SUSTAINING KEY RESOURCES

Chapter 13

Food, Soil Conservation, and Pest Management

"It's A Small World After All"

Outline

Food Security and Nutrition

A. Global food production has stayed ahead of population growth, but one in six people in developing countries cannot grow or buy the food they need.
B. Some people cannot grow or buy enough food to meet their basic energy needs and to get enough protein and other key ingredients. People need fairly large amounts of macronutrients (protein, carbohydrates, fats) and smaller amounts of micronutrients (vitamins such as A, C, E) and minerals (iron, iodine, calcium).
    1. Chronic undernutrition is suffered by those who can't grow or buy enough food. Children in this group may have stunted growth, mental retardation, and be susceptible to infectious diseases.
    2. Malnutrition results from insufficient protein and other key nutrients.
C. One in three people has a deficiency of one or more vitamins and minerals, especially vitamin A, iron, and iodine.
    1. Blindness due to a vitamin A deficiency occurs in 250,000 children under 6 each year and up to 80% die within a year.
    2. Iron is needed to prevent anemia.
    3. Iodine is needed for proper thyroid function, to prevent brain damage or formation of a goiter.
D. Droughts, floods, wars, and other catastrophic events can lead to severe food shortages that cause mass starvation, many deaths, and economic and social disruption.
E. There are several ways to reduce childhood deaths from nutrition-related causes.
    1. UNICEF studies that 1/2 to 2/3rds of these deaths could be prevented by:
        a. Immunizing children against childhood diseases
        b. Encourage breast feeding
        c. Prevent dehydration from diarrhea by giving mixture of sugar and salt in a glass of water
        d. Give children vitamin A capsules 2X/year to prevent blindness
        f. Provide family planning services for spacing children
        g. Increase education for women, emphasizing nutrition, water sterilization, and childcare.
F. Overnutrition and lack of exercise can lead to reduced life quality, poor health, and premature death.

Food Production

A. Food production from croplands, rangelands, ocean fisheries, and aquaculture has increased dramatically.
    1. Croplands produce 77% of the world's food.
    2. Rangelands produce meat, about 16% of the world's food.
    3. Oceanic fisheries supply 7% of the world's food.
    4. All three systems have increased their food yields since 1960.
        a. Technological advances have increased food production or harvesting.
        b. More sophisticated farming techniques have been developed.
        c. Expanded use of inorganic chemical fertilizers, irrigation, pesticides, high-yield crops have developed.
        d. Intense farming methods, such as densely populated feedlots and enclosed breeding/growing pens, and aquaculture ponds or ocean cages have been implemented.
B. Wheat, rice and corn provide more than half of the calories in the food consumed by the world's people.
C. About 80% of the world's food supply is produced by industrialized agriculture.
    1. Industrialized/high-input agriculture produces large quantities of single crop or livestock animals.
        a. This uses much energy, water, fertilizers and pesticides.
        b. It is practiced on 25% of cropland, mostly in developed countries.
        c. Plantation agriculture is industrialized agriculture, primarily in tropical developing

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countries. Monoculture crops—bananas, coffee, soybeans, and sugarcane—are cash crops.
   d. Another example of industrialized agriculture is feedlots, which support rapid growth of fattened animals for meat.

D. The United States uses industrialized agriculture to produce about 17% of the world's grain in a very efficient manner.
E. Many farmers in developing countries use low-input agriculture to grow a variety of crops on each plot of land.
   1. Traditional agriculture provides about 20% of the food supply and is practiced by 42% of the world's people.
      a. Traditional subsistence agriculture typically supports a single farm family's survival.
      b. Traditional intensive agriculture strives to feed not only the farmer's family, but also additional food to sell as income. By using fertilizer, irrigating, etc., a higher yield is sought.
      c. Some traditional farmers use four types interplanting to grow several crops on the same plot of land simultaneously.

Soil Erosion and Degradation

A. Soil erosion lowers soil fertility and can overload nearby bodies of water with eroded sediment.
   1. Water, wind and people cause soil erosion; soil components are moved from one place to another.
   2. Depletion of plant nutrients in topsoil, through farming, logging, construction, overgrazing, burning vegetation, leads to loss of soil fertility.
   3. Eroded soil becomes sediment in surface waters where it pollutes water, kills fish, clogs irrigation ditches, channels, reservoirs and lakes.
   4. Soil erosion can occur through sheet erosion, rill erosion, and gully erosion.
B. Soil is eroding faster than it is forming on more than one-third of the world's cropland.
   1. A joint UNEP and World Resources Institute report estimated that topsoil is eroding faster than it is replenished on 38% of the world's cropland. Worldwide erosion causes damage of at least $375 billion per year.
C. Soil erodes faster than it forms on most U.S. cropland, but since 1985, has been cut by about 40%.
D. About one-third of the world's land has lower productivity because of drought and human activities that reduce or degrade topsoil.
   1. Desertification occurs when production falls by 10% or more though a combination of natural causes (drought) and human activities. It may be moderate, severe or very severe, only in extreme cases does it lead to a desert.
   2. The Dust Bowl of the 1930's resulted in Congress passing the Soil Erosion Act in 1935 and established the Soil Conservation Service (a part of the USDA).
   3. Prolonged droughts can't be controlled, but the consequences can be reduced by reducing overgrazing, deforestation, and destructive forms of planting, irrigation, and mining.
   4. Restoration of these areas includes planting trees and grasses to anchor soil and hold water.
E. Repeated irrigation can reduce crop yields by causing salt buildup in the soil and waterlogging of croplands.
   1. 40% of the world's food is produced on 20% of the cropland that is irrigated.
   2. Salts left behind when irrigation water is not absorbed into the soil can be left in the topsoil. This is called salinization.
   3. Salinization has reduced yields on 20% of the world's cropland.
   4. Waterlogging occurs when saline water (from irrigation) envelops the deep roots of plants. This saline water accumulates underground and raises the water table.

Sustainable Agriculture through Soil Conservation

Soil conservation seeks ways to reduce soil erosion and restore soil fertility, mostly by keeping the soil covered with vegetation.

A. Modern farm machinery can plant crops without disturbing the soil.
   1. Conventional-tillage farming means plowing in the fall and leaving the soil bare all winter,

making it vulnerable to wind and erosion.
2. Conservation-tillage farming disturbs the soil as little as possible while planting.
3. Minimum-tillage farming allows the soil to rest over the winder. The subsurface soil is broken up and loosened but the topsoil is not turned.
4. No-till farming uses special machines to inject seeds, fertilizers, and herbicides into thin slits in the unplowed soil and, then, cover the slits.
5. About 40% of U.S. soil used conservation tillage in 2004. The USDA estimates that using it on 80% of cropland would reduce soil erosion by 50% or more.

B. Terracing, contour planting, strip cropping, alley cropping, and windbreaks are additional methods that can reduce soil erosion.
1. Terracing converts the land into a series of broad, nearly level terraces that run across the contour of the land. This method holds water for crops and reduces runoff.
2. Contour farming plows and plants crops in rows across the slope of the land, not up and down. Each row acts as a small dam.
3. Strip cropping plants alternating strips of a row crop (corn/cotton) with another crop that completely covers the soil (grass/legume). Runoff is caught by the cover crop.
4. Plant cover crops like rye or alfalfa after harvest.
5. Leave crop residues on the land after harvest.
6. Alley cropping/agroforestry plants several crops together in strips/alleys between trees or shrubs, which may provide fruit or fuelwood.
   a. The shade of the trees/shrubs reduces evaporation and helps retain soil moisture.
   b. Fruit, fuelwood, and trimming can be used as mulch.
7. Windbreaks or shelterbelts of trees reduce wind erosion, help retain soil moisture, provide fuelwood, and support bird and insect habitats.

C. Fertilizers can help restore soil nutrients, but runoff of inorganic fertilizers can cause water pollution.
1. Organic fertilizer can be used to restore lost plant nutrients.
   a. Animal manure improves soil structure, adds nitrogen, and stimulates soil bacteria and fungi.
   b. U.S. Department of Agriculture researchers are evaluating the value of burnt chicken wastes that are rich in phosphorus as an organic fertilizer
   c. Green manure plows freshly cut or growing green vegetation into the soil to increase organic matter and humus.
   d. Microorganisms in the soil break down organic matter in leaves, food wastes, paper and wood to form compost.
2. Crop rotation plants different crops to replenish the soil, especially if a previous crop has depleted the soil of certain nutrients.
3. Inorganic fertilizers, used with organic fertilizers, can restore soil fertility.
   a. Commercial inorganic fertilizers contain nitrogen, phosphorus, and potassium.
   b. There are advantages and disadvantages to the use of inorganic fertilizers (figure 14-15).

The Green Revolution and its Environmental Impact

A. Since 1950, high-input agriculture has produced more crops per unit of land. The following steps describe this green revolution:
1. Key grain crops of plant monocultures are bred or enhanced to produce high-yield varieties.
2. High-yields are sustained by using large amounts of fertilizer, water, and pesticides.
3. The number of crops grown per year is increased through multiple cropping.
4. There have been two green revolutions. The first revolution occurred in developing countries between 1950-1970. The second revolution has occurred since 1967 in developing countries with enough rain and/or irrigation capability.
   a. Fast-growing dwarf varieties of rice and wheat, especially for tropical and subtropical climates, have been introduced.
   b. Use of pesticides, water, and fertilizers, food yields have increased.
   c. Several crops can be planted during one year increasing food yields further.
   d. Such revolutions use machinery and fossil fuel to plant and harvest.

B. Lack of water, high costs for small farmers, and physical limits to increasing crop yields hinder expansion of the green revolution.
C. Modern agriculture has a greater harmful environmental impact than any human activity.
D. Loss of a variety of genetically different crop and livestock strains might limit the genetic raw material needed for future green and gene revolutions.

The Gene Revolution

A. To increase crop yields, we can mix the genes of different organisms. Farmers and scientists have used crossbreeding and artificial selection to develop genetically improved varieties of crop strains.
    1. The current third green revolution – a gene revolution – involves using genetic engineering to develop improved strains of crops and livestock.
    2. Genetic engineering, which splices a gene from one species into the DNA of another species, is creating improved strains of crops and livestock animals.
        a. This process takes 6 times as much time as traditional methods to develop a new crop.
        b. It cuts costs.
        c. It allows for all kinds of potential product development.
        d. More than 2/3rds of food products on the U.S. shelves contain ingredients made from genetically engineered crops.
        e. Scientists are experimenting with cell cultures to produce a variety of food and medical products in fermentation tanks or bioreactors.
B. Genetic engineering holds much promise but has some disadvantages. GMF (genetically modified food) has generated much controversy and fear.
    1. GMF may possibly solve the world's food problems.
    2. Advantages and disadvantages of GMF include the following: (figure 13-19)
    3. The Ecological Society of America recommended more caution in releasing genetically engineered organisms into the environment.
    4. Several scientists feel that genetic engineering of food is based on two faulty assumptions: that world hunger is caused by a global shortage of food, and that genetic engineering is the only and best way to increase food production.
C. There is controversy over legal ownership of genetically modified crop varieties and whether genetically modified foods should be labeled.
    1. Patenting the seeds of GMFs has been subject to criticism, especially by farmers in developing countries.
    2. GMFs are so labeled in Japan, Europe, South Korea, Canada, Australia and New Zealand.
    3. The U.S. Dept. of Agriculture opposed such labeling.
D. A variety of unconventional foods is available, but faces consumer resistance.
    1. One possibility is the winged bean, another is the quinoa plant grown in South America. Some insect species are edible and are called microlivestock.

Producing More Meat

A. About half the world's meat is produced by livestock grazing on grass and half is produced under factory-like conditions.
    1. Meat and meat products are good sources of high-quality protein.
    2. Animals are also fed antibiotics and steroids.
    3. Industrialized animal production accounts for about 43% of the world's beef production, half of pork production, 68% of the egg production, and almost three-fourths of the world's poultry production.
    4. In the U.S. meat production consumes 70% of the country's grain.
    5. 80% of the world's soybean production is fed to livestock.
    6. Industrial livestock production is one of the world's biggest consumers of water.
    7. Oil is also an essential ingredient in meat production. One calorie of grain-fed beef takes 33% more fossil fuel energy than producing one calorie of potatoes.
    8. Cattle and dairy cows produce 16% of the world's emission of the greenhouse gas methane.

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9. Industrialized meat production endangers workers in meatpacking plants.
10. Meat produces large amounts of animal waste and pollutes the environment.
11. Factory farms provide idea conditions for organisms that cause avian flu and mad cow disease.
12. Raising cattle on rangelands and pastures is less environmentally destructive than raising them in feedlots.

B. Eating more chicken and farm-raised fish and less beef and pork reduces the harmful environmental impacts of meat production.
   1. Animal protein production uses about 38% of the world's grain harvest.
   2. The efficiency of converting grain into animal protein is shown in Figure 13-22.

C. The number of people the world can support depends mostly on their per capita consumption of grain and meat and how many children couples have.

Catching and Raising More Fish and Shellfish

A. After spectacular increases, the world's total and per capita marine and freshwater fish and shellfish catches have leveled off.
   1. Fisheries is the third major food-producing system.
   2. About two-thirds of the annual commercial catch of fish and shellfish comes from the ocean. The rest comes from use of aquaculture to raise marine and freshwater fish like livestock in ponds and underwater cages.
   3. Figure 13-23 shows the effects of the global efforts to boost the seafood harvest.
   4. Today, 75% of the world's fisheries are being fished at or above their sustainable capacity.
   5. A 1995 study suggested that some depleted fish stocks could recover with careful management.

B. Government subsidies given to the fishing industry are a major cause of over fishing.
   1. Subsides include fuel tax exemptions, price controls, low-interest loans, and grants for fishing gear.
   2. Critics suggest shifting some of the money to buying out some fishing boats and retraining the crews.

C. Raising large numbers of fish and shellfish in ponds and cages is the world's fastest growing type of food production. Aquaculture is the process of raising fish and shellfish for food like crops, rather than harvesting them in the seas and inland waters.
   1. Fish farming cultivates fish in a controlled environment and harvests them at a particular size.
   2. Fish ranching holds species in fenced-in areas during the time they live in salt water and then releases them to harvest as they spawn in fresh water.
   3. The advantages and disadvantages of aquaculture are shown in Figure 13-24.
   4. Farm raised fish such as salmon have been found to contain more toxins than wild-caught fish.
   5. Figure 13-25 lists some ways to make aquaculture more sustainable.

Solutions: Moving Toward Global Food Security

A. People in urban areas could save money by growing more of their food; up to 70% of the world's food is wasted.

B. Governments can give farmers subsidies to encourage food production or let farmers and fishers respond to market demand.
   1. Price controls keep prices artificially low.
   2. Farming subsidies and tax breaks encourage food production.
   3. Allow market demand to determine prices. In this situation, poor people would suffer from likely rising food prices. It is felt that this should be coupled with increased aid for the poor and lower middle class.

C. We can increase global food supply by slowing population growth, sharply reducing poverty, and slowing environmental degradation of the world's soils and cropland. According to Lester R. Brown, president of the Earth Policy Institute, the world needs to
   1. Slow population growth
   2. Drastically reduce poverty
   3. Reduce topsoil erosion losses to below the natural rate of new topsoil formation

4. Halt desertification that is engulfing cropland
5. Eliminate overgrazing that is converting grassland to desert
6. Arrest the fall in water tables by slowing the removal of water from aquifers so they can be recharged by precipitation
7. Protect prime cropland from being converted to urban and other nonfarm uses
8. Reduce the rate of global warming that threatens to reduce harvests in some areas
9. Mount a crash program to stem the HIV epidemic in Africa.

Protecting Food Resources: Pest Management

A. Organisms found in nature control populations of most pest species as part of the earth's free ecological services. A pest is any species that competes with us for food, damages lawns and gardens, destroys wood, spreads disease, or invades ecosystems
   1. Worldwide, only about 100 species of plants, animals (mostly insects), fungi, and microbes cause about 90% of the damage to the crops we grow.
   2. In natural ecosystems, natural enemies (organisms) control populations of about 98% of potential pest species.
   3. Clearing forests, grasslands, and spreading pesticides upsets the checks and balances of natural populations.

B. We use chemicals to repel or kill pest organisms as plants have done for millions of years. To help control pest organisms we have developed a variety of pesticides.
   1. Common pesticides include insecticides, herbicides, fungicides, and rodenticides.
   2. Plants have produced chemicals to ward off, deceive or poison herbivores for millions of years and is a co-evolutionary process.
   3. People used sulfur, arsenic, lead and mercury to kill insects on crops, but abandoned this practice in the 1920s when people were also poisoned.
   4. The first generation natural insecticides were nicotine sulfate, pyrethrum, and rotenone.

C. Chemists have developed hundreds of chemicals that can kill or repel pests.
   1. In 1939, Paul Muller discovered DDT was a potent insecticide. It was the first of the second-generation pesticides.
   2. Since 1970 chemists have returned to natural repellents and poisons produced by plants.
   3. Since 1950, pesticide use has increased 50-fold and their toxicity has increased by 10-100 times.
   4. About $1/4^{th}$ of pesticide use is for non-agricultural uses in the U.S.
   5. Children playing on lawns where pesticides have been used are particularly vulnerable to them.
   6. Broad-spectrum pesticides are toxic to many species. Narrow-spectrum pesticides are effective against a selectively defined group of organisms.
   7. Pesticides vary in their persistence, the length of time they remain deadly in the environment.

D. Modern pesticides save lives, increase food supplies, increase profits for farmers, and are safe if used properly.
   1. Some important benefits of modern chemicals, shown in Figure 13-28, are:
      a. they save lives (an estimated 7 million)
      b. they increase food supplies (about 55% of the world's potential food supply is lost to pests)
      c. they increase profits for farmers
      d. they work fast
      e. when used properly, their health risks are very low compared to their benefits.
   2. Newer pesticides are safer and more effective than many older pesticides.
   3. Botanicals and microbotanicals are the basis for a number of new pesticides.
   4. Genetically engineered pest-resistant crops could also reduce the use of toxic insecticides.

E. Scientists work to develop more efficient and safer pesticides but through Coevolution pests find ways to combat the pesticides we throw at them. The ideal pest-killing chemical would
   1. Kill only the target pest
   2. Not cause genetic resistance in the target organism
   3. Disappear or break down into harmless chemicals after doing its job
   4. Be more cost effective than doing nothing

F. Pesticides can promote genetic resistance to their effects, wipe out natural enemies of pest species,

create new pest species, end up in the environment, and sometimes harm wildlife and people.

1. Insects can rapidly become genetically resistant to widely used pesticides.
   a. The main problem with synthetic pesticides is that it accelerates the development of genetic resistance to these chemicals by pest organisms.
   b. About 1,000-1,500 organisms have developed genetic resistance to pesticides since 1945. This has led to a reemergence of a number of diseases, especially in the tropics.
2. Farmers may also be on a financial treadmill where it costs more for less effective treatment of pest organisms.
3. Some insecticides kill natural predators and parasites that help control the pest populations.
4. Pesticides do not stay put and can pollute the environment. Of the herbicides applied by spraying, more than 95% end up in the air, surface water, and groundwater, sediments, food, and non-target organisms.
5. Some pesticides harm wildlife such as honeybees needed for pollination of crops. In addition they kill more than 67 million birds and 6-14 million fish each year.
6. Some pesticides can threaten human health. At least 3.5-5 million agricultural workers in developing countries and at least 300,000 in the U.S. are seriously poisoned each year Premature death from cancers have been attributed to pesticide use. Children are much more susceptible to low levels of pesticides and other toxic chemicals.

G. Government regulation has banned a number of harmful pesticides but some scientists call for strengthening pesticide laws.
   1. A federal law regulates pesticide use in the U.S., but it can be improved.
      a. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was established by Congress in 1947 and amended in 1972. It requires EPA approval for use of all commercial pesticides. After more than 30 years, less than 10% of the active ingredients in pesticide products have been evaluated by the EPA.
      b. The EPA has banned or severely restricted 57 active pesticide ingredients between 1972 and 2005.
      c. The 1996 Food Quality Protection Act (FQPA) increased public protection from pesticides.
      d. Banned or severely restricted chemicals are still manufactured and exported to other countries.

H. There are cultivation, biological, and ecological alternatives to conventional chemical pesticides. A number of methods are available.
   1. Fool the pest using cultivation practices such as crop rotation.
   2. Provide homes for pest enemies.
   3. Implant genetic resistance.
   4. Bring in natural enemies.
   5. Use insect pheromones to lure pest insects into traps or to lure natural predators to crop fields.
   6. Use hormones that disrupt the normal insect life cycle and prevent them from reaching maturity. The disadvantages are that they take weeks to kill an insect, are often ineffective if the infestation is large and they must be applied at the right time in the life cycle.
   7. Scald them. Hot water sprayed on crops has worked well on cotton, alfalfa, and potato fiends and citrus groves.

I. Integrated pest management (IPM) is an ecological approach to pest control uses a uses a mix of cultivation and biological methods, and small amounts of selected chemical pesticides as a last resort.
   1. The overall aim is integrated pest management (IPM) is to reduce crop damage to an economically tolerable level. Fields are carefully monitored for damage.
   2. The Indonesian government banned 57 of the 66 pesticides used on rice. Within 5 years pesticide use dropped 65% and rice production rose by 15%. A well-designed IPM program can reduce pesticide use and pest control costs while increasing crop yields.
   3. IPM is an important form of pollution prevention that reduces risks to wildlife and human health.
   4. However, IPM requires expert knowledge about each pest situation and acts more slowly than convention pesticides.
   5. Widespread use of IPM is hindered by government subsidies for conventional chemical

pesticides and opposition by pesticide manufacturers. There are not enough experts to help farmers shift to IPM.

6. A growing number of scientists urge the USDA to use strategies to promote IPM in the United States.

Solutions: Sustainable Agriculture

A. We can produce food more sustainably by reducing resource throughputs and working with nature. Hunger, malnutrition and environmental degradation can be reduced by
   1. Slowing population growth
   2. Sharply reducing poverty
   3. Develop and phase in systems of more sustainable, low-input agriculture over the next few decades, and increase the use of organic agriculture.
   4. Figure 13-33 lists the major components of more sustainable agriculture, and Figure 13-34 shows the environmental benefits of organic farming over conventional farming.

B. More research, demonstration projects, government subsidies, and training can promote more sustainable organic agriculture.

Summary

1. Even though food production has leveled off in the last in the last 25 years, the world still produces enough food to meet the basic nutritional needs of people. However, the food cannot be evenly distributed throughout the world. The average daily intake of food has increased for people throughout the world since 1961 but at least 15,100 people PER DAY die from poverty-related causes. Many of these deaths come from malnutrition or lack of resistance to diseases. Modern agricultural techniques have the most harmful environmental impact than any other human activity, especially Western farming methods. These methods are extremely energy inefficient, using ten times more energy of nonrenewable fossil fuel to produce the food than one unit of the energy which the food provides. This kind of waste is unacceptable. In addition, agricultural methods pollute the environment, compromise soil (soil erosion and salinization) and water supplies (waterlogging), and produce food that is wasted.

2. Three systems produce the foods for human consumption. Croplands produce mostly grains, about 77% of the world's foods. Rangelands provide meat, about 16% of the world's food. Ocean fisheries supply about 7% of the world's food. We must, however, produce more food for our growing world population and to increase sharply food available to the one of five people who now cannot afford sufficient food.

3. Soils are degraded and eroded by water, wind, and people. Soil erosion is primarily caused by flowing water and wind. Human activities such as farming, logging, construction, off-road vehicles, etc. also disturb soil and hasten erosion. In much soil there is also salt buildup and waterlogging. Crops can be planted today without disturbing the soil through conservation-tillage, tillage, contour farming and strip farming. Farmers may also use cover crops to help hold the soil in place. Several crops planted between trees and shrubs, alley cropping, help preserve soil and its productivity. And windbreaks are used to prevent soil's being blown away. Conservation and fertilization can be used to restore soil fertility but fertilizing with commercial pesticides brings its own set of problems.

4. The green revolution uses particular methods to raise crops. Monocultures are developed and planted, bred selectively or genetically engineered to produce high yields of particular crops. Large amounts of fertilizer, pesticides and water are added to the crops. Yields of crops are increased through multiple cropping throughout the year. The second green revolution since 1967 had involved using fast-growing dwarf varieties of wheat and rice in countries with tropical and subtropical climates. Traditional agriculture uses interplanting, several crops grown together on the same area of land; uses agroforestry which grows crops and trees together; and applies polyculture where various plants are planted together but mature at different times.

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5. Food production can be increased by using crossbreeding techniques on similar organisms and using genetic engineering on different organisms. Genetic engineering, including using advanced tissue culture techniques, is growing in use; but many people are concerned about the potential harm such crops may cause. Irrigating more land and cultivating more land are additional solutions but they may not prove sustainable. Rangelands can be managed more efficiently with the land area better protected; but the primary diet of the western world—heavy in meat and meat products—needs to be reevaluated. Over fishing and habitat degradation dominate the marine environment; better management of this food source and protection of the marine environment would ensure continued availability of fish worldwide. Government policies keep food prices low and subsidize farmers who are sometimes even encouraged NOT to plant crops. These types of artificial price controls must stop and allow food prices to be determined by market demand. Then, the true cost of food would be charged to each person. But these methods do not address the root cause of hunger: poverty and inequality.

6. More sustainable agricultural systems can be created by reducing resource throughput and working with nature. We must reduce population growth, reduce poverty, and develop low-input agriculture. Technologies based on ecological knowledge are used to increase crop production, to control pests and to build soil fertility. Such low-input organic farming is friendlier to the environment by reducing carbon dioxide emissions, using half the energy that conventional farming demands, improving soil fertility. Low-input organic farming is, also, more profitable for farmers. To shift to such agricultural practices, we need more research on sustainable agriculture and the improvement of human nutrition. We also need demonstration projects available to farmers; we need to provide subsidies and foreign aid to encourage organic farming; and we need training programs for farmers, agricultural officials and agricultural schools/universities.

7. Pesticides are chemicals that kill or control populations of organisms we consider undesirable. Types include insecticides, herbicides, fungicides, and rodenticides. The advantages of using pesticides include the fact that they save lives, increase food supplies, lower food cost, and increase profit for farmers, and work fast. The disadvantages include the acceleration of pest resistance to pesticides and pesticides dispersing widely, harming wildlife, and threatening human lives. The Federal Insecticide, Fungicide, and Rodenticide Act established in 1947 and amended in 1972, as well as the 1996 Food Quality Protection Act regulate pesticide use in the United States. Alternatives to pesticides include integrated pest management, cultivation practices, food irradiation, genetic engineering, biological control, hot water, and pheromones. These all reduce pesticide use but may prove timely, costly, and not as reliable.

Objectives

1. Summarize the state of global food production. Define *malnutrition* and *undernutrition*, and *overnutrition*. Indicate how many people on Earth suffer from these problems and where these problems are most likely to occur. List six steps proposed by UNICEF to deal with malnutrition and undernutrition. Describe a strategy to reduce overnutrition.

2. List four major types of agriculture. Compare the energy sources, environmental impacts, yields, and sustainability of traditional and industrial agriculture.

3. Define *interplanting* and explain its advantages. List and briefly describe four types of interplanting commonly used by traditional farmers.

4. Describe the problems of soil erosion and desertification. Describe both world and U.S. situations, and explain why most people are unaware of this problem.

5. Describe the problems of salinization and waterlogging of soils and how they can be controlled.

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6. Define soil conservation. List nine ways to approach the problem of soil erosion. Be sure to distinguish between conventional-tillage and conservation-tillage farming. Describe a plan to maintain soil fertility. Be sure to distinguish between organic and inorganic fertilizers.

7. Evaluate the green revolution. What were its successes? Its failures? Summarize the benefits and problems of livestock production over the history of agriculture.

8. Summarize environmental impacts from agriculture.

9. Summarize food distribution problems. Describe the possibilities of increasing world food production by increasing crop yields, cultivating more land, and using unconventional foods and perennial crops.

10. Discuss the use of genetic engineering techniques to improve the human food supply.

11. Discuss problems associated with the production of livestock on rangeland.

12. Describe trends in the world fish catch since 1950. Assess the potential for increasing the annual fish catch and use of aquaculture. Distinguish between fish farming and fish ranching.

13. Assess the pros and cons of agricultural subsidies and international food relief. Describe strategies that you feel would be most sustainable.

14. List the five types of pesticides and what they are used to treat.

15. List the five major classes of pesticides. Tell if each is broad spectrum or narrow spectrum; state its degree of persistence; give two examples; and tell if each undergoes bioaccumulation or is biologically magnified.
16. Give seven reasons to use pesticides. List five characteristics of the ideal pesticide.

17. Describe the consequences of relying heavily on pesticides. Describe the pesticide treadmill. Be sure to describe biological magnification. Briefly describe the threat of pesticides to wildlife and human health.

18. Name the U.S. law that controls pesticide regulation. Give three reasons why this law is considered the weakest and most poorly enforced of the environmental laws. Summarize how the 1996 Food Quality Protection Act extends this law.

19. List and briefly describe nine alternative pest management strategies.

20. Define *integrated pest management.* Analyze the pros and cons of using IPM. List six steps which could be taken to help promote IPM.

21. Define *sustainable agriculture*. Summarize how the United States could move toward creating a more sustainable agricultural system.

Key Terms **(Terms are listed in the same font style as they appear in the text.)**

advanced tissue culture (p. 286)	*first-generation pesticides* (p. 295)
age of genetic engineering (p. 286)	**fisheries** (p. 291)
agribusiess (p. 276)	**fish-farming** (p. 292)
agrobiodiversity (p. 285)	**fish-ranching** (p. 292)
agroforestry (p. 277)	*food factory systems* (p. 286)
agroforestry (p. 282)	Food Quality Protection Act (p. 299)
alley cropping (p. 277)	**food security** (p. 271)

SUSTAINING KEY RESOURCES

Chapter 13
Food, Soil Conservation, and Pest Management

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