Chapter 20 Opener
Environmental Science for a Changing World with Extended Coverage

Desperate residents plead to the Kenyan Red Cross for food in 2008.

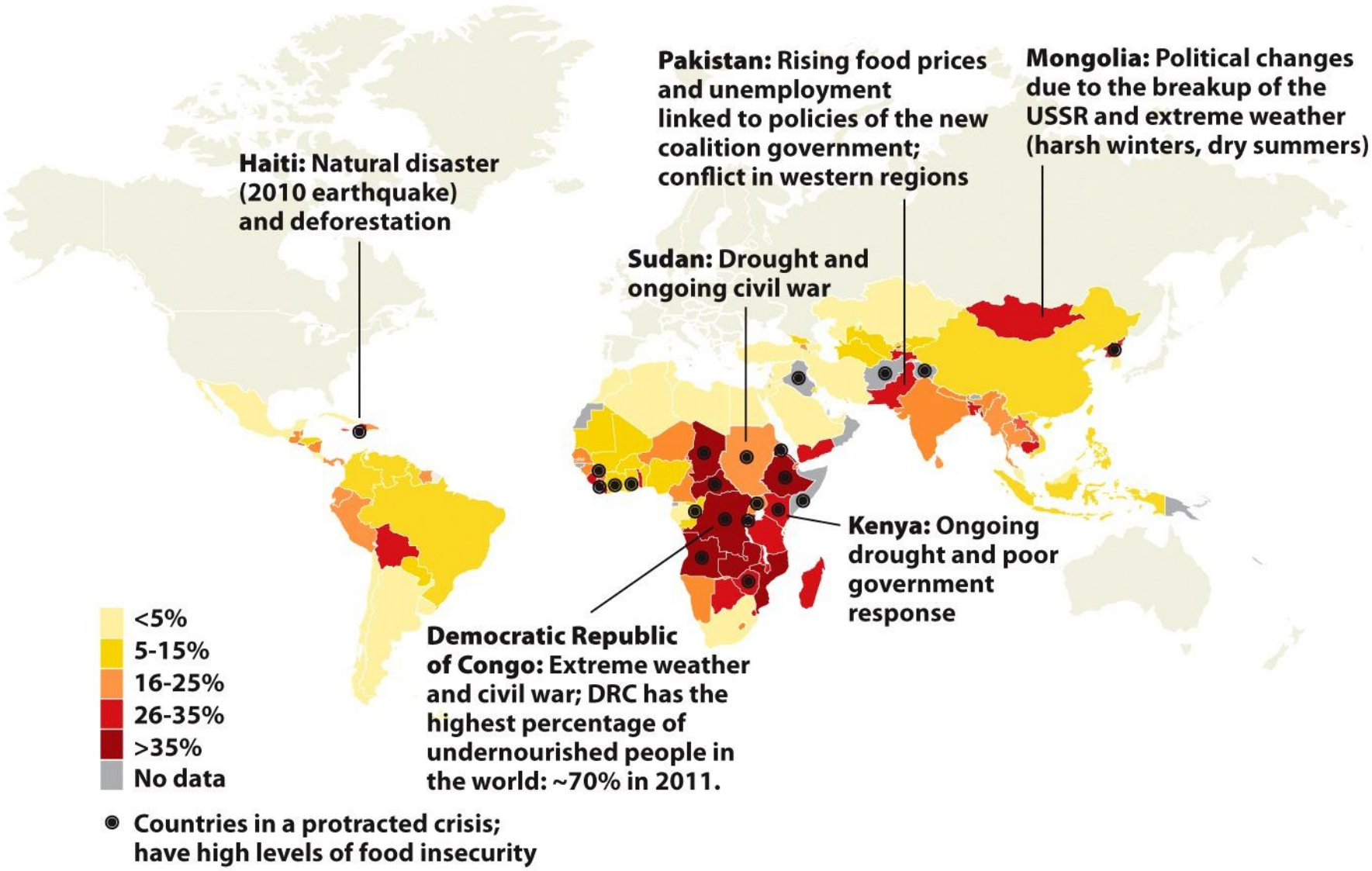
A Gene Revolution: Can Genetically Engineered Food Help End Hunger?

Chapter 20: Feeding the World

United Nations 2010 estimate: 925 million people (16% of world population) suffered from undernutrition—meaning they did not consume enough calories.

World Health Organization: 50 million people starve to death every day.

PERCENTAGE OF POPULATION UNDERNOURISHED (2006–2008)



Infographic 20.1 part 1

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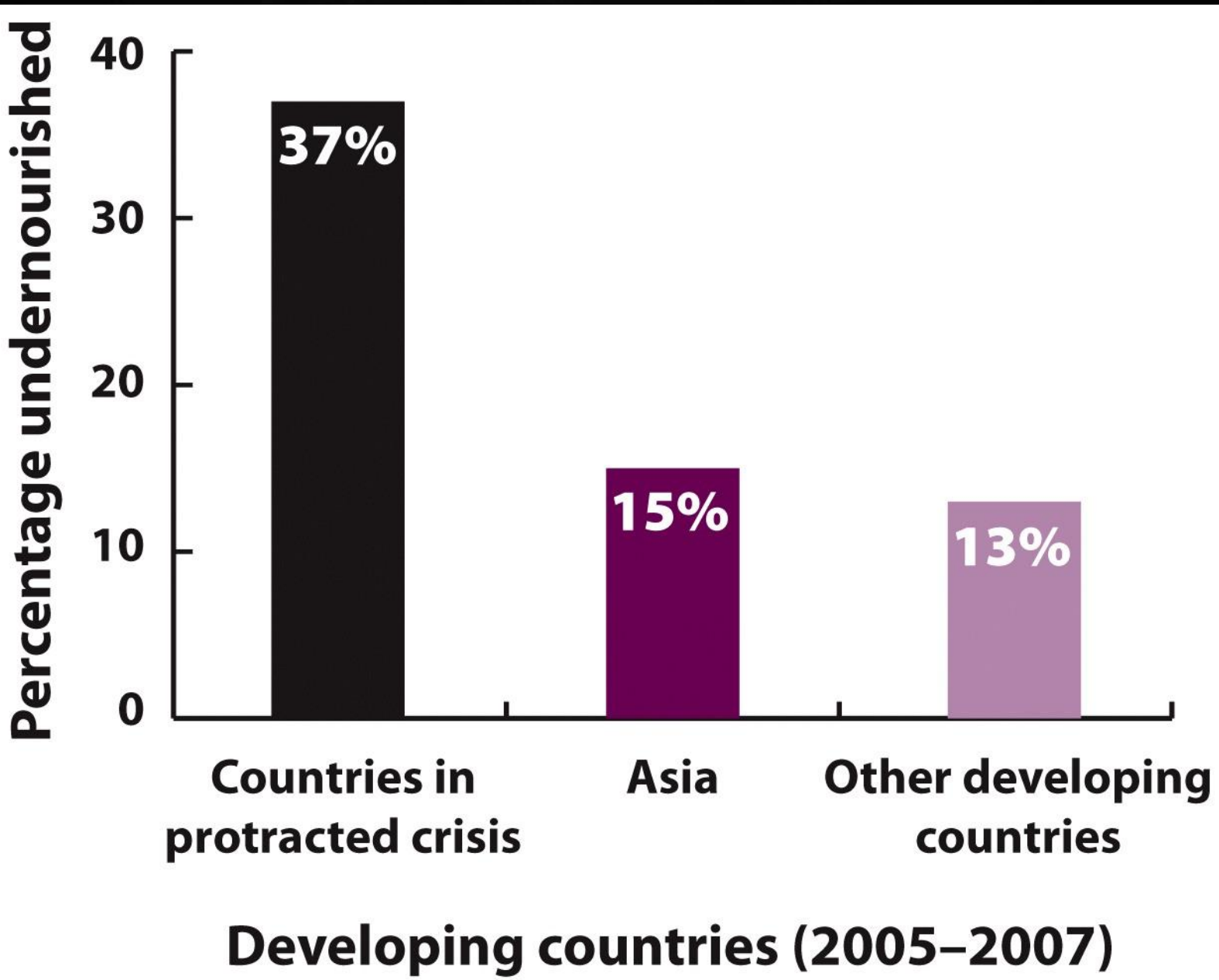

Infographic 20.1 part 2

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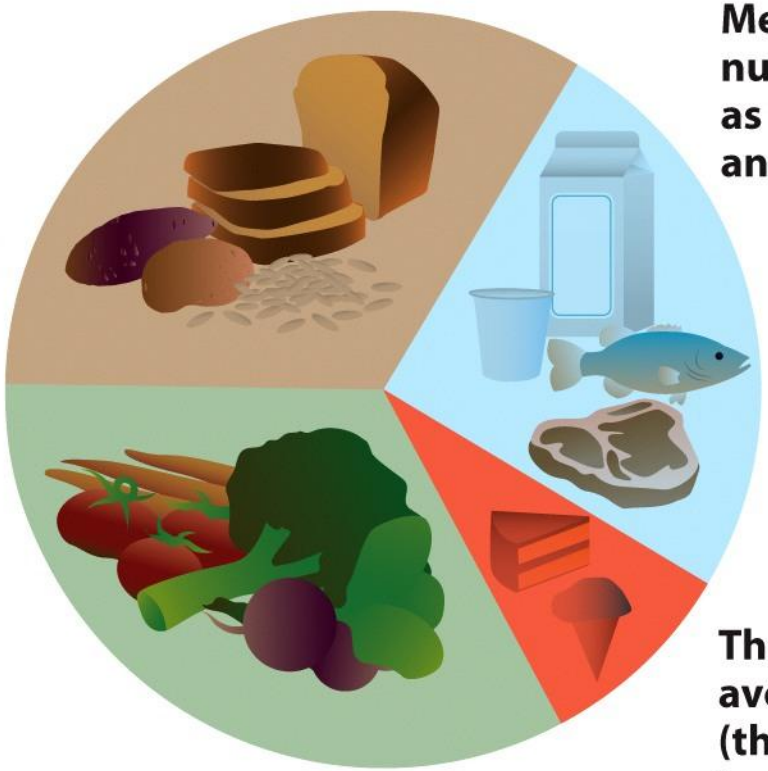
United Nations' goal is to achieve total food security—all people at all times having access to sufficient, safe, and nutritious food.

Grains, fruits, and vegetables provide carbohydrates and fiber and are a rich source of many micronutrients, such as the vitamins and minerals needed for good health.



Meat, fish, dairy, legumes, and nuts are good sources of protein as well as of some needed vitamins and minerals.

Fats are also necessary, but some food sources of fat are better than others. The intake of saturated animal fats should be minimized.

There is a little room in the average diet for empty calories (those that provide only energy but no nutrition), but not much!

Infographic 20.2

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Infographic 20.3 part 1
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Malnutrition is defined as a state of poor health that results from inadequate or unbalanced food intake.

NUTRIENT	HEALTH PROBLEMS FROM DEFICIENCY	CORRECTIVE MEASURES
Vitamin A: Found in plant-based foods that contain red and orange pigments (carotenoids)	Developmental problems and immune deficiencies; acute deficiencies lead to blindness. More than 100 million children suffer from vitamin A deficiency.	Breast-feeding is helpful since it is a good source of vitamin A; supplements or fortified foods can be used, and golden rice—a variety of rice that is genetically engineered to be high in vitamin A—is also being pursued.
Iron: Meat is a good source of iron; it is also found in spinach, legumes, and whole grains.	Anemia (iron is needed by red blood cells to carry oxygen to cells). As many as 4–5 billion people suffer from iron deficiency-including half of all pregnant women and children under 5; worldwide, 2 billion people are iron deficient enough to be anemic.	Access to foods naturally high in iron or those that have been fortified with extra iron (such as bread and many cereals) helps prevent deficiencies.
Iodine: Found in seafood and in crops grown in regions with iodine in the soil	Thyroid function and fetal brain development are impaired; the WHO calls this the world's most preventable cause of brain damage. Though the situation is improving, almost a billion people worldwide have some level of iodine deficiency.	Iodized salt is an inexpensive solution to this deficiency. Conversely, too much iodine can cause health problems.
Zinc: Found in meat, dairy, and fish	Lowered immunity, stunted growth, and learning disabilities. The WHO estimates that as many as 2 billion people worldwide suffer from zinc deficiencies; it is especially prominent in poor regions where meat or fish intake is low.	Supplements or fortified foods can be used. Plant-breeding programs that increase zinc uptake by crops will help those who live on a largely plant-based diet.

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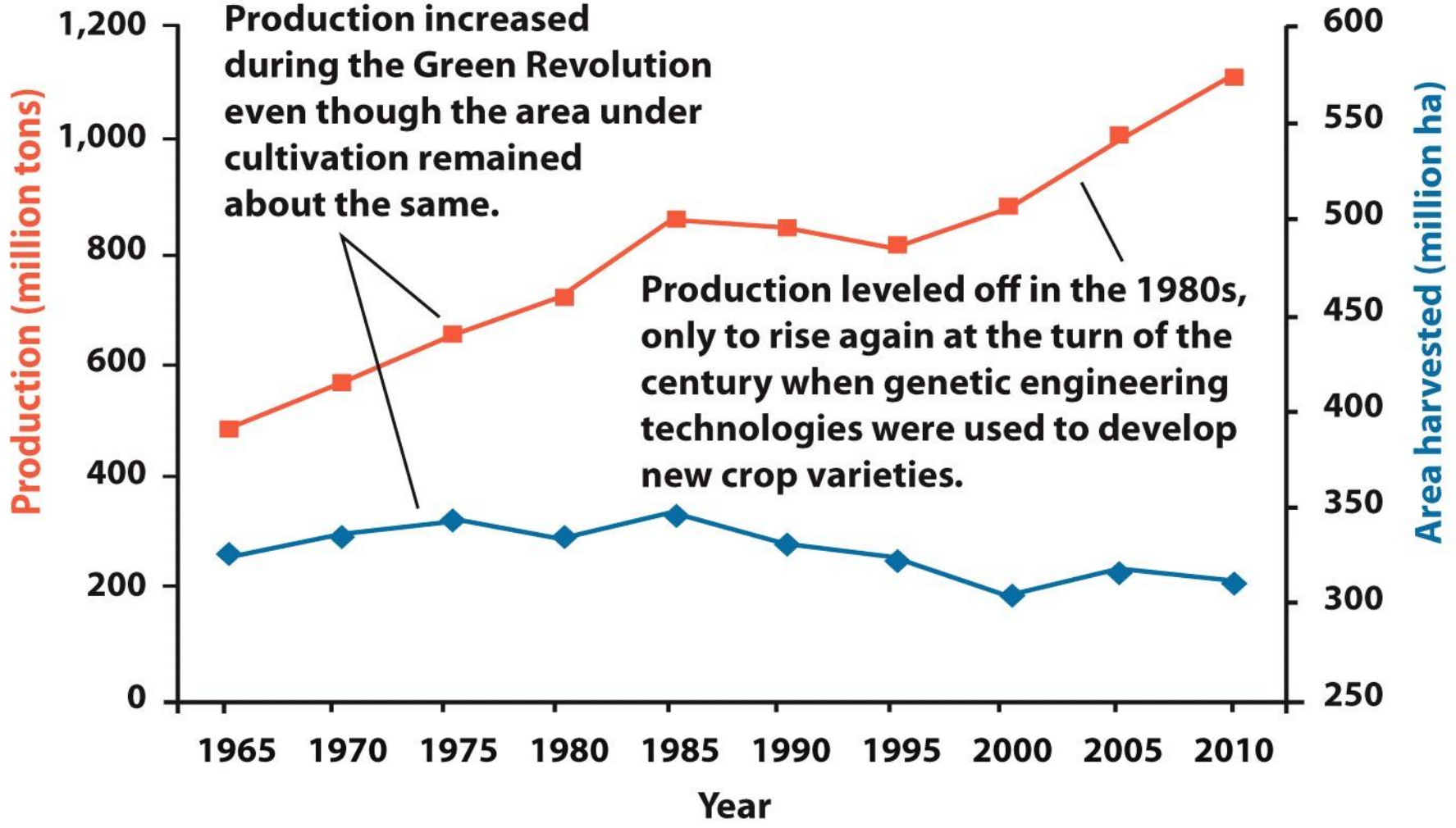
The 1960s Green Revolution increased food supplies worldwide.

AREA HARVESTED OVER TIME IN WORLDWIDE PRODUCTION OF GRAIN



Infographic 20.4

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The Green Revolution also brought new problems:

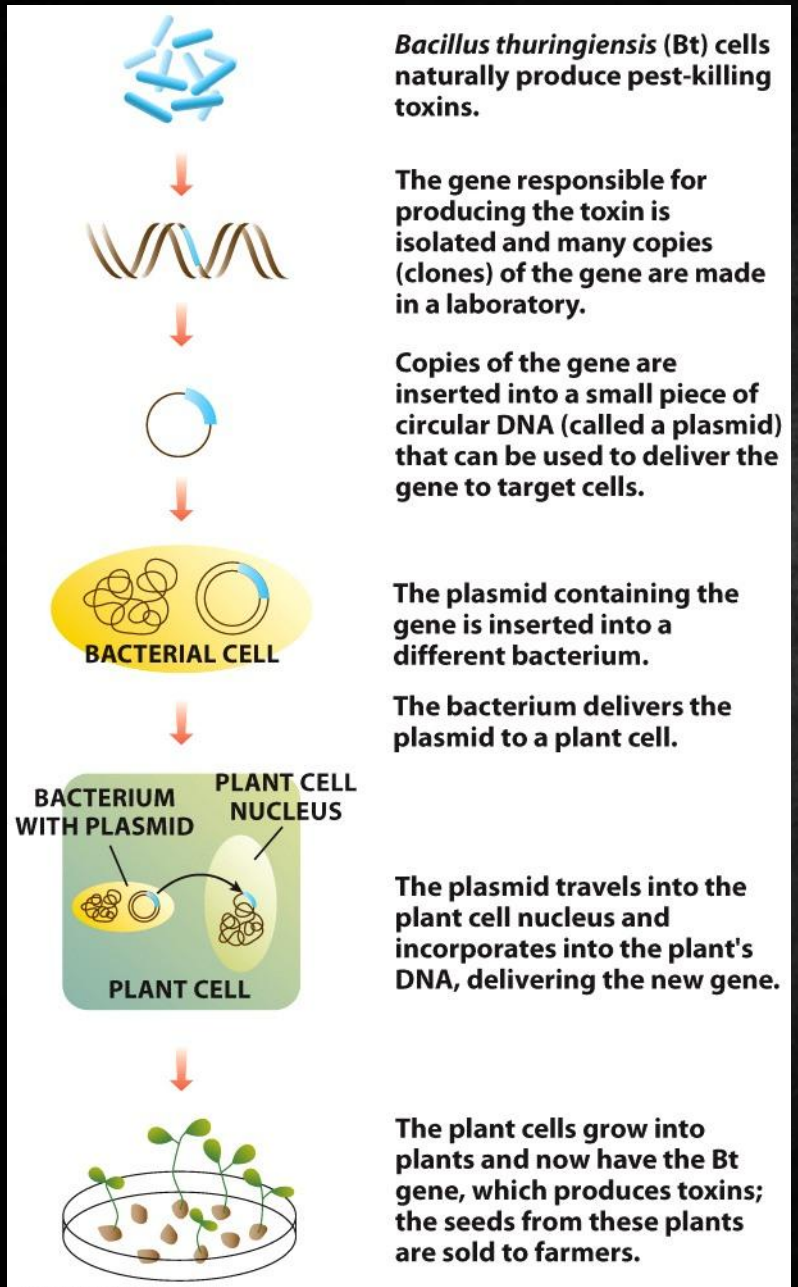
- Loss of crop diversity
- Water contaminated by runoff from farm fields
- Water shortages from overuse

Global population expected to reach 10 billion by 2050.

Experts say we will need to produce twice as much food.

Farming more land = clearing more forests and destroying habitats.

One possible alternative: Genetically Modified Organisms (GMOs)



Infographic 20.5

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Genetic material can be transferred from one organism to another. This can give organisms new traits that are desirable.

Examples of GMOs:

TYPE OF GMO	EXAMPLES
HT (herbicide-tolerant) crops are not killed by the herbicide, so the herbicide can be sprayed on the crop/soil directly, where it will kill weeds but not the crop.	Bromoxynil-tolerant canola and cotton Glyphosate- (Roundup-) tolerant corn, cotton, soybeans Imidazolinone-tolerant wheat
Bt crops contain a gene from *Baccillus thuringiensis*, a naturally occurring bacterium that produces a toxin that kills some pests.	Bt corn and potatoes
Nutritionally enhanced food: Genes inserted can increase the amount of a particular nutrient or allow the crop to produce a nutrient it would not normally produce.	Golden rice—produces more vitamin A than average rice
Genetically modified animals are being developed for the food supply.	Salmon that grow faster Pigs that produce more omega-3 fatty acids (a healthy fat)

Infographic 20.6

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In the United States, more than 75% of processed foods contain GMOs, including 85-90% of corn, soybeans, cotton.

Critics question:

- Are GMO foods safe?
- Will too much of food supply be controlled by corporations who hold GMO seed patents?

“Food security in private hands is no food security at all, because corporations are in the business of making money. Not feeding people.”

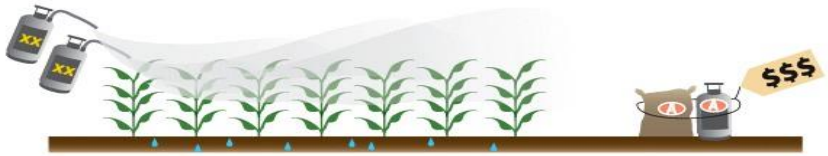
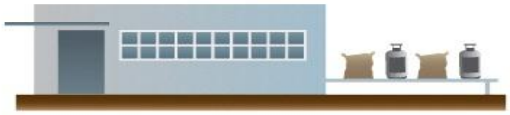
-U.S. Senator Tom McGovern

Proponents say private investment is essential in countries that lack large-scale research and development.

“[Africa’s] programs, agencies, and research centers don’t have expertise. And they don’t have time to build it from scratch.”

-Bill Gates,
Bill and Melinda Gates Foundation

Environmental pros, cons also must be weighed:

GMO TRAIT	ADVANTAGES	DISADVANTAGES
HERBICIDE TOLERANCE	 Weeds are controlled by simply spraying herbicide.	 • More herbicides are used since they do not harm the crop (potential water pollutant). • The farmer is locked into using the herbicide the crop can tolerate. • The company producing the seed and herbicide has an unchallenged market (no competitors), so prices can be high.
PEST RESISTANCE	 Less pesticide may be used because crops can defend themselves from pests.	 • The pest-resistance trait could be transferred to weeds. • The crop may repel beneficial insects like pollinators. • Pesticide-resistant pest populations may increase. • Secondary pests (those not affected by the GMO trait) may increase.
CORPORATE FUNDING	 Corporations have absorbed the tremendous cost and time of developing useful GMO products, saving taxpayers money.	 • The price of the seeds goes up, reflecting the corporation's time and financial investment; farmers must purchase new seeds every year (as opposed to harvesting them for future use). • The seeds are patented, allowing the corporation to sue farmers whose fields are accidently pollinated by GMO plants. • If cross-pollination accidently contaminates fields of organic produce, the contaminated crop no longer qualifies as organic.

Infographic 20.7

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It will take a combination of strategies to achieve global food security.

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Some are re-examining low-tech options, such as these hand-dug Zai pits in Africa's Sahel region that facilitate water infiltration to help prevent drought and help seedlings grow.

“Helping small farmers grow more food sustainably [in developing countries] is the best way to fight hunger and poverty over the long term.”

-Bill Gates