Chapter 7
Food and Agriculture
We can’t solve problems by using the same kind of thinking we used when we created them.
–Albert Einstein
CASE STUDY: Farming the Cerrado
7.1 Global Trends in Food and Nutrition

• Food production has been transformed from small-scale, diversified, operations to vast operations of thousands of hectares, growing one or two genetically modified crops, with abundant inputs of fuel and fertilizer, for a competitive global market.

• Since 2005, food costs have risen, especially for the world’s poorest populations, but global food supply problems have more to do with distribution than with supplies.
Food Security is Unevenly Distributed

• Fifty years ago, hunger was one of the world’s most persistent problems.

• The world’s population has risen from 3 billion to about 7 billion, but food production has increased even faster (2.2% compared to 1.7%).

• Food availability has increased in most countries to well over 2,200 kilocalories, the amount generally considered necessary for a healthy and productive life and protein intake has increased as well.
Changes in Dietary Energy and Protein Consumption

(a) Dietary energy
(b) Protein consumption
Hunger Around the World Has Not Been Eliminated
Changes in Number and Rate of Malnourishment Across the World

(a) Number of people malnourished

(b) Percentage malnourished
What is Food Security?

• **Food security** is the ability to obtain sufficient, healthy food on a day-to-day basis, is a combined problem of economic, environmental, and social conditions.

• Even in wealthy countries such as the United States, millions lack a sufficient, healthy diet.

• In the poorest countries, entire national economies can suffer from a severe drought, flood, or insect outbreak.

• At least 6 million children under 5 years old die every year of diseases exacerbated by hunger and malnutrition.
Hungry Children in Somalia

• **Famines** are large-scale food shortages, with widespread starvation, social disruption, and economic chaos.
Famines Usually Have Political and Social Roots

- Globally, widespread hunger arises when political instability, war, and conflict displace populations, removing villagers from their farms or making farming too dangerous to carry on.

- Even when better conditions return, it often takes a long time to recover because the people may have consumed their seed grain and breeding livestock.
7.2 How Much Food Do We Need?

• You need the right nutrients, as well as enough calories for a productive and energetic lifestyle.

• 3 billion people (almost half the world’s population) suffer from vitamin, mineral, or protein deficiencies, collectively known as malnourishment.
Overeating is a Growing World Problem

• Today, there are now more overweight people than underweight people.
• In the U.S., and increasingly in Europe, China, and developing countries, highly processed foods rich in sugars and fats have become a large part of the diet.
• Some 64% of adult Americans are overweight, up from 40% only a decade ago. About 1/3 of us are seriously overweight, or **obese** (more than 20% over the ideal weight for a person’s height and sex).
• Slow food movement...
Chronic Obesity is a Growing Problem Worldwide

[Bar chart showing percentage of overweight individuals in various countries (United States, United Kingdom, Canada, France, Japan, China, India) with data from 1960 and 2010.]

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7.3 The Foods We Eat

- Of the thousands of edible plants and animals in the world, only 14 plant species make up most of the world’s food supply.
Production of Major Food Crops in the U.S.
Rising Meat Production is a Sign of Wealth

- Meat consumption has grown in both developed and developing countries.
- Global meat production has doubled in the past 45 years.
Number of kg of Grain Required to Produce Different Foods

- 1 for bread
- 1.5 for fish
- 2 for chicken
- 3 for pork
- 8 for cow
Confined Animal Feeding Operation (CAFO)
Seafood is Both Wild and Farmed

• Seafood provides about 15 percent of all animal protein eaten by humans, and it is the main animal protein source for about 1 billion people in developing countries.

• Overharvesting and habitat destruction threaten most of the world’s wild fisheries.

• The problem is too many boats using efficient but destructive technology to exploit a dwindling resource base.

• Aquaculture is providing an increasing share of the world’s seafood.
Aquaculture Fish Pens in Thailand

- Net pens anchored in nearshore areas allow spread of diseases, escape of exotic species, and release of feces, uneaten food, antibiotics, and other pollutants into surrounding ecosystems.
7.4 Living Soil Is a Precious Resource

• Soil is a marvelous substance, a living resource of astonishing complexity and frailty.

• Soil contains:
  – mineral grains weathered from rocks,
  – partially decomposed organic molecules, and a host of living organisms.

• Soil can be considered a living ecosystem by itself.
Carefully Managed, Soil is a Renewable Resource

• Building a few mm of soil can take anything from a few years to a few thousand years.

• With careful management that prevents erosion and adds organic material, soil can be replenished and renewed indefinitely.
Idealized Soil Profile
7.5 Ways We Use and Abuse Soil

• Agriculture both causes and suffers from environmental degradation.

• The causes of this extreme degradation vary:
  – Erosion
  – Nutrient depletion
  – Saltation
  – Conversion
Global Causes of Soil Erosion and Degradation
Wind and Water are the Main Agents that Move Soil Around

Sheets Erosion
Rill erosion
Gully Erosion
Desertification
7.6 Agricultural Inputs

• Soil is only part of the agricultural resource picture.
• Agriculture is also dependent upon:
  – Water
  – Nutrients
  – Favorable climates to grow crops
  – Productive crop varieties
  – The mechanical energy to tend and harvest the crops
Irrigation is Often Needed for High Yields

• Agriculture accounts for the largest single share of global water use. Irrigation increases yields of most crops by 100% to 400%.

• The efficiency of irrigation water use varies greatly.
  – Poor farmers may over-irrigate because they lack the technology to meter water and distribute just the amount needed.
  – In wealthier countries, farmers can afford water-saving technologies such as drip irrigation or downward-facing sprinklers.
Downward-facing Sprinklers are More Efficient
Fertilizer Boosts Production

• Plants require small amounts of inorganic nutrients from soil.
• Much of the doubling in worldwide crop production since 1950 has come from increased inorganic fertilizer use.
• Overfertilization causes environmental pollution.
  • eutrophication
Modern Agriculture Runs on Oil

• The food system in the United States consumes about 16% of the total energy we use.
• Our foods require more energy to produce, process, and get to market than they yield when we eat them.
Pesticides Save Crops but Have Health Risks

• Biological pests reduce crop yields and spoil as much as ½ of the crops harvested every year in some areas. Modern agriculture largely depends on toxic chemicals to kill or drive away these pests. Our reliance on them has grown steadily over the years.

• Indiscriminate pesticide use, however, has caused many problems, such as killing nontarget species, creating new pests of organisms that previously were not a problem, and causing widespread pesticide resistance among pest species.
Pesticides Health Risks

- Children may suffer neurologically from pesticides and show increased levels of anger, aggression, autism, and attention deficit disorder.

Value of Global Trade in Pesticides
The Green Revolution Has Increased Yields

• Most of this gain was accomplished by use of synthetic fertilizers along with conventional plant breeding: geneticists laboriously hand-pollinating plants and looking for desired characteristics in the progeny.

• Starting about 50 years ago, agricultural research stations began to breed tropical wheat and rice varieties that would provide food for growing populations in developing countries.
Genetic Engineering Could Have Benefits and Costs

• Genetic engineering: splicing a gene from one organism into the chromosome of another.

• Genetically modified organisms (GMOs): organisms with entirely new genes, and even new organisms, often called “transgenic” organisms.
Most GMOs are Engineered for Pesticide Production or Pesticide Tolerance

• *Bacillus thuringiensis* (*Bt*), a bacterium, makes toxins lethal to butterfly and beetle pests.

• Biotechnologists have created plants with genes for natural insecticides.

• So far this is effective, but experts worry that *Bt* plants churn out toxin constantly, and may create the perfect conditions for creating *Bt* resistance in pests.
BT toxin’s, the Start of Biotechnology Issues

• The toxin is produced year round creating:
  • Perfect conditions for resistance development
  • Threats to non-target species
• Also present in pollen, potentially threatening non-target insects such as Monarch butterflies
• Acreage planted with genetically modified crops (GMCs) has grown rapidly since 1996
Is Genetic Engineering Safe?

• The greatest danger is the ecological effects if these organisms spread into the native populations.
• There are social and economic implications of GMOs. Will they help feed the world, or will they lead to a greater consolidation of corporate power and economic disparity?
• Are GMOs required if we hope to reduce malnutrition and feed eight billion people in 50 years?
Transgenic Crop Releases

![Bar chart showing the number of notifications and release permits for transgenic crop releases from 1986 to 2008. The chart displays the year on the x-axis and the number of notifications and release permits on the y-axis. The chart indicates a trend of increasing approvals with a peak in 2000, followed by a slight decrease.](chart.png)
7.8 Sustainable Farming Strategies

• The goals of **sustainable agriculture**, or **regenerative farming**, aim to reduce or repair the damage caused by destructive practices.

  • Erosion reduction techniques:
    
    – **Contour** plowing, plowing across the hill rather than up and down. Combined with **strip farming**.
    
    – **Terracing** is shaping the land to create level shelves of earth to hold water and soil.
Groundcover and No-till Planting Protects the Soil

• Don’t leave the soil bare use crop residues on the land after harvest to cover the surface and break the erosive effects of wind and water.

• Alternately, **cover crops** such as rye, alfalfa, and clover can be planted immediately after harvest to hold and protect the soil.

• No-till plowing involves shooting the seeds into the soil.
Low-input Sustainable Agriculture Can be Beneficial

• In contrast to the trend toward industrialization, some farmers are going back to a more natural, agroecological farming style.

• The Minar family, for instance, operates a highly successful 150-cow dairy operation on 97 ha (230 acres) near New Prague, Minnesota.
  – No synthetic chemicals are used on their farm.
  – Cows are rotated every day between 45 pastures or paddocks to reduce erosion and maintain healthy grass.
Winter on the Minar Family Farm

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7.9 Consumer Choices Can Reshape Farming

• You can be a locavore.
  – Locavore: a person who consumes locally produced food.

• You can eat low on the food chain.
  – Since there is less energy involved in producing food from plants, you can reduce your impact by eating more grains, vegetables, and dairy and a little less meat.

• You can eat organic, low-input foods.
  – If you buy organic food, you are supporting farmers who use no pesticides or artificial fertilizers.
Shop at a Local Farmer’s Market