

Ecological fate of chemicals used in agriculture

Topic division

- Definitions
- Pesticide usage
- Fate of pesticides in environment
- Effects of pesticides
- Pesticide tragedies
- Control measures
- Reviews
- Conclusion

Ecology

- **At community level**, ecology can be defined as complex interactions that exist among interdependent organisms that cohabit the same geographical area and with their environment
- **At individual level**, it entails the relationships that exist between particular individual with numerous physical and biological factors

Fate ?

- Developments of events outside a person's control
- Life cycle of a chemical (pesticide) or biological (enzyme) pollutant after its release in the environment

Agricultural Policy

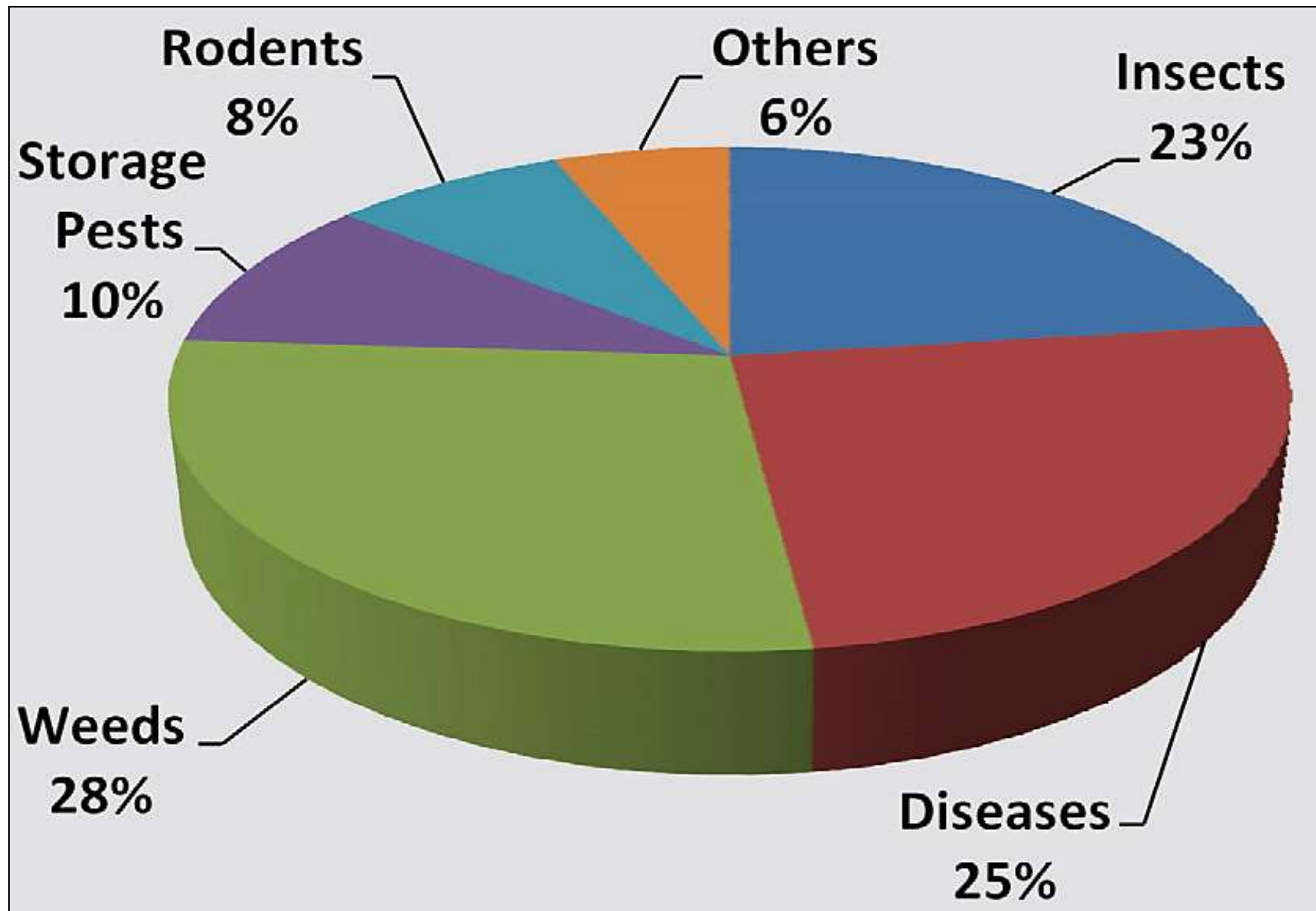


Higher production and increased efficiency

Intensification of the farming system

Increase of pollution risks

Losses caused by different pests



Agriculture pollution

- Contamination of soil, air and water environments due to farming activities

The primary agricultural pollutants are:

- ✓ Nutrients(Nitrogen and phosphorus)
- ✓ **Pesticides**
- ✓ Sediments
- ✓ Salts
- ✓ Wastes



Pesticides?

- A substance used for destroying of pests (insects or other organisms) harmful to cultivated plants or animals
- A pesticide is any substance or mixture of substances specifically intended to prevent or repel or destroy or lessen the effect of a pest

Pesticides includes

- Herbicide
- Insecticide
- Nematicide
- Rodenticide
- Bactericide
- Fungicide
- Disinfectant
- Repellent
- Sanitizer.....etc



Fate of pesticides in environment

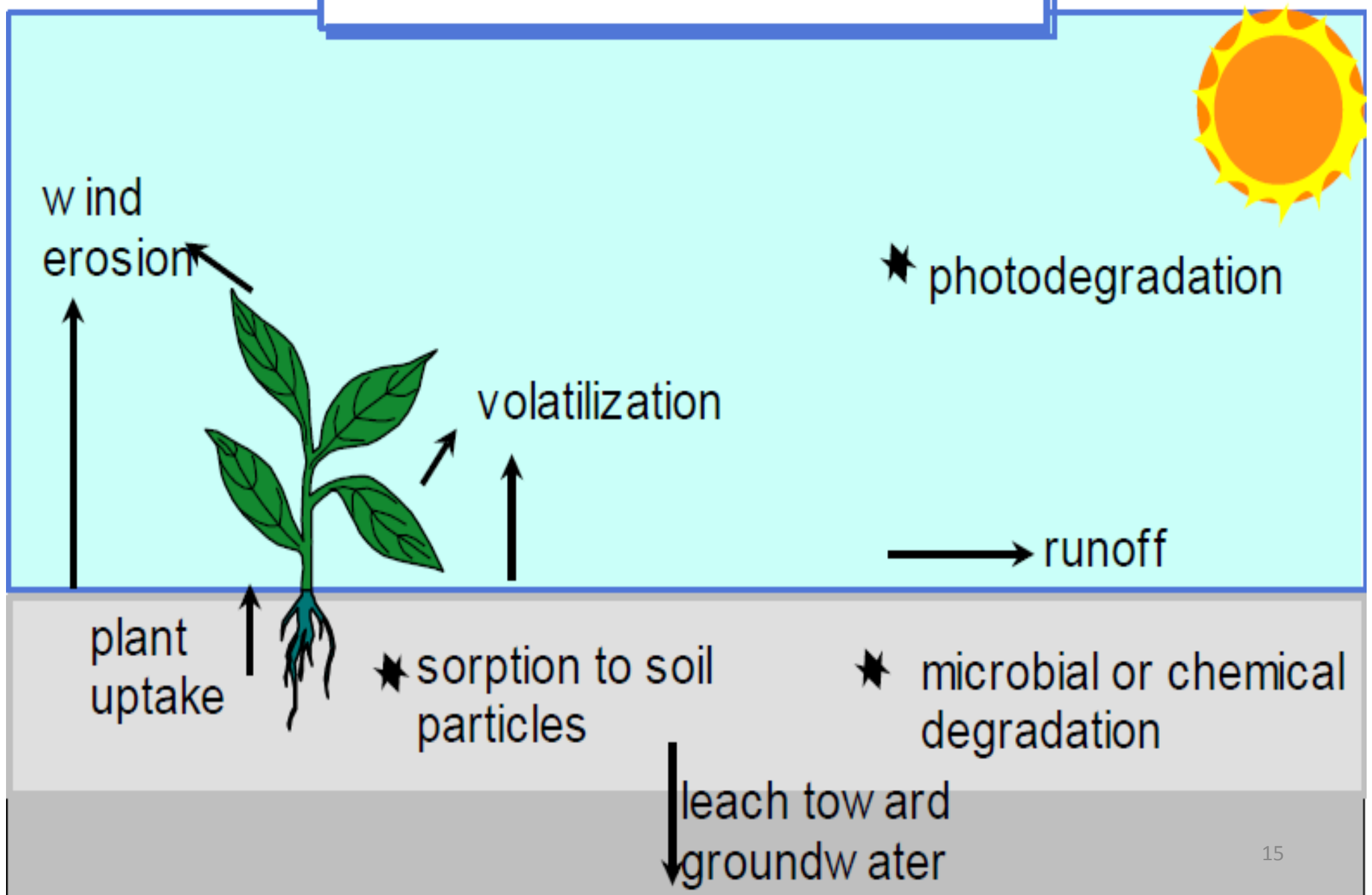
Transfer Processes

- ✓ Adsorption
- ✓ Volatilization
- ✓ Spray Drift
- ✓ Runoff
- ✓ Leaching
- ✓ Absorption

Breakdown Processes

- ✓ Microbial breakdown
- ✓ Chemical breakdown
- ✓ Photo degradation

Chemical fate processes



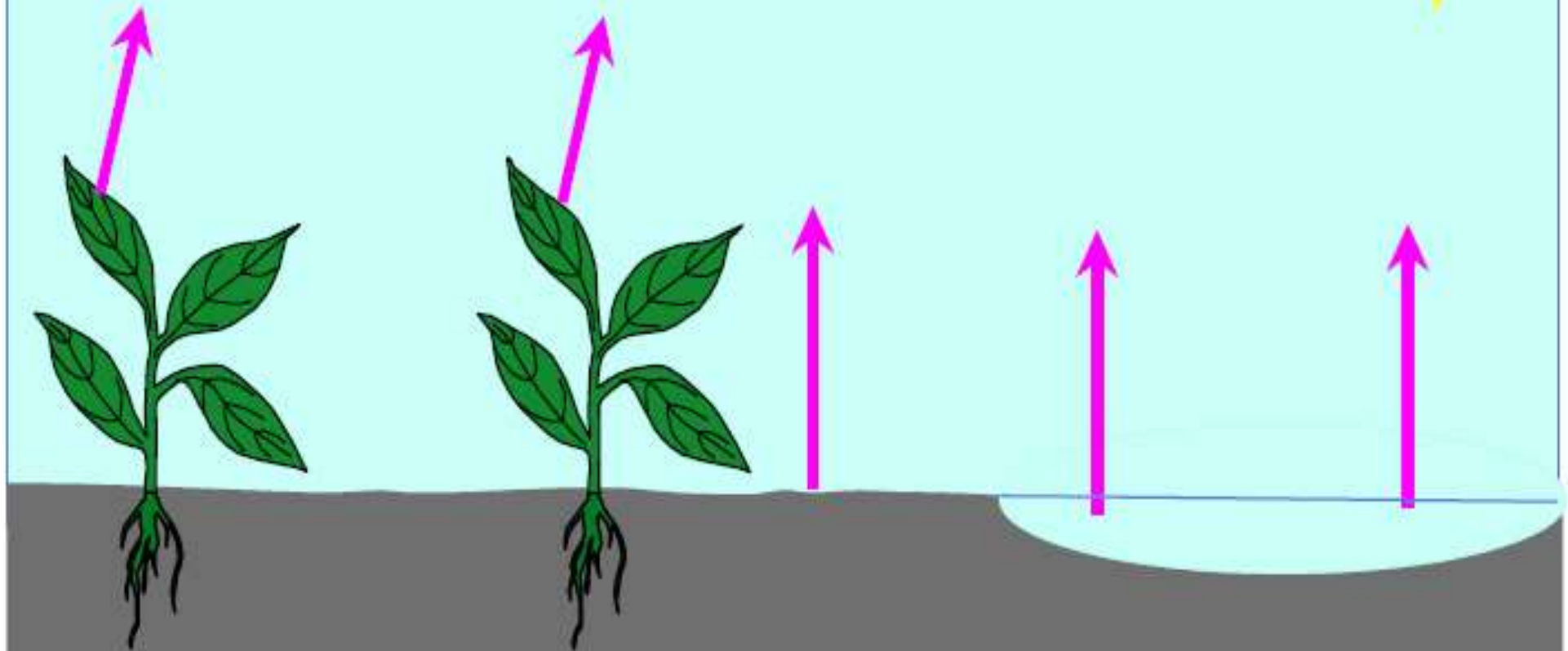
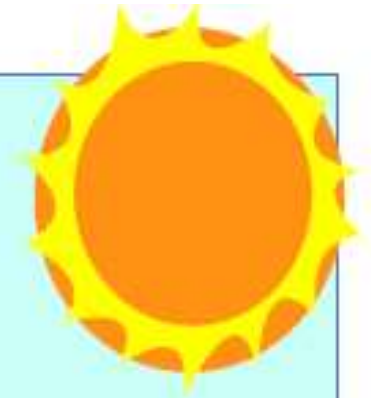
Adsorption

- Adsorption is the binding of pesticides to soil particles
- The amount a pesticide is adsorbed to the soil varies with the type of pesticide, soil moisture, soil pH and soil texture
- Pesticides are strongly adsorbed to soils that are high in clay or organic matter
- They are not strongly adsorbed to sandy soils
- Most soil-bound pesticides are less likely to give off vapours or leach through the soil

Volatilization

- Volatilization is the process of solids or liquids converting into a gas, which can move away from the initial application site
- Pesticides volatilize most readily from sandy and wet soils
- Hot, dry or windy weather and small spray drops increase volatilization
- Incorporation of the pesticide into the soil can help reduce volatilization

Volatilization



volatile loss from plant, water, or soil surfaces

Spray drift

- **Spray drift** is the airborne movement of spray droplets away from a treatment site during application



- **Spray drift is affected by:**
 - ✓ Droplet size – smaller- more likely they will drift
 - ✓ Wind speed – stronger- more pesticide spray will drift
 - ✓ Distance between nozzle and target plant or ground
- Drift may also hazard to people, domestic animals, pollinating insects
- Drift can contaminate water bodies like ponds, streams, and ditches; harm to the fish or other aquatic plants and animals

Runoff

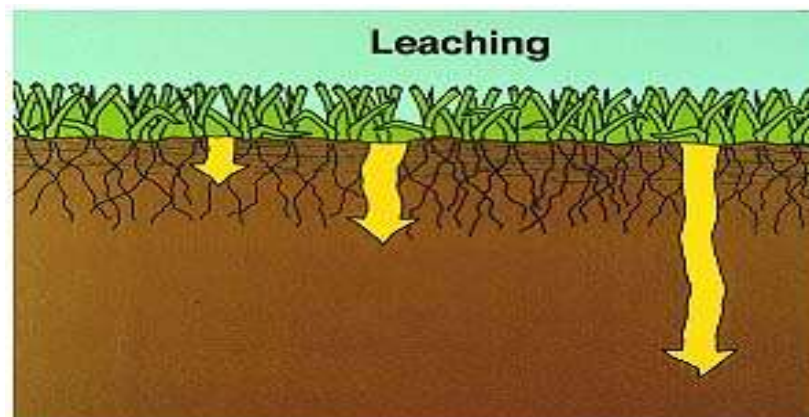
- Runoff is the movement of pesticides in water over a sloping surface
- The pesticides are either mixed in the water or bound to eroding soil
- Runoff can also occur when water is added to a field faster than it can be absorbed into the soil
- Runoff from areas treated with pesticides can pollute streams, ponds, lakes, and wells



- Pesticide residues in surface water can harm animals and contaminate groundwater
- Water contamination can affect livestock and crops downstream
- Pesticide losses from runoff are greatest when rains heavily right after the spray
- Reduce the chances of runoff by watching the weather forecast
- If heavy rain is expected, delay spraying to avoid runoff
- Irrigate according to label instructions

Leaching

- Leaching is the movement of pesticides in water through the soil
- Leaching occurs downward or sideways
- Groundwater may be contaminated if pesticides leach from treated fields, mixing sites, washing sites, or waste disposal areas



Absorption

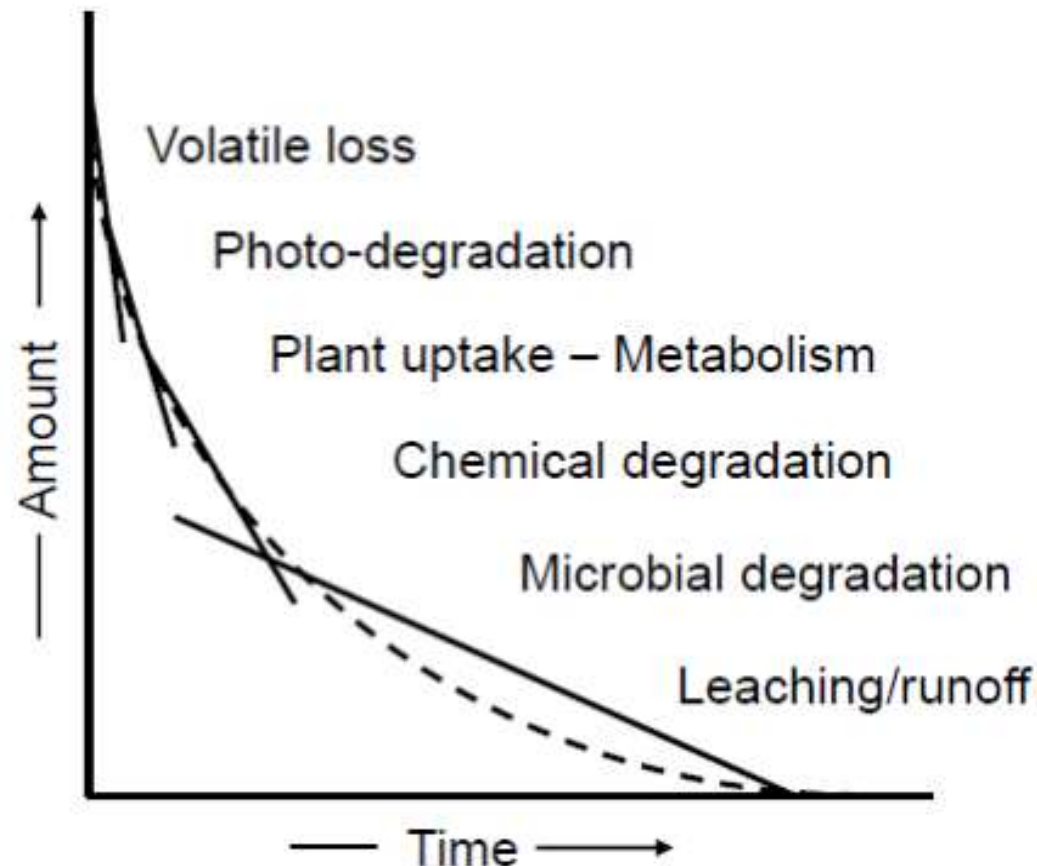
- Uptake of pesticides and other chemicals into plants or microorganisms
- Pesticide residues may be broken down or remain inside the plant or animal, when the animal dies or as the plant decays released back
- Some pesticides stay in the soil long enough to be absorbed by plants grown in a field years later
- They may damage or leave residues in future crops

Degradation or Breakdown Processes

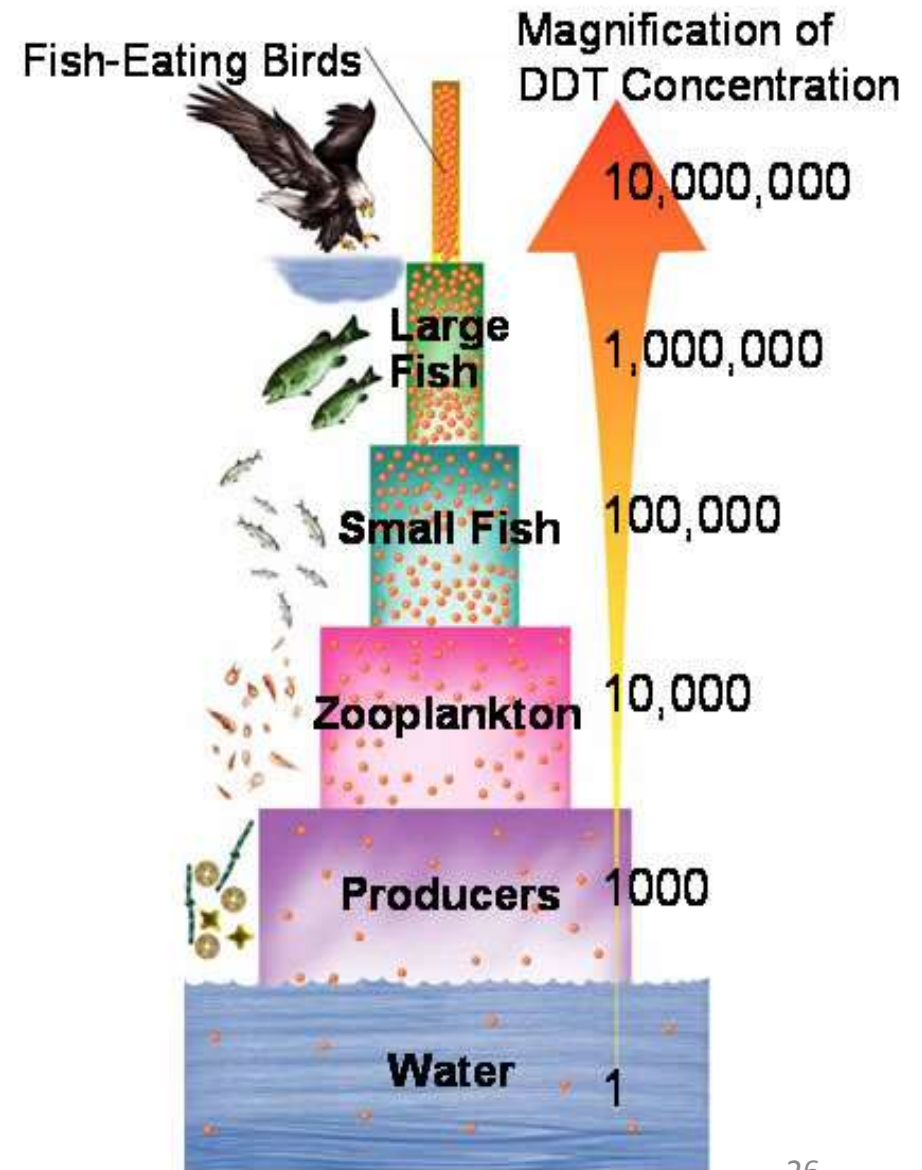
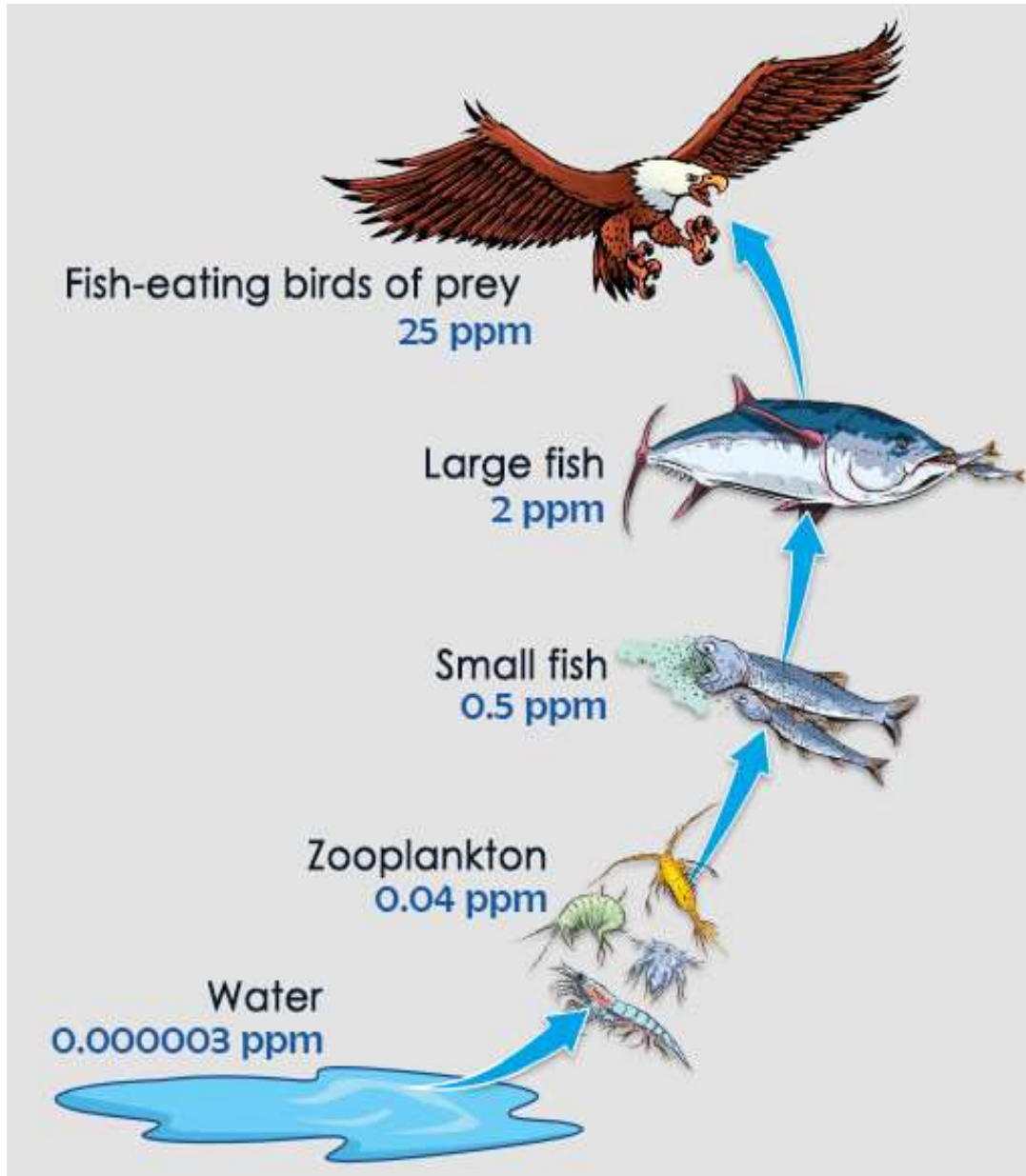
- **Microbial breakdown** is the breakdown of chemicals by microorganisms such as fungi and bacteria
- **Chemical breakdown** is the breakdown of pesticides by chemical reactions in the soil
- **Photo degradation or Photolysis** is the breakdown of pesticides by sunlight. All pesticides are susceptible to photo degradation to some extent
- **Hydrolysis:** Water also degrades pesticides by dividing large molecules into smaller ones

Pesticide dissipation in the environment

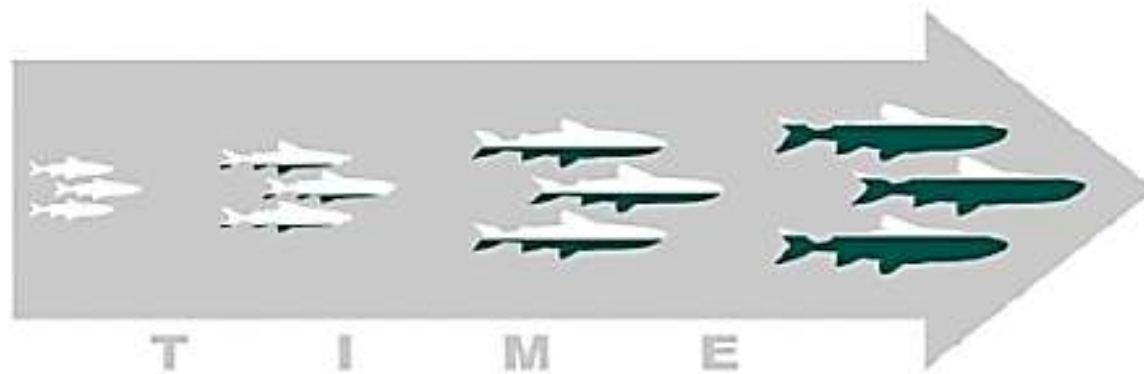
- How fast and which pathway predominates depends on chemical properties and environmental condition



Biomagnification



- The accumulation of more toxin in the bodies of organisms as move you from producers to primary consumers and then secondary consumers etc.
- It occurs when a chemical becomes more and more concentrated as you move up a food chain



Ecological effects of pesticides



- Explained the environmental problems associated with indiscriminate use of pesticides
- “Silent Spring” published in 1962
 - Chemical and pesticide industry alarmed by book’s success
 - “**Most influential book**” on environmental movement¹⁶

Ecological effects of pesticides

- Loss of species diversity among the food chains and food webs
- Effects on pollinators
- Effects on nutrient cycling in ecosystem
- Effects on soil erosion, structure and fertility
- Effects on water quality
- Effects on human beings
- Effects on birds

Contd...

- Contaminate the food
- Effects on fish and other aquatic organisms
- Pesticides disrupt the natural balance between pest and predator insects
- Pesticides cause pest rebound and secondary pest outbreaks
- Pesticides may cause pest resistance

Effects on pollinators



(a) Zinnia and butterfly



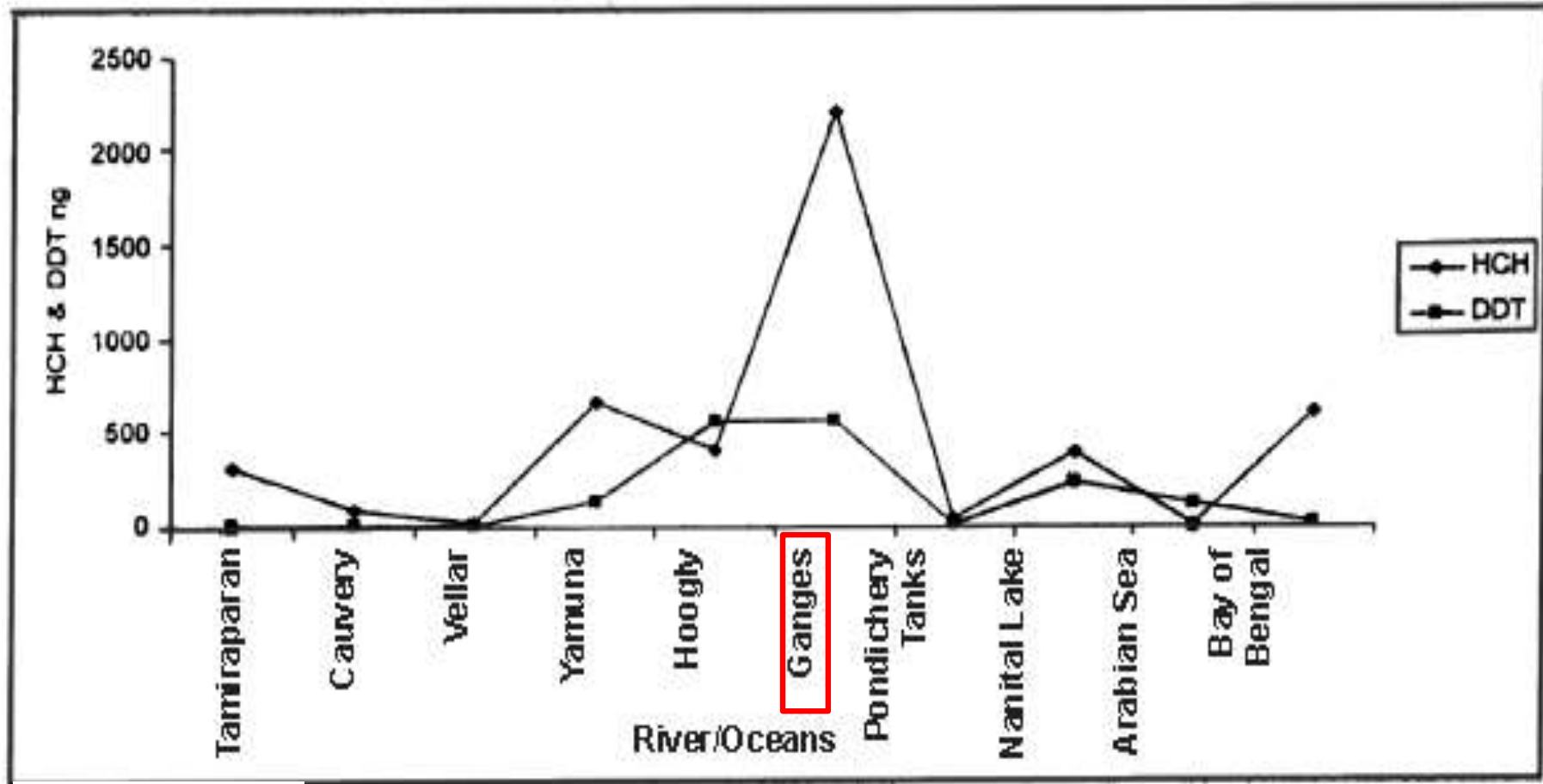
(b) Hibiscus and hummingbird



(c) Saguaro cactus and bat



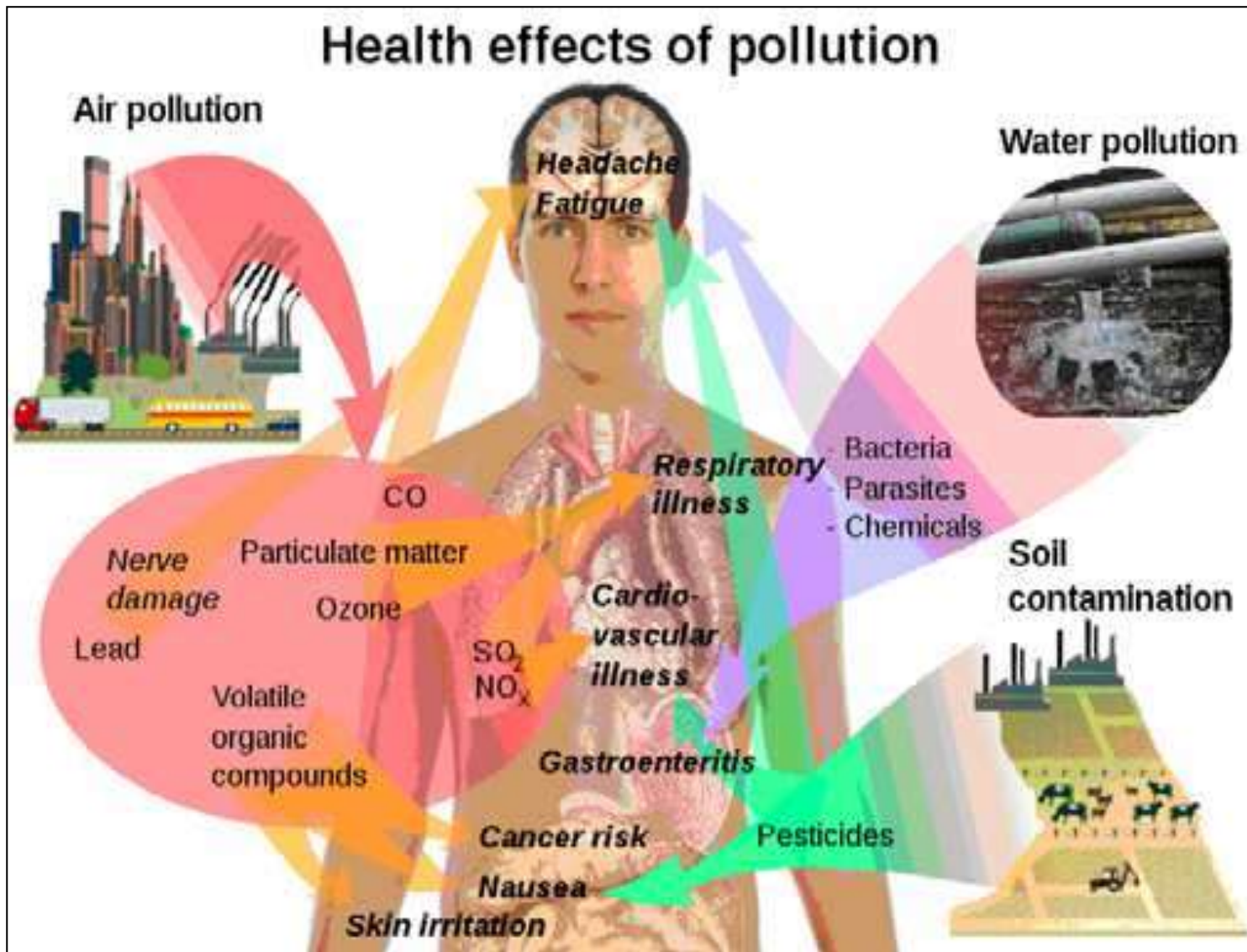
Effects on water quality



Dissolved pesticides in various river water in south Asia

(James, 2000)

Health effects of pollution



Reproductive performance of persons involved in spraying operation

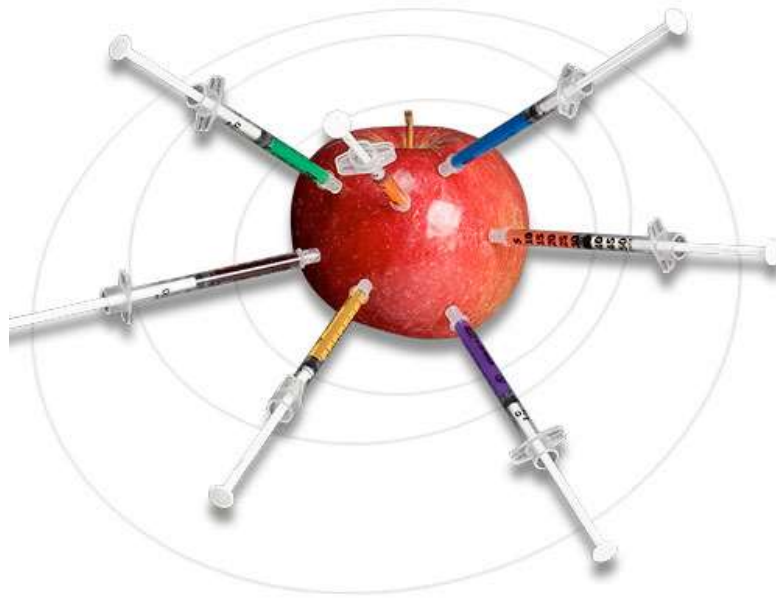
- Data on reproductive toxicity were collected from 1,106 couples when the males were associated with the spraying of pesticides (OC, OP and carbamates) in cotton fields.

Analysis of the reproductive performance

Abortion	15 %
Still births	2.6 %
Neonatal deaths	2.2 %
Congenital defects	0.1 %

- A cytogenetic study revealed a significant increase in chromatid breaks and gaps in chromosomes in the workers exposed to pesticides.

Contaminate the food



Conclusion

- In modern agriculture use of pesticides is a must, but proper and efficient use has to be done
- To save current and also future generation, ecology; judicious use of chemicals is recommended
- Alternative strategies- Bio-pesticides, **IPM**