

APES Ch 12 Outline: Food Resources

12-1 How Is Food Produced? Food on the planet is produced by croplands, rangelands, and ocean fisheries.

A. Croplands produce 77% of the world's food.

B. Rangelands produce meat, which is about 16% of the world's food.

C. Oceanic fisheries supply 7% of the world's food.

D. All three systems have increased their food yields since 1950.

1. Technological advances have increased food production or harvesting.
2. More sophisticated farming techniques have been developed.
3. There has been expanded use of inorganic chemical fertilizers, irrigation, and pesticides, and high-yield crops have been developed.
4. Intense farming methods, such as densely populated feedlots and enclosed breeding/growing pens, and aquaculture ponds or ocean cages have been implemented.

E. Food to feed the planet must be produced in ever-increasing quantities.

1. Genetic engineering brings some promise to this endeavor.
2. The planet's net primary productivity is being degraded by human activities.
3. The world's poverty must be reduced so that people can obtain enough food to sustain them.

F. The foods that sustain the world are wheat, rice, and corn. They must be replanted each year.

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 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.
2. 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 to produce additional food to sell as income. By using fertilizer, irrigating, etc., a higher yield is sought.

12-2 Producing Food by Green Revolution and Traditional Techniques

A. The green revolution has increased yields in food production per unit of existing cropland. The following steps describe this 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.

B. There have been two green revolutions.

1. The first revolution occurred in developing countries between 1950 and 1970.
2. 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 as well as food yields have increased.
 - c. Several crops can be planted during one year, increasing food yields further.
3. Such revolutions use machinery and fossil fuel to plant and harvest; high-input green revolution agriculture uses 8% of the world's oil output.

C. The U.S. agricultural system produces 17% of the world's grain but affects the environment more than any other industry.

1. Agriculture is bigger than the automotive, steel, and housing industries combined in total annual sales.
2. Agriculture has doubled crop yield of wheat, corn and soybeans, using no more land, since 1940.
3. Large agribusinesses (huge corporate/family-owned farms) control three-fourths of U.S. food production. Labor and resource costs, with the exception of pesticides, have decreased since 1950.

4. This development was possible because of cheap energy. But the efficiency of U.S. agriculture is far below that of traditional subsistence farming or traditional intensive farming.
5. Considering energy used to grow, store, process, package, transport, refrigerate, and cook all plant and animal food, about 10 units of nonrenewable fossil fuel is needed to put 1 unit of food energy on the table.

D. Growing techniques in traditional agriculture are used to make yields more productive.

1. Interplanting grows several crops on the same plot of land.
 - a. Polyvarietal cultivation plants several varieties of the same crop on a plot.
 - b. Intercropping grows two or more different crops on the same plot at the same time.
 - c. Agroforestry/alley cropping grows crops and trees together.
 - d. Polyculture plants many different crops, which mature at various times, together.
 - 1) Polyculture requires less fertilizer and water because of the root systems are at different levels.
 - 2) The soil is protected from wind and water erosion because crops are growing year-round.
 - 3) Multiple habitats support natural predators of crop-eating insects, so less insecticide is needed.
 - 4) There are fewer weeds and less need for herbicides.
 - 5) With several crops, bad weather will not destroy every one of them.
2. Low-input polyculture produces higher crop yields than high-input monoculture.
3. Use of tassas, small pits filled with manure, has tripled yields on at least 100,000 hectares.

12-3 Soil Erosion and Degradation: Soil erosion and degradation affect crop yield and farming success.

A. Preserving the world's topsoil is of great importance in feeding the world's masses.

1. Land degradation occurs when the future ability of the land to support crops, livestock, or wild species is decreased.
2. Water, wind, and people cause soil erosion; soil components are moved from one place to another.
3. Depletion of plant nutrients in topsoil, through farming, logging, construction, overgrazing, and burning vegetation, leads to loss of soil fertility.
4. Eroded soil becomes sediment in surface waters where it pollutes water, kills fish, and clogs irrigation ditches, channels, reservoirs, and lakes.
5. Soil is a renewable resource unless eroded faster than it can form.

B. A 1992 joint UN 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 \$375 billion per year.

1. Soil erosion in the U.S. is being slowed through planting crops without disturbing the soil and government-sponsored soil conservation programs.
2. The Dust Bowl of the 1930s resulted in Congress passing the Soil Erosion Act in 1935 and established the Soil Conservation Service (a part of the USDA).
3. 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.
4. Prolonged droughts can't be controlled, but the consequences can be reduced by reducing overgrazing, deforestation, and destructive forms of planting, irrigation, and mining.
5. Restoration of these areas includes planting trees and grasses to anchor soil and hold water.

C. Loss of crop productivity can result from repeated irrigation, which produces salt buildup and water logging of plant crops.

1. Forty percent of the world's food is produced on twenty percent 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.

12-4 Soil Conservation: Soil conservation seeks ways to reduce soil erosion and restore soil fertility.

A. To reduce soil erosion, farmers must eliminate plowing and tilling and keep the soil covered with vegetation.

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 winter. 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 45% of U.S. farmers used conservation tillage in 2003. The USDA estimates that using it on 80% of cropland would reduce soil erosion by 50% or more.

B. Additional methods to reduce soil erosion include:

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.
6. Windbreaks or shelterbelts of trees reduce wind erosion, help retain soil moisture, provide fuelwood, and support bird and insect habitats.

C. Soil fertility can be maintained best through soil conservation. The next best thing is to restore some of the nutrients by the use of fertilizer.

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. The 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 12-15).

12-5 Food Production, Nutrition, and Environmental Effects: Food production increased significantly from 1950 to 1985 when production leveled off.

A. Per capita food production has begun to decline, particularly in Africa since 1970, in the former Soviet Union since 1990, and in China since 1998.

B. More than enough food is produced to meet everyone's basic needs, but one in six people go hungry because of uneven food distribution.

C. Poverty and inequality are the root causes of hunger and malnutrition. War, corruption, tariffs, and subsidies are other factors at work here.

D. People need fairly large amounts of macronutrients (protein, carbohydrates, and fats) and smaller amounts of micronutrients (vitamins such as A, C, and E) and minerals (iron, iodine, and 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.
 - a. Marasmus and kwashiorkor are two of the most common diseases of malnutrition.
 - b. Marasmus is a wasting, especially when a diet is low in both calories and protein. If the child is treated in time the effects of malnutrition can be reversed.
 - c. Kwashiorkor is severe protein deficiency of infants and children ages 1–3. If caught in time, the effects can generally be reversed.

- d. About one in six people in developing countries are chronically undernourished with an estimate of 5.5 million people dying prematurely from poverty, undernutrition, malnutrition, and increased susceptibility to normally non-fatal diseases. About 80% are children under age 5.
3. UNICEF studies show that one-half to two-thirds of these deaths could be prevented by:
 - a. immunizing children against childhood diseases,
 - b. encouraging breast feeding,
 - c. preventing dehydration from diarrhea by giving a mixture of sugar and salt in a glass of water,
 - d. giving children vitamin A capsules two times per year to prevent blindness,
 - e. providing family planning services for spacing children, and
 - f. increasing education for women, emphasizing nutrition, water sterilization, and childcare.

E. WHO states that about one in three people suffer from a deficiency of one or more of the following: vitamin A, iron, and iodine.

1. Blindness due to vitamin A deficiency occurs in 250,000 children under 6 each year, and up to 80% die within a year.
2. Golden rice has a gene spliced into it to enrich beta-carotene, but poorly nourished people can't convert beta-carotene into vitamin A.
3. Iron is needed to prevent anemia, and iodine is needed for proper thyroid function and to prevent brain damage or formation of a goiter.

F. Overnutrition is when food intake exceeds energy needs and results in body fat. Too little exercise, too many calories, or both cause overnutrition.

G. Both overnutrition and undernutrition in people lead to similar health problems: lower life expectancy, greater susceptibility to disease and illness, and lower productivity and life quality.

1. After smoking, overnutrition is the second leading cause of preventable death.
2. In developed countries, one of every seven adults suffers from overnutrition.

H. The most harmful environmental impact caused by human activity is modern agriculture.

1. Modern agriculture is responsible for most groundwater depletion.
2. Modern agriculture is responsible for 70% of water pollution.
3. Agriculture is contributing to reduced food production and contributing to land degradation.
3. These environmental factors will limit food production: soil erosion, salt build-up and waterlogging, water deficits and droughts, and loss of wild species that provide genetic resources.

I. Population growth, economic growth, lack of resources, and harmful environmental effects of food production may limit crop production in China.

1. Grain production has fallen since 1998.
2. Incomes have risen and with it, increased meat consumption.
3. Indications are that China may soon exceed its carrying capacity if it hasn't already.
4. Other experts say that China can begin exporting grain again by 2020 and has more potential cropland than previously thought.

12-6 Increasing Crop Production: Crossbreeding, which mixes the genes of similar types of organisms, and genetic engineering, which mixes genes of different organisms, can be used to increase yields of crops.

A. Crossbreeding is a 15⁺-year process. The varieties are useful only for a few years; then pests and diseases reduce the effectiveness of the new varieties.

B. Genetic engineering, which splices a gene from one species into the DNA of another species, is creating improved strains of crops and livestock animals.

1. This process can take half as much time than traditional methods to develop a new crop.
2. It cuts costs.
3. It allows for all kinds of potential product development.
4. More than two-thirds of food products on the U.S. shelves contain ingredients made from genetically engineered crops.
5. Scientists are experimenting with cell cultures to produce a variety of food and medical products in fermentation tanks or bioreactors.

C. 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 are listed in Figure 12-19.

D. The unknowns of genetically modified crops on human health and ecosystems are widespread.

1. GMFs are so labeled in Japan, Europe, South Korea, Canada, Australia, and New Zealand.
2. The U.S. Dept. of Agriculture opposed such labeling.
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.

E. The green revolution may not be expandable indefinitely.

1. The green revolution crop varieties require huge amounts of fertilizer and water.
2. The costs of these crops are too high for subsistence farmers in developing countries.
3. There is a limit to the yield that increasing fertilizers, water, and pesticides will produce. Eventually, there will be no additional increase in crop yield.
4. As environmental effects take place, crop yields in some areas may well begin decreasing.
5. Comparisons of yields are based on old and new monocultures rather than between even higher yields per hectare for polyculture cropping systems.
6. Seeds used throughout the world are fairly uniform, and this increases the vulnerability of the crops to pests, diseases, and harsh weather.

F. People do not try new foods easily; most will reject insects as a protein source, for example.

1. Possibilities of new food include: winged bean from SE Asia, black ant larvae from Mexico, giant water bugs in Thailand, emperor moth caterpillars in South Africa, etc.
2. The above-mentioned protein sources are four times as protein rich as beef, fish, or eggs.

G. Polycultures of perennial crops have been suggested as a way to decrease tilling the soil, reduce energy use, save water, and reduce soil erosion and water pollution.

H. Irrigated land per person has decreased since 1978. This is partly explained by the increasingly rapid rise of world population, by depletion of underground aquifers, inefficient use of irrigation water, and salt buildup in soil.

I. Many analysts believe that significant increase in cropland is unlikely over the next few decades.

J. People in urban areas should grow more of their own food—in backyards, in rooftop and balcony gardens, etc.

K. Much food that is produced is wasted through spoilage, inefficient processing and preparation, and plate waste. It is estimated that affluent countries waste nearly 60% of their food.

12-7 Producing More Meat

A. Meat and meat products are good sources of high-quality protein.

B. Producing more meat is probably not a viable solution.

1. Meat production uses much water.
2. Meat production uses more than one-third of the world's grain. In the U.S., meat production consumes 70% of the country's grain.
3. Meat produces large amounts of animal waste and pollutes the environment.
4. Livestock production has an enormous impact on grain use and on the world's catch of fish.

C. Overgrazing can lead to soil erosion and limit livestock production.

1. It lowers the net primary productivity of grassland vegetation.
2. It reduces grass cover.
3. It exposes soil to erosion by wind and water.
4. It compacts the soil.
5. It enhances the invasion of land by woody shrubs and prickly pear cactus and limits livestock production.

D. The most widely used method for more sustainable rangeland management is to control the number of grazing animals and the time any given area is grazed. This can be difficult to do.

1. Livestock tend to aggregate around natural water sources known as riparian zones.
2. Sixty-five to seventy-five percent of wildlife in the western U.S. depends totally on riparian habitats.
3. Livestock grazing has damaged about 80% of stream and riparian ecosystems in the U.S.

4. Recovery of these areas is possible if the riparian areas are fenced off.
5. Locating waterholes/tanks and salt blocks at strategic places can also help.
6. Several methods of pest plant removal can be used such as herbicide spraying, mechanical removal, or controlled burning.
7. Less expensive is to have controlled, short-term trampling by large numbers of livestock, then replant with native grass seeds.

E. *We can reduce the environmental impacts of meat production by shifting from less grain-efficient forms of animal protein (beef and pork) to more grain-efficient forms (poultry and farmed fish).*

F. *Cattle and sheep use rangeland to eat grass, and this area is not suitable for crop-raising, so reducing livestock production would not free up much land or grain to feed people.*

12-8 Catching and Raising More Fish and Shellfish

A. *Fisheries are the third major food-producing system. About 55% 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.*

B. *Fish and shellfish provide about 7% of the global food supply and are the primary source of animal protein for about 1 billion people, primarily in developing countries.*

C. *Commercial marine fishing is an industry that uses high tech methods to locate and harvest fish and shellfish.*

1. Trawler fishing is used to catch fish and shellfish that live on or near the ocean floor. This involves dragging funnel-shaped, weighted nets along the bottom. This often destroys bottom habitats and catches and kills other species such as seals and endangered or threatened species of sea turtles.
2. Purse-seine fishing catches surface living species such as tuna, mackerel, anchovies, and herring. Once a school of fish is located, a large net is used to surround the school and draw the net closed like a purse string. This method has killed large numbers of dolphins.
3. Long lining involves putting out lines up to 80 miles long with thousands of hooks. This method is used for open ocean fish like tuna, shark, and swordfish but also catches sea turtles, birds, pilot whales, and dolphins.
4. Drift-net fishing can lead to overfishing of the desired species and may trap and kill large numbers of unwanted fish and marine mammals. A UN ban on drift nets longer than 1.6 miles in international waters has sharply reduced the use of this technique, but increased use of long-lines.

D. *Commercial fish amounts have been declining since 1980.*

1. The world's commercially valuable marine fish are already being overfished.
 - a. Too little fish have been left to provide breeding stock.
 - b. Commercial extinction means that it is not profitable to hunt a particular species; it has almost been eradicated by overfishing.
2. Man has raped the ocean of marine fish species and contributed to their continuing decline by degrading the environment, destroying habitat, and polluting wetlands, estuaries, coral reefs, salt marshes, and mangroves.
3. Commercial species may be able to come back but will need protection by fishing quotas, restricted use of particular fishing gear/methods, and limits on fishing boats, etc.

E. *Government subsidies, price controls, low-interest loans, and grants for fishing gear are major causes of overfishing. Some of the money should be shifted to buying out some fishing boats and retraining the crews.*

F. *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 saltwater and then releases them to harvest as they spawn in freshwater.
3. The advantages and disadvantages of aquaculture are listed in Figure 12-27.
4. Use of aquaculture to grow single-celled cyanobacteria such as *Spirulina* has been proposed. *Spirulina* is 70% protein.
5. Raising large, carnivorous fish in farms could deplete smaller fish species used to feed them and could result in the collapse of both the ocean fishing industry and of aquaculture.

12-9 Government Agricultural Policy

A. *Governments apply various agricultural policies to affect food production.*

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.

B. *Perhaps we should use subsidies for farmers who protect soil, conserve water, reforest degraded land, etc.*

12-10 Sustainable Agriculture

A. *There are three main ways to reduce hunger and malnutrition and the harmful effects of agriculture.*

1. Slow population growth.
2. Reduce poverty.
3. Develop and phase in systems of more sustainable or low-input agriculture (organic farming).
 - a. This relies more on perennial polyculture than on raising annual crops.
 - b. This relies on use of manure and tilled-in crop residues to build and maintain soil fertility.
 - c. There is very judicious use of pesticides so that pests have less chance of becoming resistant to pesticides.

B. *In 2002, agricultural scientists reported that a 21-year study comparing organic and conventional farming methods show that there are a number of advantages to low-input organic farming.*

1. Low-input farming used up to 56% less energy per unit of yield.
2. There was improved soil health and fertility.
3. This method also provides more habitats for wild plant and animal species.

C. *Four major strategies have been suggested to help farmers make the transition to more sustainable agriculture.*

1. Increase research on sustainable agriculture and improving human nutrition.
2. Set up demonstration projects throughout each country for farmers.
3. Provide subsidies and increased foreign aid to encourage its use.
4. Establish training programs in sustainable agriculture for farmers and government agricultural officials; encourage the creation of college curricula in this area.

D. *The goal is to feed the world's people while sustaining the world's natural capital and living off the natural income it provides.*