

Chapter 11

Feeding the World

Friedland and Relyea Environmental Science for AP[®], second edition
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Module 31

Human Nutritional Needs

After reading this module, you should be able to

- describe human nutritional requirements.
- explain why nutritional requirements are not being met in various parts of the world.

Human nutritional requirements are not always satisfied

- **Undernutrition** The condition in which not enough calories are ingested to maintain health.
- **Malnourished** Having a diet that lacks the correct balance of proteins, carbohydrates, vitamins, and minerals.
- **Food security** A condition in which people have access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life.
- **Food insecurity** A condition in which people do not have adequate access to food.

Human Nutritional Needs

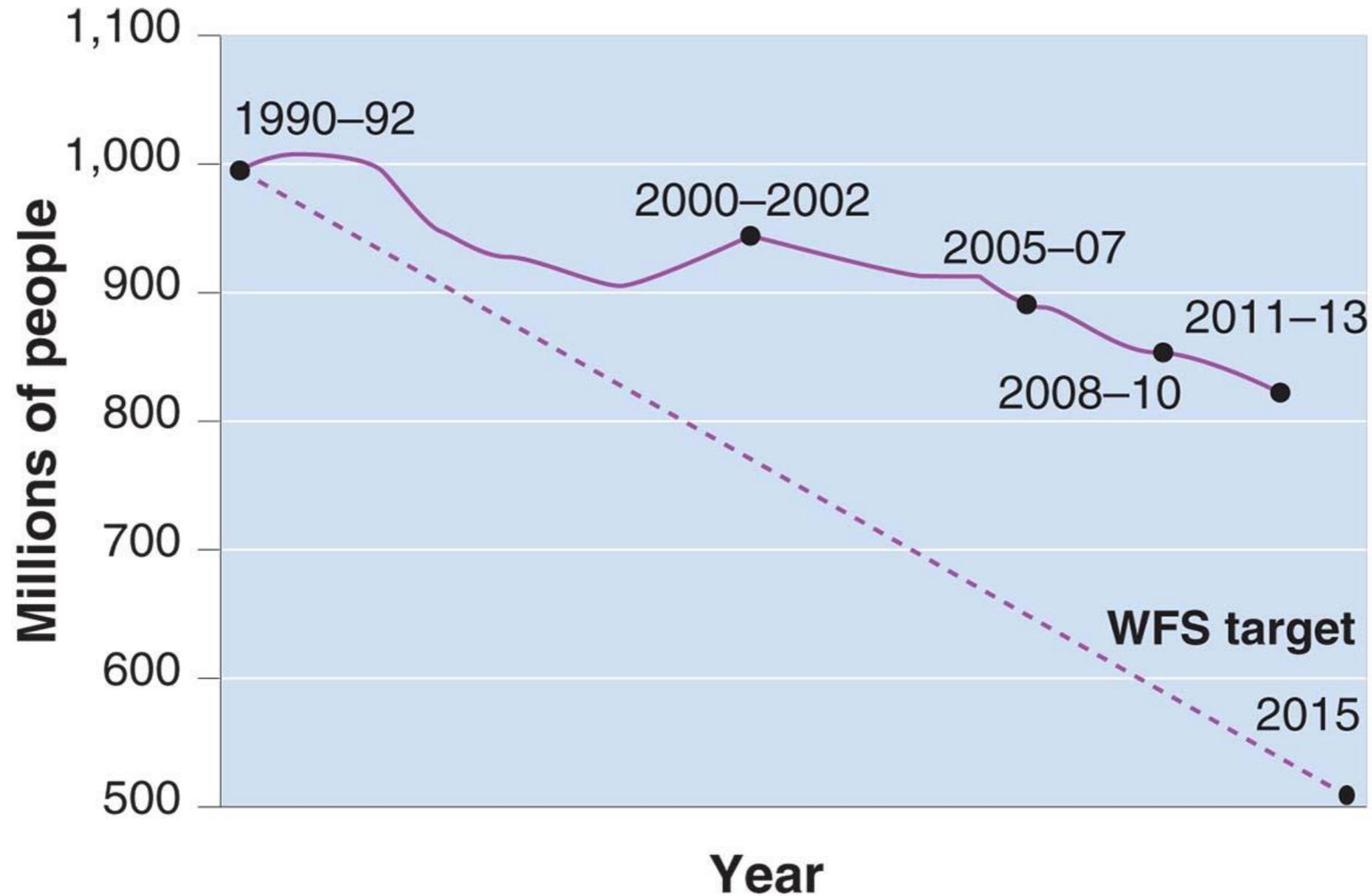


Figure 31.1
Environmental Science for AP[®], Second Edition
Data from FAO, IFAD, and WFP. 2013. *The State of Food Insecurity in the World 2013. The multiple dimensions of food security.*
Rome, Food and Agriculture Organization

Global undernutrition. The number of undernourished people in the world has declined from 1990 through the present (solid line), but is still greater than World Food Summit targets (dashed line).

Human Nutritional Needs

- **Famine** The condition in which food insecurity is so extreme that large numbers of deaths occur in a given area over a relatively short period.
- **Anemia** A deficiency of iron.
- **Overnutrition** Ingestion of too many calories and a lack of balance of foods and nutrients.
- **Meat** Livestock or poultry consumed as food.

Human Nutritional Needs

- Humans eat a variety of foods, but grains (corn, rice, wheat) make up the largest portion of the human diet.
- There are roughly 50,000 edible plants, but 3 species (corn, rice, wheat) constitute 60 percent of the human energy intake.
- Meat, is the second largest component of the human diet.

Human Nutritional Needs

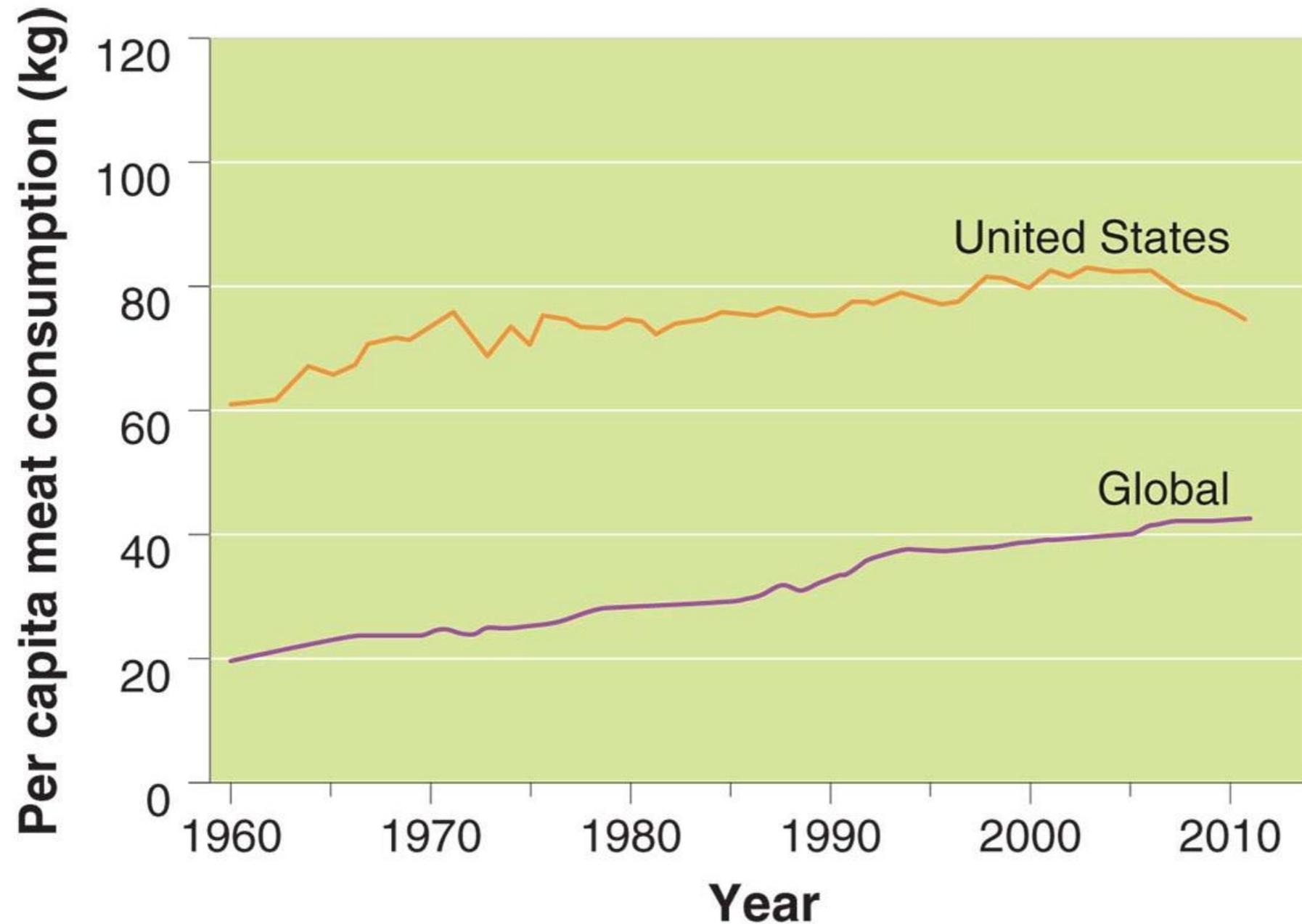


Figure 31.2
Environmental Science for AP®, Second Edition
Data from www.fao.org and http://www.earth-policy.org/data_highlights/2012/highlights25

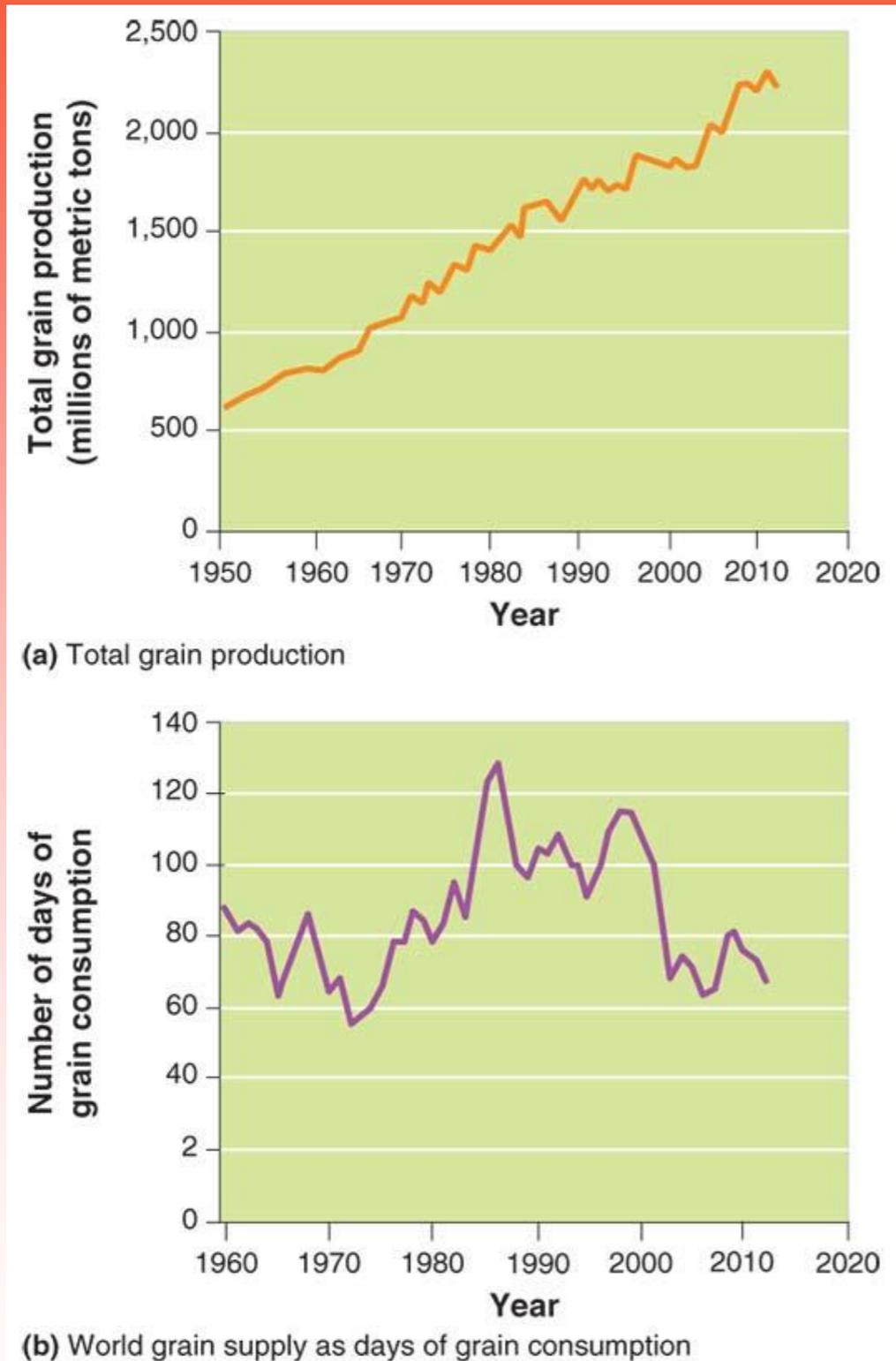
Per capita meat consumption through 2012. Per capita meat consumption has begun to decrease in the United States. It has been steadily increasing worldwide.

Undernutrition and malnutrition occur primarily because of poverty

Several factors contribute to malnutrition:

- Poverty
- Political unrest
- Poor governance
- High food prices and other economic conditions

Reasons for Malnutrition



Global grain production, 1950–2012.

(a) Global grain production grew rapidly from 1950 through the mid-1980s. Growth has continued since then, but per capita growth has slowed. (b) World grain supply (days of supply for everyone in the world) has been declining.

Figure 31.3

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Data from <http://www.earth-policy.org/indicators/C54>

Module 32

Modern Large-Scale Farming Methods

After reading this module you should be able to

- describe modern, large-scale agricultural methods.
- explain the benefits and consequences of genetically modified organisms.
- discuss the large-scale raising of meat and fish.

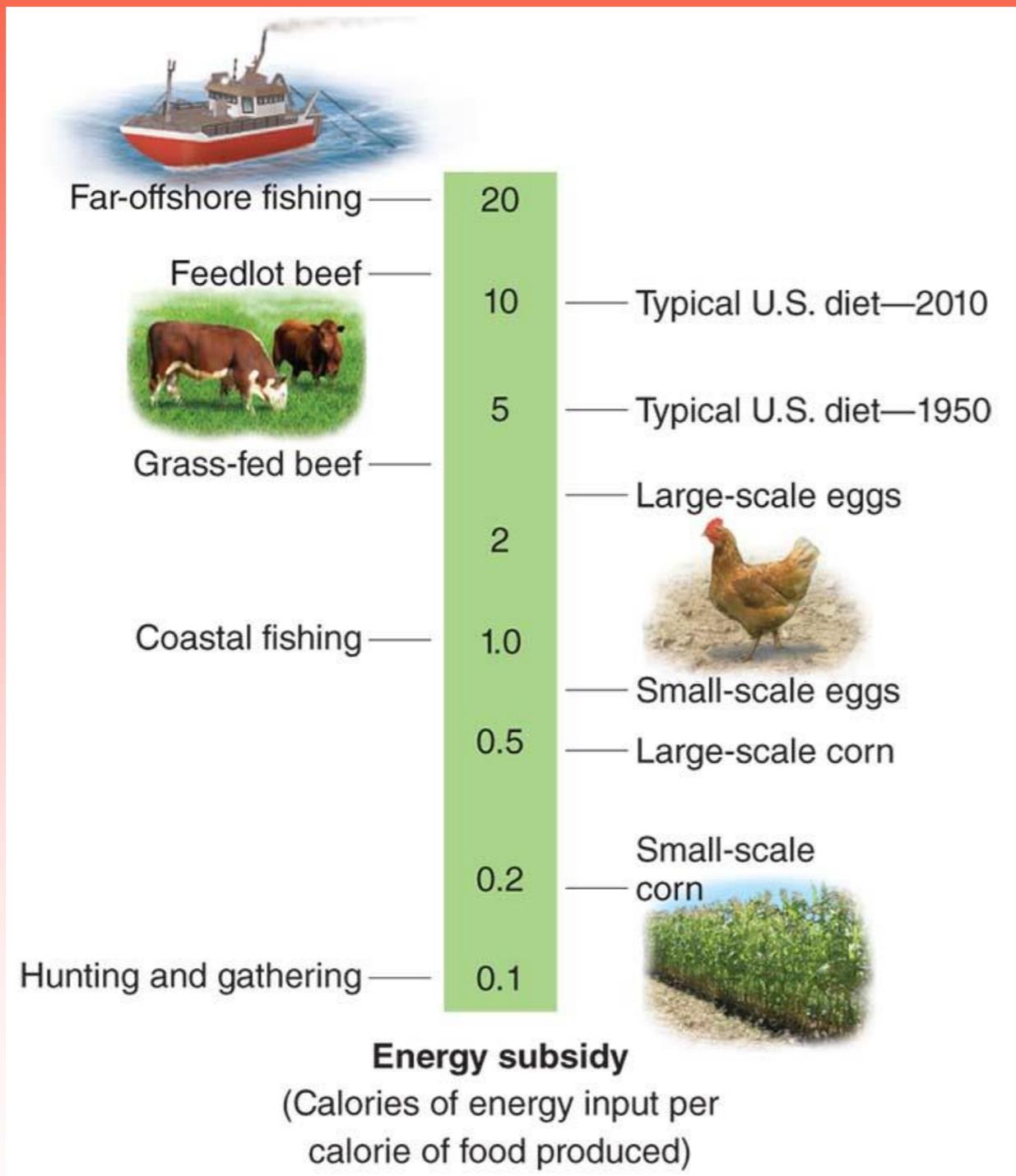
Modern industrial farming methods have transformed agriculture

- **Industrial agriculture** Agriculture that applies the techniques of mechanization and standardization. *Also known as **agribusiness**.*
- **Energy subsidy** The fossil fuel energy and human energy input per calorie of food produced.

The Energy Subsidy in Agriculture

- It may take 20kg of grain to make 1kg of beef.
- Most of the energy subsidies in modern agriculture are in the form of fossil fuels used to produce fertilizers and pesticides, and to harvest food and prepare it for transport.
- Transporting food from farm to your plate is another large energy subsidy.

The Energy Subsidy in Agriculture



Energy subsidies for various methods of food production and diets. Energy input per calorie of food obtained is greater for modern agricultural practices than for traditional agriculture. Energy inputs for hunting and gathering and for small-scale food production are mostly in the form of human energy, whereas fossil fuel energy is the primary energy subsidy for large-scale modern food production. All values are approximate, and for any given method there is a large range of values.

Figure 32.1
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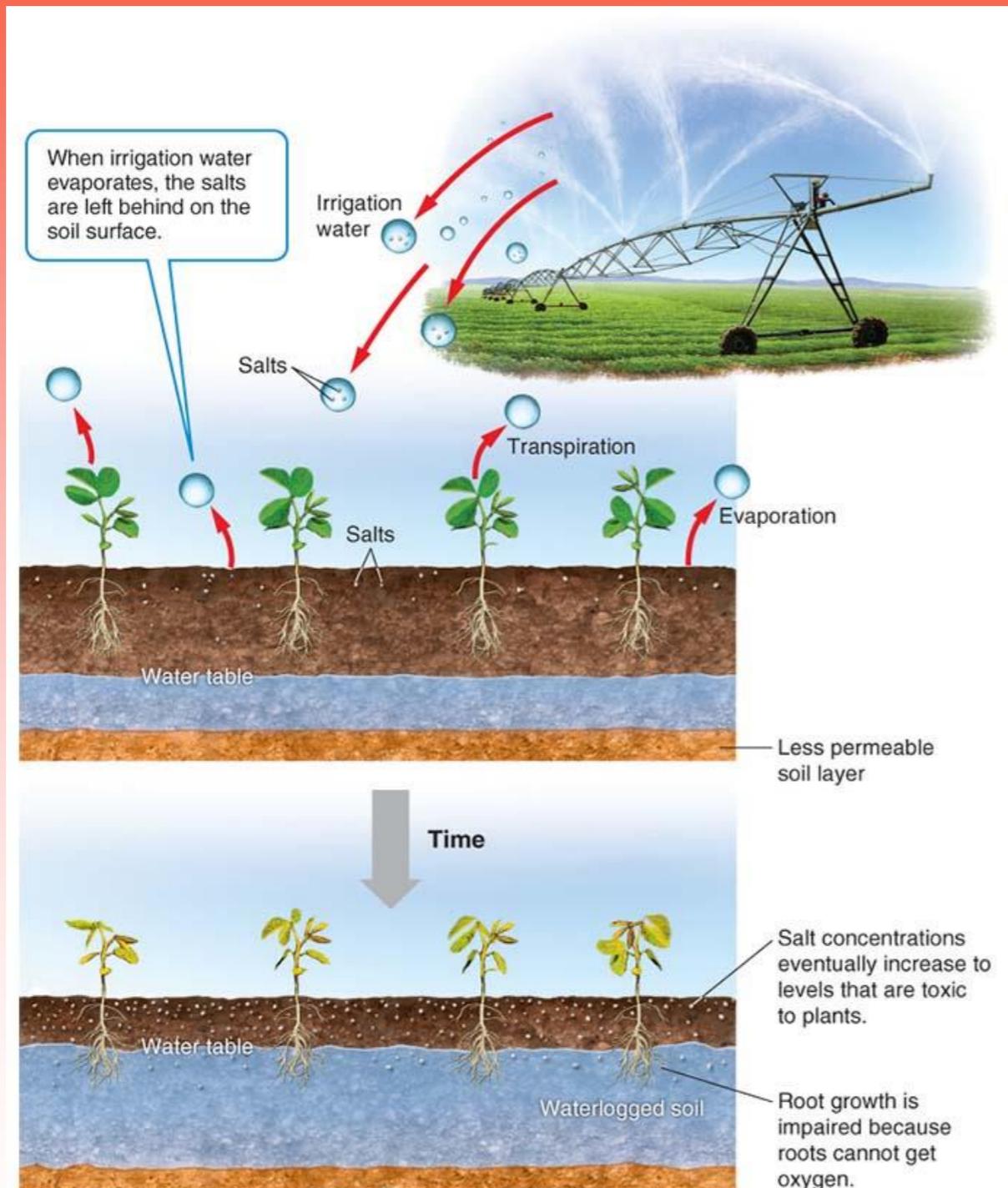
The Green Revolution

- New management techniques and mechanization as well as fertilization, irrigation, and improved crop varieties has increased food production dramatically.
- The abundance of food supplied by agriculture is one factor that has led to the exponential growth of the human population.
- **Green Revolution** A shift in agricultural practices in the twentieth century that included new management techniques, mechanization, fertilization, irrigation, and improved crop varieties, and that resulted in increased food output.
- **Economies of scale** The observation that average costs of production fall as output increases.

The Green Revolution: Irrigation

- Irrigation creates certain problems including waterlogging and salinization.
- **Waterlogging** A form of soil degradation that occurs when soil remains under water for prolonged periods.
- **Salinization** A form of soil degradation that occurs when the small amount of salts in irrigation water becomes highly concentrated on the soil surface through evaporation.

The Green Revolution: Irrigation



Irrigation-induced salinization and waterlogging. Over time, irrigation can degrade soil by leaving a layer of highly concentrated salts at the soil surface and waterlogged soil below.

Figure 32.3
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The Green Revolution: Fertilizers

- Fertilizers are either organic or synthetic (inorganic).
- **Organic fertilizer** Fertilizer composed of organic matter from plants and animals.
- **Synthetic fertilizer** Fertilizer produced commercially, normally with the use of fossil fuels. *Also known as inorganic fertilizer.*

The Green Revolution: Pesticides

- **Monocropping** An agricultural method that utilizes large plantings of a single species or variety.
- **Pesticide** A substance, either natural or synthetic, that kills or controls organisms that people consider pests.
- **Insecticide** A pesticide that targets species of insects and other invertebrates that consume crops.
- **Herbicide** A pesticide that targets plant species that compete with crops.

The Green Revolution: Pesticides

- **Broad-spectrum pesticide** A pesticide that kills many different types of pest.
- **Selective pesticide** A pesticide that targets a narrow range of organisms.
- **Persistent pesticide** A pesticide that remains in the environment for a long time.
- **Nonpersistent pesticide** A pesticide that breaks down rapidly, usually in weeks or months.

The Green Revolution: Pesticides

- **Pesticide resistance** A trait possessed by certain individuals that are exposed to a pesticide and survive.
- **Pesticide treadmill** A cycle of pesticide development, followed by pest resistance, followed by new pesticide development.

Genetic engineering is revolutionizing agriculture

Benefits of genetic engineering:

- Greater yield
- Greater food quality
- Reductions in pesticide use
- Reduction of world hunger by increased food production
- Increased profits

Genetic Engineering

Concerns about genetic engineering:

- Safety for human consumption
- Effects on biodiversity
- Regulation of genetically modified organisms

Modern agribusiness includes farming meat and fish

- **Concentrated animal feeding operation (CAFO)** A large indoor or outdoor structure designed for maximum output.
- **Fishery** A commercially harvestable population of fish within a particular ecological region.
- **Fishery collapse** The decline of a fish population by 90 percent or more.
- **Bycatch** The unintentional catch of nontarget species while fishing.

Harvesting Fish

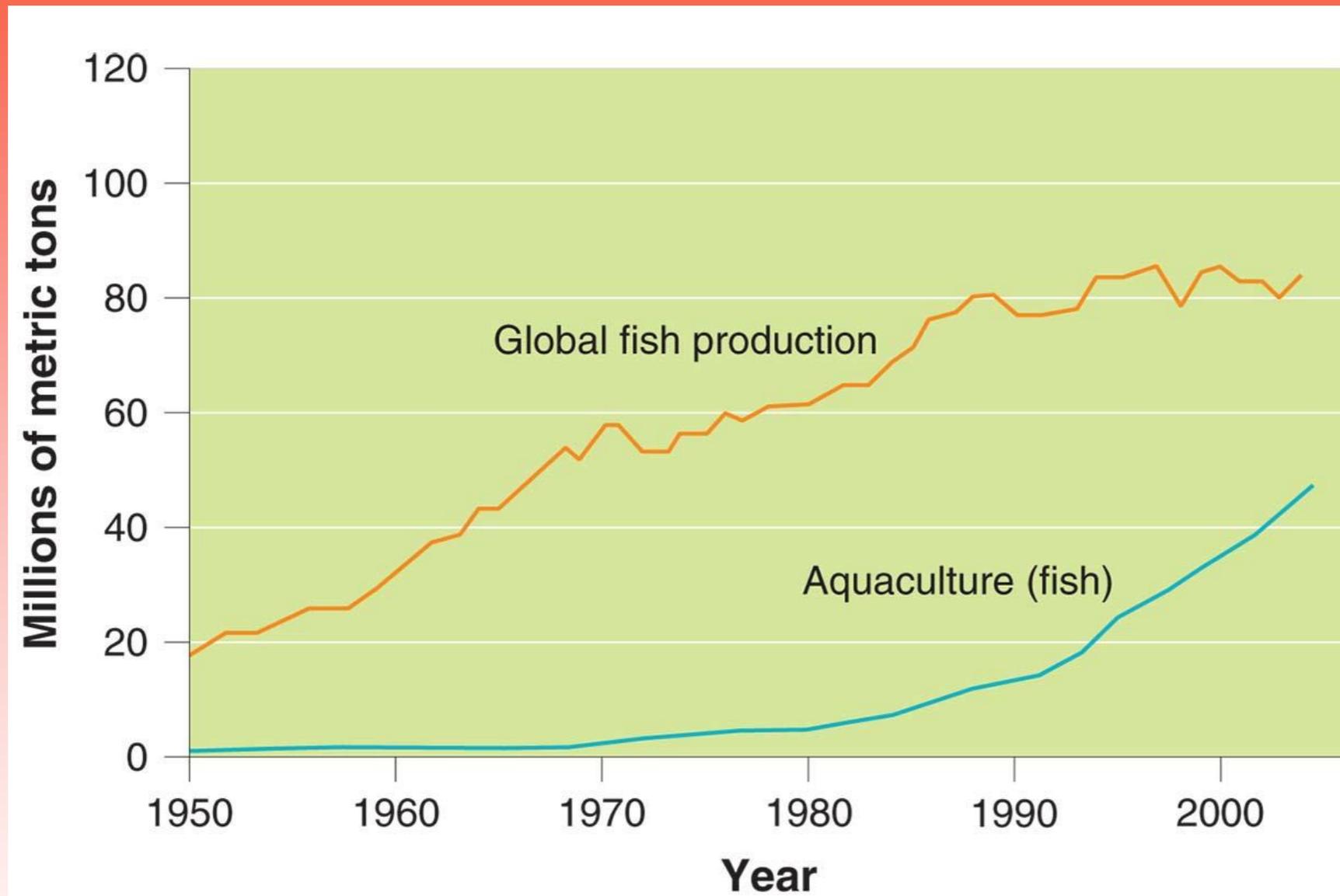


Figure 32.9
Environmental Science for AP®, Second Edition
Data from K. M. Brander, PNAS 104 (2007): 19709–19714

Global fish production. Global fish production has increased by more than 30 percent since 1980, primarily as a result of the large increase in aquaculture. The graph shows data for aquaculture-raised fish (blue) and global fish production (orange), which includes both wild-caught fish and aquaculture-raised fish.

Module 33

Alternatives to Industrial Farming Methods

After reading this module, you should be able to

- describe alternatives to conventional farming methods.
- explain alternative techniques used in farming animals and in fishing and aquaculture.

Alternatives to industrial farming methods are gaining more attention

- Industrial agriculture is now considered conventional.
- When cost of labor is not the most important consideration, traditional farming techniques may be economically viable.

Shifting Agriculture and Nomadic Grazing

- **Shifting agriculture** An agricultural method in which land is cleared and used for a few years until the soil is depleted of nutrients.
- **Desertification** The transformation of arable, productive land to desert or unproductive land due to climate change or destructive land use.
- **Nomadic grazing** The feeding of herds of animals by moving them to seasonally productive feeding grounds, often over long distances.

Shifting Agriculture and Nomadic Grazing

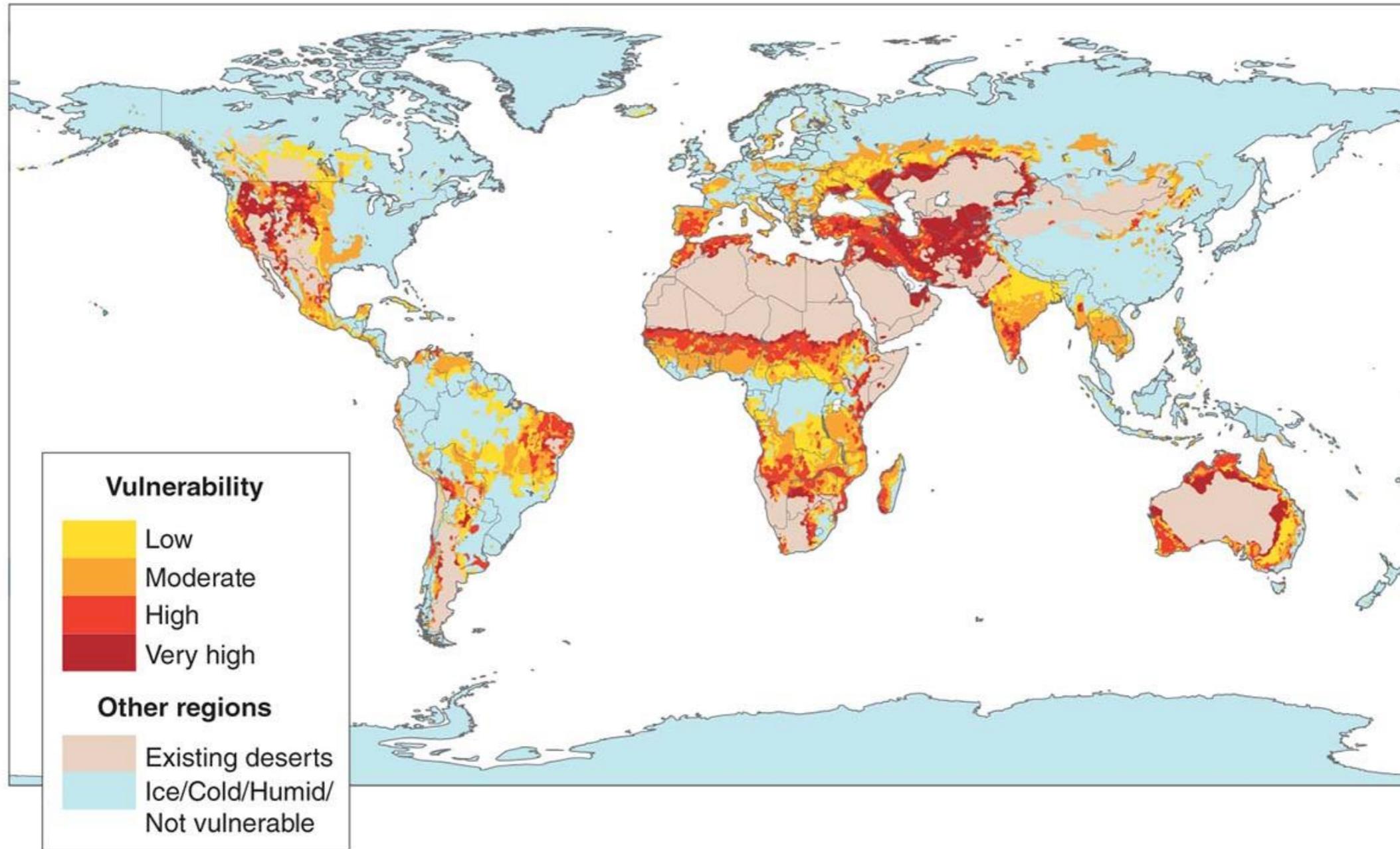


Figure 33.2
Environmental Science for AP®, Second Edition
Data from www.fao.org

Vulnerability to desertification. Certain regions of the world are much more vulnerable to desertification than others.

Sustainable Agriculture

- **Sustainable agriculture** Agriculture that fulfills the need for food and fiber while enhancing the quality of the soil, minimizing the use of nonrenewable resources, and allowing economic viability for the farmer.

Practices used in sustainable agriculture :

- **Intercropping** An agricultural method in which two or more crop species are planted in the same field at the same time to promote a synergistic interaction.
- **Crop rotation** An agricultural technique in which crop species in a field are rotated from season to season.
- **Agroforestry** An agricultural technique in which trees and vegetables are intercropped.
- **Contour plowing** An agricultural technique in which plowing and harvesting are done parallel to the topographic contours of the land.

No-Till Agriculture

- **Perennial plant** A plant that lives for multiple years.
- **Annual plant** A plant that lives only one season.
- **No-till agriculture** An agricultural method in which farmers do not turn the soil between seasons as a means of reducing topsoil erosion.

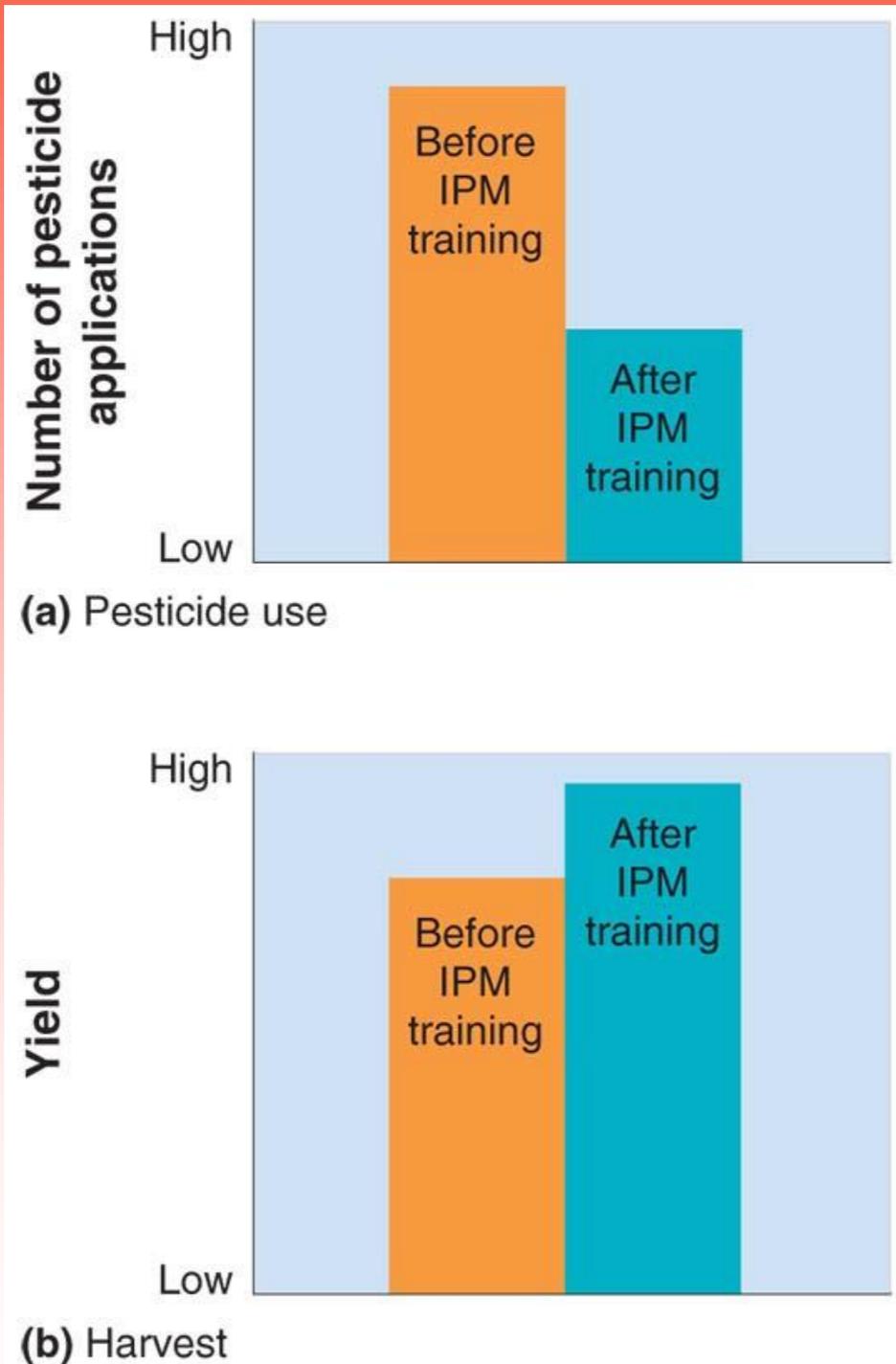
Integrated Pest Management

- **Integrated pest management (IPM)** An agricultural practice that uses a variety of techniques designed to minimize pesticide inputs.

Characteristics of IPM:

- Crop rotation
- Intercropping
- Planting pest resistant crop varieties
- Creating habitats for predators
- Limited use of pesticides

Integrated Pest Management



Effects of IPM training. (a) IPM training of farmers in Indonesia led to a significant reduction in pesticide applications. (b) Yield improvements also occurred after the training because of the additional attention the farmers gave to their crops.

Figure 33.7
Environmental Science for AP[®], Second Edition
Data from www.fao.org

Organic Agriculture

- **Organic agriculture** Production of crops without the use of synthetic pesticides or fertilizers.

Principles of organic agriculture:

- Use ecological principles and work with natural systems.
- Keep as organic matter and nutrients in the soil and on the farm.
- Avoid the use of synthetic fertilizers and synthetic pesticides.
- Maintain soil by increasing soil mass, biological activity, and beneficial chemical properties.
- Reduce the adverse environmental effects of agriculture.

Alternatives techniques for farming animals and fish are becoming more popular

- Free-range beef and chicken are becoming increasingly popular.
- Free-range meat is more likely to be sustainable.
- Free range farming does not require treatment and disposal of massive quantities of manure.
- Free-range animals are less likely to spread disease; the use of antibiotics and other medications can be reduced or eliminated.
- Free range farming uses more land and cost is significantly higher than CAFOs.

More Sustainable Fishing

- Many countries around the world have developed fishery management plans with international agreements.
- The Sustainable Fisheries Act passed in 1996 shifted fisheries management from a focus on economic sustainability to a species-sustainability approach.
- **Individual transferable quota (ITQ)** A fishery management program in which individual fishers are given a total allowable catch of fish in a season that they can either catch or sell.

Aquaculture

- **Aquaculture** Farming aquatic organisms such as fish, shellfish, and seaweeds.
- Aquaculture involves constructing an aquatic ecosystem. It usually requires keeping the organisms in enclosures.
- Proponents of aquaculture believe it can alleviate some of the human-caused pressure on overexploited fisheries and provide protein for the more than 1 billion undernourished people in the world.
- Critics of aquaculture point out that it can create many environmental problems.