# Applied Pesticide Science and Environmental Management

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**Course description**:

Range and classification of pesticides: herbicides, insecticides, nematicides, fungicides and rodenticides; pesticide formulation, physical and chemical properties of pesticides; mode of action; resistance to pesticides; toxicology and food safety: risk assessment and management of pesticide residues in agricultural crops, pesticide residues and maximum residue limits, public health aspects, international trade implications; pesticide regulation, legislation and registration and marketing; Techniques and equipments for pesticide application; choice of appropriate pesticides; environmental fate of pesticides: persistence, inactivation and disposal, safe handling and storage of pesticides.

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Environmental degradation; environmental impact assessment and audit; state of environment; air, water and noise pollution; Environmental Management and Co-ordination Act, (EMCA) 1999; Climate Change; protocols conventions, agreements; millennium development goals; conservation of biodiversity and agrobiodiversity; erosion, agroforestry, waste management and utilization; environmental education and awareness.

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Course topics:

1. Range and classification of pesticides: herbicides, insecticides, nematicides, fungicides and rodenticides
2. Pesticide formulation
3. Physical and chemical properties of pesticides
4. Mode of action of pesticides
5. Resistance to pesticides
6. Toxicology and food safety:

# (continue)

1. Risk assessment and management of pesticide residues in agricultural crops
2. Pesticide residues and maximum residue limits, public health aspects, international trade implications;
3. Pesticide regulation, Legislation and registration and marketing
4. Techniques and equipments for pesticide application
5. Choice of appropriate pesticides
6. Environmental fate of pesticides: persistence, inactivation and disposal, safe handling and storage of pesticides.

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1. Environmental degradation;
2. Environmental impact assessment and audit;
3. State of environment; air, water and noise pollution;
4. Environmental Management and Co-ordination Act, (EMCA) 1999;
5. Climate Change; protocols conventions, agreements; millennium development goals;
6. Conservation of biodiversity and agrobiodiversity;
7. Erosion, agroforestry,  waste management and utilization;
8. environmental education and awareness.

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Practicals :

1. Pesticide label information and formulations
2. Srpayer calibration

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**List of reading books:**


1. G. A. Matthews Pesticide application methods
2. Van Emden and Peakall, D. Beyond silent spring
3. Handa S. K. Principles of pesticide chemistry
4. Carlile W. R Control of crop diseases

# Type of pesticides

Pesticides: Definition

Any substance used for controlling, preventing, destroying, repelling or mitigating any pest.

Pesticides includes groups of chemicals that do not actually kill pests

# Pesticide classes and their use

| Pesticide class | function |
|---|---|
| insecticide | Control insects |
| Herbicides | Kills weeds |
| Fungicides | Kills fungi |
| Nematicides | Kills nematodes |
| Rodenticide | Kills rodents |
| Bacteriocide | Kills bacteria |
| Acaricide | Kills mites and ticks |
| miticide | Kills mites |
| molluscide | Kills snails and slugs |
| Avicide | Controls or repels birds |
| piscicide | Controls fish |
| ovicide | Destroys eggs |

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| Pesticide class | Function |
|---|---|
| disinfectant | Destroy or inactivate harmful organisms |
| Growth regulator | Stimulate or retard plant growth |
| Defoliator | Remove leaves |
| dessicator | Speed drying of plants |
| repellent | Repel insects, mites, ticks, vertebrate pests |
| Attractant | Attract insects |
| chemosterilant | Sterilize insects |

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**Fungicides**

Chemicals used to kill fungi or control fungi which cause plant diseases are called fungicides.

Fungicides are classified on the basis of mode of action, use and chemical composition. Based on mode of action these are classified as follows:

i. **Fungistatics:**- Chemicals which do not kill the fungi by inhibit the growth of the fungi
ii. **Protectants**:- These check entry of the fungi into the plant but do not kill the established organisms
iii. **Eradicants** :- These destroy, control, or kill the established organisms

# (Continue)

iv. **Systemic fungicides**: The systemic fungicide is a compound that is taken up by the plant and is then translocated within the plant thus protecting it by the attack of pathogenic fungi

**Chemical classification**:

On the basis of chemical structure fungicides can be grouped into two major groups: 1. Inorganics 2. organics

Inorganics:

i. Sulphur fungicides
ii. Mercury fungicides
iii. Copper fungicides

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Term Paper:

1. Discuss pesticide usage in Kenya.T he paper should include a Summary in a table the quantities of pesticides value of different groups of pesticides imported in Kenya for the last five years. Calculate the percentage of total monetary value of the different groups of pesticides
2. Summarize in a table cropwise consumption of pesticides (Fungicides, Insecticides, herbicides) for Major crops
3. List of fungicides registered by Pest Control Products Board

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**The nomenclature of pesticides:**

I. **Common names**: are selected officially by appropriate scientific society (USA and UK) and approved by the national standards Institute and the international organization for standardization

II. **Proprietary name, trade name or brand name** for pesticide is given to a particular pesticide by various formulators. There may be a lot of trade names. Common names are assigned to avoid the confusion resulting from the use of several trade names

III. Structural formula: is the printed picture of the pesticide molecule

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3. Chemical name:  is usually presented according to the principles of nomenclature used in chemical abstracts, scientific abstracting journal which is generally accepted as the world standard for chemical names
4. Molecular or empirical formula indicates the various numbers of atoms for comparative purposes

**History of pesticides**

- The history of pesticides dates back to the beginning of agriculture  and from that time it is a history that combines important events (discoveries and defining moments), influential people, institutions, organizations and governments
- Chemical pesticides (synthetic ) or organic synthetic pesticides came to prominence in early 1940s ie DDT, dieldrin, aldrin , 2, 4-D, Zineb, Warfarin, captan
- Their recognitio  throughout the world was because they are effective , simple and quick method of pest control

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- 1962 publication of :”Silent Spring” by Rachel Carson highlighted the negative effect of pesticides to humans and the environment
- 1969- USDA adopts policy on pesticides to avoid  use of persistent materials
- 1970- USA Environmental Protection Agency which became responsible for registration of pesticides
- 1970s banning of some pesticides eg DDT, Dieldrin, Adrin

# Pesticide formulation

- Pesticide Formulation is the processing of a pesticide compound by any method that will influence its properties of storage, handling, application, effectiveness, or safety
- The formulation is the form in which the pesticide is sold for use. The term is reserved for commercial preparation prior to actual field use
- Pesticides are formulated so as to be: effective, safe, easy to apply, economical, satisfactory storage, easy of application

**Common formulations of pesticides:-**

1. Sprays (Insecticides, fungicides, herbicides)

i. Emulsifiable concentrates

ii. Water miscible liquids

iii. Wettable powders

iv. Flowable or sprayable suspensions of ground toxicant in water

v. Water soluble powders

vi. Oil solutions

vii. Ultra low volume concentrates

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2. Dusts (insecticides, fungicides)
i. Undiluted toxic agent
ii. Toxic agent with active diluent eg sulfur
iii. Toxic agent with
iv. Aerosol dust
3. Granules (insecticides, herbicides)
4. Aerosols (insecticides)
5. Fumigants (insecticides, nematicides)
i. Space and stored products treatments
ii. Plastic strips impregnated with volatile insecticides
iii. Soil treatments liquids which vaporize

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5. Impregnating materials (Insecticides, fungicides)

- Wood preservatives
- Moth proofing preparations for woolens

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1. **Emulsifiable Concentrates**:

- They are concentrated oil solutions of the technical grade material with enough emulsifier added to make the concentrate mix readily with water for spraying
- The emulsifier is a detergent-like material that makes possible the suspension of small oil droplets in water to form emulsion
- When an Emulsible Concentrate is added to water, the emulsifier causes the oil to disperse immediately and uniformly throughout the water, if agitated , giving an milky appearance

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2. **Water Miscible liquids:**

- Water-miscible liquids are water miscible
- The formulations resemble the emulsible concentrates in viscosity and colour, but do not become milky when diluted with water

3. **Wettable powders**

- They are concentrated dusts containing a wetting agent to facilitate the mixing of the powder with water before spraying
- The technical material is added to the inert diluent, in this case a finely ground clay, in addition to a wetting agent

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- Because wettable agents contain clay, they sink rather to the bottom of the spray tanks unless the spray is agitated constant

**4. Water-soluble Powders (SP)**

- Technical grade material is a finely ground water-soluble solid and contains  nothing else
- When added into the spray tank, it dissolves immediately
- The formulation does not require constant agitation
- They are true solutions and form no precipitate

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5. **Fumigants:**

- Soil fumigants are used in horticultural nurseries, greenhouses and on high-value cropland to control nematodes, insect larvae and diseases

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**Choice of formulation:**

- Formulation have usually been selected on the basis of convenience to the user
- Availability of equipment in developing countries
- Reduction of drift particularly with aerial application
- Determined by phytotoxicity of plants, varieties
- Persistence of a formulation
- Eliminate the handling of toxic products
- Availability and price :when assessing the cost the whole application technique needs to be considered , since the use of a particular formulation may affect the labour required, the equipment and spraying time

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- Control may vary with climate and geographical location. A formulation effective in one part of the country may not be necessary be effective or safe in another part

# Fungicides

Fungicides are chemicals used to kill or control fungi which cause plant diseases are called fungicides.

Fungicides can be grouped into two major groups:

1. Inorganics (metal based fungicides)
2. Organics

The categories of inorganics are:-

1. Sulphur fungicides eg wettable sulphur
2. Mercury fungicides eg agrosan, mercuric chloride
3. Copper fungicides eg Bordeaux misture, copper oxychloride

The categories of organic compounds are divided into:-

1. Organtins
2. Organomercuricals

Organtins divided into:

1. Organophosphorous
2. Diethylthiocarbamates
3. Oxathiins
4. Carboxyamides
5. Azole compunds
6. Triazoles
7. Piperazine derivatives
8. Quinoline derivatives
9. antibiotics

(CHECK FROM THE NPCB LIST AND WRITE AN EXAMPLE OF EACH LIST AND MODE OF ACTION)

# (Continue)

Organomercurials is divided into:-

1. Benzene derivatives
2. Polyhalogen alkenic sulphony group
3. Quinones
4. Dinitrol alkylphenols
5. Benzimidazole derivatives
6. Hetecyclic fungicides
7. Pyrimidines
8. Morpholine derivatives

(CHECK FROM THE NPCB LIST AND WRITE AN EXAMPLE OF EACH LIST AND MODE OF ACTION)

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**NEMATICIDES**

Nematicides are chemicals which prevent, repel, inhibit or destroy nematodes.

Nematicides are classified into five groups:-

1. Halogentated hydrocarbons eg Methy bromide,ethylene Dibromide, 1, 3 Dichloropropene, DD, Nemagon, 1,2-dichloropropane
2. Isothiocynatates eg Metham sodium, Dazomet,
3. Organophosphates eg  phorate, Fenamiphos
4. Carbamates eg aldicarb, carbofuran (Furadan)
5. Botanicals eg  Neem, Marigold

(CHECK FROM THE NPCB LIST AND WRITE AN EXAMPLE OF EACH LIST AND MODE OF ACTION)

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**Mode of action of pesticides**

1. Insecticides: are classified into inorganic compounds, organic compounds and botanicals

Mode of actions of insecticides:

1. **Stomach insecticides-** are applied to the part of the crop which serves as food for the pest and is required in the normal process of eating. Their application is through food and entry through the midgut of the insect. Stomach poisons are necessarily , therefore to be ingested during feeding eg DDT
2. **Contact poisons**: Contact poisons are those which kill the pest only due to contact or absorbed.

Their application is through the body surface and entry through the cuticle and tracheae. Eg pyrethrum

3. **Fumigants:** gaseous poisons used for killing insects. They are applied in vapour state and their entry is through the tracheae. Eg methyl bromide
4. **Systemic insecticides:** are toxicants which when applied to the root, stem or leaves of plants are rapidly absorbed and translocated to various parts of the plant in amounts lethal to insects feeding on them. Eg carbofuran (Furadan)

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**Mode of action of Fungicides**

Based on mode of action, fungicides can be classified as follows:

1. **Fungistatics-** Chemicals which do not kill the fungi but inhibit the growth of the fungi
2. **Protectants**: These chemicals check the entry of the fungi into the plant but do not kill the organism
3. **Eradicants**: They destroy , control or kill the established organisms
4. **Systemic fungicides**:- They are taken up by the plant and transported within the plant thus protecting the plant from attack of the fungi. Systemic fungicides are absorbed by roots, seeds or leaves of the plant and then translocated at least within the plant

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Nematicides :

1. Nematicides muat have a high vapour pressure to spread through the soil and to contact the nematodes in the water films surrounding soil particles.
2. Nematodes are covered with an impermeable cuticle which provides them with considerable protection. Chemicals used have the ability to penetrate the cuticle
3. Nematicides should have high water solubility

# Resistance to pesticides

- The formation of resistance against pesticides is the development of the ability of pest organisms to tolerate doses of a chemical compounds which are lethal to the majority of individual pest in normal, untreated populations of the same species
- The phenomena of resistance has been recognized for long time (since early 1900s)
- However, the development of resistance became more important after the introduction of synthetic organic pesticides
- Today resistance to one or more chemical compounds has been recognized for more than 400 different species of plant pests

- There is observed resistance development against insect, fungi, bacteria, bacteria and weeds

**Development of resistance:**

Development of resistance represents a selection process. This occurs when there are only a few individuals in a population with genetically determined lower sensitivity to the chemical compound being used, and which because of this property survives its application. With repeated application of pesticides, slowly at first, and then more rapidly in subsequent generations, the frequency of pest organisms with genes for resistance increases, until finally a large proportion of the population is affected only by the use of very high amounts

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The likelihood, the speed and the extent of resistance development against pesticides are greater:-

- The more frequently the same chemical substance is used
- The more resistance individuals are present in the initial population and the more a high resistance can be developed through genetic combination of weak resistance factors
- The more pest individuals with genes for resistance survive in the remaining populations after the introduction of a pesticide
- With increasing pest population and propagation rate of the pest organisms

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- With decreasing immigration or influx of susceptible individuals from no-treated locations
- The lower the number of genes responsible for resistance, which means in general the more specific the mode of action of the pesticides

**Types of resistance to pesticides**

1. **Behavioural resistance:-** through its reaction to the pesticide, the pest organism comes less intensively into contact with chemical compound or avoids absorbing it . Eg certain strains of codling moths which escape the effects of the poison, when immediately after breaking out of the egg, the larvae penetrated the skin of the apples and evaded the outer skin poisoned surface. Cases are recorded with flies, in which the development of resistance was conditioned by the development of a population for which the insecticide acted as repellent. Thus the flies kept away from the toxic surfaces

2. **Morphologically conditioned resistance**:- penetration of the surface is impeded or severely restricted in resistant in resistant pest individuals by morphological-anatomical properties. Severe pilosity, thickness and impermeability of the cuticle and of the lipoprotein membranes of pest organisms may be significant resistance factors. Pilosity, thickness of the waxy layer on the leaf, protected position of the vegetation and similar factors can also play a role in resistance of plants to herbicides

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3. **Physiological conditioned resistance: -** The pest organism is capable, because of its physiological properties and reactions, of influencing the process of action of a pesticide in one or more places. More impeded uptake, reduced transport, increased excretion, enhanced inactivation thorough deposition with reserve substances, reduced affinity to the binding sites at the site of action, intensified enzymatic degradation or diminished intensity of activation can contribute to resistance. Lower reaction rates between the substance and enzyme, whose activity is thus impeded to a lesser extent, can be responsible for resistance. **Physiological factors are the most important cause of resistance**

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**Resistance to one or more active substances can occur. Such Resistance can either be cross-resistance or multiple resistance:-**

i. **Cross-resistance:-** effective against two or more pesticides and dependent on the same genetic basis, ie against compounds of the class eg against compounds from the group f chlorinated hydrocarbons or phosphoric acid esters; triazole compounds or bicarboximides. Only one gene or few genes are responsible for this type of resistance. Cross resistance can either be _

   a) positive cross-resistance- in which resistance to one substance is combined with increased resistance to one or more other substance

# (Continue)

b) Negative cross-resistance: in which resistance to one compound is combined with increased sensitivity to another compound

**Cross resistance is considerable importance for some groups of systemic fungicides and economically important fungal diseases**

**ii) Multiple resistance:** effective against two or more pesticides with different modes of action and on a different genetic basis, i.e depending on several different genes eg insecticidal resistance to chlorinated hydrocarbons and phosphoric esters; with fungicides to benzimidazole derivatives and trazole compounds

Multiple resistance plays a role with insecticides and acaricides

**As a result of prolonged and severe selection pressure by repeated application, resistance is most likely to occur in particular with insecticides, acaricides and fungicides**

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**Prevention or delaying development of resistance:**

i. The preferential use of compounds which lead to resistance to a lesser extent

ii. The **use of combination preparations**, containing compounds with different mechanisms of action. This method is more successful, as the probability of the development of multiple resistance is lower with very different types of compounds.

**iii. Routine alternation** in the use of preparations with different compounds. . This is because more pesticides are not suitable for mixing, or may produce other problems

**iv. Addition of anti-resistant or synergist**, which assist at appropriate points in the course of the action of the chemical compound by preventing its inactivation in the target pest

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v. Reduction of the use of pesticides to the absolutely necessary extent. i.e access the economic threshold or control threshold of the pest
vi. Supplementing the chemical measures by other procedures in order to render selection pressure more balanced
vii. Exemption of small parts of a field from necessary control measures. The selection pressure of resistance development can be delayed through migrating population into the affected population in the field
viii. Use of concentrated pesticides in baits for soil pests

# Toxicity of pesticides

What is toxicity ?. 1. It is the study of adverse effect of chemicals on living systems. It is the concern of impact of chemicals on health and environment

2. It the stud of the properties of the pesticides used in agriculture, their action on warm blooded animals, insects, bacteria, fungi, plants and ecological systems

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Toxicity manifest itself in many ways in humans:

i. Cancer
ii. Reproductive effects
iii. Ageing disease due to chemicals on food
iv. Skin/eye irritation
v. Skin and lung allergies

# (Continue)

**Toxicity is governed by:-**

- dose,
- degree of exposure,
- how much of a given chemical reaches a vital tissue,
- route of administration or exposure,
- the rate of absorption
- The rate of absorption through the skin, lungs or intestine
- The distribution in various tissues of the body
- The chemical modification by the bodily processes
- The length of time over which dosing occurs and
- The possibility of accumulation

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**Humans to be safeguarded from exposure to pesticides:**

1. **Industrial workers** engaged in manufacturing, formulation and transportation
2. **Operators** are involved in the application of the formulated compounds on crops and other areas
3. **Consumers** may eat produce on which residues are minute and hence the total dosage intake is likely to be relatively small even if we assume a lif time exposure
4. **Residents** leaving near application areas may receive exposure of varying degrees eg on their proximity to the crops being treated, on their dependence on run-ff waters or on their dependence o exposed animals or plant for food supply

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**Terms used in toxicology or routine toxicity studies:-**

1. **Acute toxicity** : the injury induced by a single toxic dose through oral, dermal or inhalation route of administration trough a period of14 days
2. **Sub-acute toxicity**: effects of repeated doses upto one month
3. **Lethal dose** (LD50%)- that dose which causes the death of 50% of the treated animals
4. **Chronic toxicity**: is the result of repeated action of relatively small amount s of pesticides and manifests itself in slowly developing malfunction of normal, vital activity. The consequences of long term repeated exposure to small amounts of the toxic material

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5. **Tetragenecity**: determine if the test material causes foetal abnormalities when given to mother during pregnancy
6. **Carcinogenecity**: detect if test material induces tumors
7. Reproduction: determine any effect on fertility, pregnancy or reproduction
8. **Toxicokinetics**: determine metabolic fate of test compound in the body
9. **Environmental toxicity**: Test are performed to assess the potential hazards to the environment at large. The latter include livestock, domestic animals, wildlife, mammals, birds, fish, bees, beneficial insects (bees) and soil organisms

WHO RECOMMENDED CLASSIFICATION OF PESTICIDES BY HAZARDS OR TOXICITY (very toxic, toxic, harmful, cautious) CHECK FROM INTERNET

# (Continue)

**The hazards associated with exposure to the formulated pesticides products is affected by:**

1. Concentration of a.i in the formulation
2. Type of formulation
3. Volatility

**The most common route of exposure of pesticides is through skin contact. The degree of dermal absorption depends on :_**

i. The dermal toxicity of the formulation
ii. The extent of exposure or the amount of body surface exposed
iii. The part of the body exposed
iv. Time between exposure and skin decontamination

**Exposure through inhalation** : This can cause damage to nose, throat and lung tissues

**Exposure through the mouth**: This is through smoking, eating or drinking when working with chemicals; accidental touching the skin; accidental contamination of food during transport and storage

READ:

1. "INTERNATIONAL CODE OF CONDUCT ON THE DISTRIBUTION AND USE OF PESTICIDES" by FAO
2. TOXICITY RATINGS, SAFETY PRECAUTIONS AND FIRST AID
3. PROTECTIVE CLOTHING

# Pesticide residues in food

- Critical amounts of the pesticide compound should be present as residues on harvested products, food or food stuffs after using pesticides
- To evaluate the toxicologically tolerable residue concentrations of pesticides in food, the average daily use of particular foodstuffs is considered, and , if possible, average consumption patterns should be taken into account
- From laboratory studies Acceptable Daily intake(ADI) value is calculated.
- **Acceptable Daily Intake is the amount of pesticides which man can regularly ingest in the daily diet without ill effects**

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- Pre-harvest Interval- this gives the time lapse which must separate the application of a pesticide from the harvesting of the crop, in order to ensure that a reside of the compound is below the upper permitted limit at harvest ( referred as **Maximum Residue Level**)
- **Maximum Residue Level** of a pesticide on a given crop is the maximum acceptable remains of that pesticide on the crop or product. It is acceptable because it has been determined not to be able to cause any harm on people when they feed on the crop

**Management of pesticide residues in agricultural crops:**

1. Ensure safe and responsible use of pesticides. This comprises application of only those pesticides which have been approved by PCBP and using them only as prescribed on the label
2. Ensure strict observation of Pre-Harvest Interval (PHI) for all pesticides
3. Use pest control products which have no MRL issue eg biologicals

**Pesticide management to ensure MRLs:**

- Manage pest resistance
- Observe of economic threshold
- Pesticide application methods
- Improved timing of pesticide application
- Reduced application rates
- Selectivity of pesticides
- Reduced selection pressure
- Introduction of new safe pesticides
- Dosage and persistence
- Selective placement

# Harmful effects of pesticides

**Problems of use of pesticides:-**

1. Pesticide residues
2. Pesticide resistance
3. Effect on the ecosystem:-

   a) on predators and parasites- the removal of predators and parasites can lead to outbreaks of pests

   b) new pests because of removal of their natural enemies

   c) Hazards to applicators, domestic animals, fish and wildlife.

   d) killing pollinators
4. Accumulation in soils, water and air

# Choice of appropriate pesticides

1. Pesticide should be effective against the target species
2. Has no side effects on humans, livestock, crop plants or beneficial and other non-target organisms
3. Selective pesticides
4. List of approved pesticides with recommendations for control of particular pests, diseases and weeds (PCBP List)
5. Cheapest and most readily available
6. Pesticides that integrate with other control measures as much as possible
7. Ease of use, safe and economically viable

# **Techniques and equipments for pesticide applica**tion

Decision to adopt insect application as a method of control will depend on:-

1. Type and level of pest infestation
2. Application equipment need to be reliable and simple in design so that it requires little maintenance
3. Ease in calibration of the spraying equipment and calculation of the spraying equipment and calculation of application rates
4. Safety aspects of the pesticide

# Selection of spraying equipment

**Factors governing the selection of application equipment:**

1. Characteristics of the area
2. Ease of use
3. Durability of equipment
4. Capital investment required
5. Availability of after-sales service
6. Operating costs of equipment
7. Speed required to treat
8. Frequency of application
9. Availability of diluent

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10. Availability of labour
11. Area requiring treatment

# Pesticide application methods

1. Hand-operated hydraulic sprayers:  eg lever-operated knapsack sprayers
2. Power-operated hydraulic sprayers eg  hand carried sprayers, tractor-mounted boom sprayers
3. Air-carrier sprayers
4. Controlled droplet application
5. Fogging
6. Dust and granular application
7. Aerial application
8. Injection and fumigation techniques

**Aerial application**:

- Prevention of disease/pest outbreaks requires rapid treatment. Treating highly populated areas rapidly is so difficult that aerial application is the only feasible method eg mosquitoes, tsetse flies locusts, quelea quelea birds, Africa bollworm
- Aerial application over an extensive area may be more advantageous, even when less devastating pest is present because of the time needed to treat with crop with ground equipment
- Disadvantages:
- 1. Higher costs
- Spray drift may be greater than with ground equipment, as droplets are released at a greater heights

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**Tractor sprayers:**

- These are mostly used where treatment is required over extensive field crop areas

**Knapsack and hand-carried sprayers:**

- Used in areas which are too small to justify tractor mounted or aerial equipment, where access is difficult, around buildings and where there is hilly or uneven terrain
- The motorised air-carrier sprayers such as knapsack mistblowers are needed ,particularly if spray has to be projected into trees or bushes

# Environmental management

**Sources of pollution and wastes**:

Some of the wastes that contribute to our environmental degradation:-

- Farm residues
- Wood ashes
- Charcoal residues
- Liquid wastes, such as sewage
- Pesticide of all uses
- Fertilizers of various compounds
- Soil sterilants
- Preservatives

**READ : EMCA Act 1999 (revised in 2007), Republic of Ken ya**

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- Agricultural activities have various impacts on people and the environment.  Excess or poor use of agrochemicals affect the environment
- Pesticides used in green houses, methyl bromide for fumigation have all negative environmental impact

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**Persistent Organic Pollutants (POPs):-**

Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. Many POPs are currently or were in the past used as pesticides. In 1995 UNEP generated a list of POPs pesticides referred as **"the dirty dozen"** and recent ones which included DDT, Dieldrin, endrin, hepatchlor, aldrin, chordane, HCB, Taxaphene

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The common characteristics of POPs are:

- Low water solubility
- High lipid solubility
- Semi-volatility
- High molecular masses

Note

- They can bioaccumulate in the fatty tissues of living organisms
- Once POPs are released to the environment, they travel long distances from their original source i.e long -range transport. They can be found all over the world affecting the atmosphere. No country is therefore safe even if they have banned POPs

**Health concerns of POPs:**

POPs exposure can cause death and illness including:

- Disruption of the endocrine, reproductive and immune systems
- Neurobehavioral disorders
- Cancers
- Diabetes

Exposure to POPs can take place through diets, environmental exposure, or accidents

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**Effects of POPs on the environment and humans:-**

- Long toxic exposures to fish, wildlife and humans have been linked to various reproductive, metabolic, neurological and behavioral abnormalities as well as immunity suppression and other life threatening problems such as cancer
- Population decreases in wildlife, increased mortality rates and reproductive problems
- Congenial malformations/birth defects
- Presence of toxic POPs in breast mil, increased incidence of cancer and changes to the human reproductive system

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**There are a number of International Conventions dealing with POPs and Pesticides:**

- **Stockholm Convention** on Persistent Organic Pollutants (POPs). Aims to reduce releases of POPs chemicals on a global basis. The convention entered into force on May 17th, 2004. Read more at http://chm.pops.int/.
- **Rotterdam Convention** on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. Aim to promote shared responsibilities in relation to importation of hazardous chemicals and contribute safe use. The Convention entered into force on 24 February 2004. Read more at http://www.pic.int/home.php?type=t&id=5&sid=16.
- **The Basel Convention** on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. It has 170 Parties and came into force in 1992. Read more at http://www.basel.int/.

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- **Convention on Long-Range Transboundary Air Pollutants (LRTAP**), Protocol on Persistent Organic Pollutants (POPs). The aim of the Convention is that Parties shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution. The aim of the protocol on POPs is to control, reduce, or eliminate discharges, emissions, and losses of persistent organic pollutants. The protocol entered into force on 23 October 2003. Read more at http://www.unece.org/env/lrtap/.
- **Globally Harmonized System (GHS) for Classification and Labelling of Chemicals**. Is a Globally Harmonized System (GHS) of Classification and Labelling of Chemicals promoting standard criteria for classifying chemicals according to their health, physical and environmental hazards. Read more at http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html.

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- **International Convention on the Control of Harmful Anti-fouling Systems on Ships**. Aim to prohibit the use of harmful organotins in anti-fouling paints. Will enter into force on 17 September 2008. Read more at http://www.imo.org/conventions/mainframe.asp?topic_id=529.

- **The Vienna Convention** for the Protection of the Ozone Layer & The Montreal Protocol on Substances that Deplete the Ozone Layer. Aims protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. Entered into force on January 1, 1989. Read more http://ozone.unep.org/.