Chapter 22: Food Resources

Food and Hunger

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Outline

- World Food and Nutrition
- Key Food Sources
- The Green Revolution and Genetic Engineering
- Food Production Policies

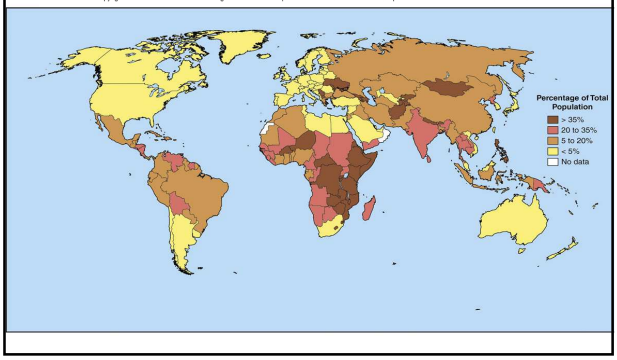
Food and Nutrition

- World food supplies have more than kept up with human population growth over the past two centuries.
- During the past 40 years, population growth has averaged 1.7% per year, while food production increased an average 2.2%.

Chronic Hunger and Food Security

- In 1960, 60% of the population of developing countries was considered chronically undernourished.
  - Today it is less than 16%.
- Poverty is the greatest threat to food security (Ability to obtain sufficient food on a daily basis).
  - Operates on multiple levels
  - Providing land grants, credit and education to women, who do 50-70% of the farm work in developing countries, would be an important step toward food security in these countries.

Hunger Around the World



Causes of Famines Usually Social and Political

- Famines are characterized by large-scale food shortages, massive starvation, social disruption, and economic chaos.
  - Mass migrations often occur because productive capacity has been sacrificed.
  - Environmental conditions are an immediate trigger.
  - However, armed conflict and political oppression, commodity hoarding, price gouging, wars and poverty are commonly underlying causes.

Famines

- Aid policies of rich countries often serve to distribute surplus commodities and produce a feeling of generosity BUT
  - Herding people into feeding camps is typically counterproductive.
  - Many die on the way, others die in epidemics or from violence.

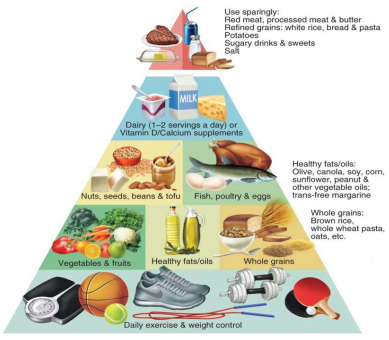
Overeating is also a Growing Problem

- In the US and other developed countries, highly processed foods rich in sugar and fat have become a large part of the diet.
- 64% of Americans are overweight.
- 33% of Americans are obese, meaning they are 20% or more over their ideal weight or have a body mass index of >30kg/m^2
- Being overweight increases your chances of hypertension, diabetes, heart attack, stroke, arthritis, respiratory problems and cancer.
- Diet and lifestyle changes are needed to combat the problem.

We Need the Right Kinds of Food

- Generally, eating a good variety of foods should give you all the nutrient you need.
- However, Americans tend to consume too many simple sugars and starchy foods.
- Researchers at Harvard University recommend following a new dietary pyramid which encourages reducing red meat and starchy foods and emphasizes consumption of nuts, legumes, fruits, and whole grains.
- This Harvard Diet also encourages adding moderate exercise to your routine.

Harvard Food Pyramid



Vitamins Can Prevent Illness

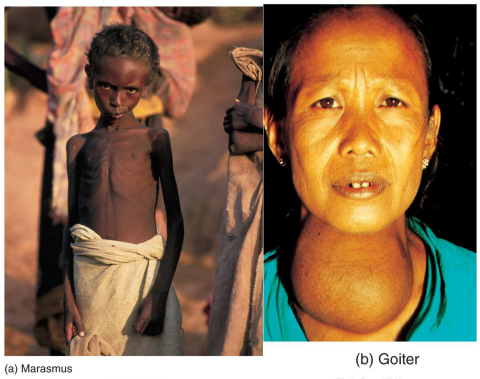
- Malnourishment - nutritional imbalance caused by a lack of specific dietary components or an inability to absorb or utilize essential nutrients
  - 3 billion people suffer from vitamin, mineral or protein deficiency.
  - Results in illness and death

Nutritional Problems

- Iron deficiency is the most common dietary imbalance in the world.
  - Leads to anemia, insufficient hemoglobin in the blood
    - Increases risk of death from hemorrhage in childbirth and affects development
- Lack of iodine leads to goiter as well as stunted growth and reduced mental capacity.
- Lack of vitamin A affects as many as 140 million children and 350,000 go blind each year.

Protein Deficiency Diseases

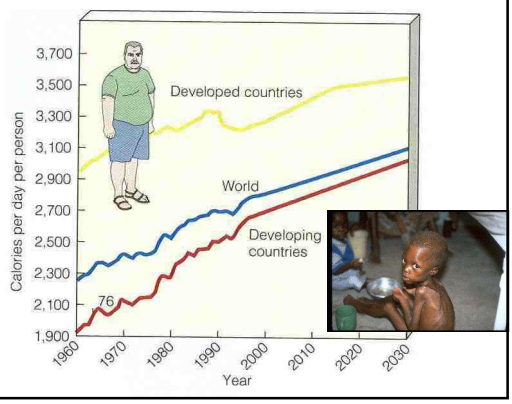
- Kwashiorkor – "displaced child" occurs mainly in children whose diet lacks high-quality protein
  - Discolored skin, bloated stomach
- Marasmus - "to waste away" - caused by a diet low in protein and calories
  - Very thin, shriveled with low resistance to infection



(a) Marasmus © Scott Daniel Peterson

(b) Goiter © Lester Bergman/Corbis

Average Daily Food Intake



Poverty, Malnutrition, Undernutrition and Disease

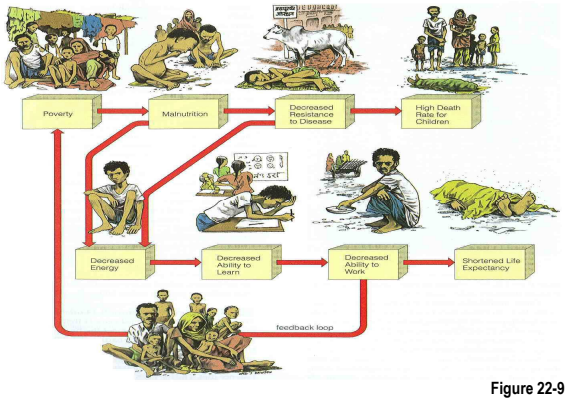


Figure 22-9

Key Food Sources

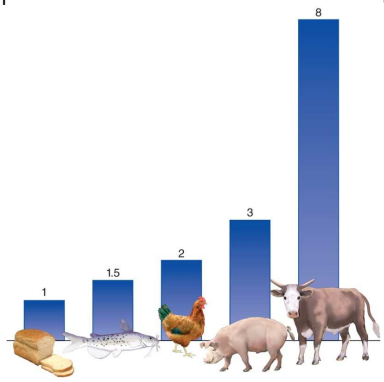
- Worldwide, three crops deliver the majority of the needed nutrients to humanity:
  - wheat, rice and corn
- Two billion metric tons are grown each year globally.
- In addition, potatoes, barley, oats and rye are staples in cool, moist climates.
- Cassava, sweet potatoes, and other roots and tubers are staples in warm, wet climates.

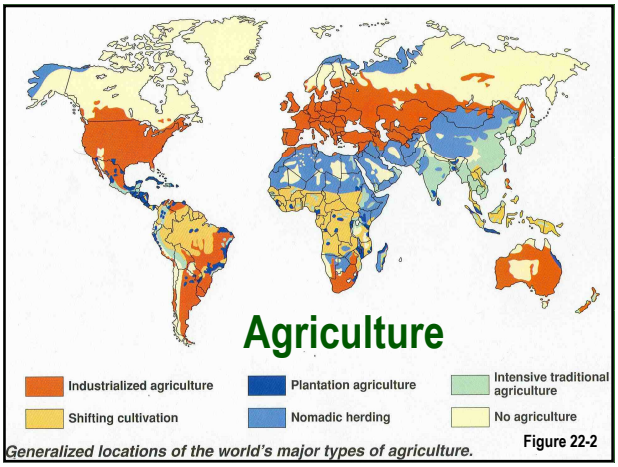
Costs and Benefits of Meat Production

- In developed countries, meat consumption has risen from 10kg/person/year in 1960 to 26kg/person/year today.
- Meat consumption in the US has risen from 90kg/person/year to 136kg/person/year in the same time interval.
- Meat is a concentrated, high-value source of protein, iron, fats and other nutrients.
- Meat production is a good indicator of wealth as meat is expensive to produce:

  it takes > 8kg of grain to produce 1kg of beef.

Grain I ats





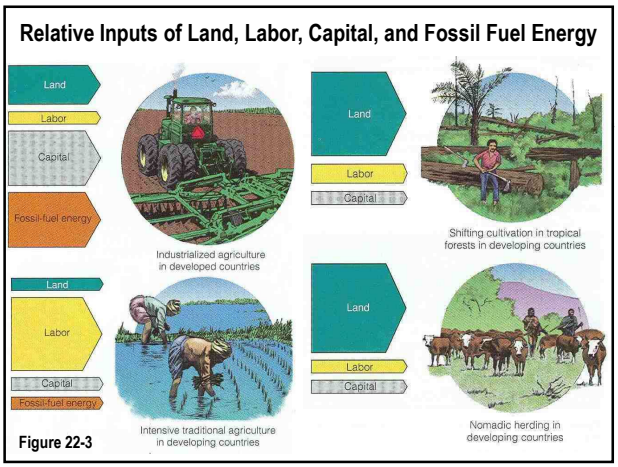
Generalized locations of the world's major types of agriculture. **Figure 22-2**

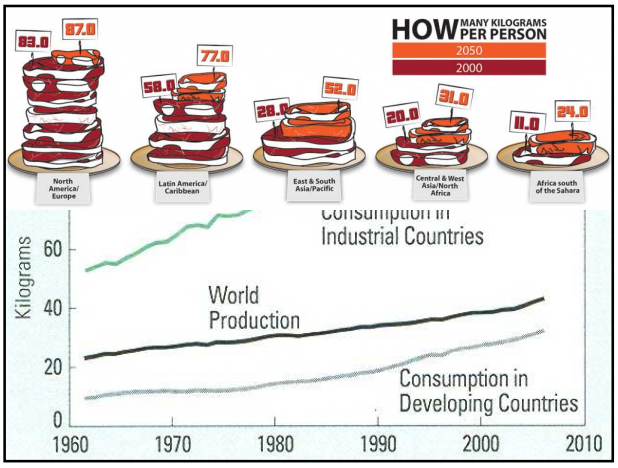
Agricultural Innovations in Meat Production

- Confined Animal Feeding Operations (CAFO) where animals are housed in giant enclosures and fed diets of soy and corn for rapid growth.
- Such operations are common in the US, Europe and China.
- New breeds of livestock have also been developed which produce meat rapidly with shorter turn-around times.
- Heavy use of antibiotics allows producers to limit the spread of disease among animals being raised in such high densities.

Meat Production is Energy-Intensive

- It takes at least 16x as much fossil fuel to produce a kg of meat as it does a kg of plant material.
- UN Food and Agriculture Organization experts estimate that livestock produce 20% of the worlds emissions of greenhouse gases.
- Reducing your meat consumption by 1/5 would reduce your energy consumption more than switching from a standard car to a hybrid!





Seafood

- Seafood is an important protein source; it is the primary source of protein for 1.5 billion people in developing countries.
- Since 1989, all major fisheries in the world have declined and many become commercially unsustainable.
- If current practices continue, the world's fisheries will be exhausted by 2050.
- Huge boats sweep large portions of the ocean and kill birds, turtles, and other species as "by-catch."
- Aquaculture (growing aquatic species in pens) is providing an increasing share of the world's seafood.

Seafood

- Aquaculture supplies food, but it
  - uses wild populations to stock and feed captive populations
  - destroys mangrove forests and wetlands used as nurseries for all marine species
  - allows the spread of disease
  - releases large quantities of feces, antibiotics and other pollutants

Risks of Intensive Food Production

- Converting land to soy and corn production for animal feed increases soil erosion.
- Bacteria-laden manure can escape from feed lots into the environment causing damage.
- Increased use of antibiotics leads to more antibiotic resistant pathogens.

The Green Revolution and New Crops

- New crops possible
  - Winged bean, entire plant is edible
  - Tricale, a hybrid between wheat and rye

Green Revolution Produced Increased Yields

- Most major improvements in farm production have come from technological advances and modification of a few well-known species.
  - Average corn yields jumped from 25 bushels per acre to 160 per acre in the past century.
- Green Revolution started over 50 years ago with the production of tropical, semi-dwarf, wheat and rice strains which are now grown in developing countries around the world.

The Green Revolution – inorganic fertilizer, pesticides, high yield varieties, irrigation, etc.

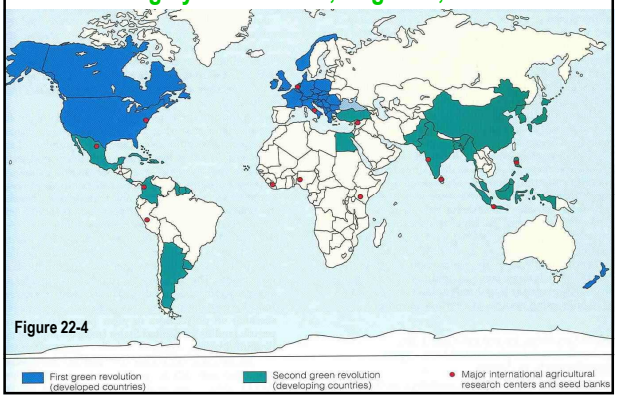


Figure 22-4

The Second Green Revolution: New Genetic Varieties of Rice and Wheat for the tropics and developing nations.

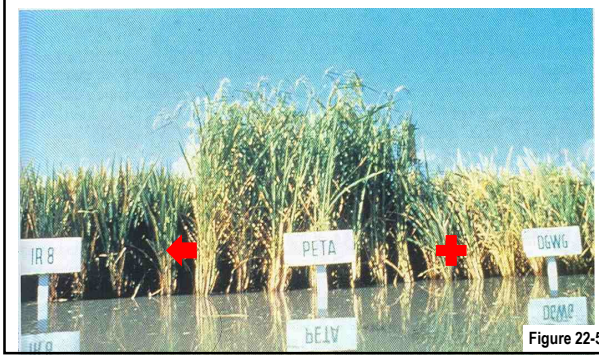
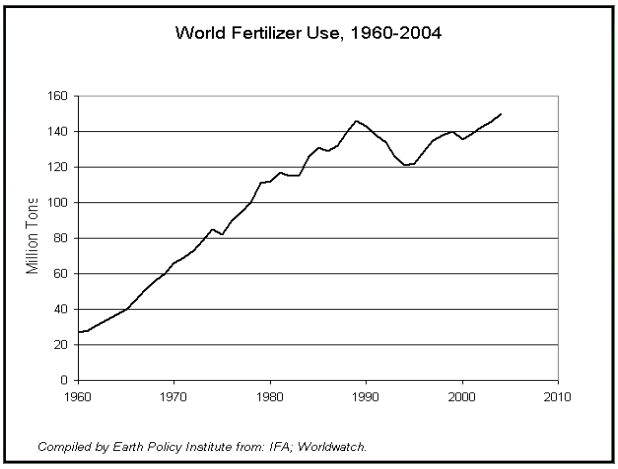


Figure 22-5

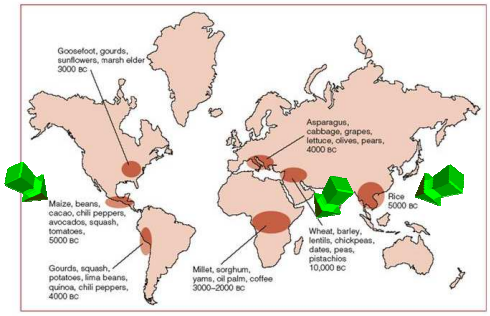
Shortcomings of the Green Revolution

- Green revolution plants are "high responders" which only show increased yields if they have fertilizers and protection from pests. If these are lacking, they may not produce as well as traditional crops.
- Poor farmers who cannot afford the costs of fertilizer, pesticides and hybrid seeds may be left out of the green revolution.



Major Hearths of Agriculture

Three Major Crops: Corn (Maize), Wheat, Rice



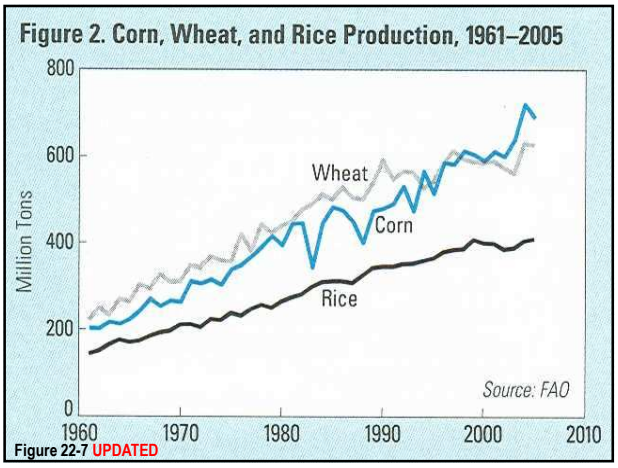
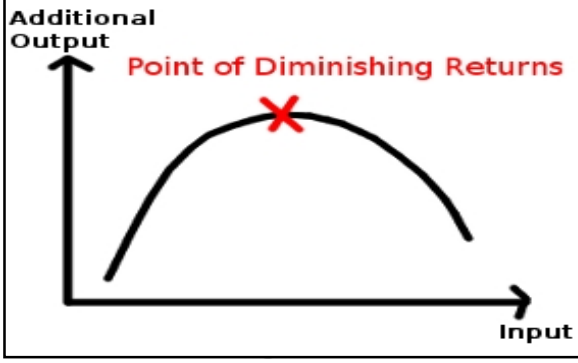


Figure 22-7 UPDATED

Principle of Diminishing Returns – at some point more fertilizer doesn't produce more food.



Industrialized Agriculture and Energy Use

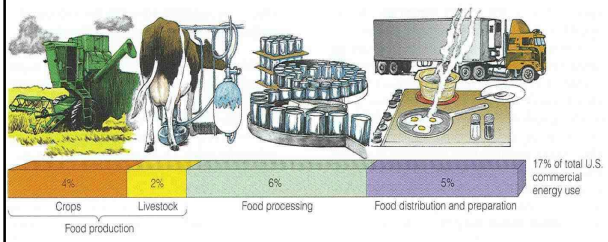
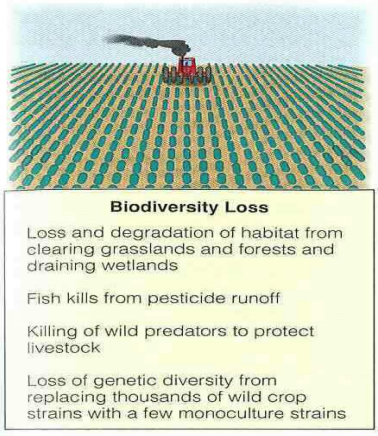


Figure 22-6

- Industrialized Agriculture

- Small Scale Agriculture



Biodiversity Loss

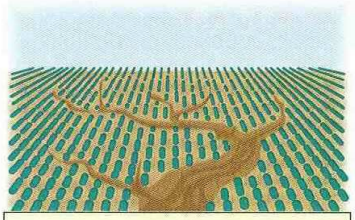
Loss and degradation of habitat from clearing grasslands and forests and draining wetlands

Fish kills from pesticide runoff

Killing of wild predators to protect livestock

Loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains

Figure 22-10



Soil

Erosion

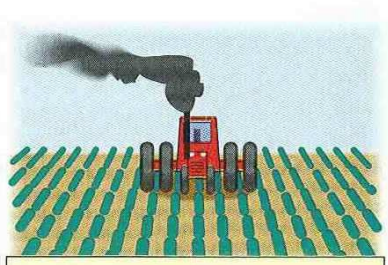
Loss of fertility

Salinization

Waterlogging

Desertification

Figure 22-10



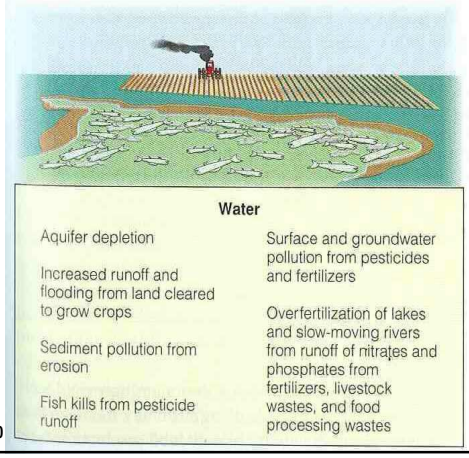
Air Pollution

Greenhouse gas emissions from fossil fuel use

Other air pollutants from fossil fuel use

Pollution from pesticide sprays

Figure 22-10



Water

Aquifer depletion

Increased runoff and flooding from land cleared to grow crops

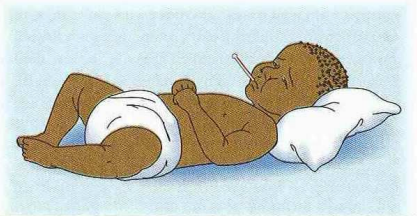
Sediment pollution from erosion

Fish kills from pesticide runoff

Surface and groundwater pollution from pesticides and fertilizers

Overfertilization of lakes and slow-moving rivers from runoff of nitrates and phosphates from fertilizers, livestock wastes, and food processing wastes

Figure 22-10



Human Health

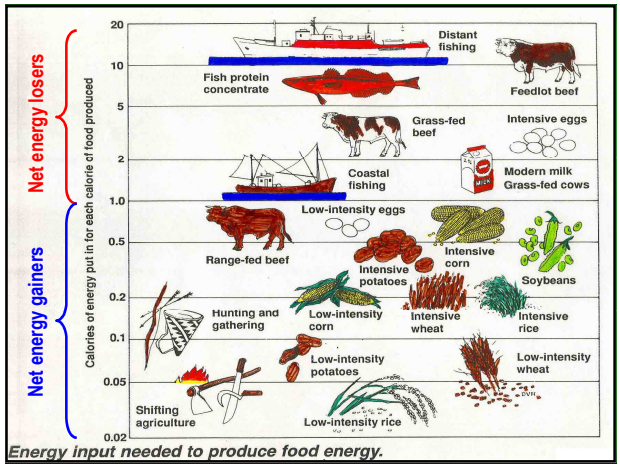
Nitrates in drinking water

Pesticide residues in drinking water, food, and air

Contamination of drinking and swimming water with disease organisms from livestock wastes

Bacterial contamination of meat

Figure 22-10



Energy input needed to produce food energy.

What's that in the dumpster?

Nutrition Facts

Serving Size 1/2 cup (91g)
Servings Per Container

Amount Per Serving

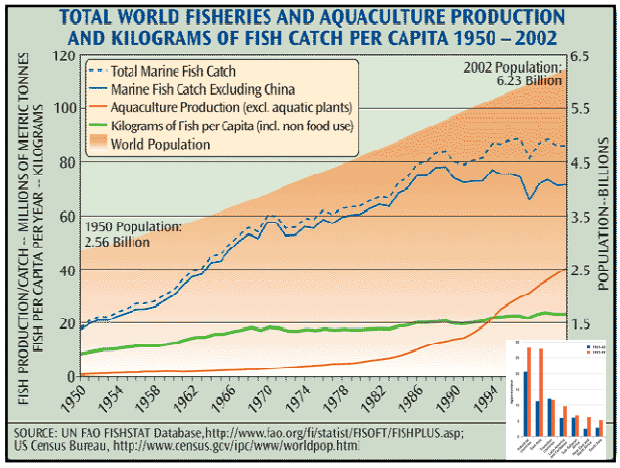
Calories 370	Calories from Fat 130
	% Daily Value*
Total Fat 15g	**23%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 35mg	**1%**
Total Carbohydrate 38g	**13%**
Dietary Fiber 6g	**24%**
Sugars 0g	
Protein 27g	
Vitamin A 0% •	Vitamin C 0%
Calcium 40% •	Iron 70%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

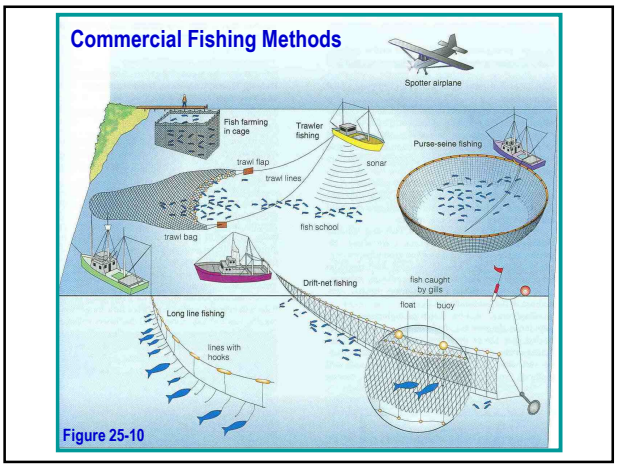
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

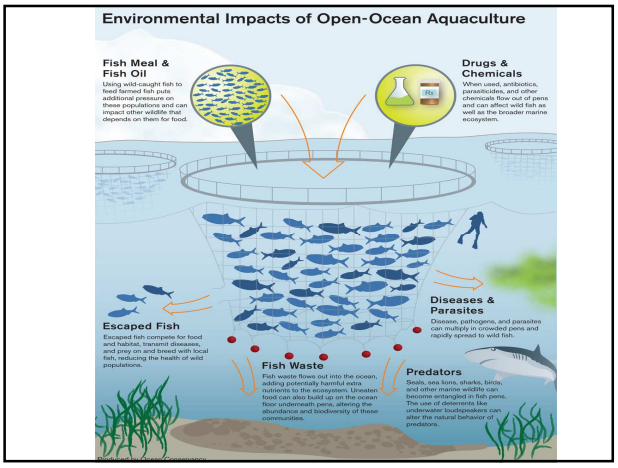
Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

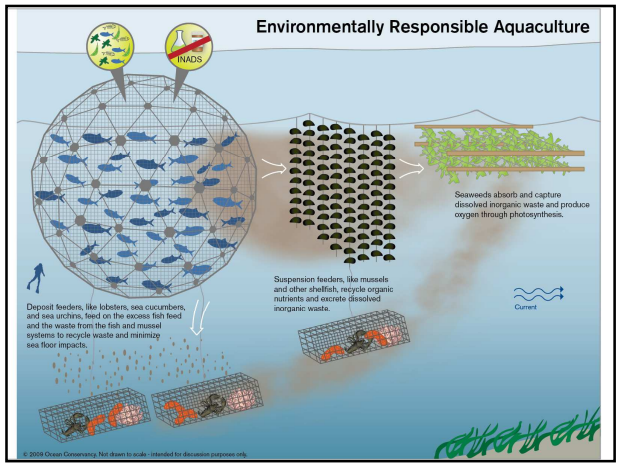
Winged bean: all parts are edible, more protein than soybean and potato, flour and "coffee" made from seeds, nitrogen fixing legume.

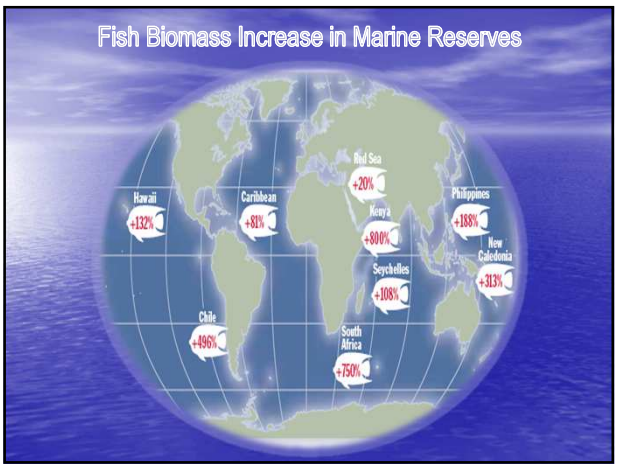


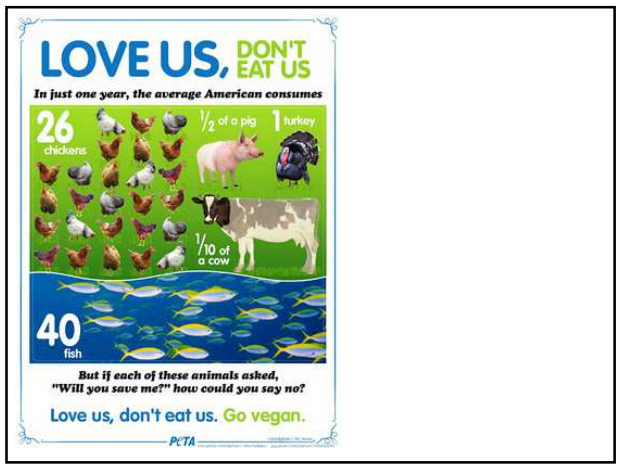
For every pound of shrimp that makes it to a shrimp cocktail, 4 to 10 pounds of fish and other sea life are thrown back into the sea dead or to die. This is called bycatch.


Commercial Fishing Methods
Spotter airplane
Fish farming in cage
Trawler fishing
Purse-seine fishing
trawl flap
trawl lines
sonar
fish school
trawl bag
Drift-net fishing
fish caught by gills
float
buoy
Long line fishing
lines with hooks
Figure 25-10


Environmental Impacts of Open-Ocean Aquaculture
Fish Meal & Fish Oil
Using wild-caught fish to feed farmed fish puts additional pressure on these populations and can impact other wildlife that depends on them for food.
Drugs & Chemicals
When used, antibiotics, parasiticides, and other chemicals flow out of pens and can affect wild fish as well as the broader marine ecosystem.
Diseases & Parasites
Disease, pathogens, and parasites can multiply in crowded pens and rapidly spread to wild fish.
Escaped Fish
Escaped fish compete for food and habitat, transmit diseases, and prey on and breed with local fish, reducing the health of wild populations.
Fish Waste
Fish waste flows out into the ocean, adding potentially harmful extra nutrients to the ecosystem. Uneaten food can also build up on the ocean floor underneath pens, altering the abundance and biodiversity of these communities.
Predators
Seals, sea lions, sharks, birds, and other marine wildlife can become entangled in fish pens. The use of deterrents like underwater loudspeakers can alter the natural behavior of predators.


Environmentally Responsible Aquaculture
INADS
Seaweeds absorb and capture dissolved inorganic waste and produce oxygen through photosynthesis.
Suspension feeders, like mussels and other shellfish, recycle organic nutrients and excrete dissolved inorganic waste.
Deposit feeders, like lobsters, sea cucumbers, and sea urchins, feed on the excess fish feed and the waste from the fish and mussel systems to recycle waste and minimize sea floor impacts.
Current

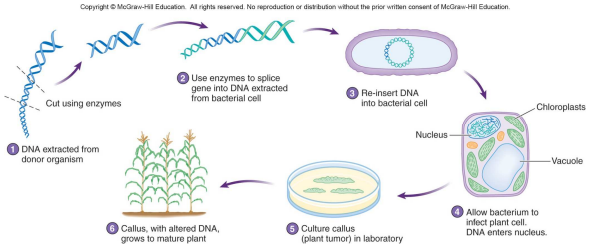

Fish Biomass Increase in Marine Reserves
Hawaii +132%
Caribbean +81%
Red Sea +20%
Kenya +800%
Seychelles +108%
Philippines +188%
New Caledonia +313%
Chile +496%
South Africa +750%


LOVE US, DON'T EAT US
In just one year, the average American consumes
26 chickens
1/2 of a pig
1 turkey
1/10 of a cow
40 fish
But if each of these animals asked, "Will you save me?" how could you say no?
Love us, don't eat us. Go vegan.
PETA

Genetic Engineering Produces New Crops

- Genetic engineering - removes DNA from one organism and splices it into the chromosomes of another. Produces genetically modified organisms (GMOs) with new traits.
  - Can produce crops with pest-resistance and wider tolerance levels to frost, drought, low nutrient and salty soils.
  - Can improve protein or vitamin content of crop
  - Can incorporate oral vaccines into foods such as bananas for use in developing nations
  - Animals can be modified to grow faster or produce pharmaceuticals in their milk.

Gene Transfer Techniques



Concerns Regarding GMOs

- Opponents worry that
  - GMOs might produce superweeds resistant to pesticides.
  - Native biodiversity may be reduced.
  - Novel toxins might be created.
  - Technology may only be available to the rich, making family farms uncompetitive and driving poor nations further into poverty.
- You are already eating GMOs: it is estimated that 60% of processed food in the U.S. now contains GMO's.

Transgenic Crops

- Genetically modified organisms are also called transgenic organisms.
- Transgenic crops can be engineered to tolerate high levels of pesticides.
  - "Roundup Ready" and "Liberty Link" are two of the most popular. Crops can grow in the presence of the pesticides (called Roundup and Liberty) while weeds within the field are killed.

Is Genetic Engineering Safe?

- Environmental and consumer groups have campaigned against transgenic organisms.
  - "Frankenfoods"
  - Some European nations have bans on GMOs.
- U.S. Food and Drug Administration declined to require labeling of foods containing GMOs.
  - New varieties are "substantially equivalent" to related traditionally-bred varieties.

Is Genetic Engineering Safe?

- Some GMOs tested so far do not survive well in the wild and are no more invasive than unmodified plants; yet rapeseed has been found growing with genes from GM varieties in adjoining fields.
- Worry that genetically modified animals will escape captivity and outcompete their wild relatives. (Salmon with added growth hormone gene grow 7X faster than their wild counterparts.)
- We should err on the side of safety.

Will GMOs help feed the world or lead to more economic disparity?