Production and Distribution of Food

As the human population continues to grow, there is concern that we will be unable to produce enough food. This concern is not new. Until 150 years ago, the majority of the population lived and worked on small farms. They used several sustainable practices:

1. traditional pest control
2. crop rotation
3. growing a variety of crops
4. animal wastes were returned to the soil as fertilizer

As farming developed, people were able to leave the farm and migrate to cities. After the Industrial Revolution (mid 1800s) less than 3% of the population produced all the food as well as a surplus for export. There were several developments which permitted this, and each had environmental costs.

1. Animal labor was replaced by machines powered by fossil fuels. This represents a huge amount of energy, and is mostly provided by the combustion of fossil fuels. Soil compaction is another problem.
2. The use of machines allowed additional land to be cultivated. Increased food production in North America was accomplished by bringing new land into production. Now that nearly all good farmland is being used, less desirable areas are being cultivated. Erosion, flooding, or depletion of water leads to the land being abandoned.
    a. The removal of tress by deforestation increases the amount of runoff, leading to flooding and erosion.
    b. After plowing, the loose, top layer of sol often blows away.
    c. Eroded soil usually ends up in rivers, lakes, or oceans, causing serious problems for aquatic and marine life.
3. The use of fertilizers and pesticides.
    a. Initially, the use of fertilizer allowed an extra 15-20 t of grain per 1 t of fertilizer used. Now, farmers are using the optimal amount of fertilizer and each additional tonne often results in an increase in yield of less than 2 t of grain. Also, when fertilizer levels are too high, plants become more susceptible to disease and pests. The leaching of fertilizer from soil leads to water pollution.
    b. Pesticides provide excellent control over insect and plant pests, but pests become more resistant over time so more chemicals need to be used. These chemicals often have harmful health effects for humans and other organisms including genetic defects and developmental problems.
4. Increased irrigation leads to water-logging if drainage is poor.
    a. Irrigation is the single largest use of water worldwide. Rivers and lakes contain salts that become deposited in soil as the water is absorbed or evaporates. Ground water is being depleted (*i.e.*, water table is dropping) as a result.

Together, these factors create a cycle of continued environmental devastation. A growing population places increased pressure on land which causes more destruction of land, leading to lower productivity. This causes increased poverty which places more pressure on land and tends to increase family size.

Soil Loss

In Canada and the US, the climate, abundant water, and fertile soil produce high crop yields that contribute to high living standards. In other countries, soil quality, water or climate limit productivity even though there might be lots of land.

In developed countries, 95% of agricultural growth has come from improved crop varieties and increased fertilization, irrigation, and pesticide use, rather than from bringing new land into production. In other words, productivity per unit area of land has increased. In many developing countries, new land is usually the cheapest way to increase production. Using more land (like forests) for agriculture has serious environmental consequences. In other words, although there is more land that *could* be put into production, maybe not all of it *should* be.

Building soil is a slow process. Good topsoil accumulates at a rate such that a 1 mm layer forms over an area of one hectare (2.5 acres) per year. Several current farming practices contribute to soil erosion. In some areas, soil is being lost at the rate of 2.5 cm per year.

Several things can degrade soil quality

a. Water and wind erosion.
b. Chemical deterioration including loss of nutrients, salt accumulation, acidification, and pollution.
    i. Minerals are incorporated into plants and are removed when the plants are harvested. As a result, the soil becomes thinner and less fertile. The usual solution is to apply inorganic fertilizer.
c. Physical deterioration including soil compaction and waterlogging.

How Can We Produce Enough Food?

Currently, enough food is produced to feed the entire human population but this may not be true in the next few decades. While we have experienced some record high yields, the per capita grain has stabilized or decreased in all regions worldwide because the population is growing so rapidly. Food production is currently declining because of soil degradation and climate change. The key is to achieve sustainable agriculture. This means we must produce food on a sustainable basis and repair the damage caused by destructive practices. Some possibilities are

1. Soil conservation
    a. Erosion can be reduced by slowing the flow of water on a hill. This can be done by
        i. leaving grass strips to trap water;
        ii. contour plowing, or plowing across the hill rather than up and down;
        iii. strip farming, or planting different crops in strips across a hill so that when one is harvested, the other remains to protect the soil;
        iv. building terraces to allow farming on very steep hillsides;
        v. providing ground cover by growing crops between rows and during the off-season and by leaving crop residues on the land after harvest;
        vi. improved irrigation practices.
2. Eat lower on the food chain.
    a. In most of the world the trend is the opposite. As people have more money, they eat more meat.
    a. In developing countries, farmers are switching to feed crops to raise animals to export meat because they can earn more money. This means that less food is produced from the land (remember the 10% rule?).
    b. Overgrazing decreases the carrying capacity of range land. This practice is not sustainable.

c. The practice contributes to global warming
    i. Forests are burned to make pasture land
    ii. Cattle release methane
    iii. Decomposition of manure increase methane. Developed countries produce manure as waste while developing countries use it as fertilizer, shelter, and fuel.

2. Convert cash crops to food crops.
3. Slow or reverse population growth.
4. Return to organic or sustainable farming. This would offer several advantages
    a. Reduced cost for fertilizer, pesticides, and herbicides and reduced environmental and health damage from these chemicals.
    b. Note that organic produce is more expensive but some people feel it is worth the health and environmental advantages it offers.
    c. Critics argue that organic farming would be insufficient to provide all the food we need.
    d. Move away from monocultures.
5. Try to increase yield further.
    a. **The Green Revolution** produced new, disease-resistant crop varieties.
        i. In the 1940s, research was was started to improve the plant varieties grown in developing countries. By selectively breeding plants with desirable characteristics, new and improved varieties were developed.
        ii. These varieties are now used throughout most of the world and have been largely responsible for food supplies keeping pace with population growth.
        iii. Several problems exist
            (1) Most of the potential has been realized already. Grain production has reached a plateau while population continues to rise. New varieties are still needed.
            (2) More food can be raised by a smaller workforce which leads to increased unemployment and migration to cities.
            (3) Most of the varieties require optimum levels of water and fertilizer to achieve their maximum yield but poor farmers rarely have the money or equipment for these and may be driven out of farming as a result.
    b. Biotechnology can be used to develop higher-yielding varieties or plants that resist pests and disease.
        i. In the last two decades, progress has been made in the development of **genetically modified organisms** (GMOs). These are organisms that contain genes from another, sometimes unrelated, species.
        ii. These varieties are created to require less pesticides or herbicides, have an increased nutritional content, or to contain vitamins or vaccines.
        iii. This technology has several dangers. These include
            (1) the fear that these plants might breed with wild plants to create “super-weeds.” In Canada in 1997, just one year after Roundup Ready canola was first planted, wild mustard plants were found to have interbred and obtained the herbicide-resistant gene;
            (2) concern that these expensive varieties will increase the control of the companies that produce them over the food system and increase the dependance of farmers on the companies;
            (3) the fact that the currently most popular GM crops are those that have been engineered to resist herbicides. This has resulted in a more heavy application of herbicides by farmers;
            (4) the accidental inclusion of allergens (known or otherwise) into the food supply.

iv. Currently, about 70% of all processed foods in North America contain GM products.

6. **Biological pest control** is the practice of using living organisms or naturally produced chemicals to control pests.
   a. Predators and pathogens - using natural predators of a pest. *e.g.*, *Bacillus thuriengensis*.
   b. Chemicals from plants - some plants produce chemicals to protect themselves naturally
   c. Disrupt insect breeding - pheromones can be used to lure male insects to traps. Another technique is to use X-rays to sterilize males so that they can breed with females but the eggs do not hatch.
7. Find other sources of food

Causes of Hunger

1. Poverty
   a. The planet produces enough food for everyone but some people are too poor to buy food and do not have the resources (like land) to grow it. This applies to the 1.4 B people who live on less than $1 a day.
   b. In some countries, the average food availability is good but some communities or families may not have enough.
   c. Within families, males often get the largest share and the most nutritious food.
   d. Remember the cash economy dictates that excess food exported from a given country will flow to economic demand rather than need. This means that even if food production is increased, people will still starve.
2. Famine
   a. Famine is a severe shortage of food accompanied by a significant increase in the death rate. It can be caused by an inability or unwillingness to distribute food to everyone.
   b. Environmental conditions are usually the immediate trigger but politics can also be important.
      i. Weather, insects and other natural disasters can mean that insufficient food is produced.
      ii. Political conflicts and war can result in food being withheld from part of the population.
3. Food Aid
   a. Should food aid be used to relieve famine or chronic hunger? Food aid is good for famine relief but should not be used in cases of chronic hunger.
   b. The problem is that local farmers cannot compete with free imported food in the market. If farmers cannot earn a profit they stop farming and join the poor. This means people who sell to farmers have less income and so on until, sometimes, the entire economy crashes. Food aid is counter productive. How, then do we solve the food problem?
   c. Food aid is often more about making us feel good because we think we are helping. It rarely addresses the root cause(s) of hunger.

Sustainable Agriculture

Maintaining production without ruining the environment by using natural ecosystems as a model.
Remember the four laws of sustainability.

1. Ecosystems dispose of wastes and replenish nutrients by recycling
    a. Organic farming - add crop leftovers, organic matter and manure to soil
    b. this is far better, and cheaper, than chemical fertilizers
2. Sunlight used as the energy source
    a. industrial farms will continue to use machinery
    b. subsistence farmers use animals, but wind and solar power could also be used
    c. in developed countries people can grow some of their own food rather than just growing grass
3. Size of consumer population is maintained to avoid overgrazing
    a. important to keep the size of the herd down so don't overuse the land
    b. pests are really just consumers so they must be controlled as well
    c. human population must be controlled
4. Biodiversity must be maintained
    a. by rotating crops a variety of food products can be grown
    b. this practice also helps control weeds and insects as well as plant diseases