Chapter 12: Effects of Agriculture on the Environment

How Agriculture Changes the Environment

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  - Off-site pollution of other ecosystems, of soil, water and air

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  - Loss of biodiversity

The Plow Puzzle

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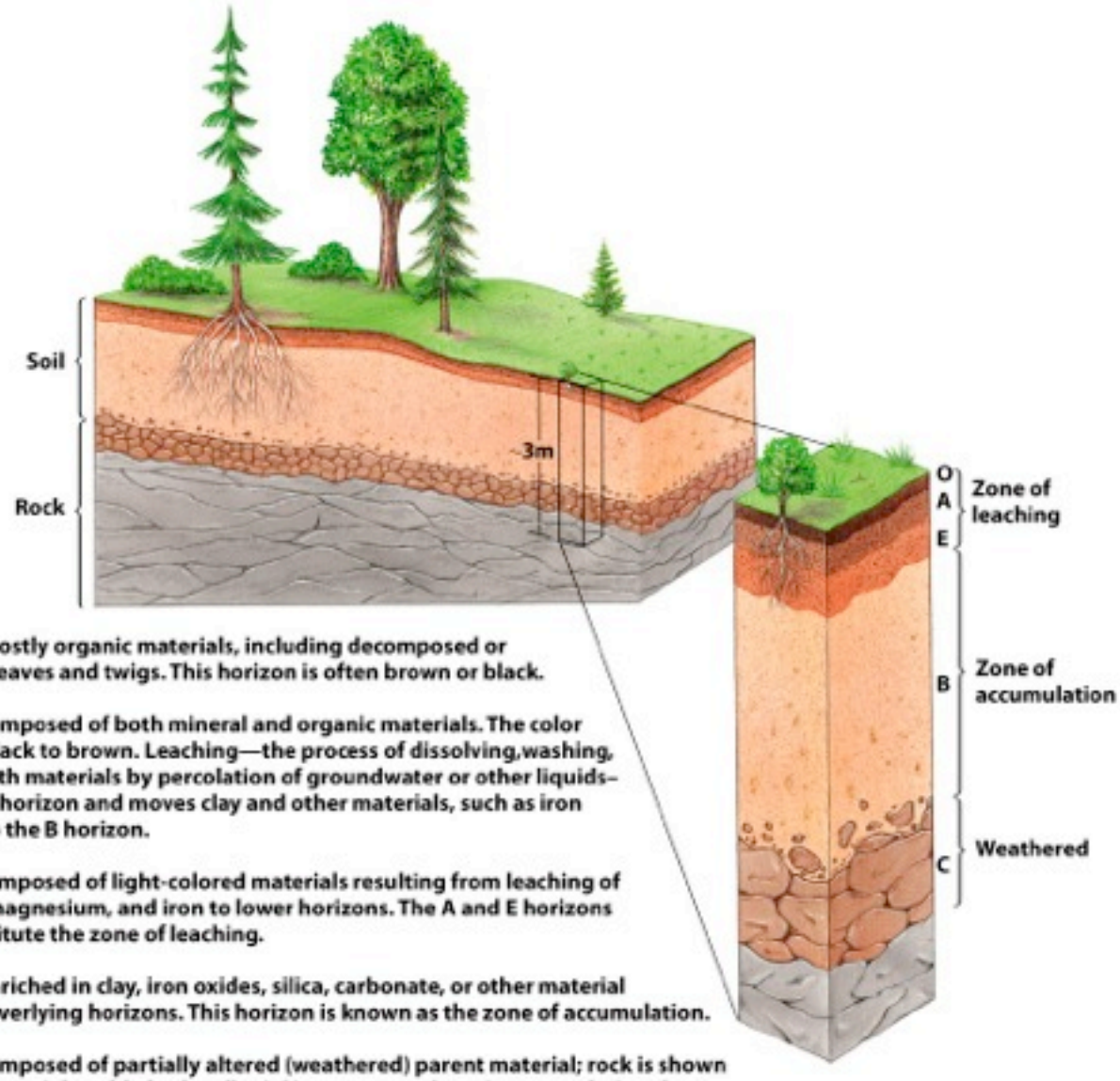
- They shape the land for efficient planting, but they destroy the soil structure thus making it more prone to erosion and loss of fertility.

Plows

- These devices reach at least 14 inches below the soil surface - some go much deeper. Imagine the amount of energy required to pull such devices through the soil….



Horizons

O Horizon is mostly organic materials, including decomposed or decomposing leaves and twigs. This horizon is often brown or black.

A Horizon is composed of both mineral and organic materials. The color is often light black to brown. Leaching—the process of dissolving, washing, or draining earth materials by percolation of groundwater or other liquids–occurs in the A horizon and moves clay and other materials, such as iron and calcium, to the B horizon.

E Horizon is composed of light-colored materials resulting from leaching of clay, calcium, magnesium, and iron to lower horizons. The A and E horizons together constitute the zone of leaching.

B Horizon is enriched in clay, iron oxides, silica, carbonate, or other material leached from overlying horizons. This horizon is known as the zone of accumulation.

C Horizon is composed of partially altered (weathered) parent material; rock is shown here, but the material could also be alluvial in nature, such as river gravels, in other environments. This horizon may be stained red with iron oxides.

R Unweathered (unaltered) parent material. (Not shown)

Our Eroding Soil

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  - Erosion is tied to the loss of particles that help maintain presence of plant nutrients

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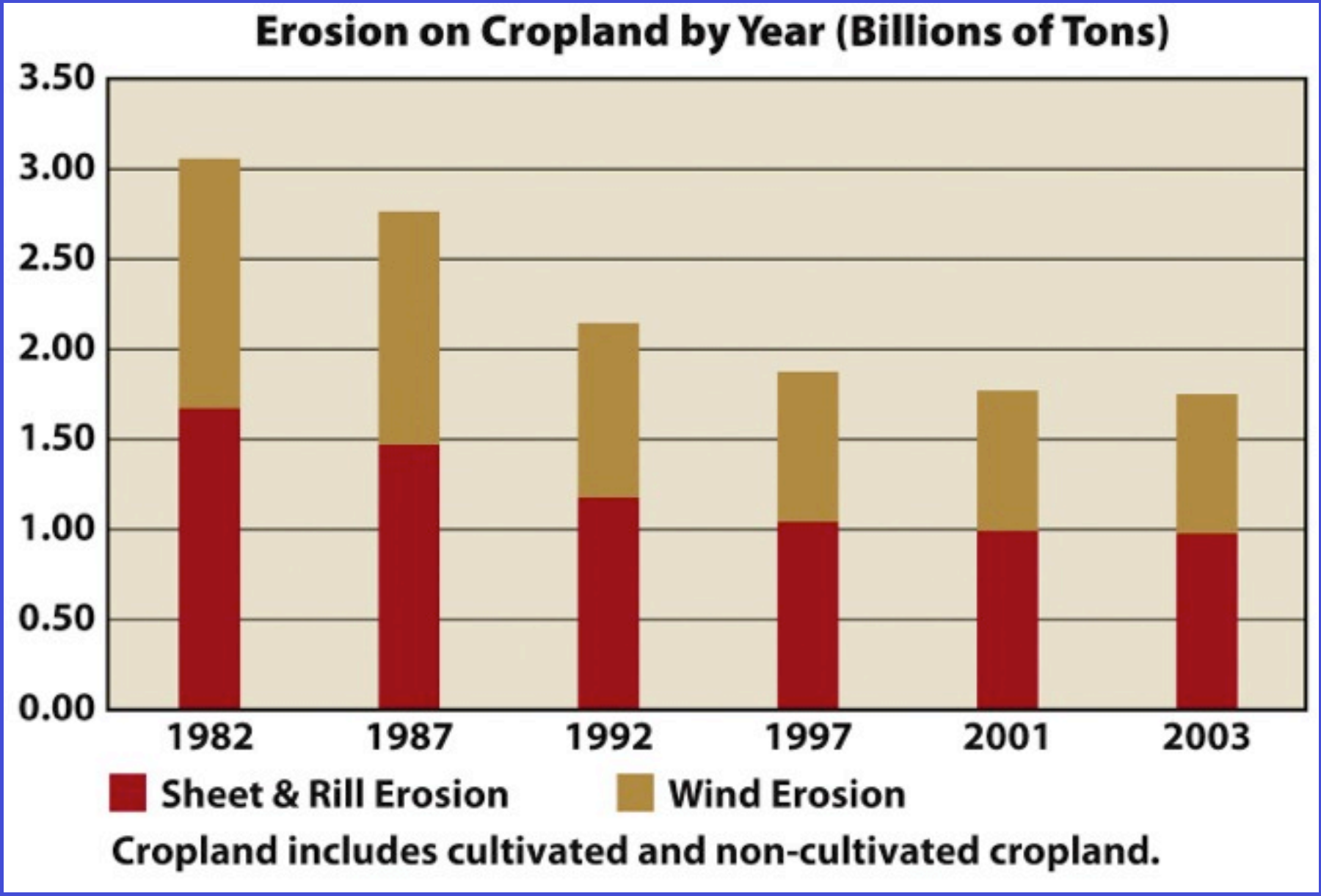
  - Erosion is tied to the loss of particles that help maintain presence of plant nutrients
- Became a national issue in the US in the 1930s
  - Intense plowing + drought
  - Loosened soil blew away during the “Dust Bowl” years


Erosion on Cropland by Year (Billions of Tons)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1982
1987
1992
1997
2001
2003
Sheet & Rill Erosion
Wind Erosion
Cropland includes cultivated and non-cultivated cropland.

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  - Soil exposed to sunlight speeds the rate of decomposition

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  - Chemical fertilizers
  - Adding nitrogen and phosphorous to the soil was easily achieved

Our Eroding Soil

- Since WWII mechanized farming has seriously damaged land
  - > 1 billion hectares
  - In US 1/3 of topsoil has been lost (washed to sea)
  - This is the result of massive disturbances to the soil by plowing and use of heavy farm equipment in concert with natural weathering

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  - Transport of toxic chemical pesticides

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- To be truly sustainable soil lost should equal amount of new soil produced

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  - Also uses less fuel and time

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  - Additional benefit is that it reduces the release of CO_2 accelerated soil decomposition

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  - Insects, nematodes, bacterial and viral diseases, weeds and vertebrates.
- Loss can be large
  - Estimated at 1/3 of potential harvest and 1/10 of the harvested crop

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  - It is a good place for crops
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  - AND early-successional plants (weeds)
- Weeds compete for all resources
  - Light, water, nutrients, and space to grow. Weed are also early successional plants as well!

The History of Pesticides

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  - The first, like arsenic, were toxic to all life
    - Killed both pests and beneficial organisms

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  - DDT, broad-spectrum
  - Aldrin and dieldrin used to control termites
    - Toxic to humans and has been found in breast milk

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- Forth stage is a return to biological and ecological knowledge.
- Biological control - the use of predators and parasites to control pests
  - The use of *Bacillus thuringiensis* (BT) is the most widely used BioInsecticide
  - Predatory insects such as ladybugs, or parasitic wasps
  - Proven safe and effective

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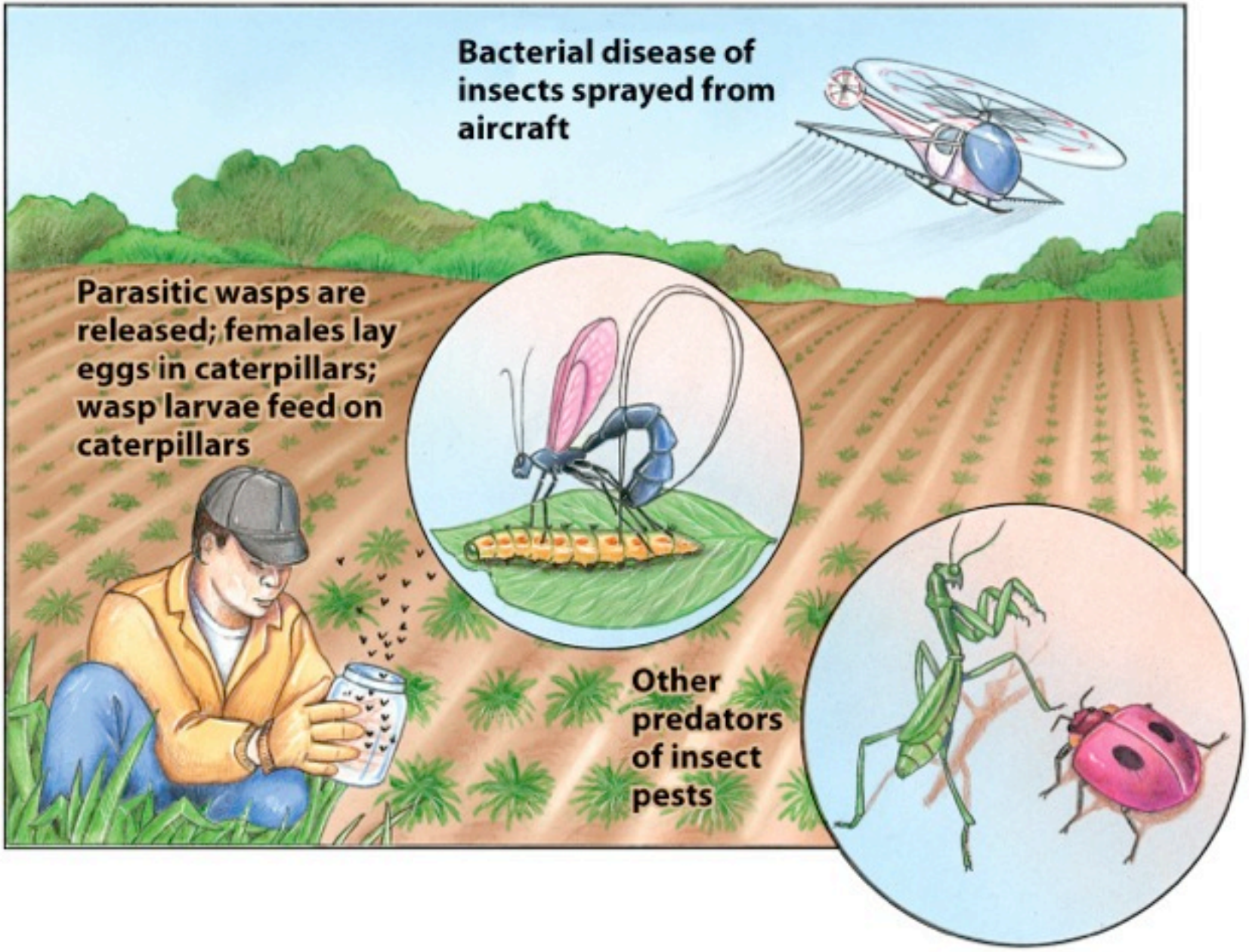
  - Sex pheromones (chemicals released to attract opposite sex) used as bait in traps to interrupt reproductive cycle


Bacterial disease of insects sprayed from aircraft
Parasitic wasps are released; females lay eggs in caterpillars; wasp larvae feed on caterpillars
Other predators of insect pests

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  - Economically makes sense
  - Does less damage to ecosystem, soil, water and air

Integrated Pest Management

- No-till or low-till agriculture another feature of IPM
  - Helps build levels of natural enemies of pests

Control of oriental fruit moth done by parasitic wasp.

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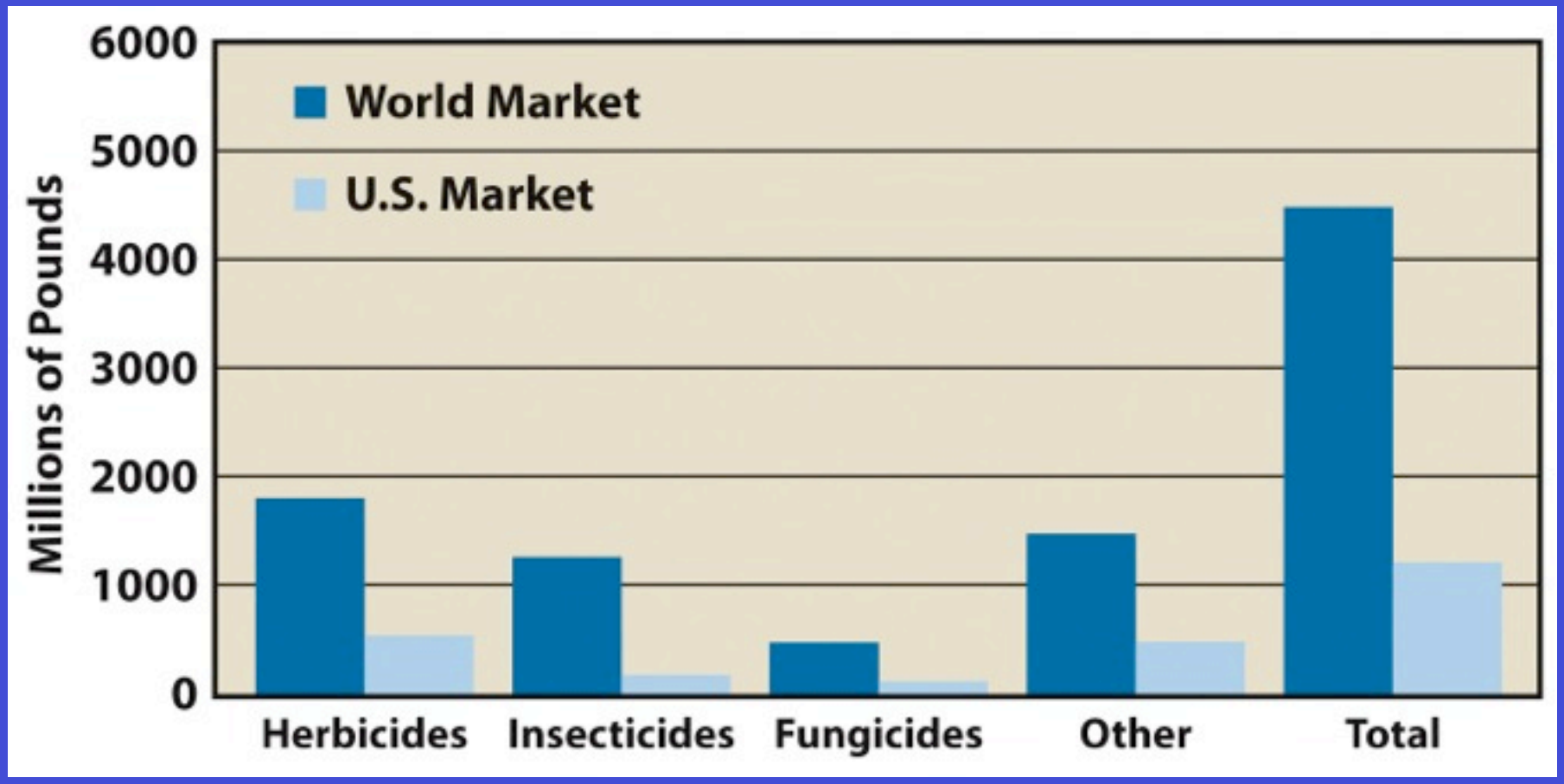
  - Eventually fully decompose but can take a long time


6000
5000
4000
3000
2000
1000
0
Millions of Pounds
World Market
U.S. Market
Herbicides
Insecticides
Fungicides
Other
Total

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  - 3. Transfer of genetic properties from widely divergent kinds of life (fish genes to Strawberries or tomatoes)

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  - Could become pest or transfer genes to closely related weeds

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  - Farmer's in poor nations must be able to grow next years crops from their own seeds

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  - Engineered corn now produces its own pesticide

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  - Monarch butterflies that eat pollen may die

Transfer of Genes

- Much concern worldwide about the political, social and environmental effects of genetic modification of crops.

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  - 30% of Earth’s land area is arid rangeland
- Arid rangeland easily damaged especially in time of drought
- Streams and rivers also damaged
  - Trampling banks and fecal matter

Traditional and Industrial Use of Grazing and Rangelands

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  - Impact varies depending on density relative to rainfall and soil fertility

Biogeography of Agricultural Animals

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  - Introduced animals may compete w/ native herbivores, threatening them w/ extinction as well

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- When the carrying capacity is exceeded, the land is overgrazed. (sometimes poor grazing practices can lead to problems even though the number of animals may have been small).

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  - Subject the land to further damage from trampling

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  - The warmer the climate the greater the rainfall needed to convert an area from desert to non-desert
  - The crucial factor is available water in the soil for plant use
  - Factors that destroy the ability of a soil to store water can create a desert

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  - Additional area due to human activities

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- Serious problem that affects 1/6 of world population (1 billion people)

What Causes Deserts

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- The leading cause of desertification are bad farming practices.

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  - Irrigation in arid lands can cause salts to build up to toxic levels

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  - Clearing land speeds decomposition

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  - Reduces diversity and increases # of endangered species