



Chapter 12

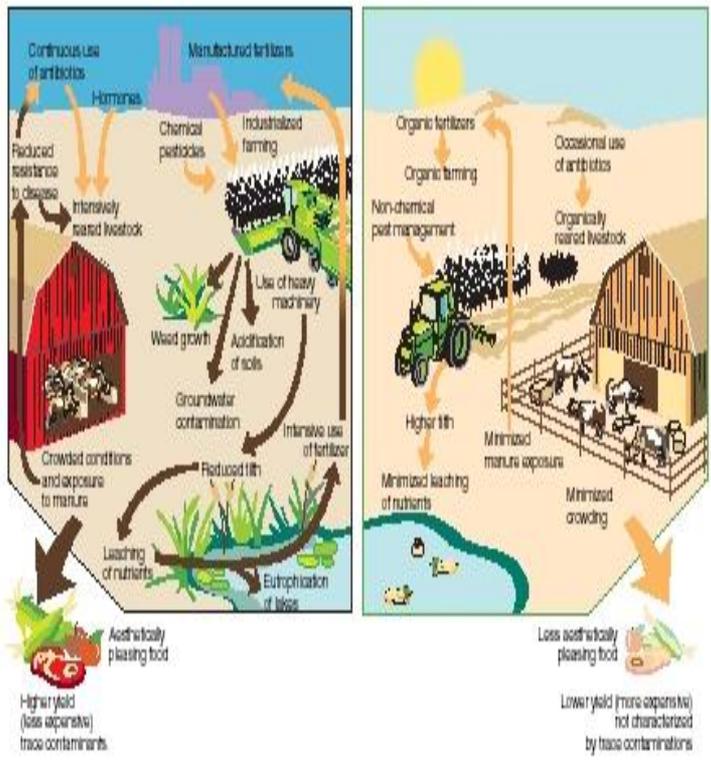
Food, Soil, and Pest Management

There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace.

- Aldo Leopold

Core Case Study: Organic Agriculture Is on the Rise

Organic agriculture



- Crops grown without using synthetic pesticides, synthetic inorganic fertilizers, or genetically engineered seeds
- Animals grown without using antibiotics or synthetic hormones
- U.S. in 2008: .6% cropland; 3.5% food sales

Industrialized Agriculture vs. Organic Agriculture

Industrialized Agriculture



Uses synthetic inorganic fertilizers and sewage sludge to supply plant nutrients

Makes use of synthetic chemical pesticides



Uses conventional and genetically modified seeds

Depends on nonrenewable fossil fuels (mostly oil and natural gas)

Produces significant air and water pollution and greenhouse gases

Is globally export-oriented

Uses antibiotics and growth hormones to produce meat and meat products



Organic Agriculture



Emphasizes prevention of soil erosion and the use of organic fertilizers such as animal manure and compost, but no sewage sludge to help replace lost plant nutrients

Employs crop rotation and biological pest control

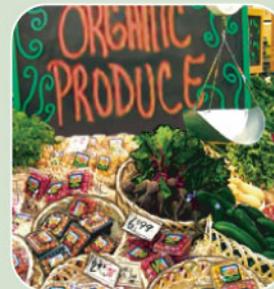
Uses no genetically modified seeds

Reduces fossil fuel use and increases use of renewable energy such as solar and wind power for generating electricity

Produces less air and water pollution and greenhouse gases

Is regionally and locally oriented

Uses no antibiotics or growth hormones to produce meat and meat products



12-1 What Is Food Security and Why Is It Difficult to Attain?

- **Concept 12-1A** *Many people in less-developed countries have health problems from not getting enough food, while many people in more-developed countries have health problems from eating too much food.*
- **Concept 12-1B** *The greatest obstacles to providing enough food for everyone are poverty, political upheaval, corruption, war, and the harmful environmental effects of food production.*

Many People Have Health Problems Because They Do Not Get Enough to Eat

Food security

- All or most people in a country have daily access to enough nutritious food to lead active and healthy lives

Food insecurity

- Chronic hunger and poor nutrition
- Root cause: poverty
- Political upheaval, war, corruption, bad weather

Starving Children in Sudan Collect Ants



What Nutrients Do Human Need?

Macronutrients

- Carbohydrates
- Proteins
- Fats

Micronutrients

- Vitamins
- Minerals

Table 12-1 Key Nutrients for a Healthy Human Life

Nutrient	Food Source	Function
Proteins	Animals and some plants	Help to build and repair body tissues
Carbohydrates	Wheat, corn, and rice	Provide short-term energy
Lipids (oils and fats)	Animal fats, nuts, oils	Help to build membrane tissues and create hormones

Chronic Hunger & Famine

- **Chronic undernutrition**, hunger
- **Chronic malnutrition** (deficiency of protein & nutrients)
- 1 in 6 people in less-developed countries is chronically undernourished or malnourished
- **Famine**
 - Drought, flooding, war, other catastrophes

World Hunger

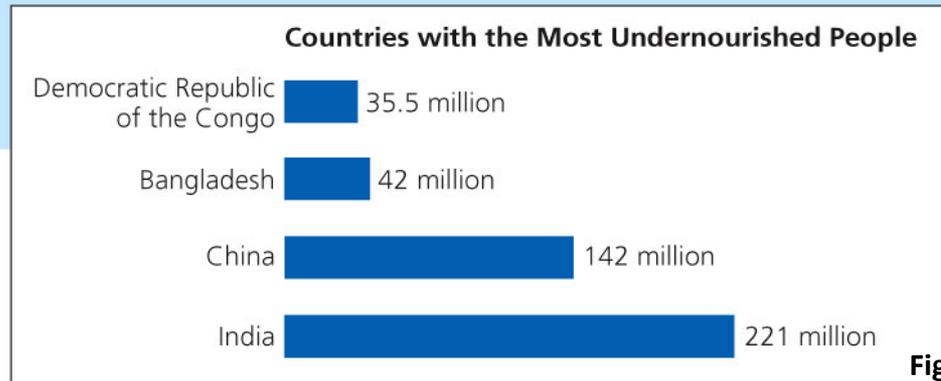
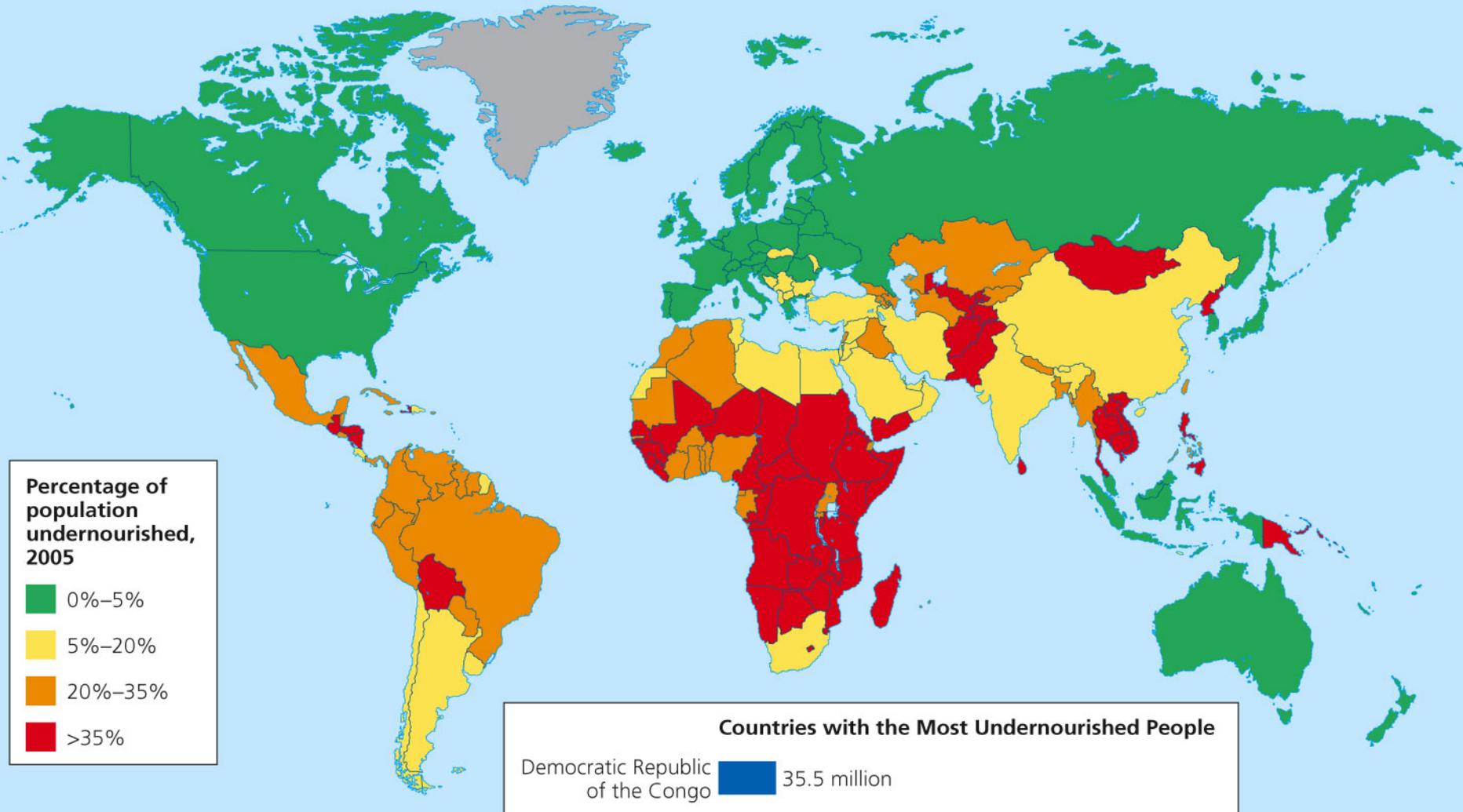
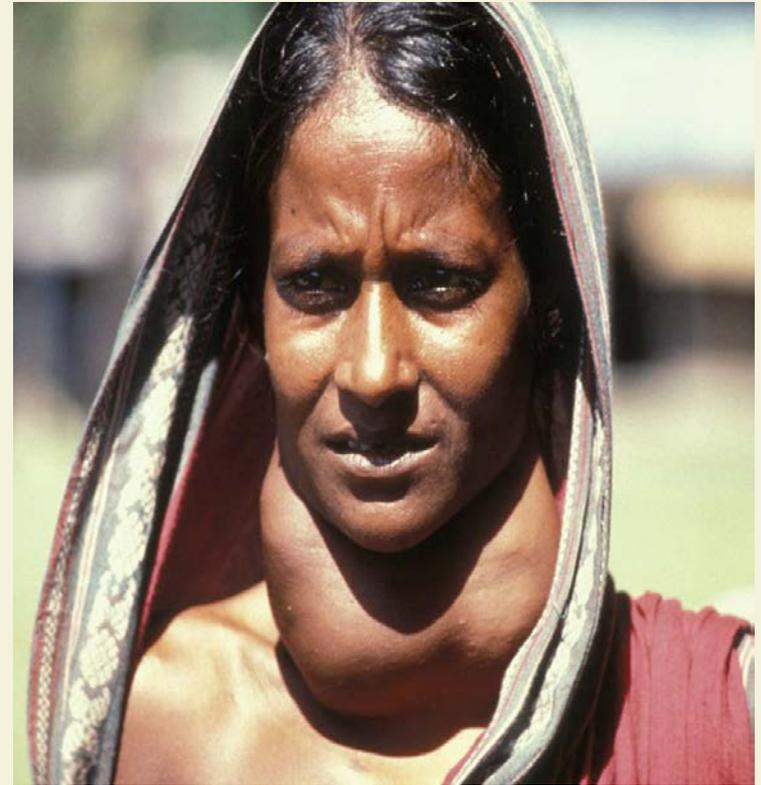


Figure 15, Supplement 8

Many People Do Not Get Enough Vitamins and Minerals

Most often vitamin and mineral deficiencies in people in less-developed countries

- Iron (anemia, fatigue)
- Vitamin A (go blind before age 6)
- Iodine (thyroid disorders)



Woman with Goiter in Bangladesh

Many People Have Health Problems from Eating Too Much

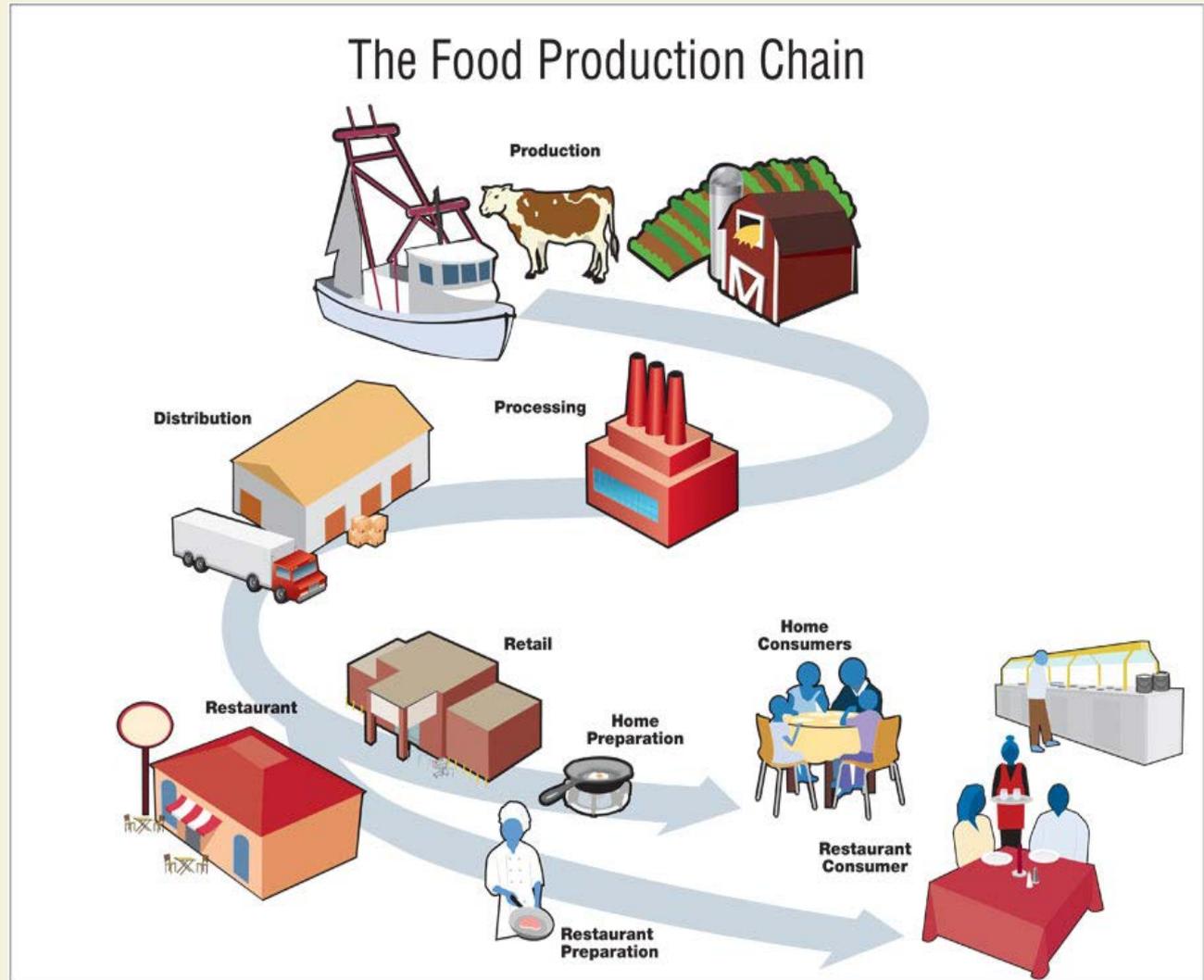
Overnutrition

- Excess body fat from too many calories and not enough exercise
- Similar health problems to those who are underfed
 - Lower life expectancy
 - Greater susceptibility to disease and illness
 - Lower productivity and life quality

12-2 How Is Food Produced?

Concept 12-2

We have used high-input industrialized agriculture and lower-input traditional methods to greatly increase supplies of food.



Food Production Has Increased Dramatically

- Three systems produce most of our food
 - Croplands: 77% on 11% world's land area
 - Rangelands, pastures, and feedlots: 16% on 29% of world's land area
 - Aquaculture: 7%
- Importance of wheat, rice, and corn
 - 48% calories of the calories people consume directly
 - 2/3 of world depend on them

Industrialized Crop Production Relies on High-Input Monocultures

- **Industrialized agriculture, high-input agriculture**

- Heavy equipment
- Financial capital
- Fossil fuels
- water
- inorganic fertilizers
- pesticides



- Goal is to steadily increase crop yield

- **Plantation agriculture:** cash crops (bananas, soybeans, sugarcane, etc)
 - Primarily in less-developed countries
- Increased use of greenhouses to raise crops

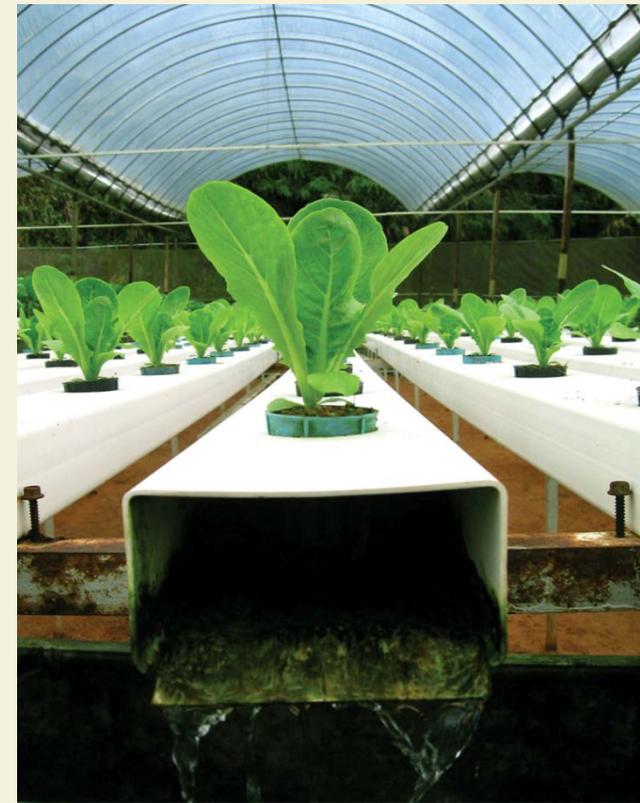
Plantation Agriculture: Oil Palms on Borneo in Malaysia



Case Study: Hydroponics: Growing Crops without Soil

Hydroponics: growing plants in nutrient-rich water solutions rather than soil

- Grow indoors almost anywhere, year-round
- Grow in dense urban areas
- Recycle water and fertilizers
- Little or no need for pesticides
- No soil erosion
- Takes money to establish
- Help make the transition to more sustainable agriculture



Traditional Agriculture Often Relies on Low-Input Polycultures

Traditional subsistence agriculture

- Human labor and draft animals for family food

Traditional intensive agriculture

- Higher yields through use of manure and water



Traditional Agriculture Often Relies on Low-Input Polycultures (2)

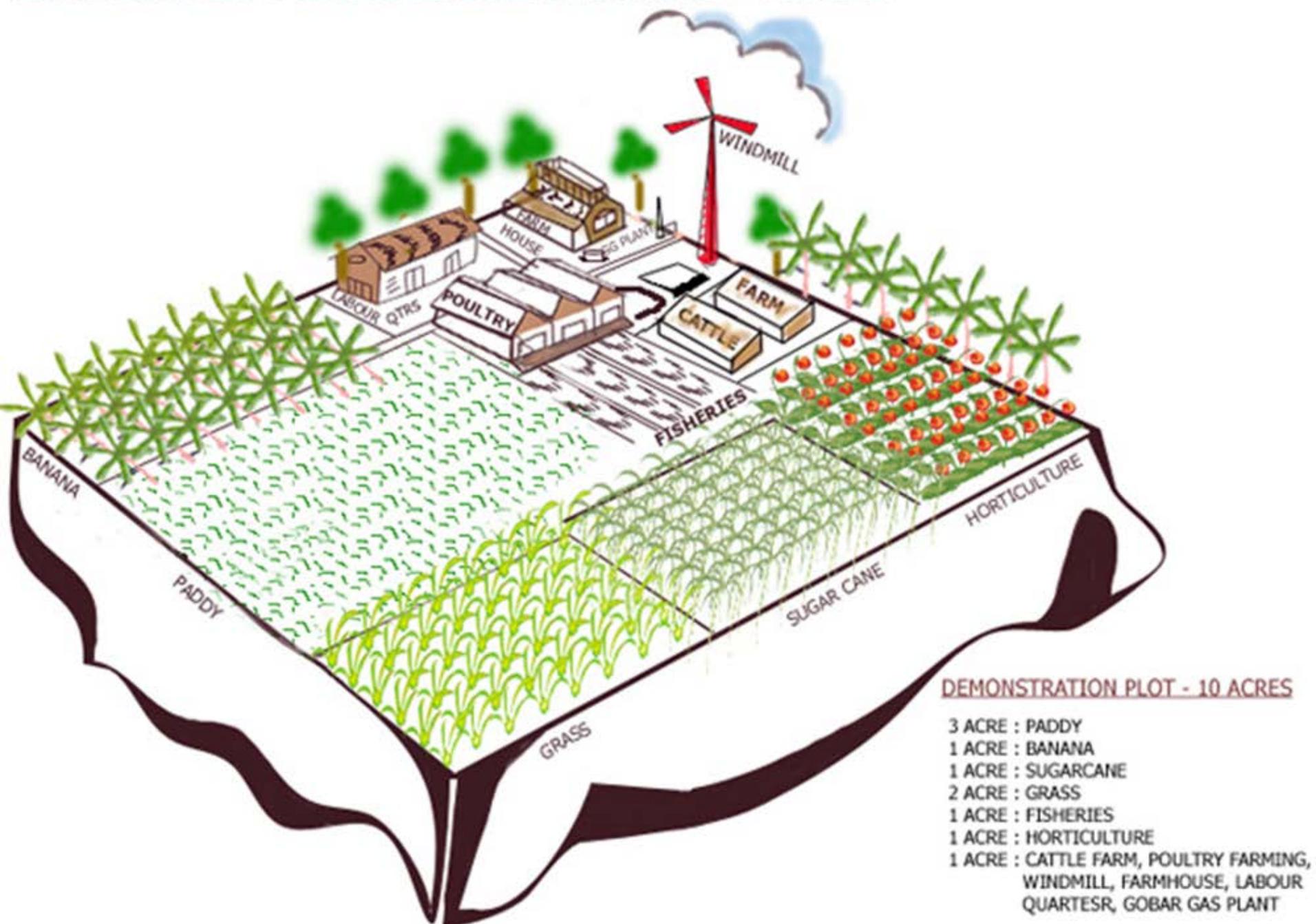
Polyculture

- Benefits over monoculture

Slash-and-burn agriculture

- Subsistence agriculture in tropical forests
- Clear and burn a small plot
- Grow many crops that mature at different times
- Reduced soil erosion
- Less need for fertilizer and water

INTEGRATED POLYCULTURE FARMING - MODEL

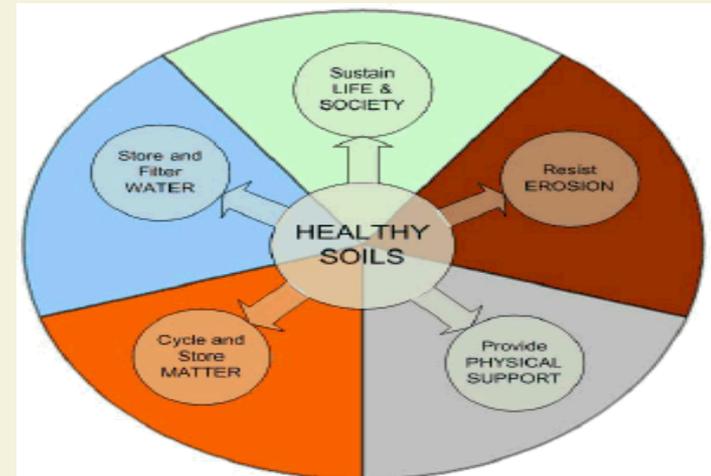
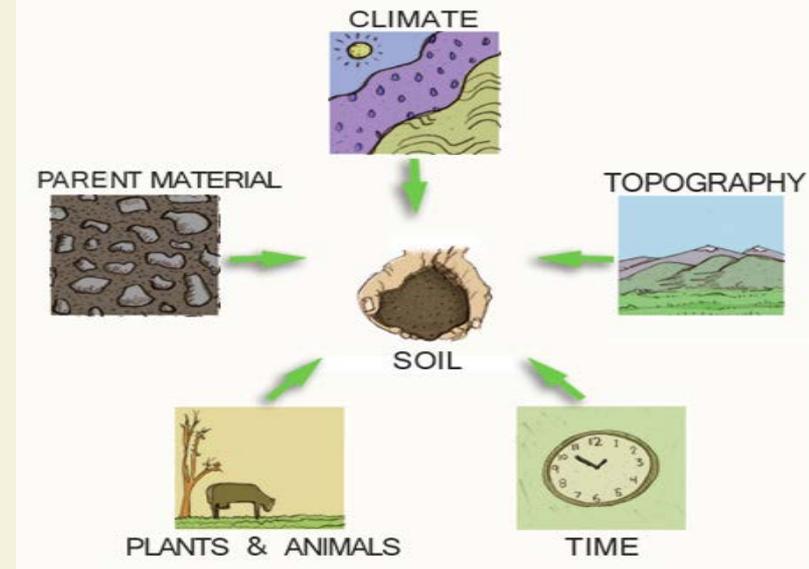


DEMONSTRATION PLOT - 10 ACRES

Science Focus: Soil Is the Base of Life on Land

Soil composition

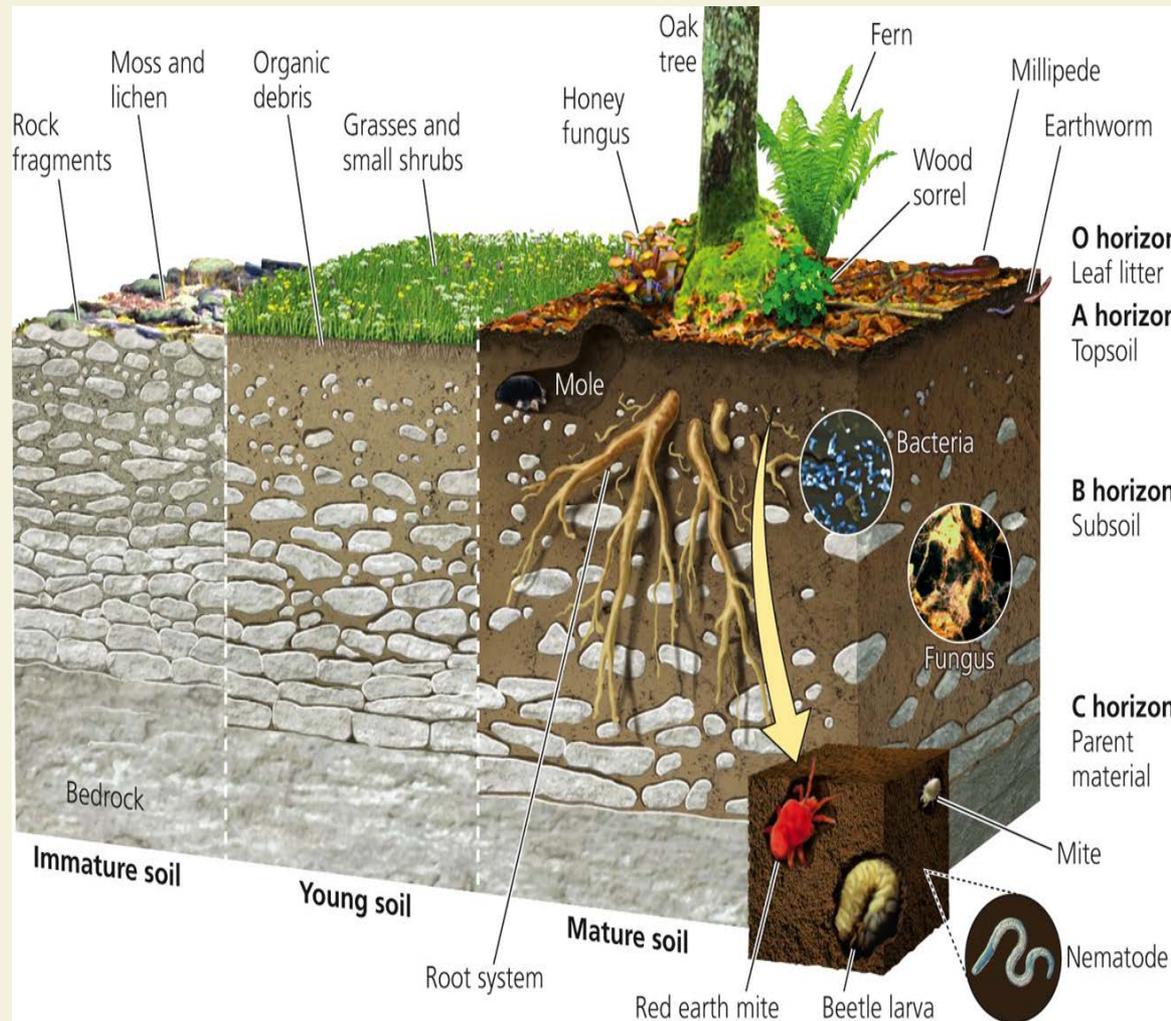
- Eroded rock
- Mineral nutrients
- Decaying organic matter
- Water
- Air
- Microscopic decomposers



Soil Formation and Generalized Soil Profile

Layers (horizons) of mature soils

- O horizon: leaf litter
- A horizon: topsoil
- B horizon: subsoil
- C horizon: parent material, often bedrock



A Closer Look at Industrialized Crop Production

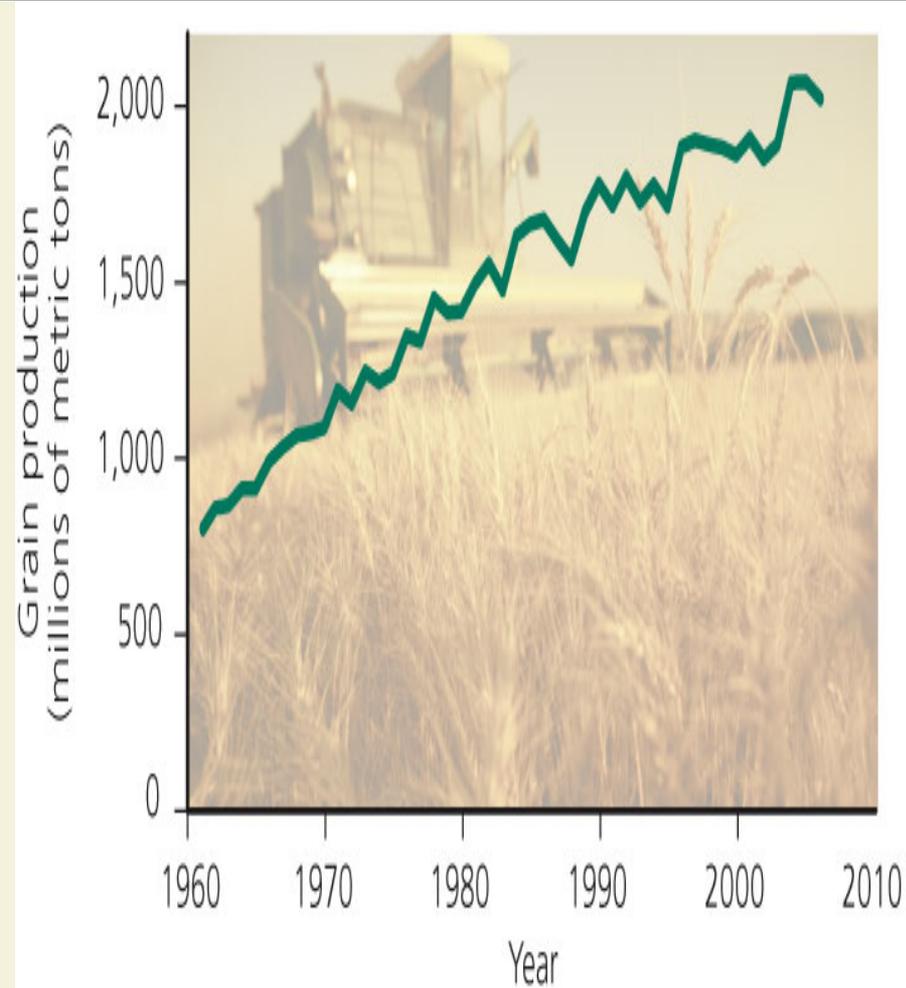
Green Revolution: increase crop yields

1. Monocultures of high-yield key crops
 - Rice, wheat, and corn
2. Large amounts of fertilizers, pesticides, water
3. Multiple cropping

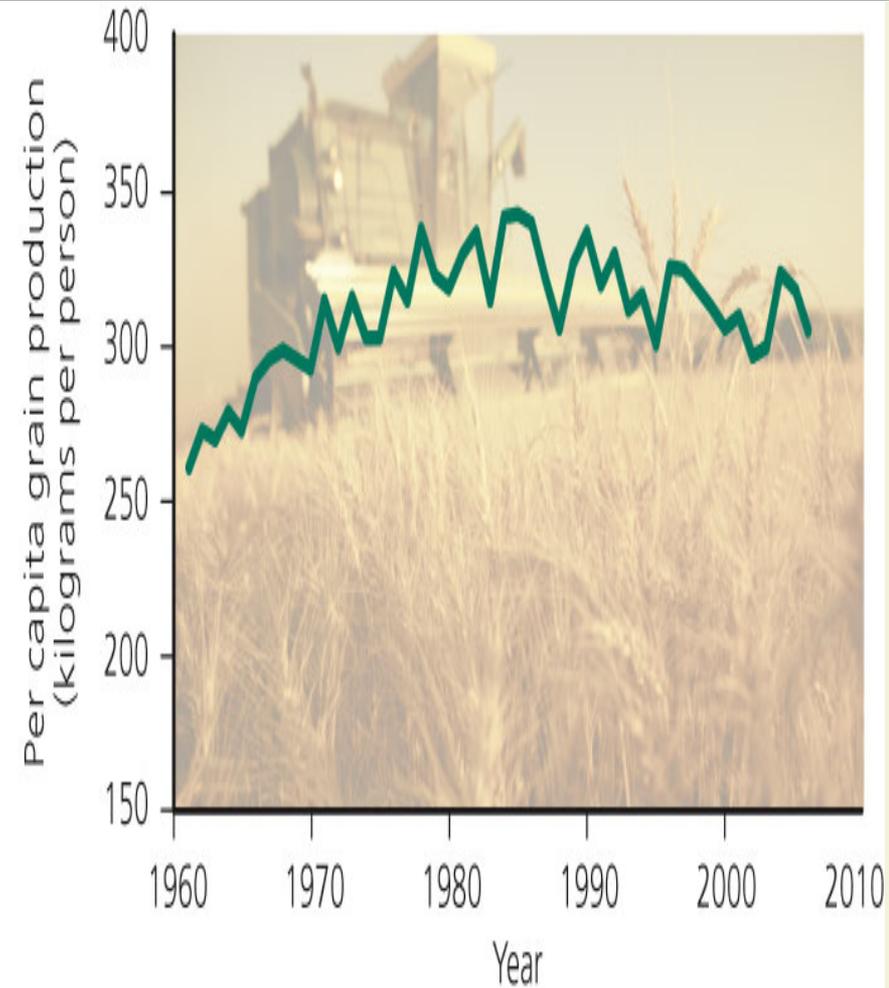
Second Green Revolution

- Fast growing dwarf varieties
- World grain has tripled in production

Global Outlook: Total Worldwide Grain Production (Wheat, Corn, and Rice)



Total World Grain Production



World Grain Production per Capita

Case Study: Industrialized Food Production in the United States

Agribusiness

- Average farmer feeds 129 people
- Annual sales greater than auto, steel, and housing combined

Food production: very efficient

- Americans spend 10% of income on food
- Hidden costs of subsidies and costs of pollution and environmental degradation

Crossbreeding and Genetic Engineering Produce New Crop/Livestock Varieties (1)

- First gene revolution
 - Cross-breeding through artificial selection
 - Slow process
 - Amazing results
- Genetic engineering = second gene revolution
 - Alter organism's DNA
 - Genetic modified organisms (GMOs): transgenic organisms

Crossbreeding and Genetic Engineering Produce New Crop/Livestock Varieties (2)

- Age of Genetic Engineering: developing crops that are resistant to
 - Heat and cold
 - Herbicides
 - Insect pests
 - Parasites
 - Viral diseases
 - Drought
 - Salty or acidic soil
- Promise and potential perils

A GMO IS:

The direct human manipulation of an organism's DNA in a laboratory environment.

GMO?

Genetically Modified Organism

A GMO IS NOT:

Plants and animals that are traditionally bred to achieve specific characteristics such as breeding dogs or cross-pollination of plants.



SCIENCE OF GMOS

Genetic modification may include the **ADDITION OF DNA** from species that would **NOT BREED** in nature.

Genetic modification may also involve **REMOVING SPECIFIC STRANDS OF DNA**.

Cross-species—or transgenic—genetic manipulation has gone so far as to **COMBINE FISH DNA WITH STRAWBERRIES** and tomatoes.



GMO foods have only existed in groceries since the late 1990's.

GMOs can be **patented**.

GMO varieties of corn and potatoes are engineered to **PRODUCE THEIR OWN PESTICIDES**.

STUDIES OF GMOS

NO LONG-TERM TESTING.

It took decades for the dangers of Trans-Fats (another artificial food) to become understood.

Mice fed GM pesticide-producing corn over four generations showed **ABNORMAL** structural and chemical changes to various organs and significantly reduced fertility.



Problems in producing GMO crops have been **RESOLVED IN INDUSTRY**.



Herbicide-resistant corn can grow without the need for **HERBICIDE-RESISTANT WEEDS**.

Herbicide-resistant crops can grow without the need for **HERBICIDE-RESISTANT WEEDS**.

Source: <http://www.fox.com>, <http://www.fox.com>, <http://www.fox.com>

PREVALENCE OF GMOS

You probably eat GMOs **EVERY DAY**.



30,000

different GMOs are in your grocery store (before it gets to you) because of their many processing/food sources used!

PERCENT OF GMOS IN TOTAL CROP PRODUCTION 2013 (USA)



PUBLIC OPINION OF GMOS

This consistently shows that a significant majority of both Americans would **NOT** be able to tell if a food ingredient purchased contains GMOs.

OUT OF A CBS NEWS POLL:



87% want GMOs labelled



53% would not buy genetically modified food

NATIONAL DIVISIONS OF GMOs:

The **USA** is the largest producer of GMO crops and does not mandate labels for GMO food.

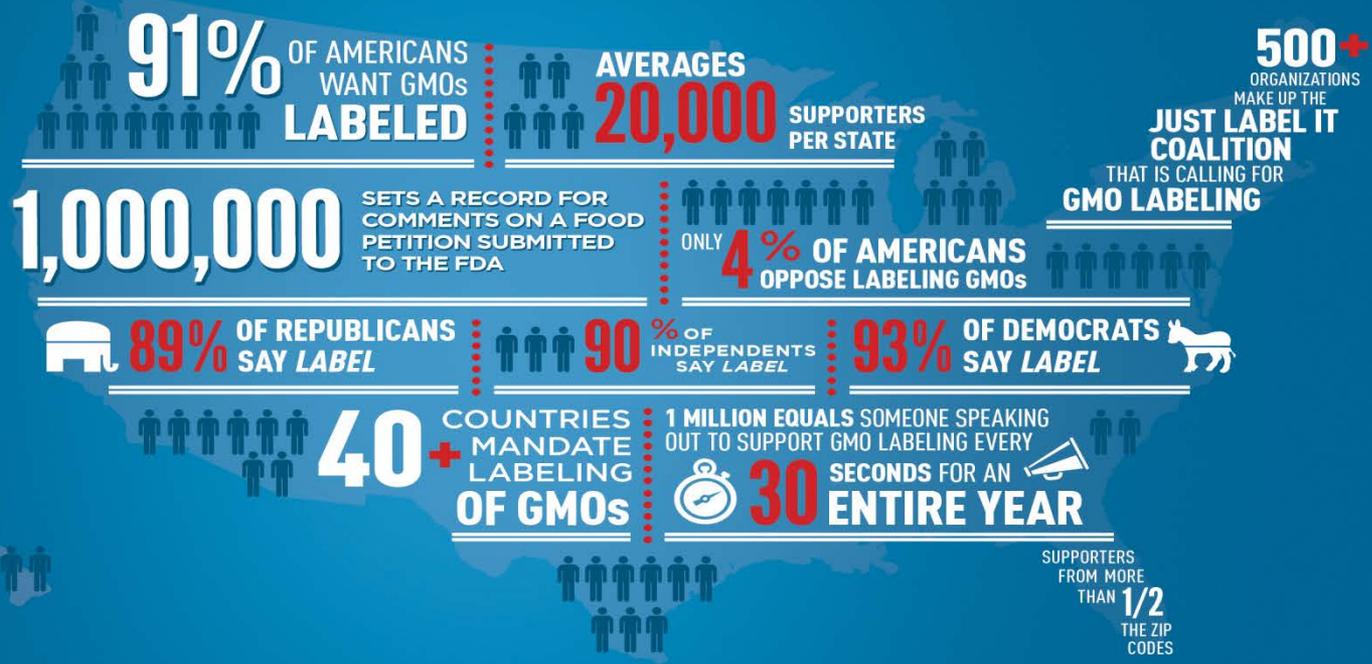


In 30 other countries there are laws or regulations on the production of GMOs, because they are not considered proven safe.

Source: <http://www.fox.com>, <http://www.fox.com>, <http://www.fox.com>

AMERICA WANTS GMOs LABELED

SUPPORTERS FROM ALL **50** STATES 



MORE THAN ONE MILLION AMERICANS HAVE CALLED ON THE FDA TO LABEL GMOs
ISN'T IT TIME FOR THE FDA TO LISTEN?

MORE AT WWW.JUSTLABELIT.ORG

*"GENETICALLY MODIFIED ORGANISMS" OR GMOs, ACCORDING TO THE WORLD HEALTH ORGANIZATION ARE ORGANISMS IN WHICH THE GENETIC MATERIAL (DNA) HAS BEEN ALTERED IN A WAY THAT DOES NOT OCCUR NATURALLY

Prop 37: Your right to know.

GMOs: Corporate Charlatans Versus Organic Heroes

Corporate agribusiness
fighting Prop 37
\$23,500,000



MONSANTO
DONATED: \$4,208,000



CORPORATE PARENT: PEPSICO
DONATED: \$1,716,300



CORPORATE PARENT: COCA COLA
DONATED: \$1,164,400



CORPORATE PARENT: CONAGRA
DONATED: \$1,076,300



CORPORATE PARENT: KELLOGG
DONATED: \$632,500



CORPORATE PARENT: GENERAL MILLS
DONATED: \$520,000



CORPORATE PARENT: SMUCKER
DONATED: \$387,000



CORPORATE PARENT: DEAN FOODS
DONATED: \$253,000

COUNSEL FOR BIOTECHNOLOGY INFORMATION (DONATED: \$375,000),
GROCERY MANUFACTURERS ASSOCIATION (DONATED: \$375,000),
BIOTECHNOLOGY INDUSTRY ORGANIZATION: (DONATED \$250,000)

VS.



Organic leaders
supporting Prop 37
\$2,600,000



DONATED: \$290,000



DONATED: \$247,000



DONATED: \$200,000



DONATED: \$50,000



DONATED: \$50,000



DONATED: \$25,000



DONATED: \$10,000



DONATED: \$2,500



DONATED: \$2,500



DONATED: \$1,500

DR. JOSEPH MERCOLA [MERCOLA.COM] (DONATED: \$800,000),
ORGANIC CONSUMERS ASSOCIATION (DONATED: \$600,000),
MICHAEL FUNK (DONATED: \$50,000)

As California Goes, There Goes the Nation.

Democratic and Republican administrations, and Congress, have repeatedly ignored the overwhelming majority of Americans who favor labeling genetically engineered (GE) food in the marketplace. Our politicians seem to be listening to the corporate executives (donors) instead of the citizenry. But in California, the people have a right to craft laws of their choosing. Proposition 37, on the ballot in California on November 6, would mandate labeling of foods containing GE ingredients. If we win this fight in California, manufacturers will likely begin to label food nationally for GE ingredients.

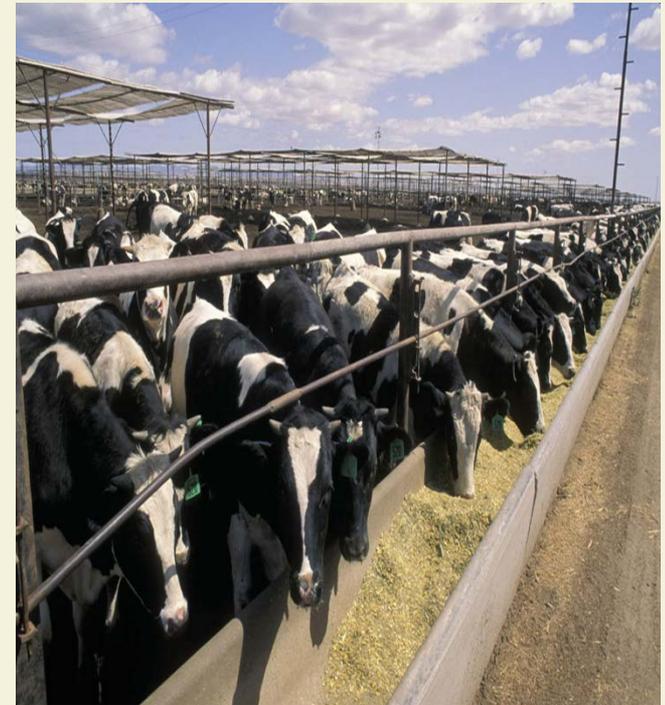
Please make your voice heard by signing the petition at cornucopia.org



CORNUCOPIA
INSTITUTE
WWW.CORNUCOPIA.ORG

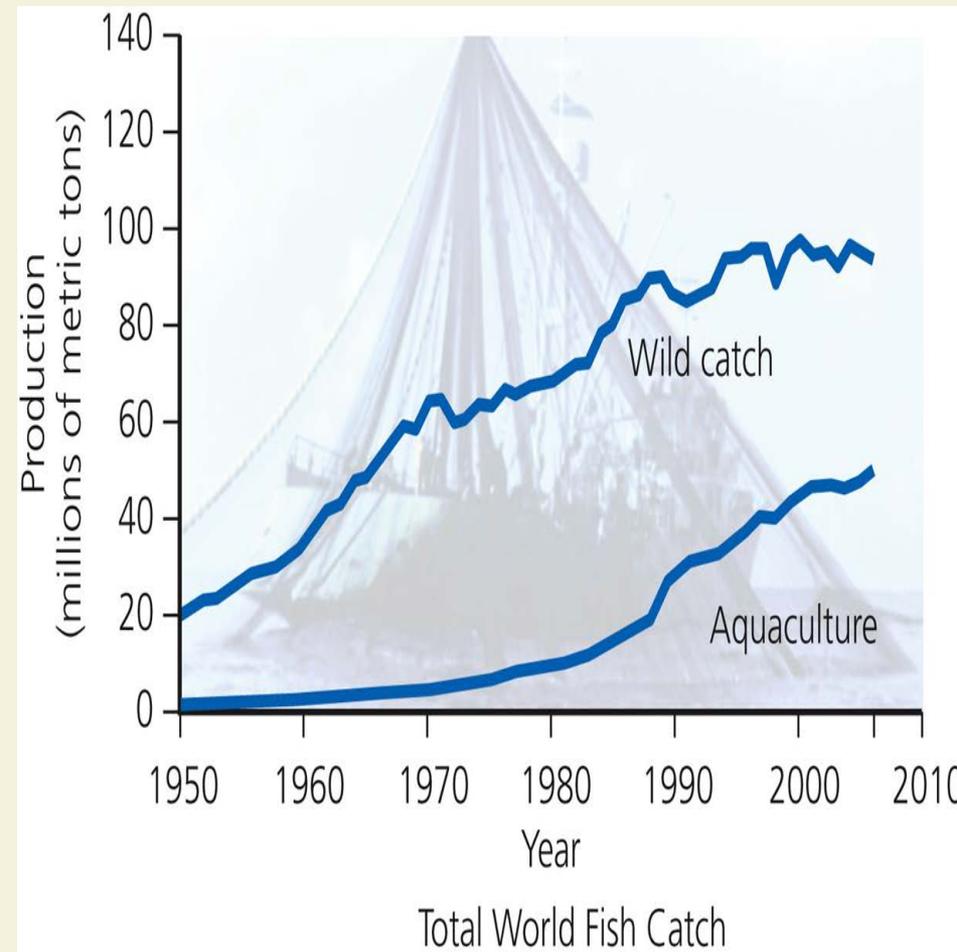
Meat Production and Consumption Have Grown Steadily

- Animals for meat raised in
 - Pastures and rangelands
 - Feedlots
- Meat production increased fourfold between 1961 and 2007
 - Increased demand for grain
 - Demand is expected to go higher



Fish and Shellfish Production Have Increased Dramatically

- Fishing with fleets depletes fisheries and uses many resources
- **Aquaculture**, blue revolution
 - World's fastest-growing type of food production
 - Dominated by operations that raise herbivorous species



Industrialized Food Production Requires Huge Inputs of Energy

- Mostly nonrenewable energy – oil and natural gas
 - Farm machinery
 - Irrigate crops
 - Produce pesticides (petrochemicals)
 - Commercial inorganic fertilizers
 - Process and transport food
 - 19% of total fossil fuel energy use in U.S.
 - U.S. food travels an average of 2,400 kilometers

12-3 What Environmental Problems Arise from Food Production?

- **Concept 12-3** *Food production in the future may be limited by its serious environmental impacts, including soil erosion and degradation, desertification, water and air pollution, greenhouse gas emissions, and degradation and destruction of biodiversity.*

Producing Food Has Major Environmental Impacts

- Harmful effects of agriculture on
 - Biodiversity
 - Soil
 - Water
 - Air
 - Human health

Natural Capital Degradation: Food Production

Natural Capital Degradation

Food Production



Biodiversity Loss

Loss and degradation of grasslands, forests, and wetlands in cultivated areas

Fish kills from pesticide runoff

Killing wild predators to protect livestock

Loss of genetic diversity of wild crop strains replaced by monoculture strains



Soil

Erosion

Loss of fertility

Salinization

Waterlogging

Desertification

Increased acidity



Water

Water waste

Aquifer depletion

Increased runoff, sediment pollution, and flooding from cleared land

Pollution from pesticides and fertilizers

Algal blooms and fish kills in lakes and rivers caused by runoff of fertilizers and agricultural wastes



Air Pollution

Emissions of greenhouse gas CO_2 from fossil fuel use

Emissions of greenhouse gas N_2O from use of inorganic fertilizers

Emissions of greenhouse gas methane (CH_4) by cattle (mostly belching)

Other air pollutants from fossil fuel use and pesticide sprays



Human Health

Nitrates in drinking water (blue baby)

Pesticide residues in drinking water, food, and air

Contamination of drinking and swimming water from livestock wastes

Bacterial contamination of meat

Topsoil Erosion Is a Serious Problem in Parts of the World

- **Soil erosion**
 - Movement of soil by wind and water
 - Natural causes
 - Human causes
- Two major harmful effects of soil erosion
 - Loss of soil fertility
 - Water pollution

Topsoil Erosion on a Farm in Tennessee



Natural Capital Degradation: Gully Erosion in Bolivia



Fig. 12-12, p. 290

Wind Removes Topsoil in Dry Areas



Fig. 12-13, p. 290

Natural Capital Degradation: Global Soil Erosion

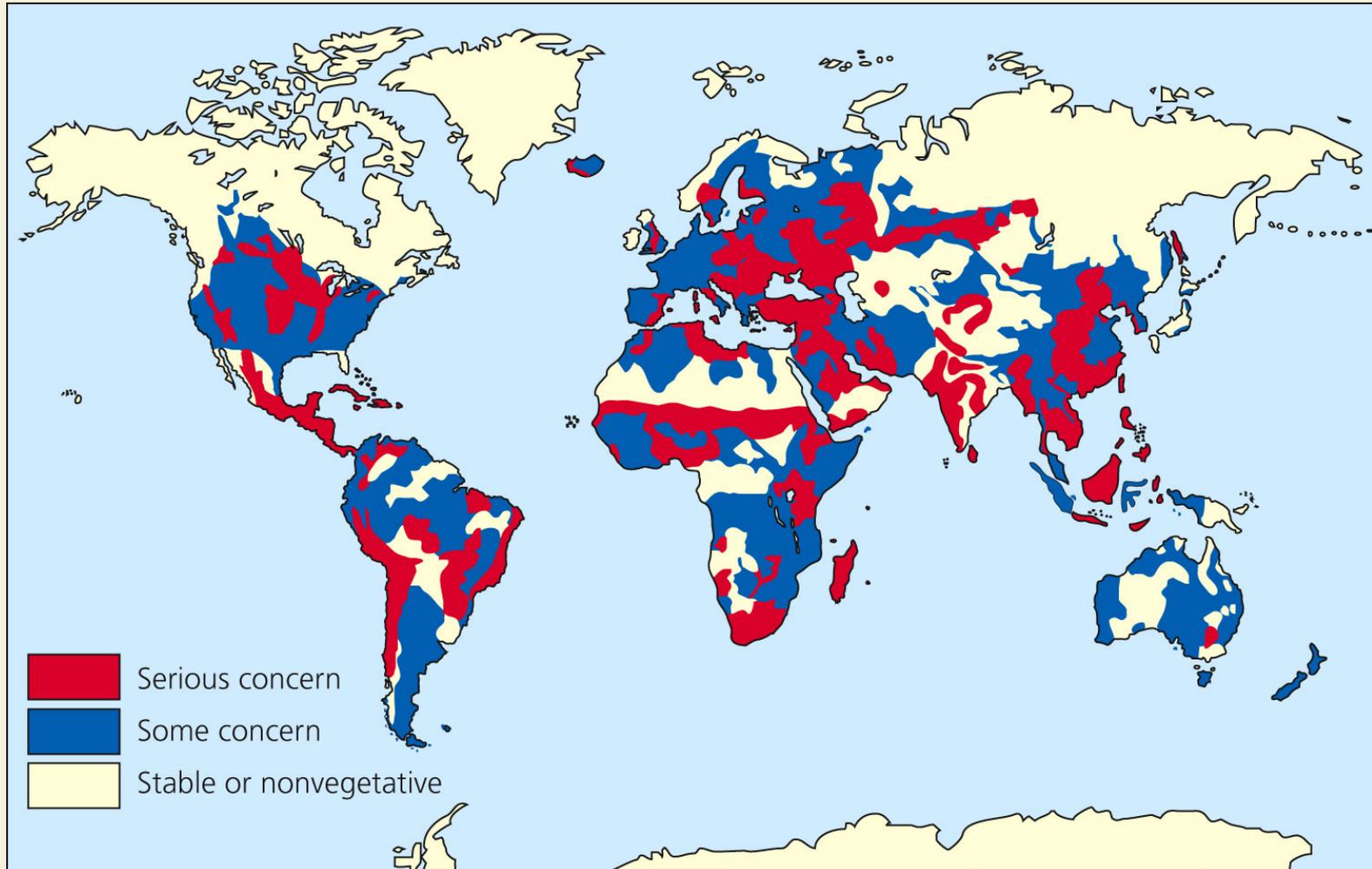


Fig. 12-14, p. 291

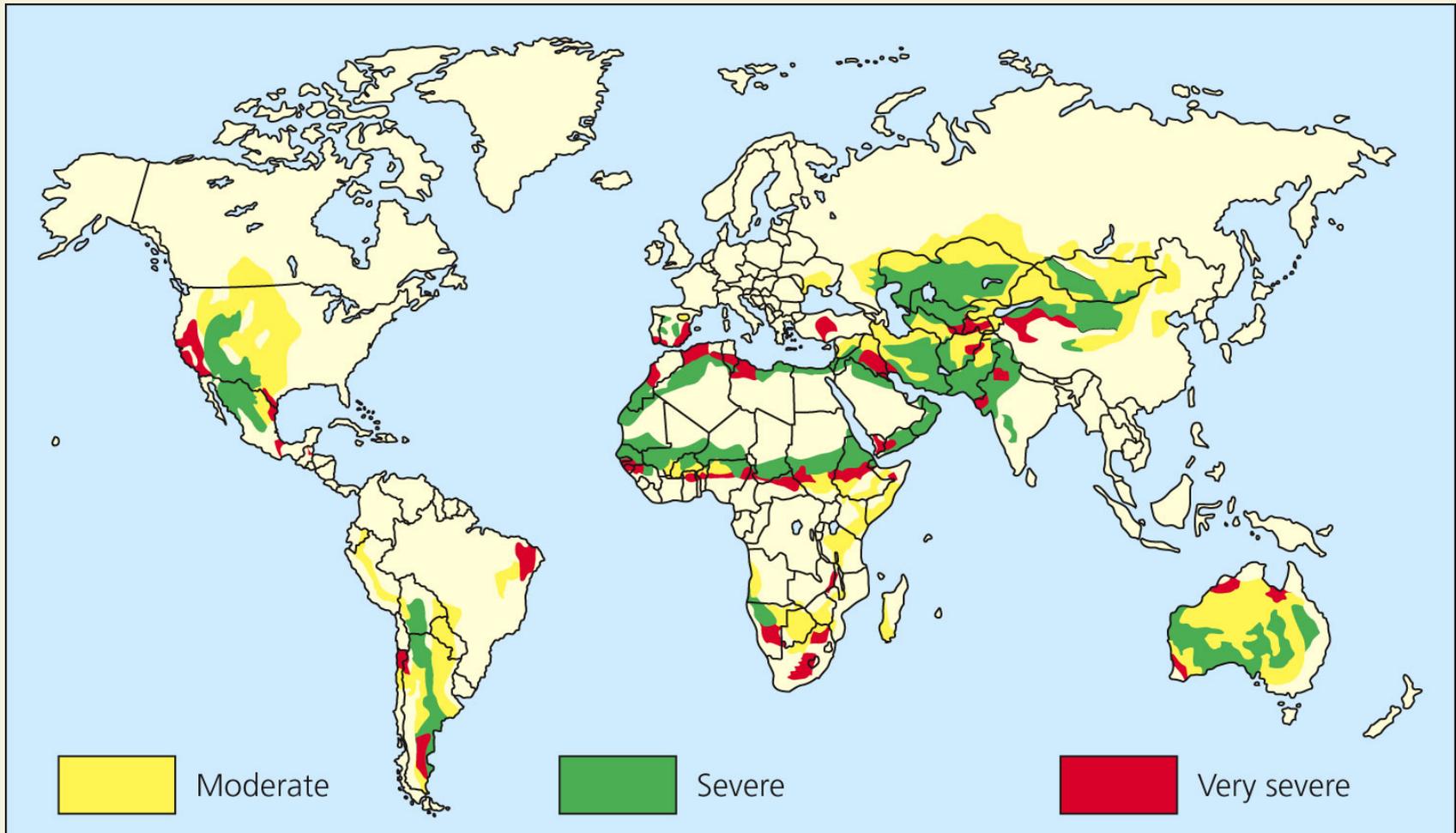
Drought and Human Activities Are Degrading Drylands

- **Desertification**
 - Moderate
 - Severe
 - Very severe
- Human agriculture accelerates desertification
- Effect of global warming on desertification

Severe Desertification



Natural Capital Degradation: Desertification of Arid and Semiarid Lands



Excessive Irrigation Has Serious Consequences

- **Salinization**
 - Gradual accumulation of salts in the soil from irrigation water
 - Lowers crop yields and can even kill plants
 - Affects 10% of world croplands
- **Waterlogging**
 - Irrigation water gradually raises water table
 - Can prevent roots from getting oxygen
 - Affects 10% of world croplands

Natural Capital Degradation: Severe Salinization on Heavily Irrigated Land

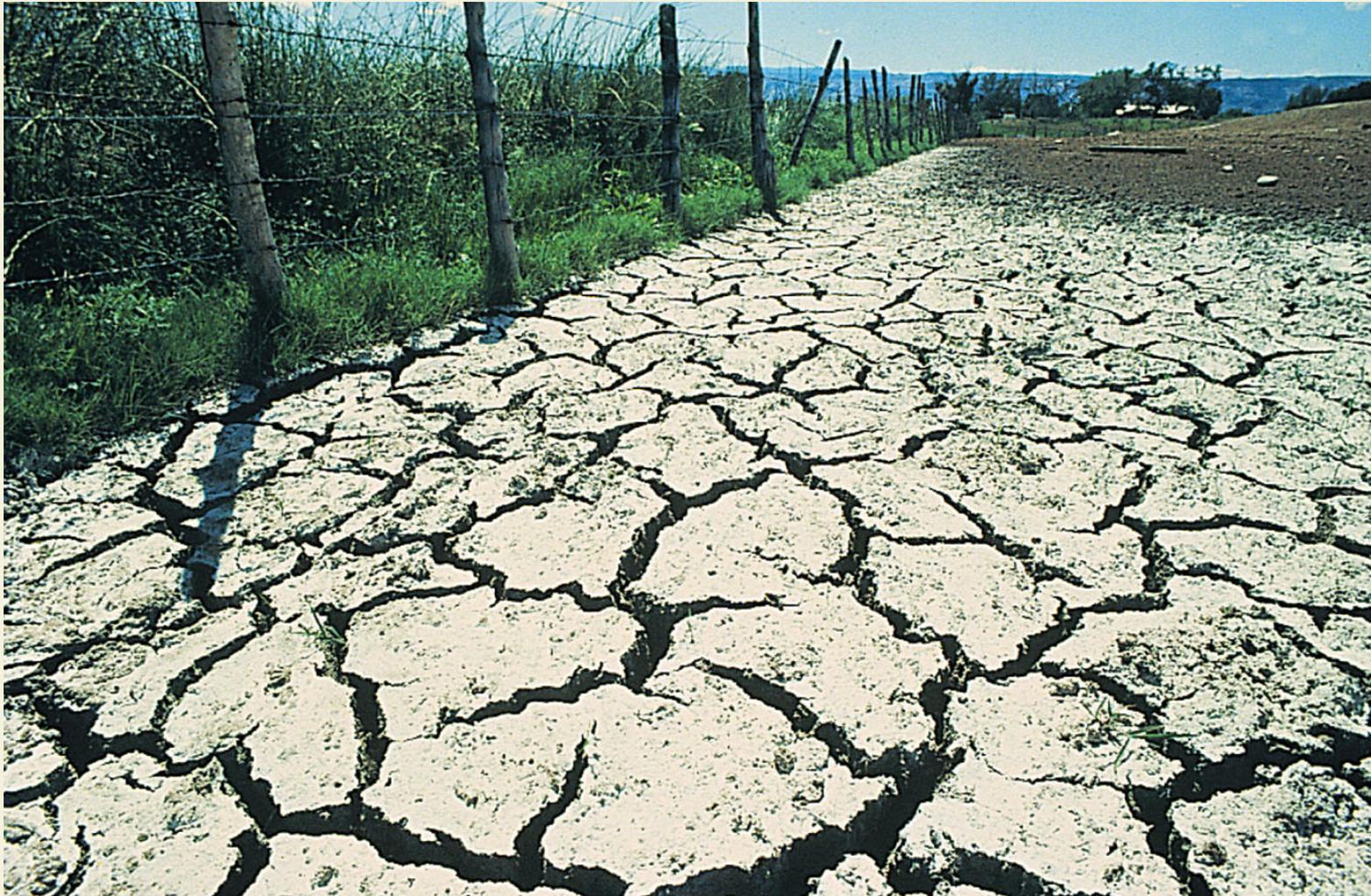


Fig. 12-17, p. 292

Agriculture Contributes to Air Pollution and Projected Climate Change

- Clearing and burning of forests for croplands
- One-fourth of all human-generated greenhouse gases
- Livestock contributes 18% of gases: methane in cow belches
 - Grass-fed better than feedlots

Food and Biofuel Production Systems Have Caused Major Biodiversity Losses

- Biodiversity threatened when
 - Forest and grasslands are replaced with croplands – tropical forests
- Agrobiodiversity threatened when
 - Human-engineered monocultures are used
- Importance of seed banks
 - Newest: underground vault in the Norwegian Arctic

Genetic Engineering Could Solve Some Problems but Create Others

Trade-Offs

Genetically Modified Crops and Foods

Advantages

Need less fertilizer

Need less water

More resistant to insects, disease, frost, and drought

Grow faster

May need less pesticides or tolerate higher levels of herbicides

May reduce energy needs



Disadvantages

Unpredictable genetic and ecological effects

Harmful toxins and new allergens in food

No increase in yields

More pesticide-resistant insects and herbicide-resistant weeds

Could disrupt seed market

Lower genetic diversity

There Are Limits to Expanding the Green Revolutions

- Usually require large inputs of fertilizer, pesticides, and water
 - Often too expensive for many farmers
- Can we expand the green revolution by
 - Irrigating more cropland?
 - Improving the efficiency of irrigation?
 - Cultivating more land? Marginal land?
 - Using GMOs?
 - Multicropping?

Industrialized Meat Production Has Harmful Environmental Consequences

Trade-Offs

Animal Feedlots

Advantages

Increased meat production

Higher profits

Less land use

Reduced overgrazing

Reduced soil erosion

Protection of biodiversity



Disadvantages

Large inputs of grain, fish meal, water, and fossil fuels

Greenhouse gas (CO_2 and CH_4) emissions

Concentration of animal wastes that can pollute water

Use of antibiotics can increase genetic resistance to microbes in humans

Producing Fish through Aquaculture Can Harm Aquatic Ecosystems

Trade-Offs

Aquaculture

Advantages

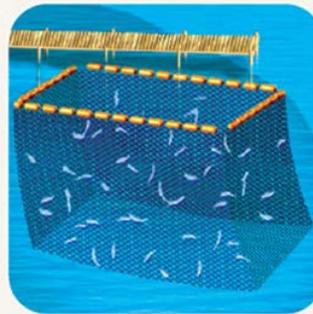
High efficiency

High yield

Reduced over-harvesting of fisheries

Low fuel use

High profits



Disadvantages

Large inputs of land, feed, and water

Large waste output

Loss of mangrove forests and estuaries

Some species fed with grain, fish meal, or fish oil

Dense populations vulnerable to disease

12-4 How Can We Protect Crops from Pests More Sustainably?

- **Concept 12-4** *We can sharply cut pesticide use without decreasing crop yields by using a mix of cultivation techniques, biological pest controls, and small amounts of selected chemical pesticides as a last resort (integrated pest management).*



Nature Controls the Populations of Most Pests

- What is a **pest**?
 - Interferes with human welfare
- Natural enemies—predators, parasites, disease organisms—control pests
 - In natural ecosystems
 - In many polyculture agroecosystems
- What will happen if we kill the pests?

Natural Capital: Spiders are Important Insect Predators



We Use Pesticides to Try to Control Pest Populations

- **Pesticides**
 - Insecticides
 - Herbicides
 - Fungicides
 - Rodenticides
- Herbivores overcome plant defenses through natural selection: coevolution

PESTICIDES

- First-generation pesticides
 - Borrowed from plants
- Second-generation pesticides
 - Lab produced: DDT and others
 - Benefits versus harm
- Broad-spectrum and narrow-spectrum agents
- Persistence varies

Individuals Matter: Rachel Carson

- Biologist
- *Silent Spring*
- Potential threats of uncontrolled use of pesticides



Modern Synthetic Pesticides

ADVANTAGES

- Save human lives
- Increases food supplies and profits for farmers
- Work quickly
- For many, health risks are very low relative to benefits
- New pest control methods: safer and more effective

Modern Synthetic Pesticides

DISADVANTAGES

- Accelerate rate of genetic resistance in pests
- Expensive for farmers
- Some insecticides kill natural predators and parasites that help control the pest population
- Pollution in the environment
- Some harm wildlife
- Some are human health hazards

Pesticide Use Has Not Reduced U.S. Crop Losses to Pests

- David Pimentel: Pesticide use has not reduced U.S. crop loss to pests
 - 1942-1997: crop losses from insects increased from 7% to 13%, even with 10x increase in pesticide use
 - High environmental, health, and social costs with use
 - Use alternative pest management practices
- Pesticide industry disputes these findings

Trade-Offs: Conventional Chemical Pesticides

Trade-Offs

Conventional Chemical Pesticides

Advantages

- Save lives
- Increase food supplies
- Profitable
- Work fast
- Safe if used properly



Disadvantages

- Promote genetic resistance
- Kill natural pest enemies
- Pollute the environment
- Can harm wildlife and people
- Are expensive for farmers

What Can You Do? Reducing Exposure to Pesticides

What Can You Do?

Reducing Exposure to Pesticides

- Grow some of your food using organic methods
- Buy certified organic food
- Wash and scrub all fresh fruits, vegetables, and wild foods you pick
- Eat less meat, no meat, or certified organically produced meat
- Trim the fat from meat

Case Study: Ecological Surprises: The Law of Unintended Consequences

- 1955: Dieldrin sprayed to control mosquitoes
- Malaria was controlled
- Dieldrin didn't leave the food chain
- Domino effect of the spraying
- Happy ending

Laws and Treaties Can Help to Protect Us from the Harmful Effects of Pesticides

- U.S. federal agencies and laws
 - EPA, USDA, FDA
 - Fungicide and Rodenticide Act, 1947
 - Food Quality Protection Act, 1996
- Effects of active and inactive pesticide ingredients are poorly documented
 - U.S. exports many banned pesticides
- Circle of poison

PESTICIDES ALTERNATIVES

Fool the pest

- Crop rotation; changing planting times

Provide homes for pest enemies

- Polyculture

Implant genetic resistance – genetic engineering

Bring in natural enemies

- Predators, parasites, diseases



PESTICIDE ALTERNATIVES

- Use insect perfumes
 - pheromones
- Bring in hormones
 - Interfere with pest life cycle
- Alternative methods of weed control
 - Crop rotation, cover crops, mulches

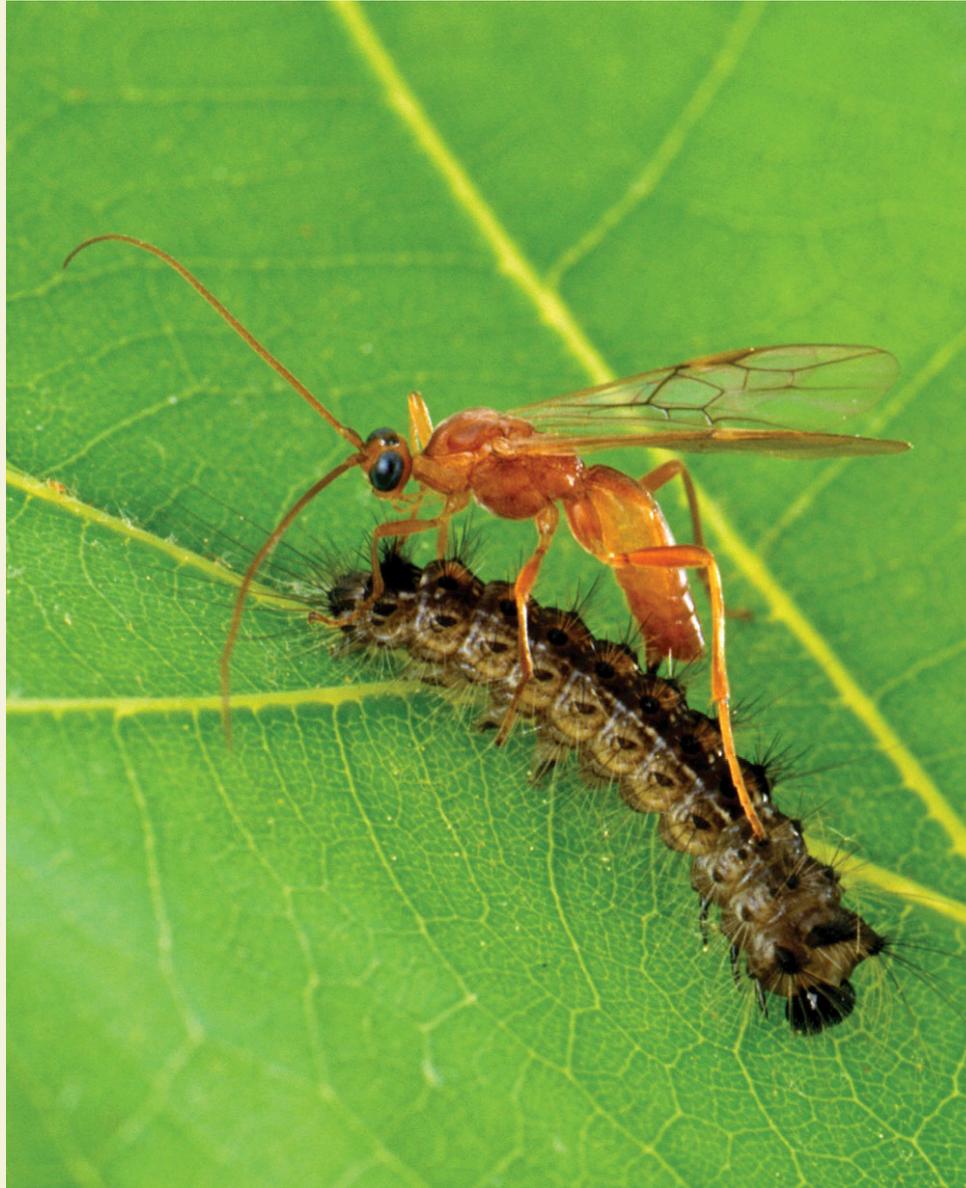


Solutions: An Example of Genetic Engineering to Reduce Pest Damage



Fig. 12-24, p. 302

Natural Capital: Biological Pest Control



Integrated Pest Management Is a Component of Sustainable Agriculture

- **Integrated pest management (IPM)**
 - Coordinate: cultivation, biological controls, and chemical tools to reduce crop damage to an economically tolerable level
 - Reduces pollution and pesticide costs
- Disadvantages
 - Requires expert knowledge
 - High initial costs
 - Government opposition

WHAT IS IPM?

Farmers use **Integrated Pest Management (IPM)** strategies to prevent crop damage from insect, weed, and disease pests.

IPM PRACTICES INCLUDE:



WHY SHOULD YOU CARE?

Because IPM practices help farmers:

- conserve our environment
- produce quality crops
- maintain farm profitability



12-5 How Can We Improve Food Security?

- ***Concept 12-5*** *We can improve food security by creating programs to reduce poverty and chronic malnutrition, relying more on locally grown food, and cutting food waste.*

Use Government Policies to Improve Food Production and Security

- Control prices to make food affordable
- Provide subsidies to farmers
- Let the marketplace decide—
 - Working in New Zealand and Brazil

Other Government and Private Programs are Increasing Food Security

- Immunizing children against childhood diseases
 - Encourage breast-feeding
 - Prevent dehydration in infants and children
 - Provide family planning services
 - Increase education for women
-
- One-half to one-third of nutrition-related deaths in children can be prevented for \$5-10 per year

12-6 How Can We Produce Food More Sustainably?

- **Concept 12-6** *More sustainable food production will require using resources more efficiently, sharply decreasing the harmful environmental effects of industrialized food production, and eliminating government subsidies that promote such harmful impacts.*

Reduce Soil Erosion

- **Soil conservation**, some methods
 - Terracing
 - Contour planting
 - Strip cropping with cover crop
 - Alley cropping, agroforestry
 - Windbreaks or shelterbelts
 - Conservation-tillage farming
 - No-till
 - Minimum tillage
- Identify erosion hotspots

Soil Conservation: Terracing



Fig. 12-26, p. 305

Soil Conservation: Contour Planting and Strip Cropping



Soil Conservation: Alley Cropping



Soil Conservation: Windbreaks



Case Study: Soil Erosion in the United States—Learning from the Past

- What happened in the Dust Bowl in the 1930s?
- Migrations to the East, West, and Midwest
- 1935: Soil Erosion Act
- More soil conservation needed

Natural Capital Degradation: The Dust Bowl of the Great Plains, U.S.



Fig. 12-30, p. 307



Fig. 12-30, p. 307

Restore Soil Fertility

- **Organic fertilizer**
 - **Animal manure**
 - **Green manure**
 - **Compost**
- **Manufactured inorganic fertilizer**
 - Nitrogen, phosphorus, calcium
- Crop rotation

Reduce Soil Salinization and Desertification

- Soil salinization
 - Prevention
 - Clean-up
- Desertification, reduce
 - Population growth
 - Overgrazing
 - Deforestation
 - Destructive forms of planting, irrigation, and mining

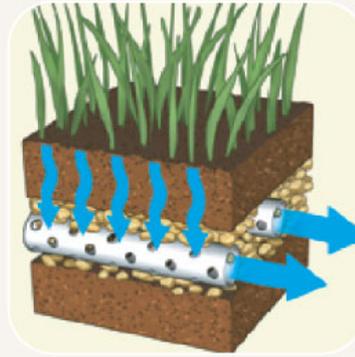
Solutions: Soil Salinization

Solutions

Soil Salinization

Prevention

Reduce irrigation



Switch to salt-tolerant crops



Cleanup

Flush soil (expensive and wastes water)

Stop growing crops for 2–5 years

Install underground drainage systems (expensive)

Solutions

More Sustainable Aquaculture

- Protect mangrove forests and estuaries
- Improve management of wastes
- Reduce escape of aquaculture species into the wild
- Raise some species in deeply submerged cages
- Set up self-sustaining aquaculture systems that combine aquatic plants, fish, and shellfish
- Certify and label sustainable forms of aquaculture

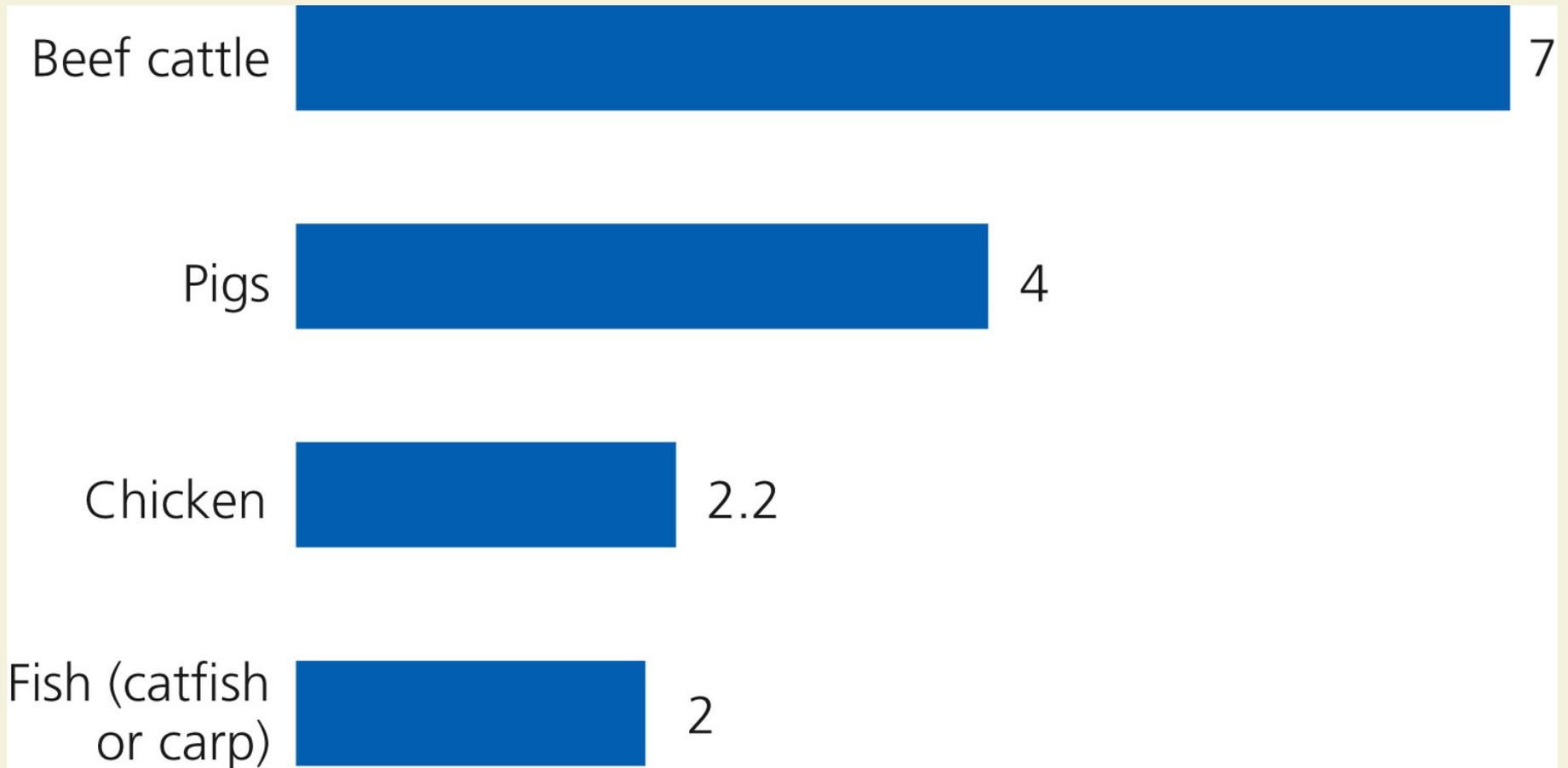
Case Study: Raising Salmon in an Artificial Ecosystem

- Cooke Aquaculture in the Bay of Fundy, New Brunswick, Canada
- Mimic a natural system with 3 species:
 - Salmon in cages
 - Shellfish in socks filter waste
 - Kelp uses some of added nutrients

Produce Meat More Efficiently and Humanely

- Shift to more grain-efficient forms of protein
- Beef from rangelands and pastures, not feedlots
- Develop meat substitutes; eat less meat

Efficiency of Converting Grain into Animal Protein



Shift to More Sustainable Agriculture (1)

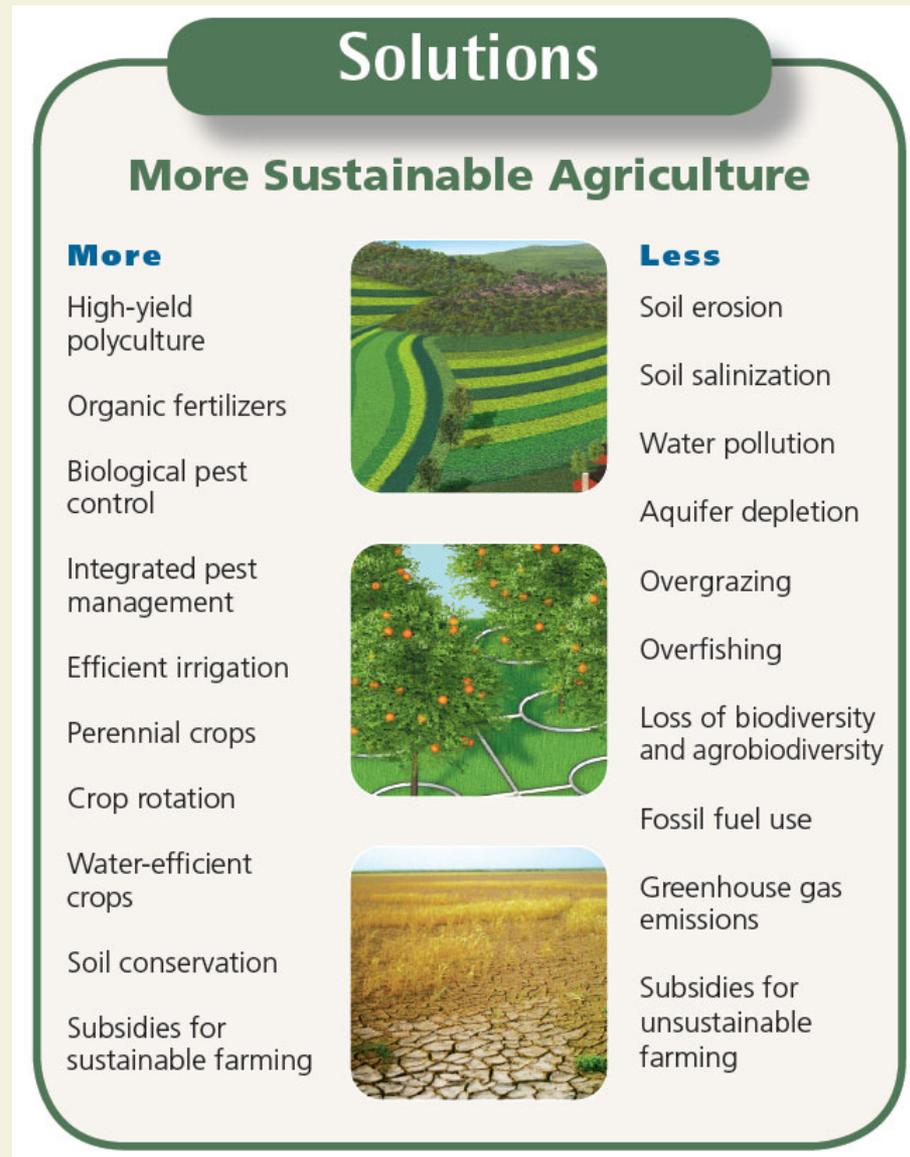
- Sustainable agriculture uses fewer inputs, creates less pollution, and contributes less to global warming
- Organic farming
 - Many benefits
 - Requires more labor

Shift to More Sustainable Agriculture

(2)

- Strategies for more sustainable agriculture
 - Research on organic agriculture with human nutrition in mind
 - Show farmers how organic agricultural systems work
 - Subsidies and foreign aid
 - Training programs; college curricula
 - Encourage hydroponics
 - Greater use of alternative energy

Solutions: More Sustainable Organic Agriculture



Solutions: Organic Farming

Solutions

Organic Farming

- Improves soil fertility
- Reduces soil erosion
- Retains more water in soil during drought years
- Uses about 30% less energy per unit of yield
- Lowers CO₂ emissions
- Reduces water pollution by recycling livestock wastes
- Eliminates pollution from pesticides
- Increases biodiversity above and below ground
- Benefits wildlife such as birds and bats



Solutions

Organic Farming

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Science Barge: Prototype of Sustainable Urban Farm in Yonkers, New York



Fig. 12-36, p. 311

Science Focus: Sustainable Polycultures of Perennial Crops

- Polycultures of perennial crops
- Wes Jackson: natural systems agriculture benefits
 - No need to plow soil and replant each year
 - Reduces soil erosion and water pollution
 - Deeper roots – less irrigation needed
 - Less fertilizer and pesticides needed

Comparison of the Roots between an Annual Plant and a Perennial Plant

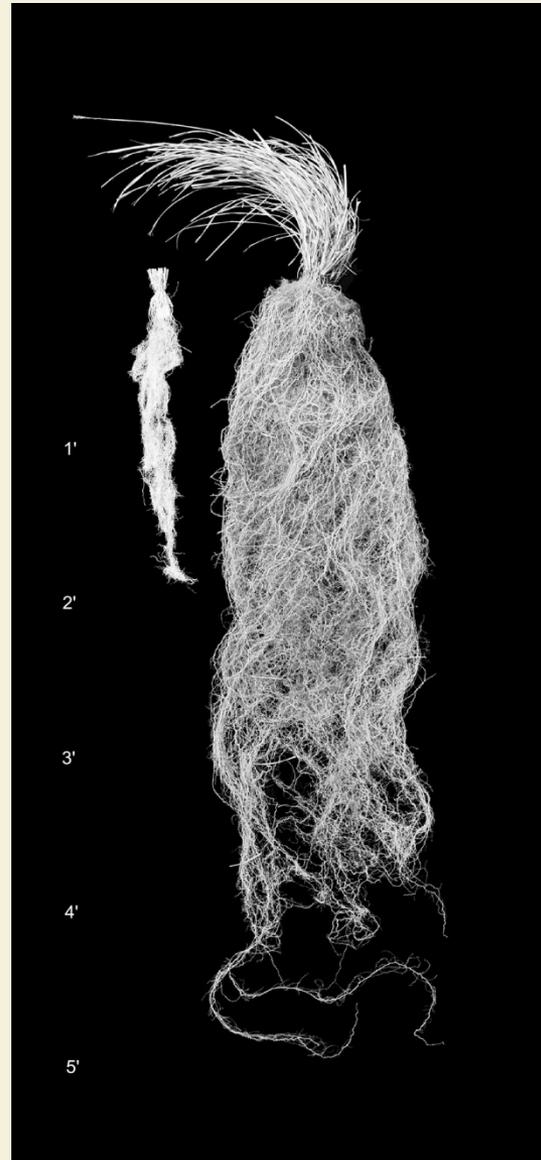


Fig. 12-C, p. 312

Buy Locally Grown Food, Grow More Food Locally, and Cut Food Waste

- Supports local economies
- Reduces environmental impact on food production
- Community-supported agriculture

What Can You Do? Sustainable Organic Agriculture

What Can You Do?

Sustainable Organic Agriculture

- Eat less meat, no meat, or organically certified meat
- Use organic farming to grow some of your food
- Buy certified organic food
- Eat locally grown food
- Compost food wastes
- Cut food waste

Three Big Ideas

1. More than 1 billion people have health problems because they do not get enough to eat and 1.1 billion people face health problems from eating too much.
2. Modern industrialized agriculture has a greater harmful impact on the environment than any other human activity.