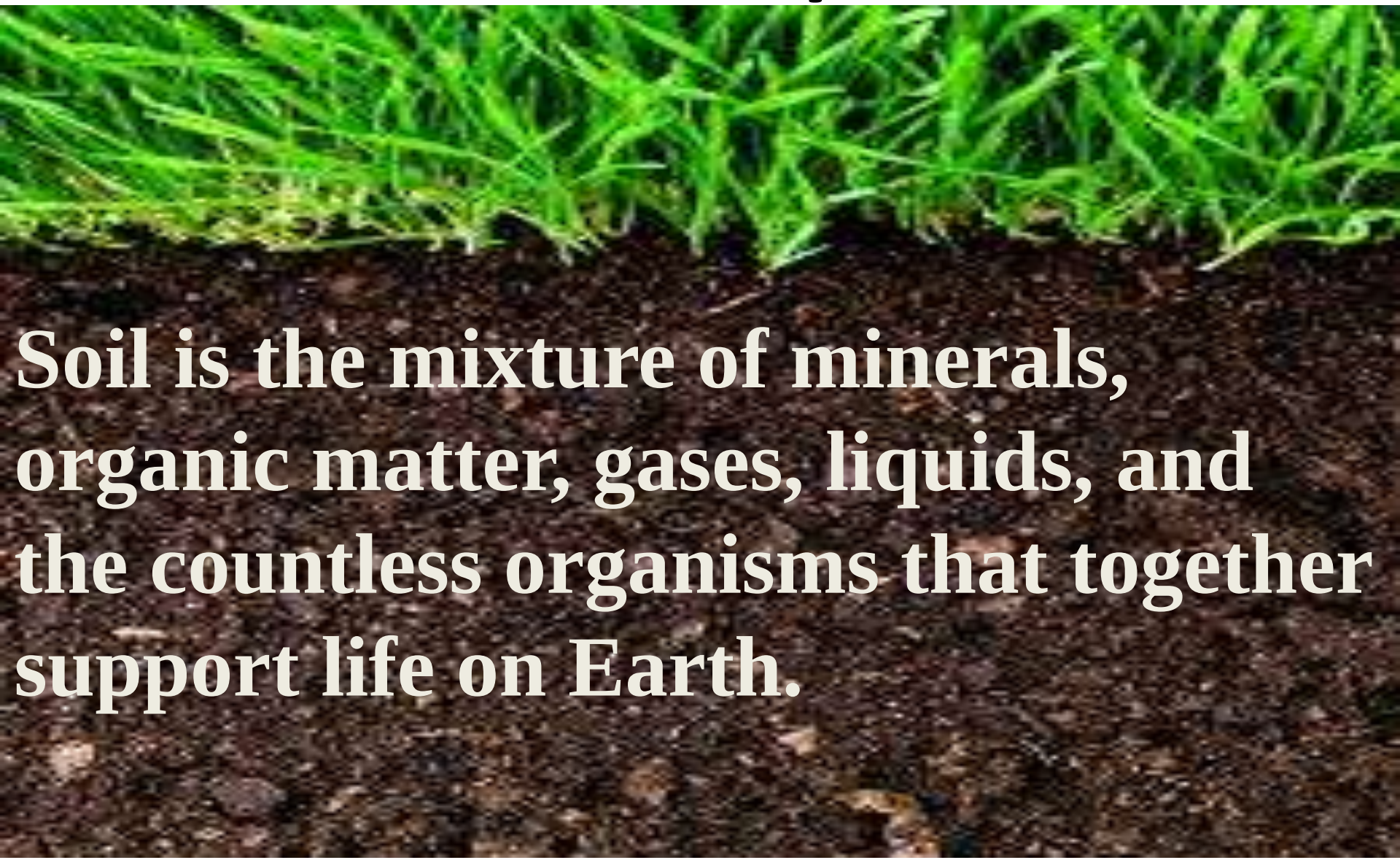
Agro inputs and Soil pollution - its impacts

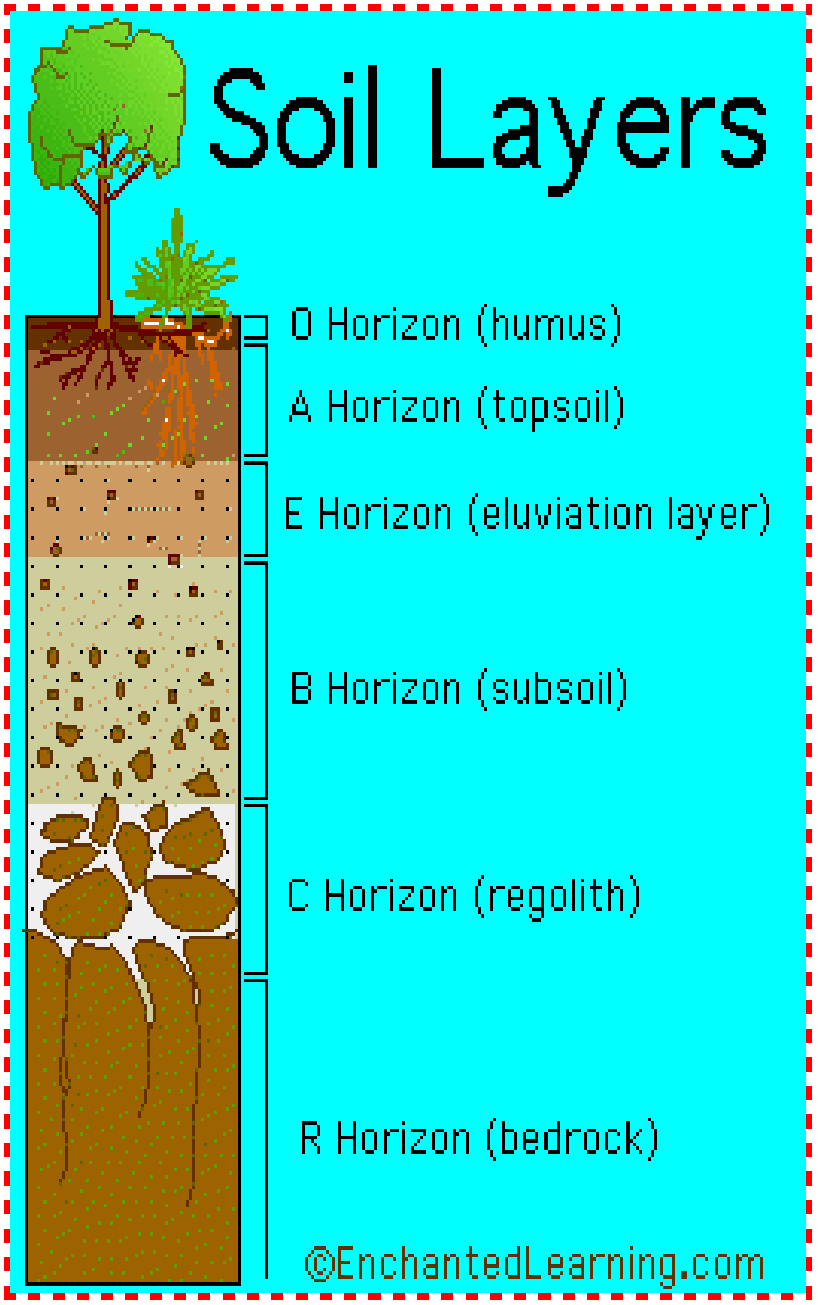
Soil and its Importance



Soil is the mixture of minerals, organic matter, gases, liquids, and the countless organisms that together support life on Earth.

- **Importance**
  - –Source of nutrients
  - –Store and purification of water (hydrologic cycle)
  - –recycle nutrients and gases
  - –Help recycle people's waste
  - –Earth Resource

- **O-horizon:** freshly-fallen & partially-decomposed leaves, twigs, animal waste, fungi & organic materials. Colour: brown or black.
- **A-horizon:** humus/partially decomposed organic matter & some inorganic mineral particles. darker & looser than the deeper layers.
- **O & A-horizon:** contain a large amount of bacteria, fungi, earthworms, small insects, forms complex food web in soil, recycles soil nutrients, & contribute to soil fertility.
- **B-horizon /(subsoil):** less organic material & fewer organisms than A- horizon.
- **C-horizon:** consists of broken-up bedrock, does not contain any organic materials. Chemical composition helps to determine pH of soil & also influences soil's rate of water absorption & retention.
- R-horizon: The unweathered rock (bedrock) layer that is beneath all the other layers



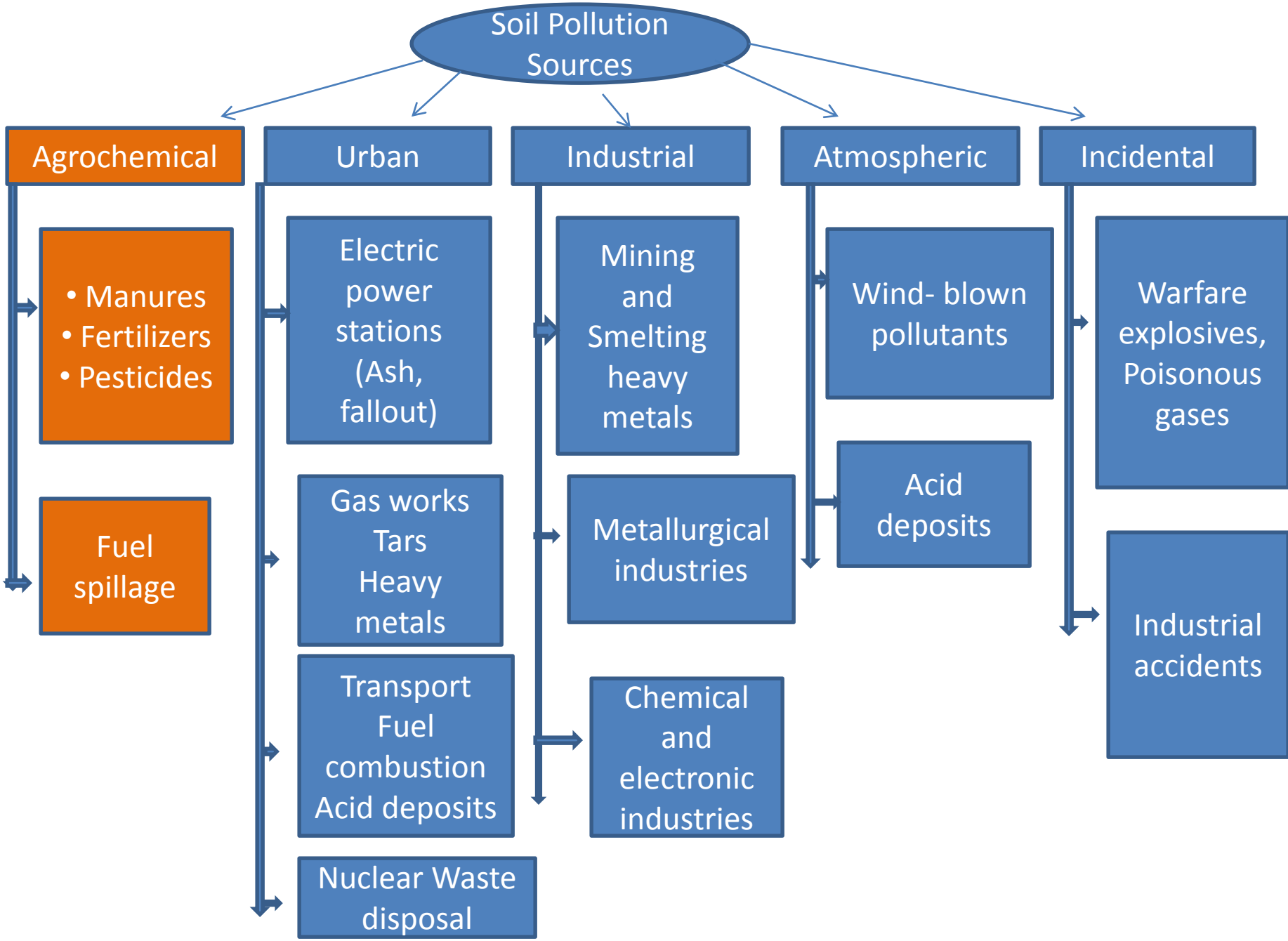
Top soil formation

- **Duration : ≥ 500 years to form an inch**
- **Ways :**
  - **Physical weathering**
  - **Chemical weathering**
  - **Biological weathering**

Soil pollution

Soil pollution is when humans introduce harmful objects, chemicals or substances, directly or indirectly into the **soil** in a way that causes harm to other living things or destroys **soil.**

- **Industrial Activity**
- **Agricultural Activity**
- **Waste Disposal**
- **Accidental Oil Spills**
- **Acid Rain**
- **Nuclear waste**


Soil Pollution Sources
Agrochemical
Urban
Industrial
Atmospheric
Incidental
• Manures
• Fertilizers
• Pesticides
Fuel spillage
Electric power stations (Ash, fallout)
Gas works Tars Heavy metals
Transport Fuel combustion Acid deposits
Nuclear Waste disposal
Mining and Smelting heavy metals
Metallurgical industries
Chemical and electronic industries
Wind- blown pollutants
Acid deposits
Warfare explosives, Poisonous gases
Industrial accidents

Pollution due to agricultural inputs

- **Manures**
- **Fertilizers**
- **Pesticides**
- **Other chemicals**

❖**Fuel spillage from Agri. Machines.**

❖Farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals are reported to cause soil pollution

Manure

- **Manure** is organic matter, mostly derived from animal feces except in the case of green manure, which can be used as organic green fertilizer in agriculture. Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil.

Manure and soil pollution

- Decomposition of manure –reduce O_2 availability in soil.
- Poultry manure – High concentration of heavy metals.
- Odor and pathogens

Fertilizers

- Material of natural or synthetic origin that is applied to soils or to plant tissues (usually leaves) to supply one or more plant nutrient essential to the growth of plants. (phosphorous, nitrogen, potassium, etc)

Fertilizers and soil pollution

- These inputs of nutrients to the agricultural system are either stored or transferred. Storage capacity is limited by the nutrient-holding ability of the soil and the amount of plant and animal matter (biomass). Losses to the environment occur when the input is greater than the rate of harvesting (use), so the storage capacity of the system fills up and ‘overflows’ - Pollution

Fertilizers and soil pollution

- Deterioration of the balance in the composition of soil
- Decrease/increase in soil pH
- Soil structure deterioration
- Accumulation of minerals

- Limit the activities of nitrifying bacteria
- **Eutrophication** of dams and waterways
- Accumulation in the soil, and uptake by plants, of heavy metals, particularly cadmium

Fertilizer pollution - Impacts

- Dangerously elevated levels of nitrogen in drinking water. (blue baby disease or Methemoglobinemia of young babies and cancer due to nitrate ingestion in food and water)
- Destroy critical soil microbes.
- Eutrophication (enrichment with nutrients) of dams and waterways, leading to the development of blue-green algal blooms, which reduce water holding capacity Reducing depth of water body and reduce dissolved oxygen, critically affect aquatic life.

Fertilizer pollution - Impacts

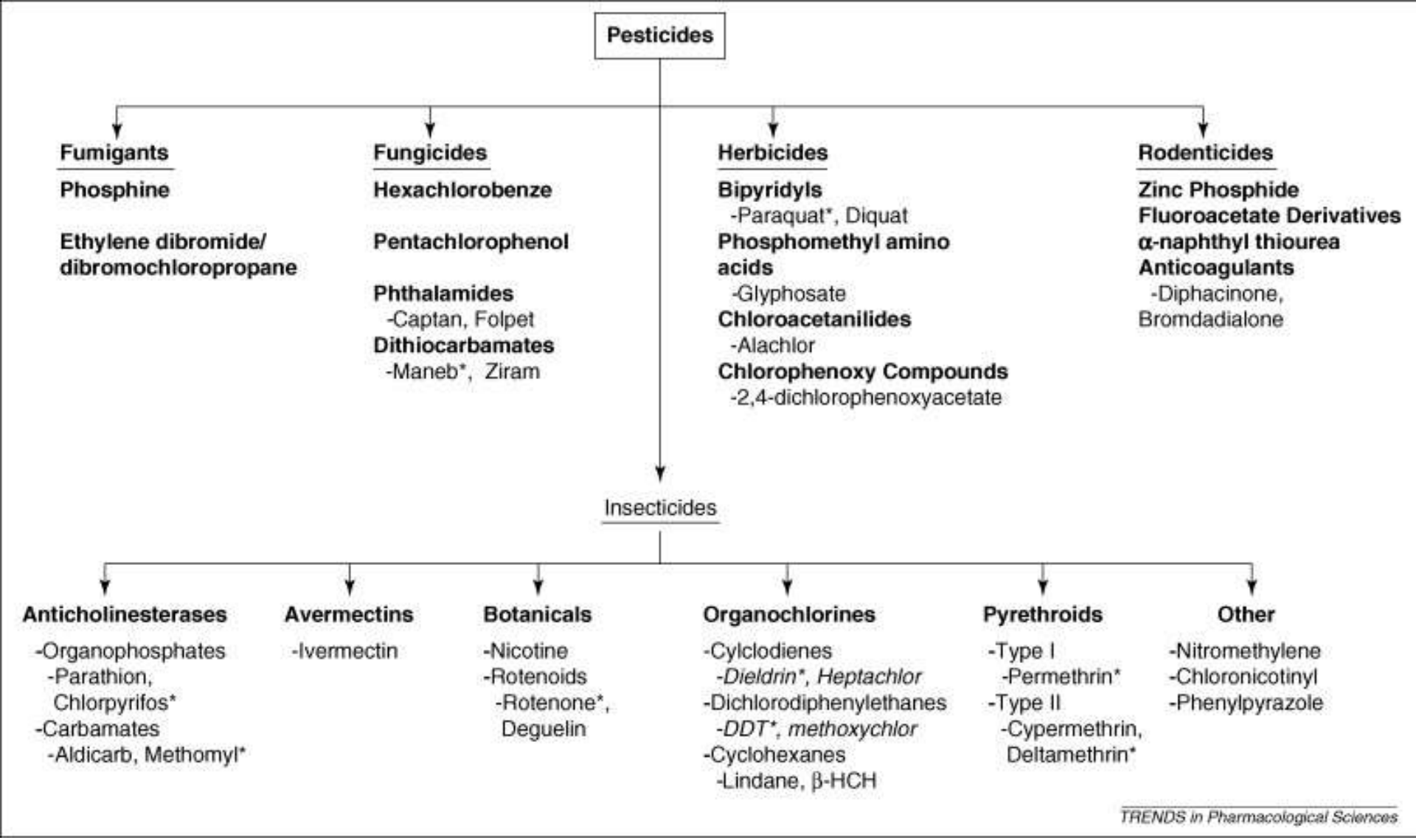
- Greenhouse Gases (CO_2, CH_4, N_2O from agriculture and fertilisers)
- Do not replace soil organic matter.
- Greater fertiliser – Increased N2 in leaves – attracts grazers –
- Increased population of Weeds

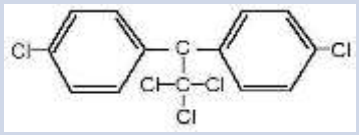
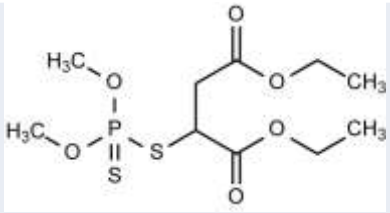
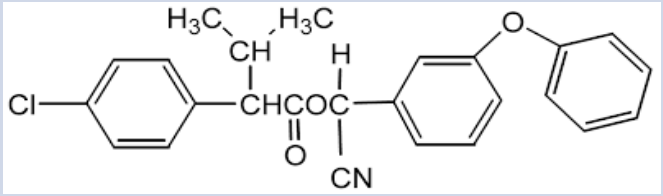
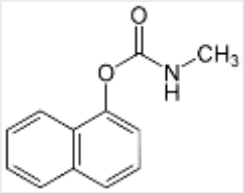
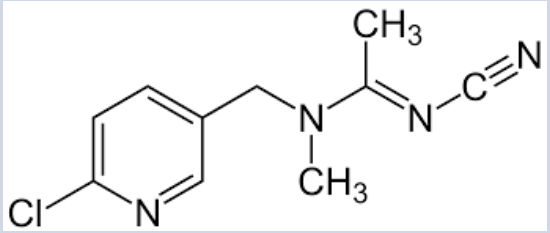
Pesticides

- **Pesticides are substances meant for attracting, seducing, and then destroying, or mitigating any pest.**

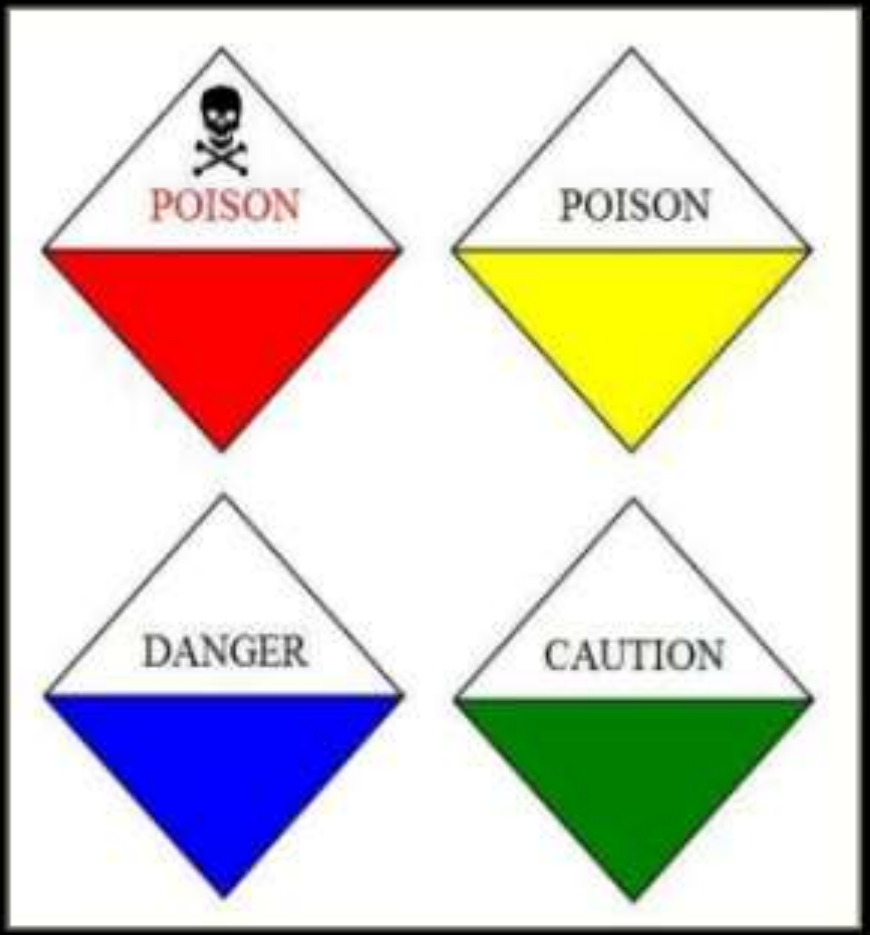
CLASSIFICATION OF PESTICIDES ACCORDING TO TARGET ORGANISM

Type of pesticide	Target pest group	Action
Herbicides	Plant	Kill weeds and other plants that grow where they are not wanted
Avicides	Birds	Repel pests, including insects (such as mosquitoes) and birds
Fungicides	Fungi & Oomycetes	Kill fungi (including blights, mildews, molds, and rusts)
Insecticides	Insects	Kill insects and other arthropods
Acaricides	Mites	Kill mites that feed on plants and animals


Pesticides
Fumigants
Phosphine
Ethylene dibromide/ dibromochloropropane
Fungicides
Hexachlorobenze
Pentachlorophenol
Phthalamides
-Captan, Folpet
Dithiocarbamates
-Maneb*, Ziram
Herbicides
Bipyridyls
-Paraquat*, Diquat
Phosphomethyl amino acids
-Glyphosate
Chloroacetanilides
-Alachlor
Chlorophenoxy Compounds
-2,4-dichlorophenoxyacetate
Rodenticides
Zinc Phosphide
Fluoroacetate Derivatives
α-naphthyl thiourea
Anticoagulants
-Diphacinone, Bromdadialone
Insecticides
Anticholinesterases
-Organophosphates
-Parathion, Chlorpyrifos*
-Carbamates
-Aldicarb, Methomyl*
Avermectins
-Ivermectin
Botanicals
-Nicotine
-Rotenoids
-Rotenone*, Deguelin
Organochlorines
-Cylclodienes
-Dieldrin*, Heptachlor
-Dichlorodiphenylethanes
-DDT*, methoxychlor
-Cyclohexanes
-Lindane, β-HCH
Pyrethroids
-Type I
-Permethrin*
-Type II
-Cypermethrin, Deltamethrin*
Other
-Nitromethylene
-Chloronicotinyl
-Phenylpyrazole
TRENDS in Pharmacological Sciences

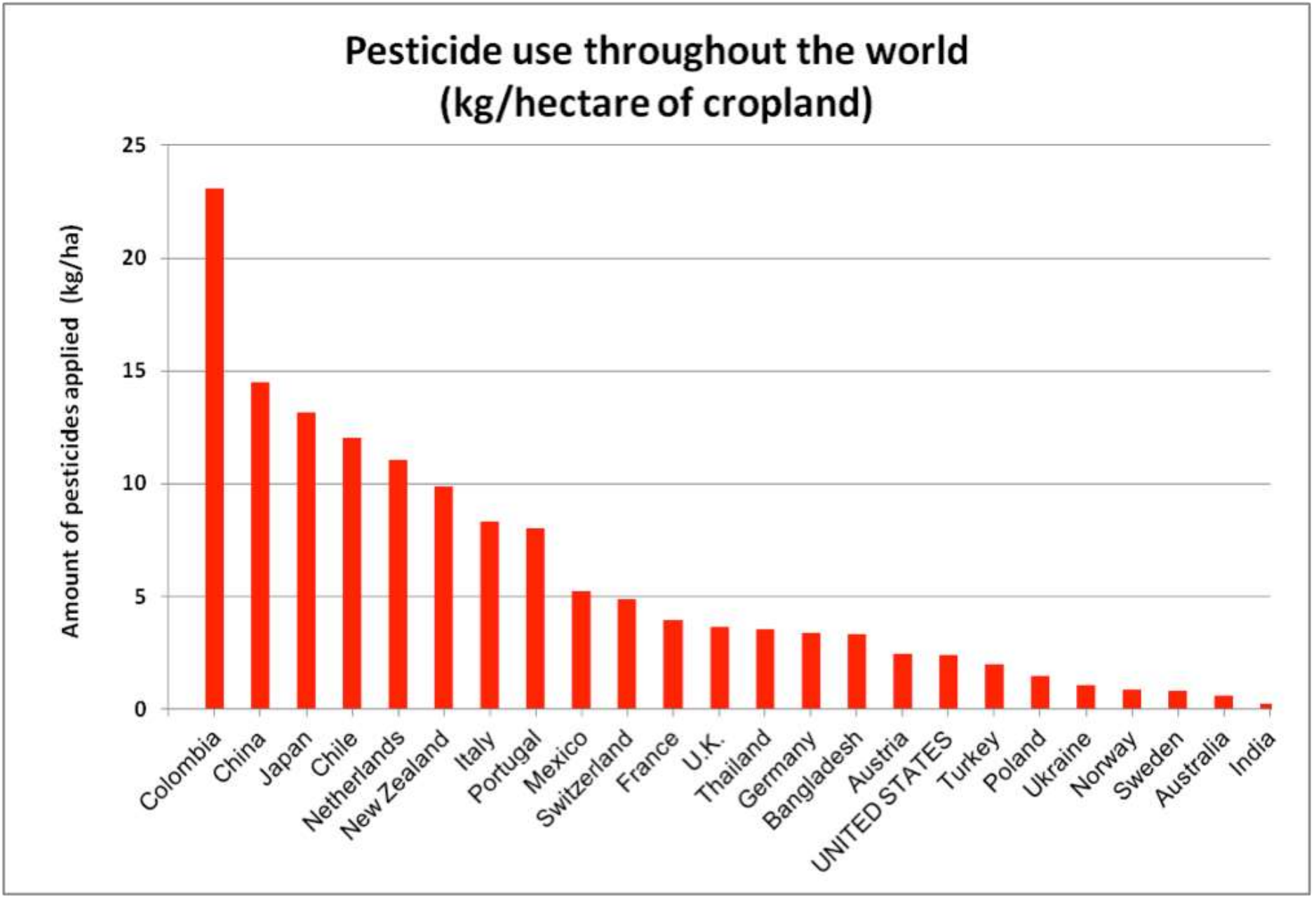
Insecticide class	Representative structure	Common pesticides
Organo chlorines		DDT, Endosulfan, BHC, Aldrin, Endrin etc
Organo phosphates		Malathion, Chlorpyriphos, Quinalphos, Triazophos, Profenophos, etc
Synthetic Pyrethroids		Fenvalerate, Cypermethrin, Deltamethrin, Cyfluthrin, etc
Carbamates		Carbaryl, Carbosulfan, Carbofuran, Carbendazim, etc
Neonicotenoids		Acetamiprid, Imidacloprid, Thiacloprid, Thiamethoxam, Dinotefuran, etc

HAZARD CATEGORIZATION OF THE PESTICIDES

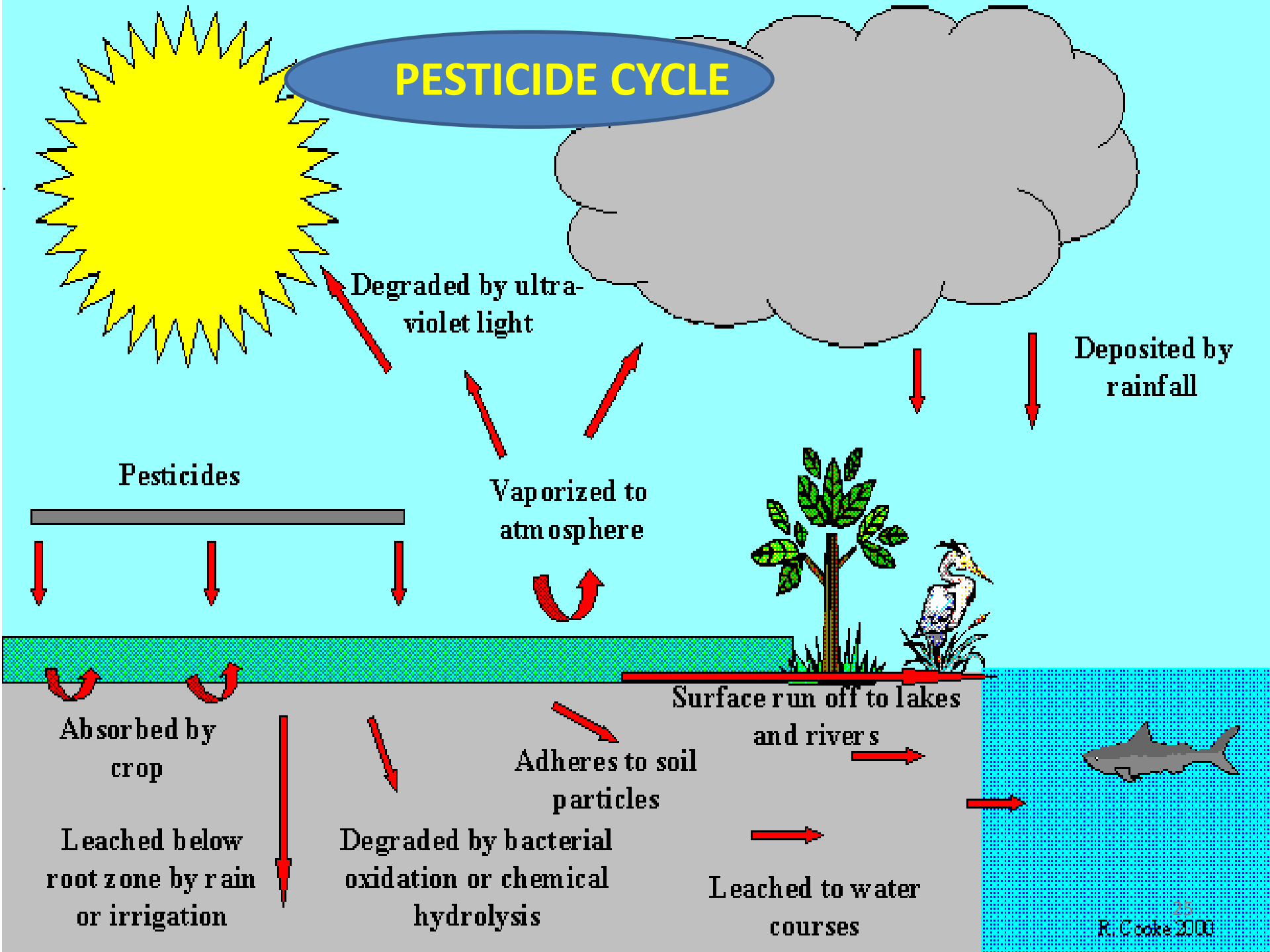


RED	EXTREMELY TOXIC
YELLOW	HIGHLY TOXIC
BLUE	MODERATELY TOXIC
GREEN	SLIGHTLY TOXIC

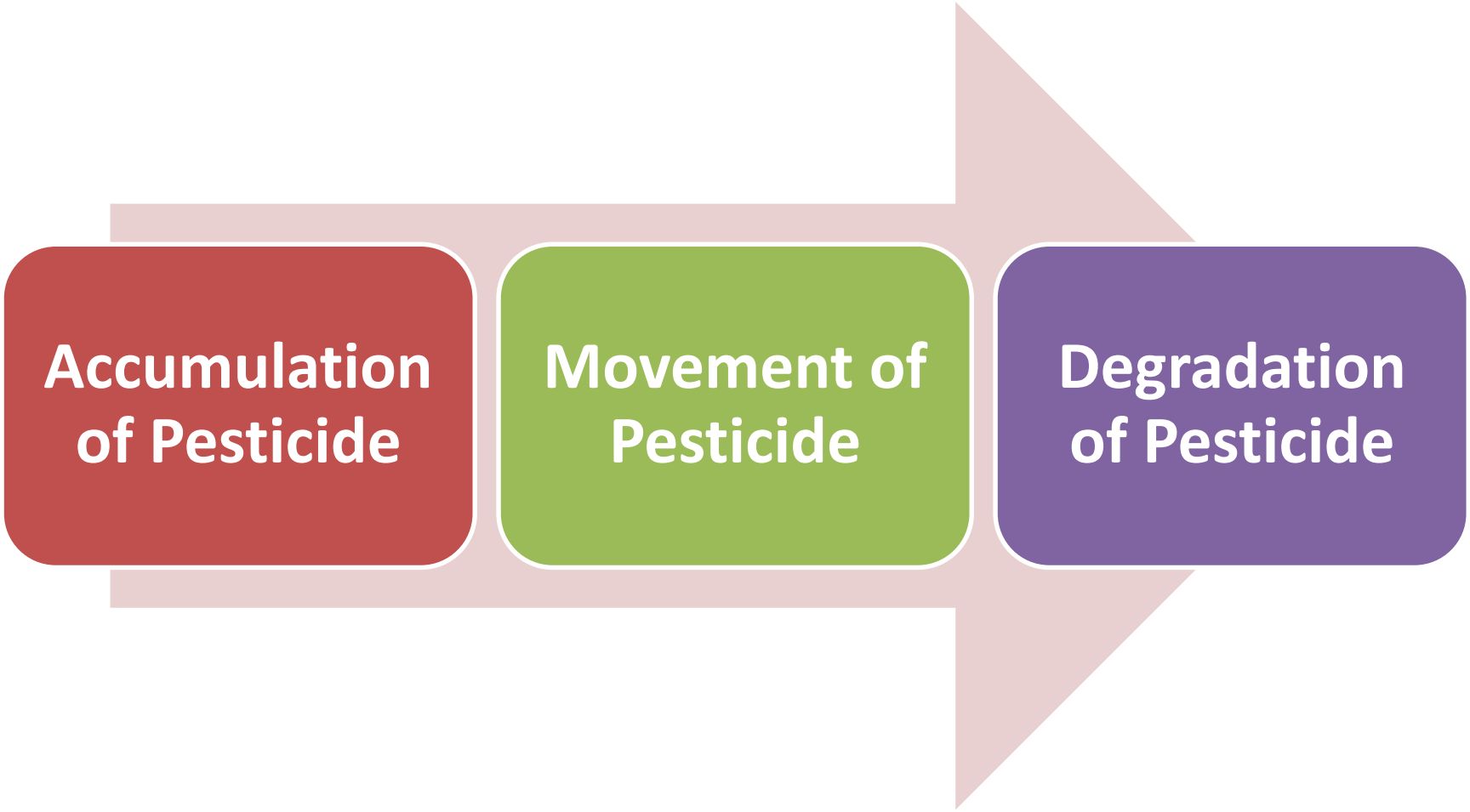
The toxicity classification applies only to pesticides which are allowed to be sold in India. Some of the classified pesticides may be banned in some of the states of India, by decision of the State Government. Some of the Red Label and Yellow label pesticides were banned in the State of Kerala following the Endosulfan



Scientificbeekeeping.com
December 2013


PESTICIDE CYCLE
Degraded by ultra-violet light
Deposited by rainfall
Pesticides
Vaporized to atmosphere
Surface run off to lakes and rivers
Absorbed by crop
Adheres to soil particles
Leached below root zone by rain or irrigation
Degraded by bacterial oxidation or chemical hydrolysis
Leached to water courses
R. Cooke 2000

Processes –Pesticide Cycle



Processes-Pesticide Cycle

Accumulation of Pesticides

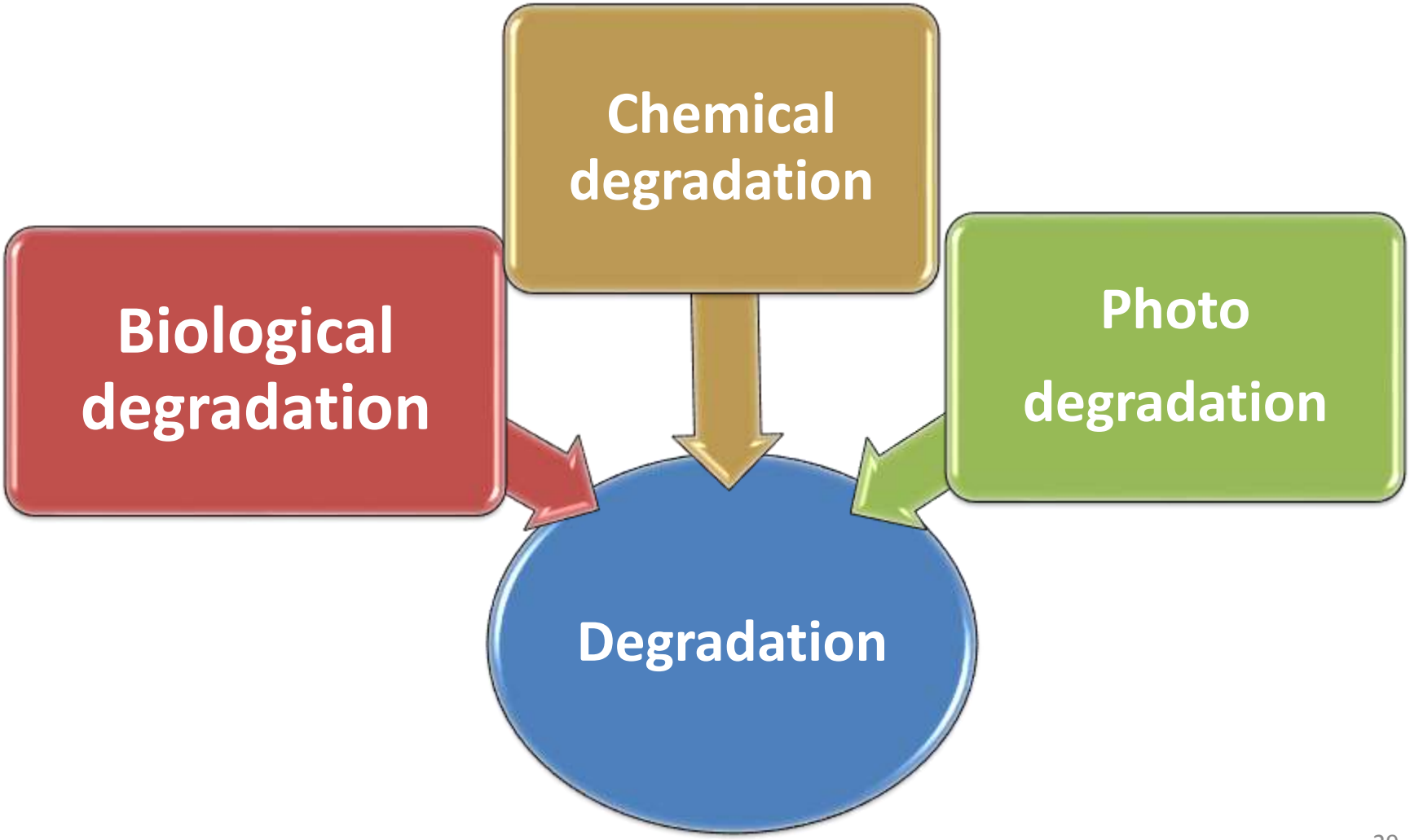
Adsorption

Movement of the pesticides

- Diffusion
- Volatalization
- Leaching
- Erosion & runoff
- Uptake by plants & microbes

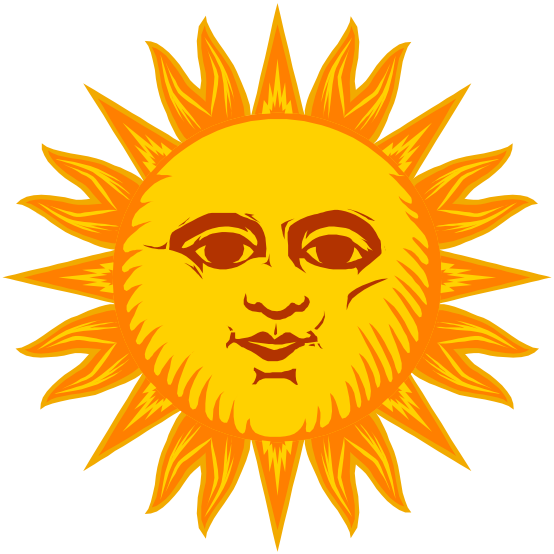
Factors Influencing Adsorption

Degradation



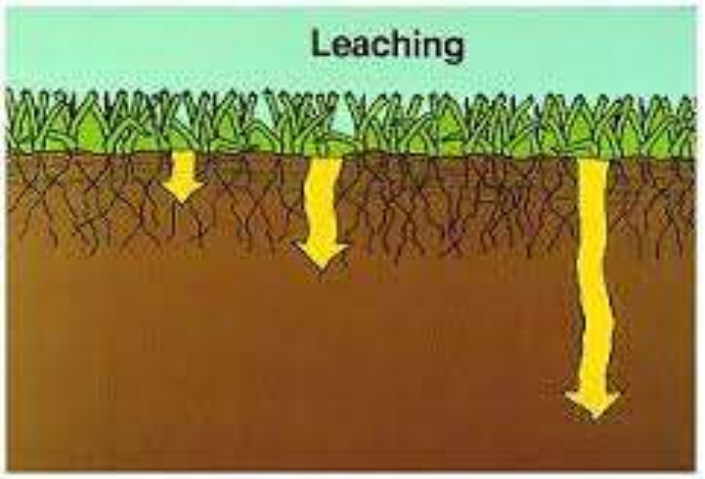
Photodegradation

- Breakdown of pesticide by sunlight
- May be reduced by soil incorporation



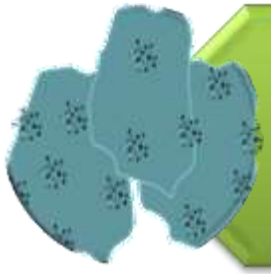
Pesticides and soil pollution

- Drain off
- Leaching
- Spillage
- Over dosage

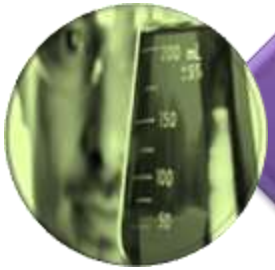


Pesticidal Characters

Persistent pesticides may be long lasting in the root zone .



With strong adsorption the leaching potential of the pesticide will be reduced.

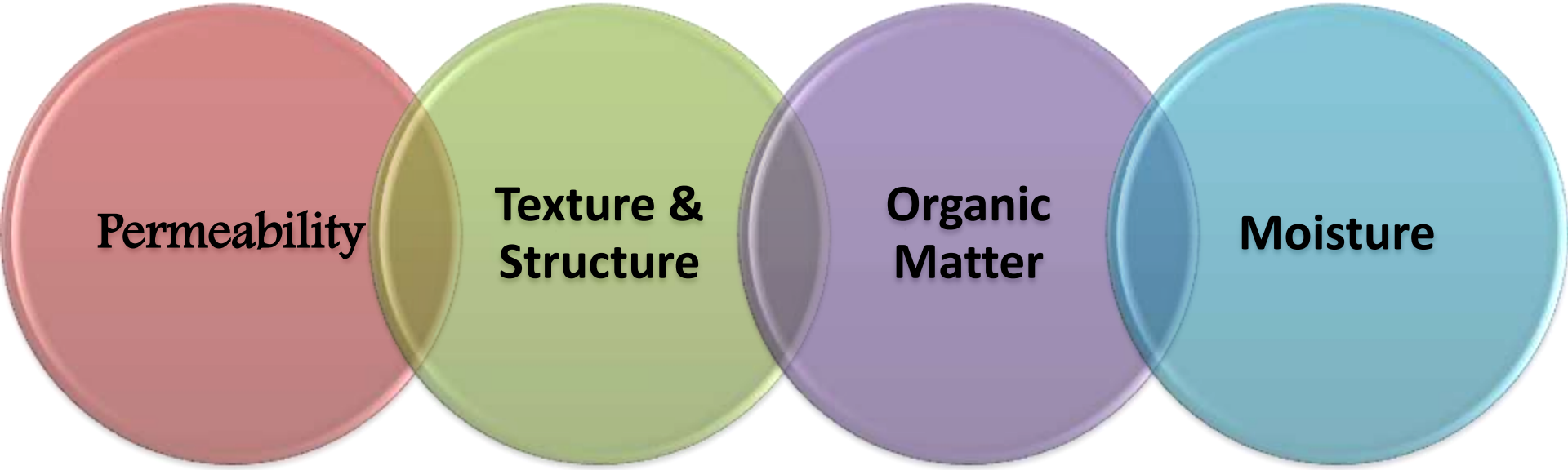


Higher the solubility greater will be the leaching.

Highly volatile pesticides especially fumigants are readily present in the soil & so their leaching is high.

(Buttler *et al.*,1998).

Soil Characters



Persistence

Half life period

- Non persistent < 30days
- Moderately persistent 30-100days
- Persistent pesticides->100 days

(Kerle, 2007)

Pesticide pollution - Impact

- Bio amplification – DDT act as cumulative poison.
- Broad spectrum Characteristics – Kill large verity of insects including natural predators.
- Decreases the general biodiversity in the soil.
- Resistance.
- Carcinogenic to mammals.

Xenoestrogens or Endocrine disruptors

- Pesticides especially OC pesticides may act as false messengers and
- By mimicking or antagonising natural hormones in the body cause human health effects such as immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities,
- Affect oncogenes, specifically in relation to breast cancer

Epizootic Ulcerative Syndrome

In 1991 a devastating fish disease wiped out a large number of fish in Kuttanad

Pesticide pollution was found to be the predisposing factor for the disease

Free Residues Vs Bound Residues

Free Residues

Extracion is possible.

Bioavailable.

Bound Residues

- **Can’t be extracted,**
- **Not bioavailble**

Critical Level of Pesticides in Soil

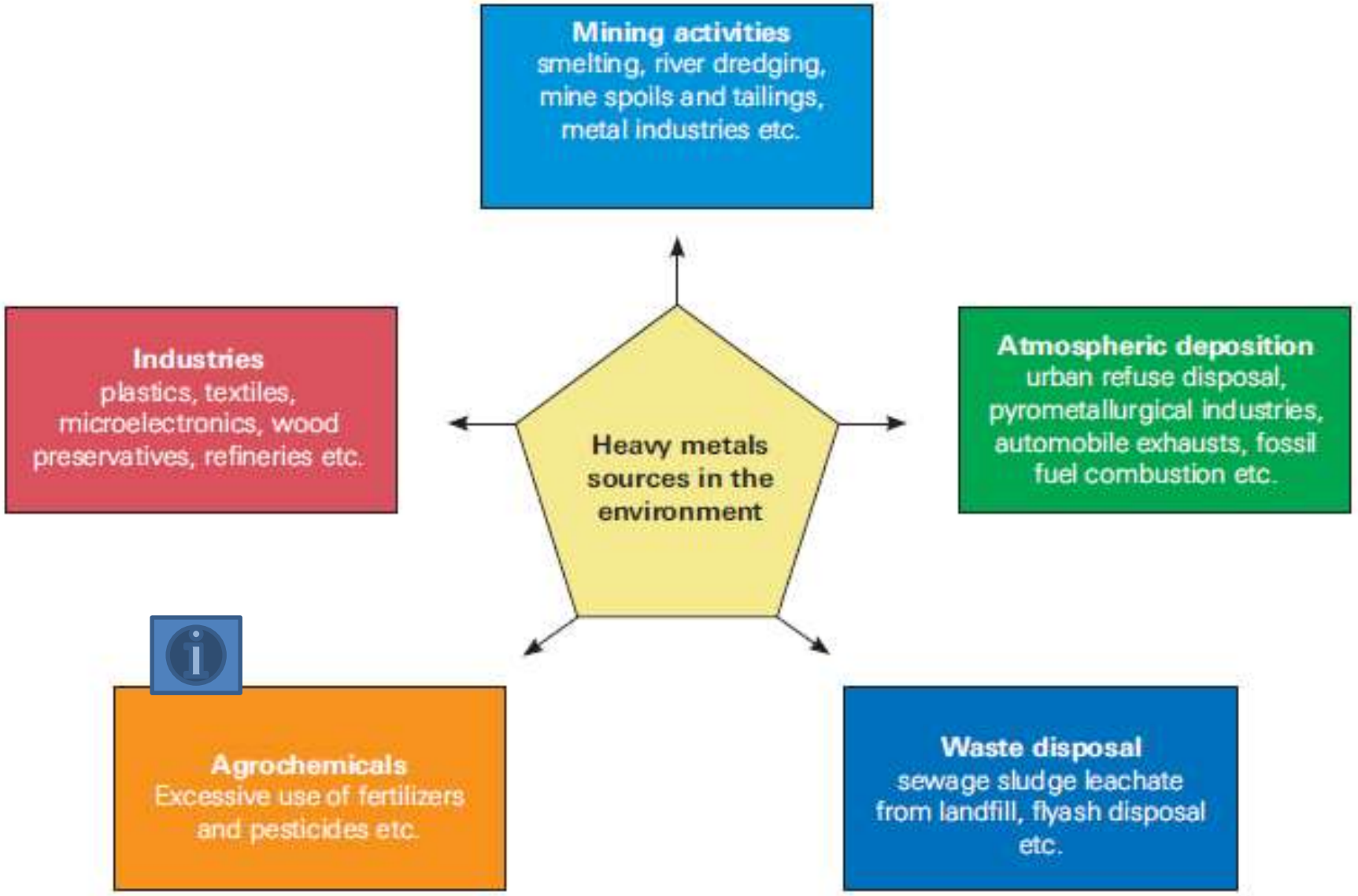
Type of Pesticide	Limit of Quantity(ppm)
Organochlorine	0.010
Organophosphate	0.025
Carbamates, Synthetic pyrethroid	0.050

(Pesticide research journal, June 2014)

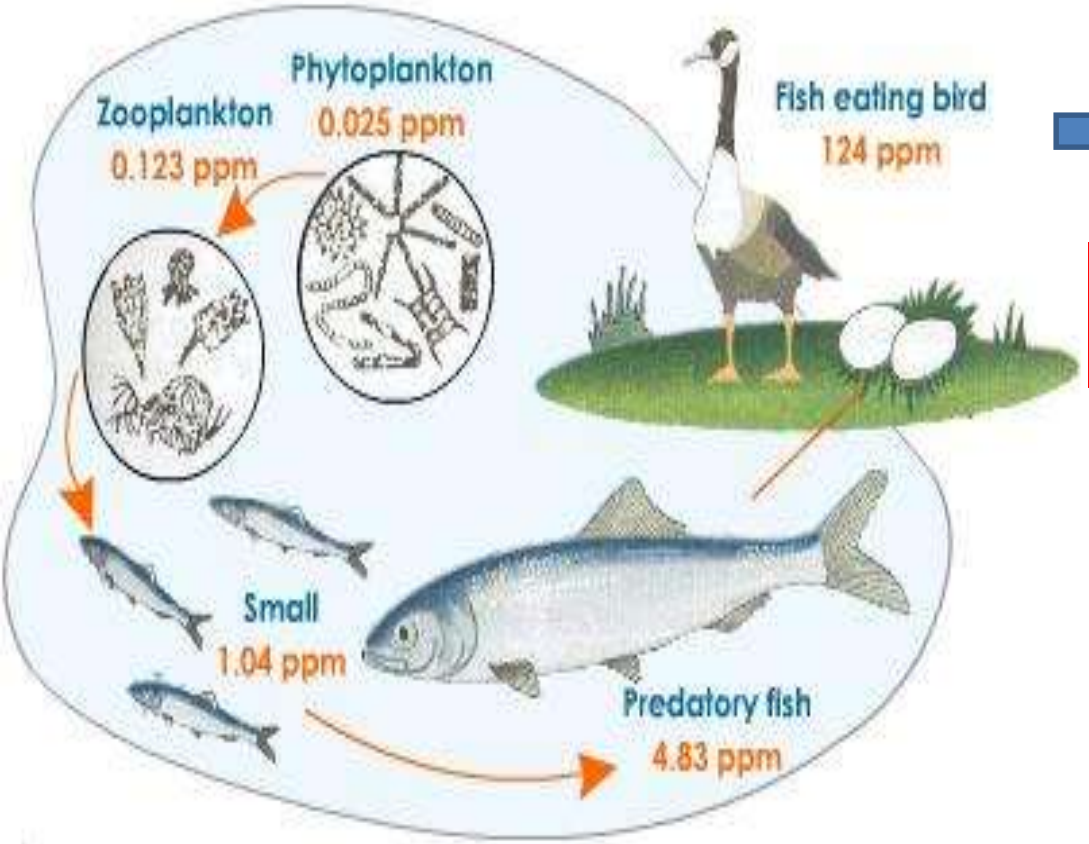
Heavy metal addition

- Metals like cadmium, cobalt, copper, and zinc can be found in relatively high level **as impurities** in pesticide preparations and in fertilizers.

Sources of heavy metals in the environment



Pollution due to heavy metals



Process of Biological Magnification;
DDT concentrations increase in organisms along the food chain

→ **Human ?**

Most persistent pollutant present in water

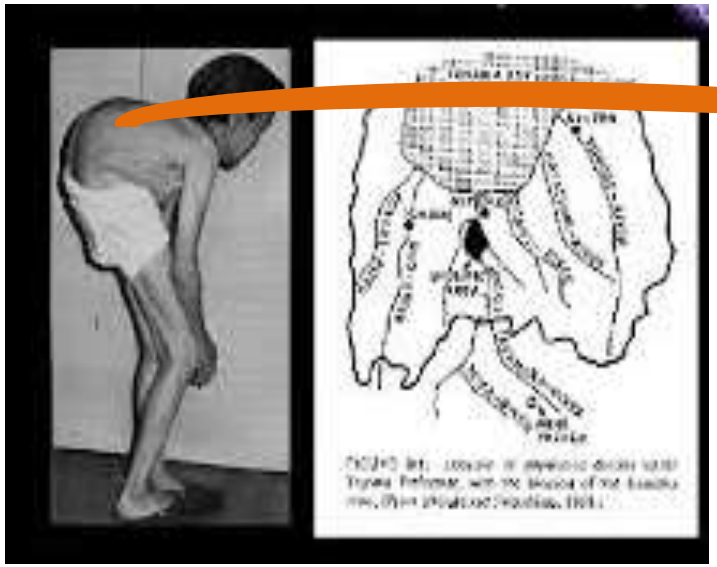
Difficult to degrade

Bioaccumulation

HUMAN HEALTH HAZARDS

- Neurobehavioural disorders - depression, insomnia,
- Birth defects and Abortions
- Foetal Brain damage
- Cancer
- Kidney damage
- Reduced intelligence, loss of short-term memory
- Cardiovascular problems
- Asthmatic and related allergic problems
- Skeletal diseases
- Life style diseases : diabetes, obesity, hair loss

Itai -itai



first documented occurrence of mass **cadmium** poisoning

- osteomalacia (softening of the bones) & osteoporosis (loss of bone mass and weakness)
- Poisons liver and kidneys
- carcinogen

Pollution and climate change – Global scenario

- CO_2 level – increases by 1.9ppm/year
- CH_4 level – 1774ppb
- N_2O level – 319ppb (from 270ppb)
- Temperature - 0.76^0C (last 100years)
- Sea level rise : 0.09 – 0.88m
- Alarm : Surface temperature : 0.6 – 2.5 ^0C by 2050

Thank You !!!