an estimated 6000 deaths **per day** in the developing world.*

## EXAMPLE OF GENETIC ENGINEERING: GOLDEN RICE



# EXAMPLE OF GENETIC ENGINEERING: GOLDEN RICE





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# CAN AGRICULTURAL BIOTECHNOLOGY *contribute to sustainability?*

14 million farmers in developed and developing countries grow biotech crops. This represents 9% of all cropland worldwide – equal to **three times the size** of California.



## REDUCED CO<sub>2</sub> EMISSIONS

CO<sub>2</sub> savings were equal to removing 6.94 million cars from the road.



## ECONOMIC SUSTAINABILITY

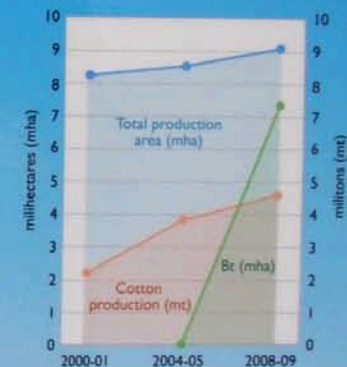
Global net economic benefit in 2008 was \$9.2 billion

**\$4.7 billion**  
in developing countries

**\$4.5 billion**  
in industrial countries

## INCREASED PRODUCTION

Cotton production in India



Crop area increased by 10%  
Crop production increased by 200%  
due primarily to Bt cotton

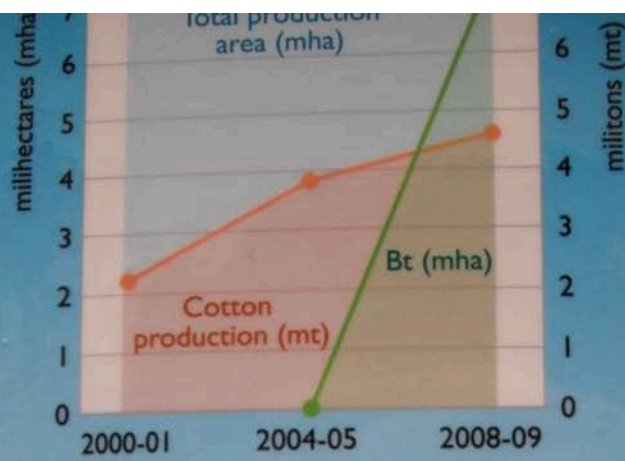


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Humans aren't the only ones who eat plants!

Plants have bugs that eat them.  
Viruses or bacteria make them sick.

Some biotech crops make insecticidal proteins from a naturally occurring microbe, called **Bt**. This protein has been used safely by backyard gardeners since the 1950's.

When insects eat the Bt plants, they eat the insecticidal protein that pokes holes in their gut causing death.

- Use of Bt crops has reduced applications of other insecticides.
- Another commercial biotech crop fends off viruses by shutting down their growth.





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# PLANTS NEED TO *protect their turf*

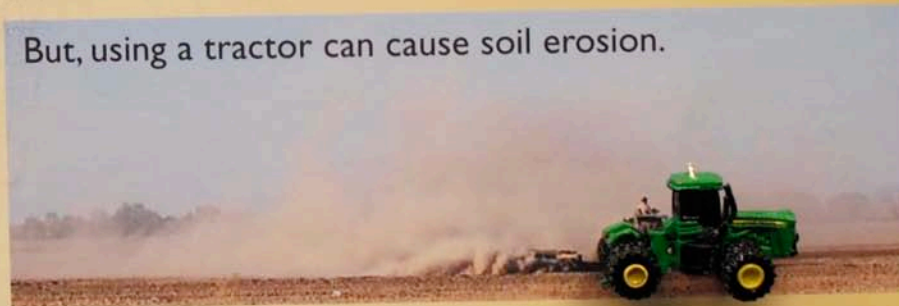
Soil is a plant's home and provides a way for their roots to find water and nutrients, while anchoring the plant against wind and rain.



Weeds in field

Plowing helps control weeds that compete with crops for water and nutrients.

But, using a tractor can cause soil erosion.



**Some biotech crops allow weed control without plowing, leaving soil relatively undisturbed which:**

- Reduces soil erosion
- Reduces water and pesticide runoff from fields
- Limits tractor fuel use
- Lowers greenhouse gas emissions
- Improves wildlife habitats



Healthy alfalfa field



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But, using a tractor can cause soil erosion.



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# *eat less*

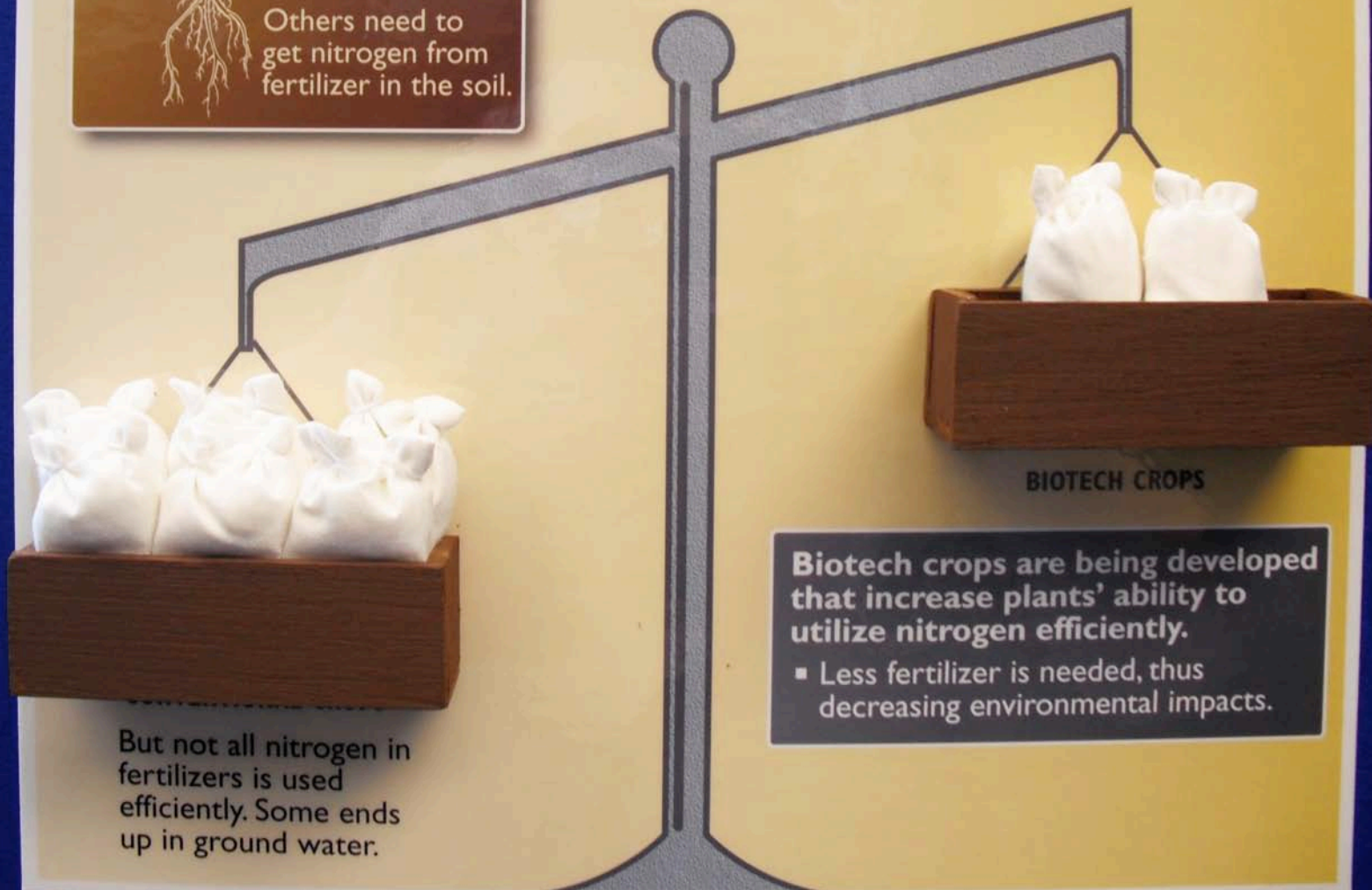


Some plants  
fix nitrogen  
from the air.



Others need to  
get nitrogen from  
fertilizer in the soil.

Plants, like humans, need nutrients to grow and one important one is nitrogen.



BIOTECH CROPS

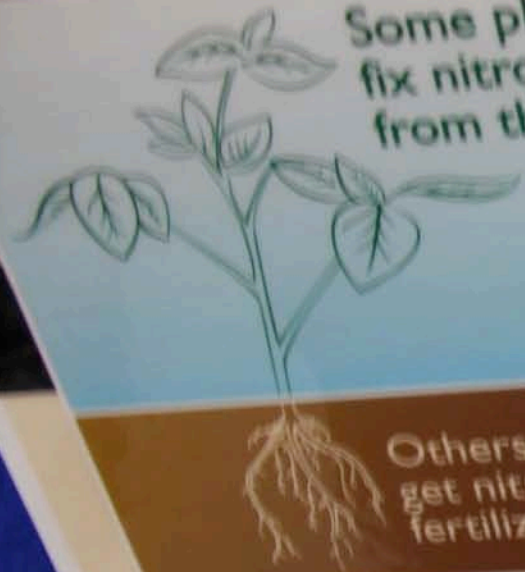
**Biotech crops are being developed that increase plants' ability to utilize nitrogen efficiently.**

- Less fertilizer is needed, thus decreasing environmental impacts.

But not all nitrogen in fertilizers is used efficiently. Some ends up in ground water.

PLANTS NEED TO

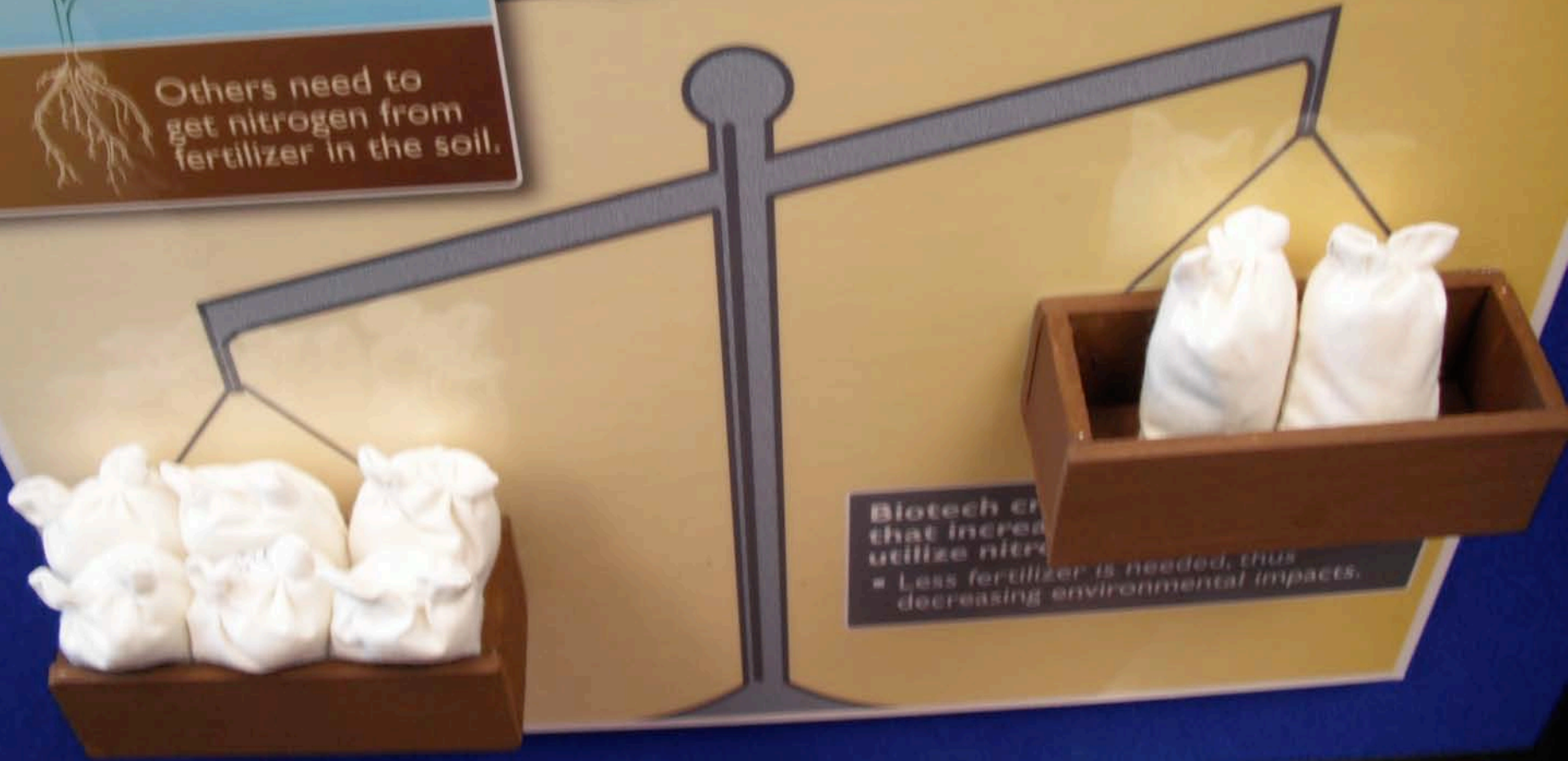
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## CONVENTIONAL CROPS

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# PLANTS NEED TO *drink less*

Plants, like humans, need water to survive and grow.

Percentage of water delivered  
by California aqueducts to:

42% Streams, wild & scenic rivers

38% Irrigated agriculture

11% Urban

9% Sacramento/San Joaquin Delta

- Plants require a lot of water. Corn may require ~40 gallons of water to produce a pound of grain.
- In California, agriculture uses a significant % of the water distributed by aqueducts, but urban areas and rivers also use water.
- Creating plants with high yields that use less water leaves more water for other needs - while still providing ample food and fiber.

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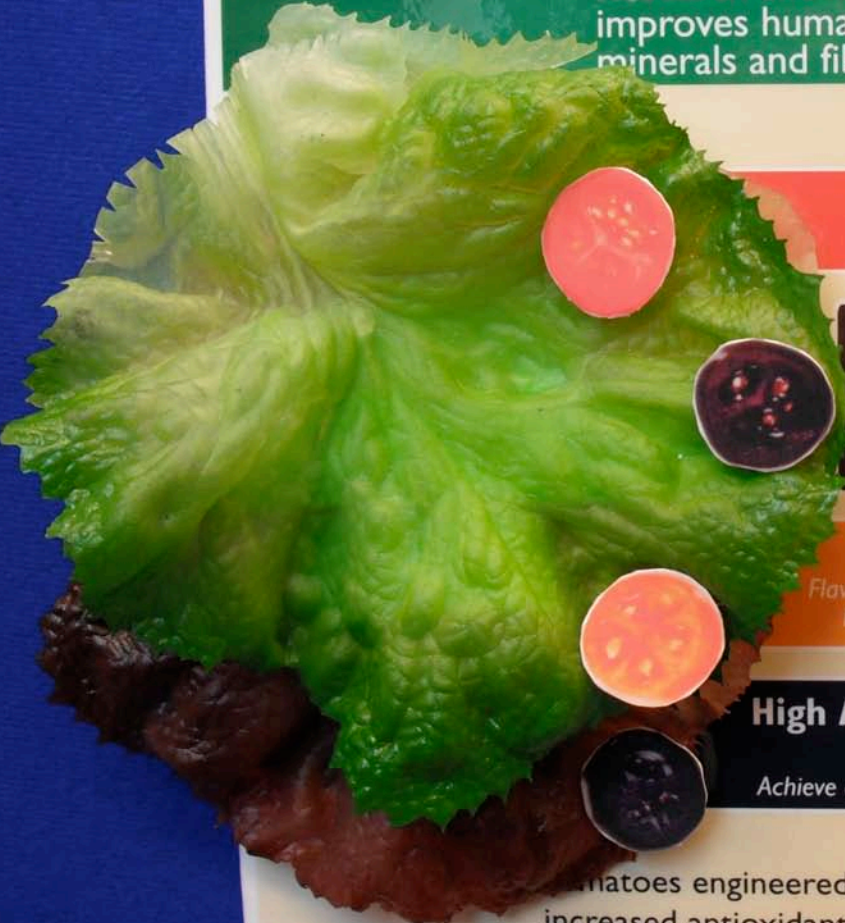
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# PLANTS CAN MAKE US *healthier*

Research shows that eating fresh fruits and vegetables daily improves human health because they contain vitamins, minerals and fiber to protect against chronic diseases.



## Regular Cherry Tomato

Source of vitamins A, D and K.

## High Anthocyanin Purple Tomato

Vitamins plus anthocyanins that help protect against cardiovascular disease and certain cancers.

Diets supplemented with 10% purple tomato increased lifespan of cancer-prone mice!

## High Flavonol Orange Tomato

Flavonols, which are similar to resveratrols, present in red wine, help prevent certain types of cancers and heart disease.

## High Anthocyanin/High Flavonol Indigo Tomato

Achieve all the benefits of both types of tomatoes.

Tomatoes engineered to have increased antioxidants, like those in red wine and blueberries.

**Biotech tomatoes were engineered to have increased antioxidant levels to help protect against certain chronic diseases.**

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# FOR MORE INFORMATION

<http://sbc.ucdavis.edu>



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