Unit 6: Human Nutrition, Agriculture, Pesticides
24,000 people starve to death daily
Nutritional Requirements

• An average person requires 2,200 Kilocalories a day to perform daily activities.

• With extended food deficit, a person gets deprived of energy and becomes more susceptible to disease; especially children and elderly.

• According to W.H.O., approx. ½ of the world’s population is malnourished- (lacking the correct balance of proteins, carbs., vitamins, and minerals)
FOOD SECURITY AND NUTRITION

• The root cause of hunger and malnutrition is 
poverty.

• *Food security* means that every person in a given 
area has daily access to enough nutritious food to 
lead an active and healthy life.

• Need large amounts of *macronutrients* (protein, 
carbohydrates, and fats).

• Need smaller amounts of *micronutrients* (vitamins 
such as A, C, and E).
Humans Eat a variety of Food

• Grains are the largest component of the human diet

• Corn, Rice and Wheat provide more than half of the world’s consumed calories.

• Meat is the 2\textsuperscript{nd} largest (beef, veal, pork, and lamb) and poultry (chicken, turkey and duck)

• Fish and shellfish are an important source of food for about 1 billion people mostly in Asia and in coastal areas of developing countries.
Food and Nutrition

• Carbohydrates
  • Sugars and starches metabolized by cellular respiration to produce energy

• Proteins
  • Large, complex molecules composed of amino acids that perform critical roles in body

• Lipids
  • Include fats and oils and are metabolized by cellular respiration to produce energy
Food Insecurity and Malnutrition

• **Food Insecurity** - people do not have access to food.

• Whether it be from economic, social or physical availability.

• 1 in 3 people has a deficiency of one or more vitamins and minerals

• **Lack of iodine** - causes goiter - enlargement of thyroid gland
Malnutrition

- **Anemia** - Fe deficiency is the most widespread nutritional deficiency in the world. (Grains, herbs, vegetables and meat can reduce anemia)

- **Kwashiorkor** indicates an associated protein deficiency, resulting in a distended belly →

- **Marasmus** is a condition primarily caused by a deficiency in calories and energy. (undernutrition)
Reasons for Under and Malnutrition

• **#1 reason is POVERTY!** The lack of resources that allows one access to food.

• Political and economic factors play an important role as well. (Refugee populations)

• Large amounts of agricultural resources are diverted to feed livestock and poultry rather than people.

• Global grain production has been level. (not increasing with the human pop)
Famine

• Failure of crops caused by drought, flood or catastrophic event

• Temporary but severe shortage of food

• Large number of deaths over a short period of time
Solutions

There are several ways to reduce childhood deaths from nutrition-related causes:

• Immunize children.
• Encourage breast-feeding.
• Prevent dehydration from diarrhea.
• Provide family planning.
• Increase education for women.
Malnutrition Hotspots

The 50 shaded countries have a high under-five mortality rate (greater than 50 per 1,000) and greater than 30% of stunting in under-fives.

The following legend represents wasting in the under-five population of these countries.

- Countries with more than 15% acute malnutrition
- Countries with more than 10% acute malnutrition
- Countries with more than 4% acute malnutrition

* No data

Haiti

Countries with the most children under-five with severe acute malnutrition. (Estimates in millions)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>8.0</td>
</tr>
<tr>
<td>DRC</td>
<td>1.3</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1.2</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1.1</td>
</tr>
<tr>
<td>Ethiopia</td>
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</tr>
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</table>

8 Stunting – Growth retardation, indicated by low height for age (height for age <-2 Z according to WHO 2005 Growth Standards).
9 Wasting – Emaciation or thinness as measured by low weight for one's height (weight for height <-2 Z according to WHO 2005 Growth Standards).
10 Burkina Faso, Chad, Democratic Republic of Congo, Eritrea, India, Lao People's Democratic Republic, Madagascar, Mauritania, Sudan, Yemen.
11 Bangladesh, Central Africa Republic, Comoros, Ethiopia, Guinea, Guinea Bissau, Haiti, Mali, Myanmar, Namibia, Nepal, Niger, Nigeria, Pakistan, Sierra Leone, Somalia, Timor-Leste, Togo.
Overnutrition: Eating Too Much

• Overnutrition and lack of exercise can lead to reduced life quality, poor health, and premature death.

• A 2005 Boston University study found that about 60% of American adults are overweight and 33% are obese (totaling 93%).

• Americans spend $42 billion per year trying to lose weight.

• $24 billion per year is needed to eliminate world hunger.
Over 1 billion are overweight!
World Grain Carryover Stockpiles

• Amounts of rice, wheat, corn and other grains remaining from previous harvest

• Provides measure of food security

• Has decreased each year since 1987

• UN feels carryover stock should not fall below 72 days

• Fell below 70 days in 2010

• 2014 was only 21 days...
World Grain Carryover Stock

Why the decline?

• Rising temperatures
• Falling water tables and droughts
• Ethanol production
• More grain is going towards feeding livestock
Green Revolution

• The **Green Revolution** was a shift in farming methods from physical labor to mechanized large industrial operations during the 20th century.

• This also included
  • Fertilization
  • irrigation
  • improved crop varieties.

• These changes increased food production and more people were fed. (yay! Right?)
Impacts of the Green Revolution

• Modern agriculture has a greater harmful environmental impact than any human activity.

• Loss of a variety of genetically different crop and livestock strains might limit raw material needed for future green and gene revolutions.

• In the U.S., 97% of the food plant varieties available in the 1940 no longer exist in large quantities.

• Crazy decline in domestic biodiversity!
Industrial Food Production aka: High Input Agriculture

• About 80% of the world’s food supply is produced by industrialized agriculture.

• Uses large amounts (high inputs) of
  • fossil fuel
  • Energy
  • Water
  • Commercial fertilizers
  • Pesticides
  • Monocultures (growing only one crop)
Advantages of Intensive Agriculture

- Maximum yield from minimum land use
- World grain production has almost tripled in the last 50 years.
- Higher yield per season
- Mechanization is efficient and reduces labor costs.
- Per capita food production has increased, reducing global hunger.
- The cost of food has declined, and more food is now traded globally.
Disadvantages of Intensive Agriculture

- Increases in yields may not be sustainable
- Pests and diseases spread rapidly in monocultures.
- Pesticide use is escalating yet its effectiveness is decreasing.
- Pesticides and fertilizers are energy expensive.
- Fertilizer use is increasing but soil and water quality continue to decline.
- Poor countries are reliant financially on outside assistance.
- Heavy machinery is expensive to purchase, operate, and maintain.
Major Environmental Effects of Food Production: Water

• Aquifer depletion

• Increased runoff and flooding from land cleared to grow crops

• Fish kills from pesticide runoff

• Surface and groundwater pollution from pesticides and fertilizers

• Over fertilization of lakes leads to eutrophication
Major Environmental Effects of Food Production: Soil

- Erosion
- Loss of soil fertility (leads to less nutrients in food)
- Salinization
- Water-logging
- Desertification
- Pollution by pesticides
Major Environmental Effects of Food Production: **Air**

- Greenhouse gas emissions from fossil fuels
- Other air pollutants and particulates from fossil fuels
- Pollution from pesticide sprays
Major Environmental Effects of Food Production: **Human Health**

- E. Coli contamination of meat & produce
- Pesticide residues in drinking water, food, and air
- Contamination of drinking and swimming water with disease organisms from livestock wastes
Major Environmental Effects of Food Production: **Biodiversity**

- Loss and degradation of habitat from clearing grasslands and forests and draining wetlands
- Fish kills from pesticide runoff
- Killing of wild predators to protect live stock
- Loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains
Traditional Agriculture: Low Input Polyculture

- Research has shown that, on average, low input polyculture (more than one crop planted together) produces higher yields than high-input monoculture.

- However it takes time and planning
Traditional Agriculture: Low Input Polyculture

• Many farmers in developing countries use low-input agriculture to grow a variety of crops on each plot of land through:

  • **Intercropping**: two or more different crops grown at the same time (basically in rows next to each other).

  • **Agroforestry**: crops and trees are grown together.

  • **Polyculture**: different plants are planted together. (beans with corn – beans climb up corn – everyone wins)
Subsistence Agriculture

• Self-sufficiency farming in which the farmers focus on growing enough food to feed themselves and their families.

• Typically uses traditional low input agricultural methods

• Examples:
  • Shifting cultivation
  • Slash and burn agriculture
  • Nomadic herding
  • Intercropping
Modern Agriculture & Pesticides
TRUE or FALSE?

1. Every person in this room has eaten pesticides in their lives
2. 25% of fresh fruit and vegetables are lost between the field and table in the US
3. Almost 1/3 of food purchased in the UK is not eaten.
4. More than 1/2 of the world’s cropland is used to produce feed grain for livestock.
5. If everyone in the world today received an equal share of the food produced, no one would have enough food to stay strong and healthy.
6. Cattle produce 15% of all methane gas released into the atmosphere.
7. Half of Australia’s landfills are made up of food waste.
8. 30% of Africa’s fish catch is discarded.
9. In the US, livestock produce 21 times more waste (manure) than humans.
10. Cattle use more than ½ of the water withdrawn each year in the US.
11. Although the pesticide DDT is illegal to use in the US, every one of us here has been exposed to this deadly chemical.
Part 1: Pesticides
The Green Revolution

- Dramatically increased per-acre yields
- Spread to the developing world in the 1940s with wheat, rice, corn
- High Input Agriculture relies on large amounts of
  - Synthetic fertilizers
  - Chemical pesticides
  - Irrigation
  - Heavy equipment

Pests and pollinators

• **Pest** = any organism that damages valuable crops
• **Weed** = any plant that competes with crops
• **Pesticides** = poisons that target pest organisms
  • **Insecticides** = target insects
  • **Herbicides** = target plants
  • **Fungicides** = target fungi
• 400 million kg (900 million lbs.) of pesticides are applied in the U.S. each year
  • 75% of this is applied to agricultural land
  • Usage is increasing in developing countries
Types of Pesticides

Broad spectrum pesticides

• A pesticide that kills a variety of organisms, not just the targeted organisms
• Kill natural predators and parasites that may have been keeping the population in check
• This can unleash new pests which the predators kept in check

Narrow spectrum pesticides

• Kill only the target species.
Types of Pesticides

First generation pesticide

• Inorganic compounds
  • Lead and mercury
• Botanicals- plant derived pesticides
  • Nicotine and pyrethrin

Second generation pesticide

• Synthetic poison
• Ex: DDT (was first, second generation pesticide)
dichlorodiphenyltrichloroethane
Effect of DDT Use in Borneo

In the early 1950's the people in Borneo, suffered from Malaria the World Health Organization had a solution, kill the mosquitoes with DDT. This is what happened.

- **DDT**
  - Original purpose: The WHO used DDT kill the mosquitoes that caused Malaria
  - Byproduct 1 Eliminated the natural predator for the thatch eating caterpillar
  - Byproduct 2 Biomagnification of DDT poisoning in cats caused an outbreak of sylvatic plague
  - DDT accumulated in Geckos

- **Overpopulation of caterpillars**
  - Caterpillars ate the roofs off the villager's houses

- **Killed parasitic wasp**

- **As the cats died, the rat population flourished and so did an outbreak of plague**
  - Eating the geckos caused more DDT to accumulate in the cats that eventually killed the wild cats
Major Groups of Insecticides

Chlorinated Hydrocarbons
- Organic compound containing Chlorine
- Slow to degrade and persist in the environment
- Banned or largely restricted
- Ex: DDT

Organophosphates
- Organic compounds that contain phosphorus
- Most poisonous insecticide
- Do not persist as long as chlorinated hydrocarbons

Carbamates
- Derived from carbamic acid
Benefits of Pesticides

Disease control
• Fleas, lice and mosquitoes carry disease
• Malaria - mosquito born
  • 2.7 million people die each year
  • Few drugs available, so focus is on killing mosquitoes

Crop Protection
• Pests eat and destroy 1/3 of world’s crops
• Farmers save $3 to $5 for every $1 they invest in pesticides
Evolution of Genetic Resistance to Pesticides

- Pest populations are evolving resistance to pesticides (right)

- Some individuals are genetically immune to a pesticide

- They survive and pass these genes to their offspring

- Pesticides stop being effective (in current doses)
1. Pests attack crops
2. Pesticide is applied
3. Most pests are killed. A few with innate resistance survive
4. Survivors breed and produce a pesticide-resistant population
5. Pesticide is applied again
6. Pesticide has little effect. New, more toxic, pesticides are developed

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Evolutionary Arms Race

chemists increase chemical toxicity to compete with resistant pests

Pesticide Treadmill

• Cost of applying pesticide increases
  • Pesticide must be applied more frequently or in larger doses

• While their effectiveness decreases
  • Because of increased genetic resistance in pests
Problems with Pesticides

Imbalances the Ecosystem

• Spraying to kill insects can affect birds, rabbits, etc.

• Despite 33-fold increase in pesticides since the 1940s, crop loss has not really changed

<table>
<thead>
<tr>
<th>Period</th>
<th>Insects</th>
<th>Diseases</th>
<th>Weeds</th>
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<tr>
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<td>12.5</td>
<td>12.0</td>
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<tr>
<td>1989-1999</td>
<td>13.0</td>
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<td>12.0</td>
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<tr>
<td>1974</td>
<td>13.0</td>
<td>12.0</td>
<td>8.0</td>
</tr>
<tr>
<td>1951-1960</td>
<td>12.9</td>
<td>12.2</td>
<td>8.5</td>
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<tr>
<td>1942-1951</td>
<td>7.1</td>
<td>10.5</td>
<td>13.8</td>
</tr>
</tbody>
</table>

Source: USDA Agricultural Research Service.
Problems with Pesticides

Creation of New Pests

• Infestation of red scale insects on lemons after DDT sprayed to control another pest.

DDT killed natural predators of this “new” pest.
Problems with Pesticides

Bioaccumulation
• The buildup of a persistent pesticide or other toxic substance in an organism's body

Biological magnification
• Increased concentration of toxic chemicals in tissues of organisms at higher trophic levels
• Ex: Peregrine Falcons & Ospreys
• Remember DDT is an endocrine disruptor
Problems with Pesticides

Mobility in the Environment

- Do not stay where they are applied
- Move through soil, water and air
Risk of Pesticides to Human Health

Short-term Effects of Pesticides

Handling food with pesticide residue

• Mild case:
  • Nausea
  • Vomiting
  • headaches

• Severe case:
  • damage to nervous system
Risk of Pesticides to Human Health

Long-term Effects of Pesticides

• Cancer - lymphoma
• Breast cancer
• Sterility
• Miscarriage
• Birth defects
• Decreases body’s ability to fight infection
• Potential connection to Parkinson’s disease
We depend on insects to pollinate crops

Not all insects are pests; some are absolutely vital
  • 800 cultivated plant species rely on insect pollinators

Pollination = male plant sex cells fertilize female sex cells
  • By wind or animals

Pollinators include:
  • Hummingbirds
  • Bats
  • Insects

Flowers are evolutionary adaptations to attract pollinators
Conservation of pollinators is vital

• Honeybees pollinate more than 100 crops – 1/3 of the U.S. diet.
• Native populations of honeybees have plummeted
• To conserve bees:
  • Reduce or eliminate pesticide use
  • Plant flowering plants
CCD linked to pesticides

• Colony collapse disorder (CCD) is the phenomenon that occurs when the majority of worker bees in a colony disappear.

• CCD causes significant economic losses because many agricultural crops worldwide are pollinated by honey bees.

• Shortages of bees in the US have increased the cost to farmers renting bees for pollination services by up to 20%.

• In the six years leading up to 2013, more than 10 million beehives were lost to CCD, nearly twice the normal rate of loss.

• A large amount of speculation has surrounded a recently introduced family of pesticides called neonicotinoids as having caused CCD.

• Other suggested causes include: infections; malnutrition; various pathogens; genetic factors; immunodeficiencies and loss of habitat.
Alternatives to Pesticides

**Pheromones and Hormones**
- Can use pheromones to lure pests to traps
- By applying insect hormones at wrong time in life cycle, insects can be killed off

**Reproductive Controls**
- Sterilizing some of the members
- Sterile male technique
Alternatives to Pesticides

Genetic Controls

• Genetically Modified plants (GMOs)
  • Bt toxin
  • Potential problem: may affect non-target species (monarch butterfly)

Quarantine

• Restriction of the importation of exotic plant and animal material that might harbor pests
  • Effective, but not foolproof
Alternatives to Pesticides

**Irradiating Food**

- Harvested food is exposed to ionizing radiation, which kills many microorganisms
- Predominantly used on meats
- Somewhat controversial due to potential for free radicals
Alternatives to Pesticides

Using cultivation methods to control pests
  • Interplant mixtures of plants (alternating rows)
  • Proper timing of planting, fertilizing, and irrigating
  • Crop rotation

Biological Control
  • Use of naturally occurring disease organisms, parasites or predators to control pests
  • Must take care that introduced agent does not attack unintended hosts
Biological Control agents may become pests themselves

- No one can predict the effects of an introduced species
- The agent may have “nontarget” effects on the environment and surrounding economies
- Removing a biocontrol agent is harder than halting pesticide use
- Due to potential problems, proposed biocontrol use must be carefully planned and regulated
Integrated Pest Management (IPM)

IPM
• Combination of pest control methods that keeps pest population low without economic loss
• Conventional pesticides are used sparingly when other methods fail
Integrated Pest Management (IPM)

IPM uses multiple techniques to suppress pests through

- Biocontrol
- Population monitoring
- Habitat alteration
- Crop rotation and transgenic (GMO) crops
- Alternative tillage methods
- Mechanical pest removal
- Chemicals, when necessary
Within 4 years of using IPM in Indonesia, rice yields rose 13%, and $179 million saved by phasing out subsidies.
Laws Controlling Pesticide Use

Federal Insecticide, Fungicide, and Rodenticide Act (1947)
- United States federal law that set up the basic U.S. system of pesticide regulation to protect applicators, consumers, and the environment.
- Shifting the burden of proof to the chemical manufacturer
- Enforcing compliance against banned and unregistered products

Food, Drug, and Cosmetics Act (1938)
- A set of laws passed by Congress in 1938 giving authority to the U.S. Food and Drug Administration (FDA) to oversee the safety of food, drugs, and cosmetics.

Delaney Cause (1958)
- 1958 amendment to the Food, Drugs, and Cosmetic Act of 1938.
- Addresses concerns about the safety of new food additives.
- The Delaney clause was a provision in the amendment which said that if a substance were found to cause cancer in man or animal, then it could not be used as a food additive.
Manufacture & Use of Banned Pesticides

Some US companies still make banned or seriously restricted pesticides

• China, India & Mexico still manufacture DDT
• May lead to the importation of food tainted with banned pesticides

Global ban of persistent organic pollutants

• International environmental treaty effective May 2004
• Aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).
The Original Dirty Dozen

Aldrin
• Pesticide widely used on corn and cotton.

Chlordane
• Pesticide used on agricultural crops, lawns and gardens and as a fumigant for termite control.

DDT
• Pesticide used for malaria control

Dieldrin
• Pesticide widely used on corn and cotton

Endrin
• Pesticide used to control insects, rodents and birds

Heptachlor
• Insecticide used in household and agricultural uses
The Original Dirty Dozen

Hexachlorobenzene (HCB)
• Pesticide and fungicide used on seeds, also an industrial byproduct

Mirex
• Insecticide and flame retardant

Toxaphene
• Insecticide primarily used on cotton

Polychlorinated biphenyls (PCB)
• Widely used in electrical and industrial equipment

Polychlorinated dibenzo-p-dioxins (PCDD)
• “Unintentional” pollutant, byproduct of incineration and industrial processes

Polychlorinated dibenzofurans (PCDF)
• “Unintentional” pollutant, byproduct of incineration and industrial processes
Part 2: GMOs
Genetically modified organisms

• Genetic engineering = laboratory manipulation of genetic material

• Genetically modified organisms = organisms that have been genetically engineered

• Recombinant DNA = DNA created from multiple organisms
Benefits & Risks of Genetic Engineering

Benefits of genetic engineering:

• Increased nutritional content
• Increased agricultural efficiency
• Rapid growth
• Disease and pest resistance

Negatives of genetic engineering:

• Risks are not yet defined or well understood
• Protests from environmental activists, small farmers, and consumer advocates
Biotechnology is impacting our lives

- **Biotechnology** = the material application of biological science to create products derived from organisms

- **Transgenic organism** = an organism that contains DNA from another species
  - **Transgenes** = the genes that have moved between organisms

- Biotechnology has created medicines, cleaned up pollution, and dissolved blood clots.
Genetic engineering versus agricultural breeding

• Artificial selection has influenced the genetic makeup of livestock and crops for thousands of years

• Proponents of GM crops say GM foods are safe

• Critics of GM foods say:
  • Traditional breeding uses genes from the same species
  • Selective breeding deals with whole organisms, not just genes
  • In traditional breeding, genes come together on their own

• Traditional breeding changes organisms through selection, while genetic engineering is more like the process of mutation
Biotechnology is changing our world

- GM foods become big business
- Most GM crops are herbicide resistant
  - Farmers apply herbicides to kill weeds, and crops survive
  - Most U.S. soybeans, corn, cotton, and canola are genetically modified

(a) GM crops by type

(b) GM crops by nation
Examples of GMOs

**Golden rice**

- Variety of rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice.
- It is intended to produce a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A, a deficiency which is estimated to kill 670,000 children under the age of 5 each year.

**Flavr Savr**

- Genetically modified tomato, was the first commercially grown genetically engineered food to be granted a license for human consumption.

**Bt Corn**

- Variant of maize that has been genetically altered to express one or more proteins from the bacteria *Bacillus thuringiensis*. The protein is poisonous to certain insect pests and is widely used in organic gardening.

**Roundup Ready Soybeans**

- A series of genetically engineered varieties of glyphosate-resistant soybeans produced by Monsanto.
- Glyphosate (Roundup) kills plants by interfering with the synthesis of the essential amino acids.
Supporters maintain that GM crops are safe

Supporters make the following points:

• GM crops pose no ill health effects
• They benefit the environment by using less herbicides
• Herbicide-resistant crops encourage no-till farming
• GM crops reduce carbon emissions by needing fewer fuel-burning tractors and sequestering carbon in the soil by no-till farming
Opponents of GMO crops...

- Dangerous to human health
- Escaping transgenes could pollute ecosystems and damage non-target organisms
- Pests could evolve resistance
- Could ruin the integrity of native ancestral races
- Interbreed with closely related wild plants
- People don’t like “tinkering” with “natural” foods
- With increasing use, people are forced to use GM products, or go to special effort to avoid them
- Multinational corporations threaten the small farmer
- Research is funded by corporations that will profit if GM foods are approved for use

Critics argue that we should adopt the **precautionary principle**... don’t do any new action until it’s understood
Nations differ in their acceptance of GM foods

• Europe opposed GM foods
  • The U.S. sued the European Union before the World Trade Organization, charging that the European Union was hindering free trade

• Brazil, India, and China approve GM crops

• Zambia refused U.S. food aid, even though people were starving, because some seeds were genetically modified
**Monsanto**

- American multinational agrochemical and agricultural biotechnology corporation.
- It is a leading producer of genetically engineered (GE) seed and Roundup, a glyphosate-based herbicide.
- Monsanto's role in agricultural changes, biotechnology products, lobbying of government agencies, and history as a chemical company have made the company controversial.
- The company formerly manufactured controversial products such as the insecticide DDT, PCBs, Agent Orange, and bovine growth hormone.
- Monsanto was among the first to genetically modify a plant cell.
- Monsanto was one of the first companies to apply the biotechnology industry business model to agriculture. Companies invest heavily in research and development, and recoup the expenses through the use and enforcement of biological patents.
Monsanto and GMOs

Food Inc Clip Monsanto & Seed Saving (3:00)
https://youtu.be/FflxmlI-Q3fY

Bill Maher Talks Monsanto, Genetically Modified Food (GMOs) – (4:09) PROFANITY
https://youtu.be/csSw3fYnICc
Part 3: CAFOs & Aquaculture
Impacts of Animal Products

As wealth and commerce increase, so does consumption of meat, milk, and eggs

- Global meat production has increased fivefold
- Per capita meat consumption has doubled
Food Inc. Clips

Food Inc Official HD Trailer  (2:15)
https://youtu.be/Rjh5aZKgtSY

McDonald's, the meat industry, and chickens  
(from Food, Inc)  (3:24)
https://youtu.be/a3P5tmkjHa8
CAFOs

Feedlots (factory farms) Also called Concentrated Animal Feeding Operations (CAFOs)

- Huge warehouses or pens designed to deliver energy-rich food to animals living at extremely high densities

- Over ½ of the world’s pork and poultry come from feedlots

Debeaked chickens spend their lives in cages; U.S. farms can house hundreds of thousands of chickens in such conditions
Benefits and drawbacks of CAFOs

The benefits of feedlots include:

• Greater production of food
• Unavoidable in countries with high levels of meat consumption, like the U.S.
• They take livestock off the land and reduces the impact that they would have on it

Drawbacks of feedlots include:

• Contributions to water and air pollution
• Poor waste containment causes outbreaks in disease
• Heavy uses of antibiotics to control disease
Energy choices through food choices

- 90% of energy is lost every time energy moves from one trophic level to the next.
- The lower on the food chain from which we take our food sources, the more people the Earth can support.
- Some animals convert grain into meat more efficiently than others.
Environmental ramifications of eating meat

- Land and water are needed to raise food for livestock
- Producing eggs and chicken meat requires the least space and water
- Producing beef requires the most

(a) Land required to produce 1 kg of protein

(b) Water required to produce 1 kg of protein
Aquaculture

- World fish populations are plummeting
- Technology and increased demand
- Aquaculture = raising aquatic organisms for food in a controlled environment
- Aquatic species are raised in open-water pens or land-based ponds
Aquaculture is growing rapidly

• The fastest-growing type of food production
• Provides a third of the world’s fish for human consumption
• Most widespread in Asia
The benefits and drawbacks of aquaculture

Benefits:

• A reliable protein source
• Sustainable
• Reduces fishing pressure on overharvested wild fish stocks
• Energy efficient

Drawbacks:

• Diseases can occur, requiring expensive antibiotics
• Reduces food security
• Large amounts of waste
• Farmed fish may escape and introduce disease into the wild
Part 4: Sustainable Agriculture
Sustainable Agriculture

• Industrial agriculture may seem necessary, but less-intensive agricultural methods may be better in the long run

• **Sustainable agriculture** = does not deplete soil, pollute water, or decrease genetic diversity

• **Low-input agriculture** = uses smaller amounts of pesticide, fertilizers, growth hormones, water, and fossil fuel energy than industrial agriculture

• **Organic agriculture** = Uses no synthetic fertilizers, insecticides, fungicides, or herbicides
  • Relies on biological approaches (composting and biocontrol)
A standardized meaning for “organic”

• People debate the meaning of the word “organic”

• Organic Food Production Act (1990) establishes national standards for organic products

• The USDA issued criteria in 2000 by which food could be labeled organic

• Some states pass even stricter guidelines for labeling
The market for organic food is increasing

- Sales increased 20% per year in Canada and the U.S. from 1989-2005
- Expanded by a factor of 40 in Europe
- Amount of land for organic farming is increasing
- 10-35% per year in the U.S. and Canada
- In 2005 the U.S. had 1.7 million acres of organic cropland and 2.3 million acres of organic pastureland
The benefits of organic farming

For farmers:
• Lower input costs, enhanced income from higher-value products, reduced chemical costs and pollution
• Obstacles include the risks and costs of switching to new farming methods and less market infrastructure

For consumers:
• Concern about pesticide’s health risks
• A desire to improve environmental quality
• Obstacles include the added expense and less aesthetically appealing appearance of the product
The U.S. doesn’t financially support organic farmers

• In 1993, the European Union adopted a policy to support farmers financially during conversion to organic farming

• The U.S. offers no such support
  • Organic production lags in the U.S.
  • Farmers can’t switch, because they can’t afford the temporary loss of income
  • In the long run, organic farming is more profitable
Locally supported agriculture is growing

• In developed nations, farmers and consumers are supporting local small-scale agriculture
  • Fresh, local produce in season

• **Community-supported agriculture** = consumers pay farmers in advance for a share of their yield
  • Consumers get fresh food
  • Farmers get a guaranteed income

• Farmers Markets—growing and becoming more popular locally.